Sapienza University of Rome

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THESIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Legality within companies and companies within legality.
Searching for new horizons
from *utopia* to *eutopia*:
the contribution of artificial intelligence

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To my family

«Handle nur nach derjenigen Maxime, durch die du zugleich wollen kannst, dass sie ein allgemeines Gesetz werde».
(Immanuel Kant, *Grundlegung zur Metaphysik der Sitten*, 1785)

«Act only according to that maxim whereby you can at the same time will that it should become a universal law».
(Immanuel Kant, *Groundwork of the Metaphysic of Morals*, 1785)

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Sintesi

La ricerca mira ad indagare la relazione tra legalità e imprese sotto una duplice prospettiva.

Da una parte, lo studio valuta come il concetto di legalità possa essere applicato all'attività di business (*legality within companies*), dall'altra, l'analisi si focalizza su come la condotta d'impresa si diriga proattivamente verso la legalità (*companies within legality*).

Il contributo più innovativo alla ricerca è rappresentato dall'impiego di una metodologia propria dell'Intelligenza Artificiale (IA): gli alberi decisionali (*decision trees*). I *decision trees* consentono di identificare automaticamente combinazioni di variabili a partire da un *dataset*, al fine di spiegare le variabili *target* secondo una prospettiva diversa, completamente nuova e non considerata da un modello finanziario già teorizzato dalla letteratura sul tema.

Questa tesi si compone di una raccolta di singoli lavori accademici, accettatati per la pubblicazione o già pubblicati in riviste scientifiche riconosciute.

Il primo capitolo presenta il *paper ""Legality rating" and "company rating" in support of culture of legality. A conceptual framework*", che fornisce un quadro concettuale della cultura della legalità e il contributo del rating di legalità e del rating d'impresa in merito. All'interno del complessivo impianto della tesi, in questo capitolo, *legality within companies* e *companies within legality* sembrerebbero riguardare l'*utopia*, cioè un "non-luogo", in considerazione del fatto che la relazione tra legalità e imprese è spiegata a livello teorico.

Di seguito, il secondo capitolo introduce il *paper "Legality rating and credit. A focus on companies in Southern Italy*", che analizza il tema di legalità e credito nel contesto imprenditoriale italiano, con un focus sul Mezzogiorno. In relazione alla struttura globale della dissertazione, questo capitolo cerca di delineare come l'*utopia* venga lentamente sostituita dall'*eutopia*, poiché emergono alcune implicazioni pratiche in merito a *legality within companies* e *companies within legality*.

Infine, il terzo capitolo propone il *paper "Company's distress and legality under the magnifying glass of artificial intelligence: the contribution of decision trees to identify best practices*", che esamina se e in che modo l'IA possa facilitare la comprensione congiunta di *distress* e legalità d'impresa. Nel complessivo impianto della ricerca, questo capitolo mostra l'applicazione dell'IA per esplorare *legality within companies* e *companies within legality*, che sancisce la transizione dall'*utopia* all'*eutopia*.

In conclusione, il percorso di ricerca si è snodato attraverso i tre capitoli illustrando, con intensità crescente, il possibile passaggio dall'*utopia* all'*eutopia*.

L'Intelligenza Artificiale, applicata per la prima volta a un *dataset* di imprese italiane in possesso del rating di legalità, al fine di comprendere contemporaneamente *distress* e legalità d'impresa, mostra l'esistenza di un "*good place*", in cui la teorizzazione di questi concetti si riflette interamente nella realtà.

Abstract

The research is aimed at investigating the relationship between legality and companies under a double perspective.

On the one hand, the study evaluates how the concept of legality can be applied within business activity (*legality within companies*). On the other hand, the analysis focuses on how business conduct is proactively run towards legality (*companies within legality*).

The most innovative contribution to the research is represented by the employment of an Artificial Intelligence (AI) methodology: decision trees (DT). DTs allow to automatically identify a combination of variables from a given dataset in order to explain the target variables according to a different perspective, completely new and not considered by a financial model already theorized by the financial literature on the topic.

This thesis consists of a collection of individual papers, accepted for publishing or already published in recognized scientific journals.

The first chapter presents the paper ""*Legality rating" and "company rating" in support of culture of legality. A conceptual framework*", which provides a conceptual framework of culture of legality as well as the contribution of "legality rating" (*rating di legalità*) and "company rating" (*rating d'impresa*) at this purpose. Within the comprehensive framework of this thesis, in this chapter, *legality within companies* and *companies within legality* appear to pertain to *utopia*, that is a "no-place", since the relationship between legality and companies is explained at theoretical level.

Then, the second chapter introduces the paper "*Legality rating and credit. A focus on companies in Southern Italy*", which analyzes the issue of legality and credit within the Italian business context, providing a focus on the Southern Italy. In relation to the overall structure of this dissertation, this chapter tries to outline how *utopia* is slowly replaced by *eutopia*, as long as some practical implications on *legality within companies* and *companies within legality* are caught up.

Lastly, the third chapter proposes the paper "*Company's distress and legality under the magnifying glass of artificial intelligence: the contribution of decision trees to identify best practices*", which examines whether and how AI may facilitate the joint comprehension of corporate distress and corporate legality. Regarding the research as a whole, this chapter shows the application of an AI methodology to explore *legality within companies* and *companies within legality* that declares the transition *from utopia to eutopia*.

In conclusion, the research path has been twisted and turned through the three chapters in order to illustrate, with crescendo intensity, the possible passage *from utopia to eutopia*.

AI methodology, applied for the first time to a dataset composed by Italian companies in possession of legality rating in order to jointly understand company's distress and legality, shows the existence of a "good place" in which the theorization of these concepts is entirely reflected in reality.

Introduction

This work represents the *summa* of my three-year PhD research path aimed at exploring the issue of legality within business context.

In this section, the theoretical framework of the research is presented. It starts with a description of the state of the art in order to illustrate the background of the individual chapters.

Then, the major research objectives are expressed in order to clarify the path that links the three chapters.

Theoretical framework

Legality identifies the state of being legal, in accordance with the law, also the observance of law, the adherence to law.

In relation to complex organization, as firms, two different companies' approaches to legality emerge, respectively, *anticorruption-based approach* and *integrity-based approach*. These approaches originate from different assumptions and produce different results. In fact, while *anticorruption-based approach* assumes the existence of corruption as starting point, so that there is no anti-corruption without corruption, instead, *integrity-based approach* does not require any logical assumptions besides integrity itself.

In order to better understand the distinguishing features of each approach, a definition of the concepts of "corruption", "anticorruption", and "integrity" appears suitable.

Corruption generates distorting effects in the optimal allocation of resources, significantly reducing economic efficiency and growth (see, for example: Mauro 1995; Ades, Di Tella 1997; Tanzi, Davoodi 1997).

In this perspective, it appears that a reflection on the semantic framework of terms is necessary.

First of all, it should be noted that considerable literature (Scott 1972; Jain 2001; Pellegrini 2011; Klitgaard 2015) has examined the definition of "corruption".

Despite the unanimous consensus identifying corruption as one of the main obstacles to economic, political and social development as well as an element that can accentuate inequalities and distort the implementation of public policies, a universal definition still not exists.

The importance of defining corruption is widely discussed in theoretical contributions (Lancaster and Montinola 1997, Philp 1997, Johnston 2001) and it is undisputed that corruption is a "social practice" put in place in a relational context, and generally, it could be interpreted as a distortion from standards of behavior (Scott 1972). In this direction, the phrase by Pellegrini (2011) is a remarkable summary of the primary aspects concerning corruption: it is "the misuse of entrusted power for private gain; it is behavior which deviates from the formal duties of a given role because of private-regarding (personal, close family, private clique) pecuniary or status gains; or violates rules against the exercise of certain types of private regarding influence".

On the other hand, "anti-corruption" does not yet seem to have found an autonomous relevance conceptual in economic and managerial studies.

Therefore, while the existence of the definition of "corruption" is undisputed, despite its multiple meanings, attention should focus on the term "anti". This prefix, from the Greek ἀντί «against», is used to indicate opposition, aversion, antagonism, aptitude to fight or prevent, especially in terms of therapeutic remedies. Therefore, this term expresses both a function of prevention and a function of contrast.

Yet, when "anti" is used together with the word "corruption", the prefix's appropriate meaning seems to be borrowed from physics: in fact, before the term "matter" it indicates a particular kind of matter that differs from the ordinary one due to some opposite properties.

Thus, it emerges that anti-corruption finds its *raison d'être* in the corruption itself, which is configured as its necessary logical and ontological requirement.

Therefore, according to *anticorruption-based approach*, since there is no "anti-corruption" without "corruption", accepting the existence of anti-corruption means implicitly admitting that corruption exists regardless of its accidental attributes and different contexts. In this perspective, anti-corruption actions aimed at combating and preventing corruption are to be interpreted as certain and obvious in contrast to an already inherently pathological scenario.

In other words, by adopting this approach it follows that one must act "well" because "evil" exists.

The same reasoning, instead, is not applicable by adopting the *integrity-based approach*. In fact, the word "integrity", from the Latin, composed of the prefix *in*, which means negation, and *tangere* "to touch", indicates something that is not touched, whole, that possesses all its elements and attributes and preserves its unity and nature (Treccani, 2019).

Integrity, in addition to expressing a concept of unity, has an autonomous ontological value, in its meaning and absolute value, regardless of the ancillary circumstances.

Therefore, integrity is in itself, it does not require logical requirements to be legitimized to exist. Therefore, taking actions on the basis of integrity means acting and doing "well" for "good", because "good" in itself exists, even in the absence of "evil".

For completeness, it should be remarked that, differently from the "anticorruption-based" approach, the assumption of the "integrity-based" approach coincides with its result. In other words, "non-integrity" does not exist.

Fig. 1: Company's approaches to legality
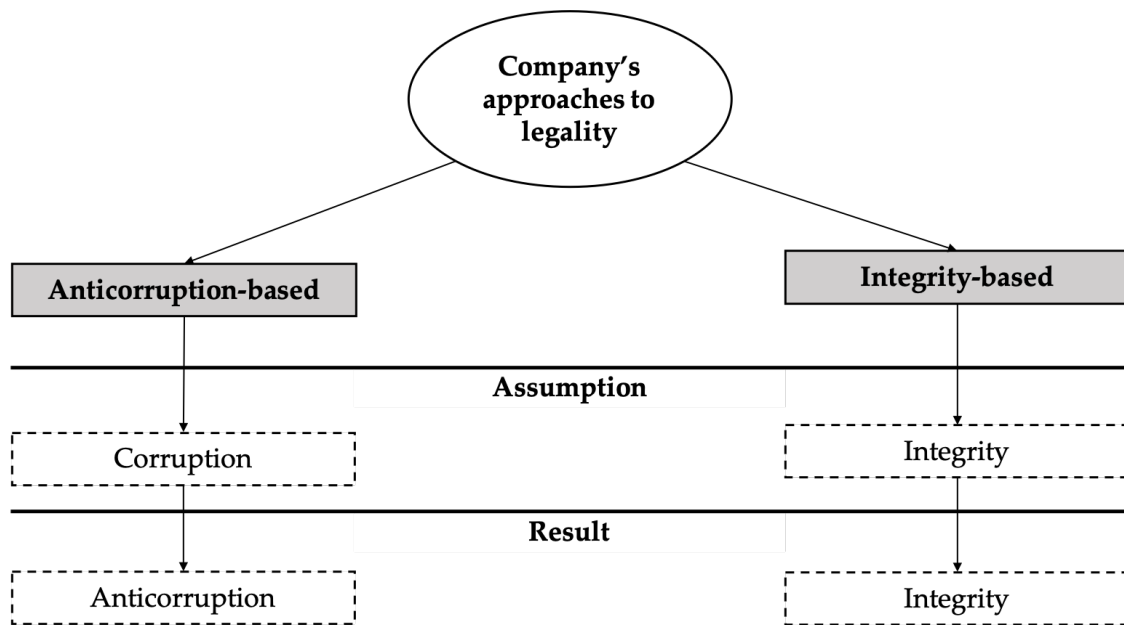
Source: author's elaboration

As illustrated in the following chapters, among the tools aimed at supporting and spreading culture of legality within a business context, there is the "legality rating" (*rating di legalità*). Starting from 20 October 2020, the new Decree implementing the Law on legality rating[1] came into force. For completeness, the references to legality rating contained in the continuation of the dissertation do not take this latest regulatory change into account.

In order to complete the theoretical framework, it is suitable to introduce the most innovative contribution to the research, based on the chief role played by *decision trees*, an Artificial Intelligence (AI) methodology.

As explained in Chapter 3, AI is used as methodological approach to represent *decision processes* according to *paths* on the *tree*'s branches or through a set of easily browsable *rules* (i.e., *decision rules* or heuristics) as explained by Witten and Frank (2011),

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[1] "*Regolamento attuativo in materia di rating di legalità*", as lastly modified by Italian Competition Authority (AGCM).

Anderson *et al.* (2015). The *decision tree* represents a useful graphical tool as it allows for intuitive understanding about a problem and can aid decision-making since it is interpretable through *if-then rules.*

People could refer to rules generated by the *decision tree* in order to take decisions since such rules are based on a short-ordered list of *features* (also known as *attributes*).

In brief, AI has been used in this research to automatically identify a combination of variables, from a given dataset, in order to explain the *target variables* according to a different perspective, completely new and not considered by a financial model already theorized by the financial literature on the topic.

Objectives

The theoretical framework depicted in the previous paragraph paves the way to the definition of the research objectives.

The research is aimed at investigating the relationship between legality and companies under a double perspective.

On the one hand, the study evaluates how the concept of legality can be applied within business activity (*legality within companies*). It means to analyze the company's compliance towards regulation because of the presence of an external imperative, represented by the Law. If the company-legality relationship exhausted here, that would mean that legality would always be perceived as an element extraneous from business activity as long as it derives from the mere obedience to dictates imposed by a third-party.

As this perspective appears incomplete, even the other side of the coin should deserve to be examined: how business conduct can be proactively run towards legality (*companies within legality*). This point of investigation, therefore, lies outside the company's behaviors featured by simple compliance and moves to the analysis of voluntary company's actions in support of legality. In this case, legality generates from

company itself and it is never imposed from the outside. It means that company's choice for legality is free and internally-pushed, based on its values' background, coherent with the overall firm's vision and aligned with the business objectives.

The perimeter of the research is illustrated in the following figure.

Fig. 2: *"Legality within companies"* and *"companies within legality"*
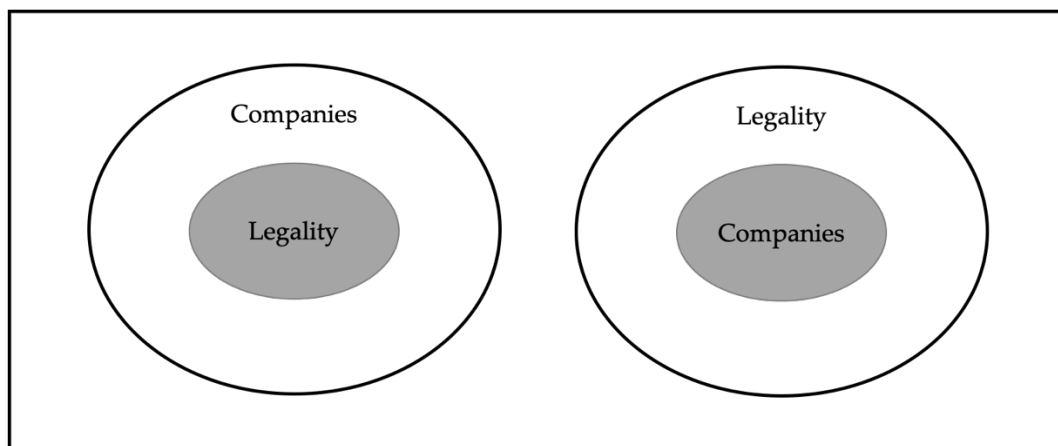
Source: author's elaboration

The perimeter of the research is composed by a "virtual space" in which *"legality within companies"* and *"companies within legality"* are included.

Basing on the assumption that reality is multiform, the consequent *modus operandi* intends to explore its multiple angulations.

As previously explained, this study is oriented towards a double perspective. Each perspective determines a plane of analysis, and each viewpoint generates multiple horizons.

For this reason, *searching for new horizons* features the whole research approach and it represents the aptitude to search for new analysis' angles.

In light of these considerations, the work is aimed at exploring the existence of new research's horizons moving *from utopia to eutopia*.

A clarification on these terms appears appropriate.

The etymology of *utopia* comes from Ancient Greek, and means "no-place" (from οὐ - "not" and τόπος - "place"). This word was coined by Sir Thomas More[2] to indicate the fictitious name of an ideal country. Literally, it means something that does not exist, a paradigm which is not reflected in reality but which is proposed as an ideal and as a model.

This neologism is featured by a basic ambiguity: *utopia*, in fact, can be understood as the Latinization from the Greek of the term εὐτοπεία, a word composed of εὖ - "good" or "well" and τόπος - "place", hence *eutopia* means "good place".

In English, the pronunciations of *utopia* and *eutopia* are identical, even if with two different meanings.

After this brief explanation, now the linkage between these words and this research is illustrated.

Given that "*legality within companies*" and "*companies within legality*" are the elements under investigation, and once introduced the aptitude for *searching for new horizons* in relation to this field, now the possible passage *from utopia to eutopia* is examined.

In particular, the application of these two concepts (*utopia* and *eutopia*) to the research framework leads to consider whether a transition from a "no-place" to a "good place" is possible.

The "no-place" is represented by a situation in which "*legality within companies*" and "*companies within legality*" are two elements completely separate, responding to a mere theorization that is not reflected in reality. It means that both how legality is applied within business activity and how business conduct is proactively run towards legality deal with a pure and simple speculation without supporting evidence. In other words, the two elements are abstract and solely conceptual in relation both to legal system and companies.

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[2] *Libellus vere aureus, nec minus salutaris quam festivus de optimo rei publicae statu, deque nova insula Utopia*, 1516.

Conversely, the "good place" is the situation in which *legality within companies* and "*companies within legality*" act together so that their theorization is entirely reflected in reality. In this case, there is a correspondence between the theorization of legality within business context and the companies' behavior in support of legality.

Within this research framework, *utopia* and *eutopia* should not be interpreted as two opposite cases, so that both legal system and companies moves in one direction or the other. They should represent, instead, a *continuum* of cases that jointly determine both the regulatory framework and companies' actions.

Last but not least, the role played by AI within the research, that is *the contribution of artificial intelligence*, is highlighted.

The study investigates in which way an AI methodology may contribute to search for new horizons of the research leading to a passage *from utopia to eutopia* in the analysis of "*legality within companies*" and "*companies within legality*".

This thesis consists of a collection of individual papers, accepted for publishing or already published in recognized scientific journals.

In light of these considerations, the work is composed by three chapters, a chapter for each paper. In order to maintain unaltered the original structure of each paper, the chapters are featured by different structures.

In particular, the first chapter presents the article ""*Legality rating" and "company rating" in support of culture of legality. A conceptual framework*", which provides a conceptual framework of culture of legality as well as the contribution of "legality rating" (*rating di legalità*) and "company rating" (*rating d'impresa*) at this purpose.

The first chapter is the author's translation in English of "*Rating di legalità e rating d'impresa a supporto della cultura della legalità. Un inquadramento concettuale*", originally written in Italian. This work has been presented at Sinergie-SIMA Management Conference 2020 "*Grand challenges: companies and universities working for a better society*" and accepted for the publication in the volume of Conference Proceedings.

The references for this work are: Buzzi I., D'Ascoli E., "*Rating di legalità e rating d'impresa a supporto della cultura della legalità. Un inquadramento concettuale*", Referred Electronic Conference Proceedings of Sinergie-SIMA Management Conference 2020, forthcoming.

Then, the second chapter introduces the paper "*Legality rating and credit. A focus on companies in Southern Italy*", which analyzes the issue of legality and credit within the Italian business context, providing a focus on the Southern Italy. This work has been presented at the Conference "*Legalità e sviluppo sostenibile. Le leve per rilanciare l'economia del Mezzogiorno*", organized by SRM (*Studi e Ricerche per il Mezzogiorno*) Intesa San Paolo. The paper has been awarded among the best papers of the prize "Premio Rassegna Economica 2018".

The references for this work are: Buzzi I., D'Ascoli E., "*Legality rating and credit. A focus on companies in Southern Italy*", Rassegna Economica – Rivista Internazionale di Economia e Territorio. Premio Rassegna Economica 2018, n. 1/2018, ISSN: 0390-010X.

Lastly, the third chapter proposes the paper "*Company's distress and legality under the magnifying glass of artificial intelligence: the contribution of decision trees to identify best practices*", which examines whether and how artificial intelligence may facilitate the joint comprehension of corporate distress and corporate legality.

The paper has been presented at the Sinergie-SIMA Management Conference 2020 "*Grand challenges: companies and universities working for a better society*" and was chosen by the Scientific Committee as selected paper to be published in Sinergie Italian Journal of Management, a peer-reviewed academic publication focusing on the main trends in management studies, ranked by: AIDEA list (rank A) and ANVUR GEV13's list (rank C).

The references for this work are: Barile S., Buzzi I., D'Avanzo E., *Company's distress and legality under the magnifying glass of artificial intelligence: the contribution of decision trees to identify best practices*, Sinergie Italian Journal of Management, forthcoming.

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Chapter 1

The chapter is the author's translation in English of "*Rating di legalità e rating d'impresa a supporto della cultura della legalità. Un inquadramento concettuale*", originally written in Italian. This work has been presented at Sinergie-SIMA Management Conference 2020 "*Grand challenges: companies and universities working for a better society*" and accepted for the publication in the volume of Conference Proceedings.

This work provides a conceptual framework of culture of legality as well as the contribution of "legality rating" (*rating di legalità*) and "company rating" (*rating d'impresa*) at this purpose.

Within the comprehensive framework of this thesis, in this chapter, *legality within companies* and *companies within legality* appear to pertain to *utopia*, that is a "no-place", since the relationship between legality and companies is explained at theoretical level.

"Legality rating" and "company rating" in support of culture of legality. A conceptual framework[3]

Objectives

This work, to be considered "work in progress" at this stage, aims to provide a conceptual framework of culture of legality, presenting its features from a sociological and organizational point of view.

A theoretical review is preliminary for the transition towards the concrete application of the culture of legality within the company, as an example of complex organization.

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[3] The references for this work are: Buzzi I., D'Ascoli E., "*Rating di legalità e rating d'impresa a supporto della cultura della legalità. Un inquadramento concettuale*", Referred Electronic Conference Proceedings of Sinergie-SIMA Management Conference 2020, forthcoming.

In particular, it was decided to investigate tools aimed at supporting and spreading culture of legality within a business context.

In this regard, this research presents the contribution of "legality rating" (*rating di legalità*) and "company rating" (*rating d'impresa*). The analysis of both ratings, also in a comparative perspective, allows identifying and evaluating potential strengths and weaknesses as well as outlining possible development scenarios.

Methodology

First of all, relevant literature on culture of legality was collected, highlighting different approaches and driving forces that influence its orientation. Furthermore, the theoretical framework supporting the social value of culture of legality was illustrated. Then, the focus is headed to the application of culture of legality within business context. For both examined tools (legality rating and company rating), references within the national legal system and the underlying regulatory framework are outlined as well as the underlying regulatory *ratio*. Furthermore, distinctive characteristics of ratings and benefits linked to their adoption are also presented, providing a comparative evaluation. In addition, the main functions of both ratings are analyzed, emphasizing their impact on company's activity.

Findings

The culture of legality originates from the awareness of gravity underlying behaviors that violate laws, which then translates into the refusal to carry them out (Montesi, 2019). This concept, therefore, has its roots into social field, which requires to consider individual behavior not for itself, but in relation to the "other", because it is able to

generate effects in sphere of others. Here, in this meaning, the ethical value of culture of legality is expressed, as ethics of responsibility and ethics of virtues.

In fact, the presence of shared values is the cradle of law: following the internalization of law, the values' sharing becomes a driving force for compliance with regulation itself.

This consideration is suitable for any social organization and any context, even the national one, often known for the "weakness of its civil antibodies"[4] (Cottarelli, 2018) and in which corruption is sometimes considered as "a sort of anthropological trait"[5] (Pagnocelli, 2014).

It is also noted that beyond criminal and disciplinary pressures, the elements expressing value, such as *esprit de corps*, widespread social capital, trust, sense of citizenship, become vehicles for the dissemination of culture of the most pervasive legality (Zatti, 2016).

This approach is also used by GRECO[6] (*GRoupe d'États contre la COrruption* - Group of States against corruption), according to which in order to fight corruption, in addition to law, a long-term perspective - based on education and well-established within the whole society - is indispensable (GRECO, 2017).

This theoretical starting point leads to consider the sanctioning apparatus provided by law as necessary but not sufficient to guarantee an entrenched legality in social systems. The guarantee of efficient sanctions can be obtained through their integration with a culture oriented towards honesty and integrity.

Two other cultural approaches are closely connected to culture of legality (Montesi, 2019): the so-called "shame culture" and the so-called "guilt culture". Cultural contrast was theorized in the first half of the twentieth century (Benedict, 1946) and then reclaimed (Dodds, 1951) to outline distinctive features respectively of Japanese and Western societies.

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[4] "*La debolezza dei suoi anticorpi civili*".

[5] "*una sorta di tratto antropologico*".

[6] GRECO is a Strasbourg-based body of European Council, established in 1999 to fight corruption. GRECO is also open to non-European states and currently has 49 members. Italy joined it in 2017.

Shame culture is typical of Japanese society and has its origin in the Homeric society. It is based on the concept according to which the human existence is legitimized only in relation to its external perception. From this, it follows that the pre-established behavioral models generate compliance with rules, so that the individual does not *a priori* develop an intrinsic sense of unworthiness nor a behavior is reprehensible in itself. The behavior, on the other hand, is deplorable because it is blamed by the community. Therefore, according to this approach, the fear of the loss of honor (τιμή) triggers the sense of shame (αἰδώς). The disappearance of social prestige is the maximum sanction: it determines a strong negative externality on "popular voice", with an extended meaning of reputation, and therefore on glory (κλέος).

The *shame culture*, therefore, is based on respect for a pre-established social scheme and it directs individual's actions towards behaviors that conform to it.

A different view governs *guilt culture*, which established itself in ancient Greece, after Homeric epic period. An authority or a moral imperative orders prohibition, so that deterrent is not public scorn, but the rules' transgression, which generates a sense of guilt. The sense of guilt is an inner movement that alters individual's relationship with society.

Therefore, unlike the *shame culture*, in the *guilt culture* the violation of a rule remains in the private sphere without generating externalities, given the absence of a critical judgment on the implemented behavior.

The antithesis between these two cultural approaches leads to the so-called "guilty-versus-shame dichotomy" (Creighton, 1990).

However, in the sociality of individual, guilt and shame are not two attributes mutually exclusive: there is a range of their combinations that moves the social being, and from this combination derives the respective culture. The elements "shame" and "guilt", each assuming "low" or "high" level, can be mapped in a 2x2 matrix, so that the resulting culture is defined as a function of their combination. Combinations placed on the secondary diagonal (gray squares) identify symmetrical combinations, in which levels of "shame" and levels of "guilt" are equivalent. Combinations of the

main diagonal, on the other hand, characterize the prevalence of a cultural element on the other.

The point marked with a cross, placed outside matrix, identifies the absolute absence of both shame and guilt. In general, the pressure for adaptation intervenes from outside matrix as an exogenous factor and pushes culture towards adaptive change.

Fig. 1: Guilt-shame matrix
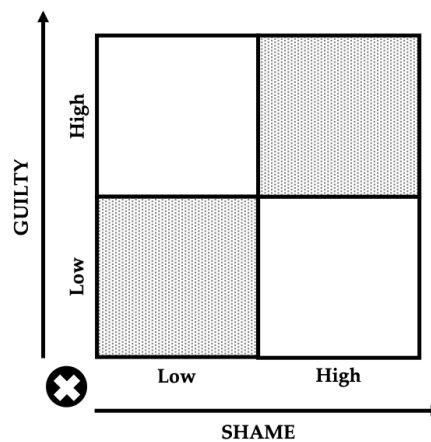
Source: re-elaborated by authors from Creighton, 1990

In light of the foregoing, the existence of three regulatory levers that can affect culture of legality is highlighted.

First of all, legal norms, direct representation of the State, are based on obedience to coercive power. This regulatory framework is based on the criterion according to which violation of rules involves activation of a penalty system and, conversely, compliance with rules is facilitated by the provision of an incentive system.

Moving to the existence of regulatory levers that reconcile guilt and shame, social and moral norms are outlined.

Social norms refer to individual's behavior in relation to external context and consist of a set of stratified traditions and habits. The violation of these rules involves public scorn and consequently generates a sense of shame, linked to the loss of social *status*.

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Finally, moral norms are related to the relationship of the individual with himself and are made up of values socially-shared and settled in the personal conscience. Therefore, transgression of these rules triggers a sense of guilt, because they represent human being's betrayal towards himself.

From the composition of these three types of norms (legal, social, and moral) originates the resulting culture of legality, the highest expression of individual in relation to community.

Fig. 2: Regulatory levers
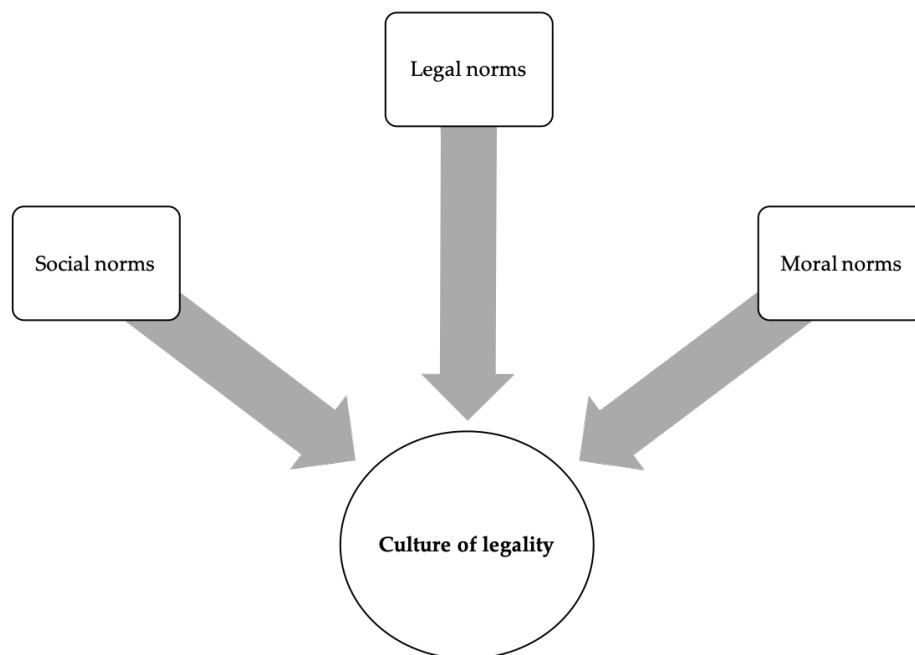
Source: re-elaborated by the authors from Montesi, 2019

In order to positively contribute to form a solid culture of legality, the three types of rules must be integrated with each other in a balanced way. In fact, if the harmonization of components fails, the so-called "inexpressive laws" (Carbonara *et al.*, 2010), which represent the opposite of expressive laws, would be produced. Laws are expressive when legal norms are consistent and well-blended with social and moral norms. When this condition lacks, legal norms translate into mere formal rules,

disjointed from the internalization of principles, so that they become inexpressive. In this case, company's values deviate from those expressed by law, which becomes totally ineffective. In this circumstance, social divisions can be triggered, since common and shared substratum that supports the institutional architecture of a given organization is lost.

Therefore, while expressive laws strengthen underlying social and moral norms, this does not happen with inexpressive laws, as they are completely disconnected from relational context. Therefore, *ceteris paribus*, the higher the degree of inexpressiveness of laws the higher the corruption (Zamagni, 2012).

Thus, these three typologies of norms, although different and distinct from an ontological and teleological point of view, are mutually indispensable to the establishment of a solid culture of legality.

In fact, the respect for law is an expression of a social value that guarantees security and imposes itself as a moral requirement even if justice in strict sense (*dike*)[7] does not coincide with the sense of justice (*dikaiosyne*) as ethical-cultural synthesis of individual (Siciliano, 2015).

This conceptual framework opens to the approach that even legal system is not a set of norms end in itself, but rather represents its derivation: it becomes a "rule beyond the rule"[8], "before the rule"[9] (Romano, 1947), in short, "a social body, having its own organization"[10] (Romano, 1953).

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[7] In order to better understand the theoretical framework, it is useful to recall the distinction from Greek origin between "*themis*" (θέμις), "*dike*" (δίκη) and "*nomos*" (νόμος) (Cosi D., 2015). While "*themis*" is the celestial law because it is based on divine institution, "*dike*" is the earthly law, product of human reason and experience, and by extension, therefore, becomes justice. "*Nomos*" represents the law codified by man, first as custom and then written law, that is, the law.

[8] "*norma oltre la norma*".

[9] "*prima della norma*".

[10] "*un ente sociale, avente una propria organizzazione*".

In light of above considerations, it surfaces a concept according to which harmonious integration of legal, social, and moral norms does not expose a community to risk of believing that living honestly is useless[11].

Therefore, a vision of a culture of legality closely linked to integrity is outlined. In fact, integrity implies that human action is motivated by the conviction of the existence of "good" even in the absence of "evil" (Buzzi, 2020).

After illustrating assumptions underlying the culture of legality and its social value, now the work wants to move from theorization to application of this concept in the context of complex organizations.

In particular, it was decided to examine some tools to promote legality within Italian private sector, evaluating their impact on organization and business activity.

Furthermore, in business context, the launch of these tools has a positive impact on company's reputation, and consequently, on reputational capital, understood as an "intangible asset that conditions market value", produces effects on the strategies of economic operators and on competitive advantage (Spirito, 2019).

Conversely, incorrect or socially-irresponsible behaviors carried out by company's members can compromise the solidity of reputation (Formisano *et al.*, 2017).

However, the promotion of legality is evolving from a purely-discretionary approach to institutionalization. In fact, while initially honesty and integrity in business activities pertained corporate best practices, now, corporate behavior is also encouraged by the introduction of codified measures.

Legislative initiatives are moving towards a not only repressive approach, but also, and above all, a preventive one, establishing enforcement mechanisms aimed at rewarding virtuous behaviors (Spirito, 2019).

In addition, it should be noted that this line of action has also been pursued by legislation against mafia infiltration throughout preventive tools at an informative, prohibitory and even reputational level (Armao, 2016).

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[11] "*La disperazione più grave che possa impadronirsi di una società civile è il dubbio che vivere onestamente sia inutile*" (Alvaro, 1961, p. 8).

Among the tools to support the culture of legality within the private sector, there are two ratings that can be used in the context of corruption prevention: legality rating and company rating.

Legality rating[12] is a synthetic indicator of compliance with high standards of legality issued by the Italian Competition Authority (AGCM). It is issued upon request by companies.

The rating system establishes the obtainment of a base score as long as the compliance with certain minimum requirements is proved. This score can be increased in the presence of compliance with any other additional requirement. Additional requirements assess, among other things, the possession of further certifications previously acquired by the company to demonstrate its orientation towards legality and sustainability. In this regard, are taken into consideration:

- compliance with procedures or legality agreements aimed at preventing and fighting infiltration of organized crime into economy, signed by the Ministry of the Interior or by the Prefectures with business and trade associations[13];

- enhancement of payment traceability tools, even for amounts lower than those set by law;

- provision and adoption of a function or organizational structure responsible for checking the compliance of company's activities with regulatory provisions applicable to company or an organizational model pursuant to Legislative Decree 231/2001;

- implementation of processes aimed at promoting forms of Corporate Social Responsibility (which also includes programs promoted by national or international organizations and acquisition of sustainability indexes);

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[12] Established in Italian legal system with Law 62/2012.

[13] These measures include the adherence to the Legality Protocol signed by the Ministry of the Interior and Confindustria on 10 May 2010. The agreement is aimed at establishing close collaboration between companies and public authorities and implementing actions in order to combat organized crime's infiltrations in the economy, through prevention tools in the field of tenders for works, services and supplies.

- registration in the so-called "white list", i.e. lists of suppliers, service providers and executors of works not subject to mafia infiltration's attempts;

- implementation of one or more of the following actions: adherence to self-regulatory ethical codes adopted by trade associations; voluntary provision of mediation clauses in contracts with customers for the resolution of disputes; adoption of protocols between consumer associations and business associations for implementation of joint conciliations.

The adoption of this type of rating, in addition to promote ethical and transparent behavior, allows companies to benefit from some advantages, such as better access to bank credit and public funding (Casadei, 2015).

Therefore, legality rating is aimed at qualifying companies towards market and supply chains (Papa, 2017). This tool allows companies to act as credible interlocutors in the relationship with different stakeholders, such as credit institutions, public administrations, customers, suppliers and subjects involved in tenders. Precisely, this connotation strengthens the company's identity (Pope, 2019). In fact, the adoption of this rating does not translate into a mere public declaration of intent by the company regarding its orientation towards legality. The provision of an official list - in which companies with legality ratings are registered - by AGCM supports decision-making processes: on the one hand, the perception of trustworthiness increases and, on the other hand, the awareness is developed by various stakeholders that interact with the company.

Conversely, company rating, not yet formalized[14], will be issued by the National Anti-Corruption Authority (ANAC) on voluntary basis. The tool is based on the so-called "past performance" of the economic operator, namely its reputational precedents, such as, for example, respect of times and costs for the execution of contracts, non-use of preliminary assistance, application of rule on mandatory reporting of extortion requests and corruption (Mongillo, Parisi, 2019).

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[14] The establishment of company rating is envisaged in implementation of the provisions of Legislative Decree 18 April 2016, n. 50 (Code of public contracts), art. 83, para. 10.

Although in original regulatory provision legality rating was a necessary requirement to obtain company rating, it should be noted that the two ratings must not be confused. In fact, while legality rating has a broad scope and is aimed at promoting honest behavior within company's context, instead, company rating applies specifically to the public procurement sector.

In particular, the new version of Public Contracts Code has clarified the coordination between the two ratings. First of all, company rating has changed from a necessary criterion to an optional criterion for the qualification of the company. Secondly, legality rating is no longer an essential condition for obtaining company rating.

In the Code, company rating discipline is settled in the section that deals with qualification, that is the action through which the players of public contracts' market tend to increase their competence.

Qualification is to be understood under a double role, negative and positive. Qualification has a "negative" connotation in the sense that company rating evaluates company's behavior in previous contracts: this provision aims to identify a minimum compliance threshold, which translates into the absence of serious ascertained deficiencies, on which basis the admission or exclusion of a subject from the tender is established.

On the other hand, qualification also has a "positive" meaning according to a rewarding point of view: in fact, for economic operators who in the past have performed public works positively or more positively than their competitors, an increase in scores of offers is established.

Therefore, company rating should be issued to companies that have demonstrated that they are able to execute contracts with a high-quality standard. From the analysis of regulatory system, it emerges that contracting authorities consider company rating in the evaluation of offer[15]. Therefore, the implicit purpose underlying the adoption of

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[15] See Code of public contracts, art. 95, para. 13.

company rating would be to raise the average quality level of companies that win public tenders.

The knowledge of the nature of both ratings allows to enhance the legislator's intent. In fact, as their adoption is not mandatory, the legal system has provided advantages to encourage companies to voluntarily subject themselves to assessment (Berloco, Correnti, 2018).

Italian legal system aims to generate social responsibility behaviors through legislative tools which, adopted on voluntary basis, determine a rewarding advantage.

Furthermore, it is noted that through provisions on legality rating and company rating, reputation has become a legal concept to be evaluated. In this regard, the explicit reference to the reputational requirements included in the regulatory framework is emphasized.

In light of the aforementioned considerations, it should be noted that both ratings are part of a complex qualification system for entities dealing with public tenders. Specifically, this system concerns: technical and professional, economic-financial and organizational[16] skills; quality certifications[17]; ethical requirements[18].

In summary, it is possible to outline some functions performed by the adoption of ratings: reputational, rewarding, ethical, informative, drive for improvement.

Ratings are reputational tools as manifestations of company's social legitimacy, that is, the recognition of its role in the society.

With regard to rewarding function, it is highlighted the impact generated by the adoption of rating on the competition.

In relation to the ethical function, it is emphasized that both ratings act in the direction of promoting ethical behavior.

Furthermore, ratings have an informative function as they promote disclosure on company's orientation towards legality.

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[16] See Code of public contracts, art. 83, para. 1 e 2.
[17] See Code of public contracts, art. 84, para. 4.
[18] See Code of public contracts, art. 80.

Finally, they constitute a tension towards continuous improvement of impacts and risk containment of the business activity.

In general, it is noted that the adoption of ratings means compliance with a standard featured by the presumption of conformity, without prejudice to the non-mandatory nature of these tools. In fact, companies are free to demonstrate substantial compliance even in different ways.

In this scenario, the role of the creation of mechanisms - that induce to operate within the framework of legality - appears crucial. In fact, the success of an organization also depends on the definition, distribution and effectiveness of the incentives' system (La Spina, 2018). Internal and external incentives push the organization towards behaviors aimed at promoting the culture of integrity, and, on the contrary, make the temptation of corruption deaf.

The adoption of ratings generates social externalities, resulting in the creation of a trust relationship between company and the different stakeholders, with particular emphasis on impacts from and to institutions and civil society.

This relationship arises from the mutual recognition of sharing a code of values and behavior, a tangible expression of culture of legality.

Research limits

The current stage of the work provides a conceptual framework for culture of legality, with specific reference to its application within the business world.

However, even outlining the main features on the subject, the discussion focuses on the evidence of two practical tools available for companies, legality rating and company rating. In detail, the work does not analyze all the particular cases envisaged by the national legal system in support of the dissemination of the culture of legality among companies.

Therefore, the study, presenting a privileged focus on two measures, is not fully exhaustive in relation to an integrated treatment of the subject.

Further future research could be oriented towards a complete recognition of the existing tools about the culture of legality in private sector, always within a theoretical speculative framework. In particular, distinctive characteristics of each tool could be illustrated and then evaluated from a comparative perspective.

This analysis would allow to test the real effectiveness of measures in relation to regulatory purposes for which they were established. This in-depth analysis, in addition to increase the literature on the subject, could be addressed to both entrepreneurs and policy-makers in order to promote the corporate integrity and the companies' fight against corruption.

On the one hand, business context could benefit from a thorough examination of solutions available for such complex organizations. This would increase knowledge of tools and strengthen awareness of the choice on the adoption of the most appropriate and tailor-made measures in relation to company objectives and business needs.

On the other hand, impetus for reflection originating from the research could support policy-maker in a complete assessment of regulatory framework, in order to test their effectiveness in an organic way and possibly act with corrective measures.

Practical implications

The evaluation of institutions on creation and dissemination of corporate culture in the field of legality allows companies to benefit from an overview of tools available in order to guide themselves in this direction.

While it is noted that legal system set up remedies to direct companies' behavior towards integrity, however the need for internal consistency and connection in the choice among the different measures that can be implemented is clearly manifested. In

fact, in order to ensure that tools are effective, it is essential, first of all, to have an in-depth knowledge of them, identifying their features and purposes.

The evaluation process allows to assess the range of existing measures and triggers the awareness on the choice among the possible options. Company will decide which tools to adopt basing on its values' background and in relation to the purposes it intends to pursue.

Therefore, a well-rooted knowledge generates for company the internalization necessary so that the tool perform its function in the best possible way.

Originality of the work

The study firstly outlines the theoretical framework related to the support culture of legality, highlighting its genesis, prominent features and socio-organizational implications.

The conceptual framework is useful to better understand gnoseological and teleological structure underlying legality. This allows to grasp distinguishing features that move cultural approach in this direction.

Then, the work moves from theory to practice, by examining in which way culture of legality can be effectively spread in the context of complex organizations, such as companies.

In this regard, an overview on tools - currently in force or soon established within the Italian legal system - on the promotion of legality in the private sector is presented.

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Chapter 2

This chapter introduces the paper "*Legality rating and credit. A focus on companies in Southern Italy*", presented at the Conference "*Legalità e sviluppo sostenibile. Le leve per rilanciare l'economia del Mezzogiorno*", organized by SRM (*Studi e Ricerche per il Mezzogiorno*) Intesa San Paolo. The paper has been awarded among the best papers of the prize "Premio Rassegna Economica 2018".

This work analyzes the issue of legality and credit within the Italian business context, providing a focus on the Southern Italy.

In relation to the overall structure of this dissertation, this chapter tries to outline how *utopia* is slowly replaced by *eutopia*, since some practical implications on *legality within companies* and *companies within legality* are caught up.

Legality rating and credit. A focus on companies in Southern Italy[19]

Abstract

The literature review highlights a gap in business-economic studies on the relationship between legality and access to credit. In fact, this issue has not yet acquired autonomous relevance in scientific research nor it has been tested at empirical level. Furthermore, the benefits of legality linked to the granting of loans to companies still seem not well quantifiable. This study aims to fill the existing gap by analyzing the issue of legality and credit within the Italian business context, providing a focus on the Southern Italy. Legality is measured by the legality rating as tool used by banks in assessing the company's creditworthiness in order to grant loans. The most innovative element of the research is represented by

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the introduction of a theoretical tool, called "legality-creditworthiness matrix", which allows to map the different levels of the two variables in order to provide indications addressed to management, banks and legislator. After providing a national overview of companies with legality rating, an in-depth analysis on the Southern-Italian companies of the is proposed, finally evaluating, in the same territory, the features of the banking exposure of solvent companies.

Introduction

The aim of the study is to examine the impact of legality on the corporate's access to credit.

So far, the literature contributions principally focused on two directions. On the one hand, the negative impact of illegality or criminality on granting of loans to businesses (Demirguc *et al.* 2005; Bonaccorsi di Patti 2009; Mazzanti, Rago 2012); on the other hand, great attention has been given to the positive impact of legality at the macroeconomic level. Legality is recognized as a driver to raise the GDP, to develop the entrepreneurial system, and to enhance the local competitiveness.

In particular, the literature review highlights a gap to the scant evidence on the relationship between legality and access to credit. So, while the negative impact of the "contrary of legality" (widely understood) on access to credit is undisputed, since it involves higher interest rates and lower access to credit, instead the benefits of legality on granting of loans to businesses are still not well quantifiable as well as this topic has not yet gained autonomous relevance in business research neither it has been tested at empirical level.

In light of these considerations, this study aims at filling the gap in business research on this issue.

At this purpose, in this research the theme of legality and access to credit is analyzed within the Italian business context, providing a special focus on the Southern Italy.

For this reason, the legality is determined by the legality rating, a tool used to measure the company's compliance with the standards of legality, introduced in the Italian legal system by the Legislative Decree n.1/2012.

Even if the legality rating is considered both by public administration, in the granting of financing, and by banks, when accessing to credit, this study focuses only on this second kind of benefit.

The evaluation of the access to credit assumes that the lower the likelihood of bankruptcy the higher the creditworthiness and by consequence, the higher the company's creditworthiness the higher the access to credit.

The most innovative element of the research is the introduction of a theoretical tool, the "legality-creditworthiness matrix", that allows to match the different degrees of both the variables (legality and creditworthiness) in order to produce conclusions for business management, banks and policy makers.

Literature review

Legality and credit

Among the main channels through which institutions influence the decisions of economic agents there are the fewer incentives to invest where the greater the probability of being expropriated of a part of the investment returns (Besley 1995, Johnson *et al.* 2002).

The bank credit is one of the sectors of the economy where the weakness of the institutional system could have a strong impact. In fact, the inefficiencies in the banking sector may have substantial repercussions on the real economy.

Criminality produces alterations in markets, reduction of competition as well as increase of the cost of money (Mazzanti, Rago 2012). In particular, the major direct

channels through which crime affects the cost of credit are: the increase in bank management costs and transparency (Bonaccorsi di Patti 2009).

In relation to the first element, banks have to use more resources in the areas with the highest crime levels. When these higher costs are transferred to local customers, the banking services in balance in the market are smaller.

Secondly, the higher the crime the more difficult the determination of the customers' quality in the absence of knowledge of the territory and local economy. In these cases, accounting information used by banks to assess the reliability of borrowers may not reflect the actual health of the company.

In presence of information asymmetries, the likelihood of rationing phenomena is higher as banks cannot incorporate the greatest risk in the interest rate.

The degree of corruption in the economic system rather than the efficiency of the legal system depresses the potential growth of businesses (Demirguc *et al.* 2005).

At this purpose, can be noticed the pivotal role of trust: this element is associated with a more advanced financial system and a wider range of financial instruments used (Guiso *et al.*, 2004).

The empirical evidence shows that criminality has an adverse effect on economic activity in general and causes fallouts through a worsening of the conditions of access to credit to businesses (Bonaccorsi di Patti 2009).

In light of these considerations, the importance of investments in forms of transparency of information that reduce the competitive disadvantage of honest companies emerges.

The literature contributions highlight the relevance of qualitative factors in credit risk assessment from banks, and that the use of qualitative variables improves the correct classification of companies, despite "the relevance of non-financial factors is mainly considered in a holistic manner" (Grunert *et al.* 2005).

In the Italian context, the legality rating is a tool in this direction.

It is a tool aimed at spreading the awareness that the reputation acquired over time with irreproachable conduct represents an intangible asset that must be increased and enhanced in relations with stakeholders (Formisano *et al.* 2017).

The legality rating

The legality rating was introduced in the Italian legal system by the Legislative Decree n.1/2012 concerning "Urgent provisions for competition, infrastructure development and competitiveness".

Recently, the Italian Competition Authority (AGCM) has delivered the "Implementation Regulation on Legality Ratings" pursuant to Article 5-ter of the aforementioned Legislative Decree, as amended by Article 1, paragraph 1-quinquies, of Decree-Law 24 March 2012, No. 29, converted, with amendments, into the law of 18 May 2012, No. 62.

The legality rating is an indicator of the compliance with the standards of legality given to the companies that have requested it.

This recognition is awarded by the Italian Competition Authority (AGCM) based on the company's declaration.

The Authority assigns the rating on the request of a party based on the methods and criteria established in a specific provision, prepared by the Authority itself, in compliance with the provisions of the law.

The Regulation n. 24075, published in the Official Journal n. 294/2012 and in the Authority Bulletin n. 49/2012, establishes the fundamental elements, the technical and operational procedures for the assignment of the rating and the subsequent maintenance: access requirements, evaluation criteria, procedural procedures, duration, renewal procedures, as well as cases of suspension and revocation.

The recipients are companies that meet the following basic requirements:

    a) operational headquarters in the national territory;

b) a minimum turnover of two million euros in the last financial year closed in the year prior to the request for rating, referring to the single company or group to which it belongs[20] and resulting from a financial statement approved and published in accordance with the law;

c) at the date of the rating request, the registration in the business register for at least two years.

The legality rating is represented by a score expressed in stars, that varies from a minimum of one star ("*") to a maximum of three stars ("***").

The parameters taken into consideration by the Authority refer both to the legal persons requesting the rating and to the natural persons belonging to them.

In relation to the legal persons, in order to obtain the legality rating the company must meet the following requirements:

- absence of convictions in relation to: offenses envisaged pursuant to Legislative Decree 231/2001; provisions of the Authority and the European Commission for serious antitrust violations, which have become unassailable or confirmed by a final judgment in the two years preceding the rating request; measures for unfair commercial practices confirmed with a final judgment in the two years preceding the rating request

- absence of declaratory findings in relation to: payment of taxes and fees and violations regarding the remuneration, social security and insurance obligations confirmed with a final judgment in the two years preceding the rating request; compliance with the provisions of law relating to the protection of health and safety in the workplace, which have become unassailable or confirmed by a final judgment in the two years preceding the rating request.

In relation to the natural persons, it is necessary that the entrepreneur and the company management have not been adopted or undertaken: personal and patrimonial prevention measures; personal and patrimonial precautionary measures;

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[20] The reference to Group turnover was explicated by a new version of the original Regulation, 24 published in Official Journal. n. 140/2014.

penal sentences of conviction; plea bargaining for tax offenses pursuant to Legislative Decree 74/2000, for offenses pursuant to Legislative Decree 231/2001, for certain crimes against the Public Administration, against property and for offenses relating to social security; criminal proceedings for mafia crimes.

In the case of collective enterprises, these requirements must be held also by the natural persons holding majority shareholding, even if relative.

The basic score (equal to "*") can be increased by one "+" for each additional requirement that the company respects.

The achievement of three "+" involves the assignment of an additional star, up to a maximum score of "***".

In particular, the basic score is increased by one "+" for each of the following conditions:

1. adherence to protocols or agreements on legality aimed at preventing and combating the infiltration of organized crime into the legal economy, signed by the Ministry of the Interior or by the Prefectures with business and trade associations;

2. use of traceability systems for payments also for sums lower than those established by law;

3. adoption of an organizational function or structure, also in outsourcing, that performs the control of compliance of the company activities with regulatory provisions applicable to the company or of an organizational model pursuant to Legislative Decree n. 231/2001;

4. adoption of processes aimed at guaranteeing forms of Corporate Social Responsibility also through the adherence to programs promoted by national or international organizations and the acquisition of sustainability indices;

5. to be registered in one of the lists of suppliers, service providers and executors of works not subject to mafia infiltration attempts established in accordance with the applicable provisions of the law (white list);

6. to have adhered to self-regulation ethical codes adopted by trade associations or to have provided, in contracts with their customers, mediation clauses, when not obligatory by law, for the resolution of disputes or to have adopted protocols between associations of consumers and business associations for the implementation of joint conciliations;

7. to have adopted organizational models for preventing and combating corruption.

The legality rating has a duration of two years from the issue and is renewable upon request.

The relevance of the legality rating is given by its consideration both by public administration, in the granting of financing, and by banks, when accessing to credit.

This study focuses, in particular, on this second kind of benefit.

At this purpose, it is important to underline that banks consider the presence of the legality rating assigned to the company in the investigation process in order to reduce the time and costs involved in granting loans.

The banks define and formalize internal procedures to regulate the use of the legality rating and its impact on the timing and costs of the investigations.

It is noteworthy that banks consider the legality rating among the variables used for the assessment of access to credit and take it into account in determining the economic conditions of disbursement, if they are relevant with respect to the performance of the credit relationship.

At national level, the evidence on this topic is produced by the Bank of Italy, that noticed that in 2016, the companies with a legality rating that requested funding were 3398. The 33% of these companies (equal to 1119 companies), gained benefits by the legality rating in terms of better economic conditions of access to credit, lower timing and costs of investigation (table 1).

Table 1: *Legality rating and access to credit*

Companies	Kind of benefit	N. of companies
Financed and benefited by the legality rating		*1119(*)*
	Reduction of investigation time	*850*
	Better economic conditions when accessing or renegotiating the loan	*623*
	Reduction of investigation costs	*396*
With legality rating that have applied for funding		**3398**

* The total exceeds the number of companies for each kind of benefit, since multiple benefits are recognized.

Source: Bank of Italy (2017)

Methodology

The analysis is based on the list of companies published by the Italian Competition Authority (AGCM), updated at 12/10/2018, whose legality rating was conferred for the first time or renewed. So, companies whose legality rating was revoked, canceled by office or is pending, are excluded from the analysis. Hereinafter, only the companies matching these requirements will be included among the companies labelled as "with legality rating".

The fiscal codes of these companies have been searched on the database Bureau van Dijk AIDA (*Analisi Informatizzata delle Aziende Italiane*) that contains comprehensive information on companies in Italy. The data extraction has produced 6080 records.

The database contains registry information, economic and financial data for each company. These data have been integrated with elaborated data to obtain information on the size-class and the creditworthiness.

The analysis on the size-class considers three parameters and defines four categories of companies: micro, small, medium and big[21] (table 2).

Table 2: Size-classes

Size-class	Parameters (at least two out of three)		
	Total Assets	Sales Revenues	Employees
Micro	≤ € 175.000	≤ € 350.000	≤ 5
Small	≤ € 4.400.000	≤ € 8.800.000	≤ 50
Medium	≤ € 20.000.000	≤ € 40.000.000	≤ 250
Big	> € 20.000.000	> € 40.000.000	> 250

Source: authors' elaboration

In order to evaluate the access to credit, the research links this dimension to the creditworthiness, basing on the assumption that the lower the likelihood of bankruptcy the higher the creditworthiness.

This assumption is based on the results of the study by Altman and Hotehkiss (2006) that classified the corporate credit rating measured by the Z-score model, equivalent to classification of the creditworthiness used by the agency Standards & Poor's.

In this study, the corporate bankruptcy prediction is measured by the Altman Z' Score (Altman 1993)[22]. This score refers to the Altman model of 1993, elaborated as adjustment of the original model of 1968 to the situation of not listed companies. Due to this feature, it has been chosen since it better fits the Italian business context.

The Z' score is identified by the following linear relationship:

$$Z' = 0,717\ X_1 + 0,847\ X_2 + 3,107\ X_3 + 0,420\ X_4 + 0,998\ X_5$$

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[21] This classification derives from the Italian Legislative Decree n. 139/2015 that distinguishes the limited companies (*società di capitali*) based on quantitative parameters. The data to calculate the size-class refer to the 2016 financial year.

[22] The choice to use the "Z' score" rather than the "Z'' adapted", adopted by Altman and Hotehkiss (2006), is motivated by the fact that this score is not suitable for the features of the companies within the sample. The data to calculate the Z' score refer to the 2016 financial year.

Where:

X1= Working Capital/ Total Assets

X2= Profit (loss) for the period/ Total Assets

X3= Earnings Before Interest and Taxes (EBIT)/ Total Assets

X4= Book Value of Equity/ Total Liabilities

X5= Sales/ Total Assets

The model identifies three zones (distress, grey, safe) depending on the values of the Z′ score (table 3). This classification has been applied to all the companies in the dataset.

Table 3: *Likelihood of bankruptcy*

| Zone	Z′ score
Distress	< 1,23
Grey	1,23 < Z′ score < 2,90
Safe	> 2,90

Source: Altman (1993)

The values of the Z′ score must be compared with the critical point, the cut off point. The cut off of the model corresponds to a score equal to 2,675. Compared to this value, companies with a higher Z′ score are classified as potentially healthy; on the contrary, companies with a Z′ score lower than this threshold are to be considered cases of possible distress. In relation to Italian territory, the companies in the dataset have been classified into four geographical areas ("North East", "North West", "Centre", "South and Insular"), according to the NUTS 1 (Nomenclature of Territorial Units for Statistics at the first level – subdivision for Groups of Regions), based on the Region of the operational headquarters. In absence of this information, the Region of the legal headquarters has been chosen. For the sake of simplicity, hereinafter the "South and Insular" area is labelled as "Southern". The first part of the analysis provides a general overview of all Italian companies in the sample, while the second part of the analysis

offers a focus on the Southern Italy. The business cluster of Southern Italy includes the companies belonging to the "Southern" area whose legality rating is not null[23]. This sample is composed by 1689 companies. The core analysis is aimed at providing a comparison between the legality rating and the creditworthiness, measured by the Altman Z' score previously cited.

To this purpose, the research suggests the introduction of a theoretical tool, called "legality-creditworthiness matrix" (figure 1), whose validity is tested in the empirical analysis. It is 7x3 matrix, whose variables are respectively the grades of legality rating (measured by the stars) and the zones of creditworthiness (measured by the Z' score). The underlying logic leads to prefer the creditworthiness to the legality rating. It means that, according to this model, higher solvency is preferred to higher degrees of legality rating. Therefore, being equal the legality rating, the safest zone is preferred.

It derives that two antithetical cases are identified: the "best" case given by the combination "***" and "safe zone"; the "worst" case given by the combination "***" and "distress zone". It can be noticed that the "best" and the "worst" cases are not diametrically opposed: while the "best" case is given by the maximum legality rating and the maximum creditworthiness, the "worst" case is given by the maximum legality rating and the minimum creditworthiness (in fact, the "worst" case is not given by the combination "*" and "distress zone"). The choice is justified by the degree of severity linked to each case: the "distress zone" being equal, it is more serious that this condition belongs to high legality rating ("***") than low legality rating ("*").

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[23] It means that the companies in this cluster have at least one star in the list provide by AGCM.

Figure 1: Legality-creditworthiness matrix
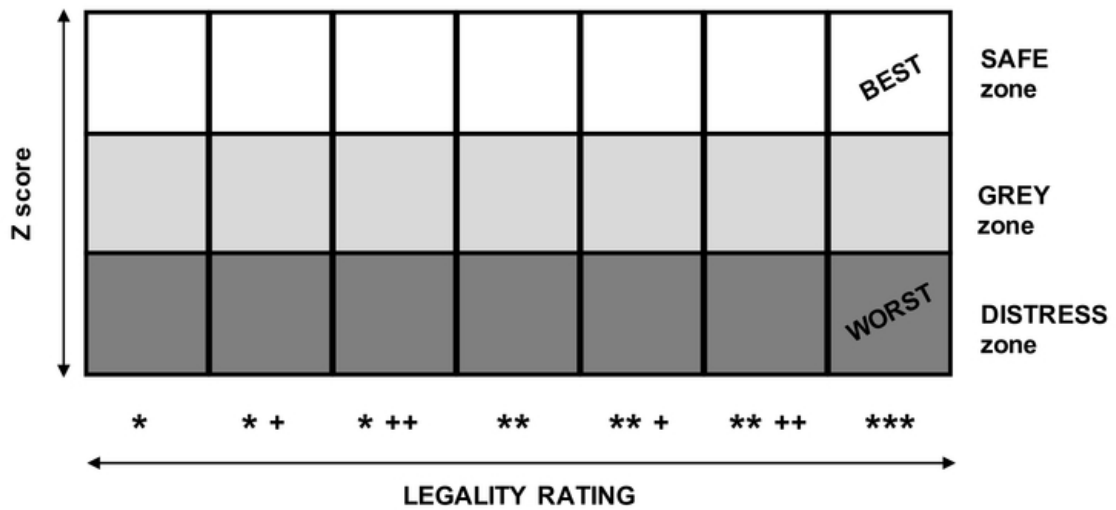
Source: authors' elaboration

Findings

In order to examine the distinctive traits of the companies with legality rating, in this part of the analysis, a comparative cross-Region overview is presented.

Firstly, at national level the geographical distribution of companies is almost equally divided among the four Groups of Regions (chart 1).

*Chart 1: Geographical distribution of companies with legality rating*
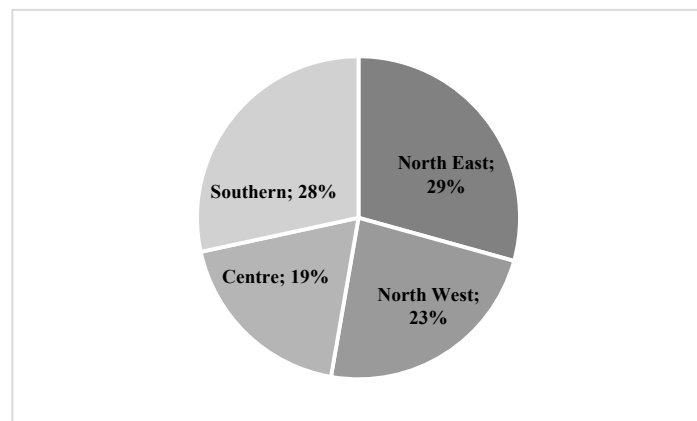
Source: authors' elaboration on dataset

In relation to the company's year of foundation, five-time intervals are defined: before 1950; between 1951 and 1970; between 1971 and 1990; between 1991 and 2010; between 2011 and 2017.

Even in this case, a common cross-Region trend emerges (chart 2): in general, few companies populate the extreme time intervals, while most of them were founded between 1991 and 2010.

Chart 2: Company's year of foundation
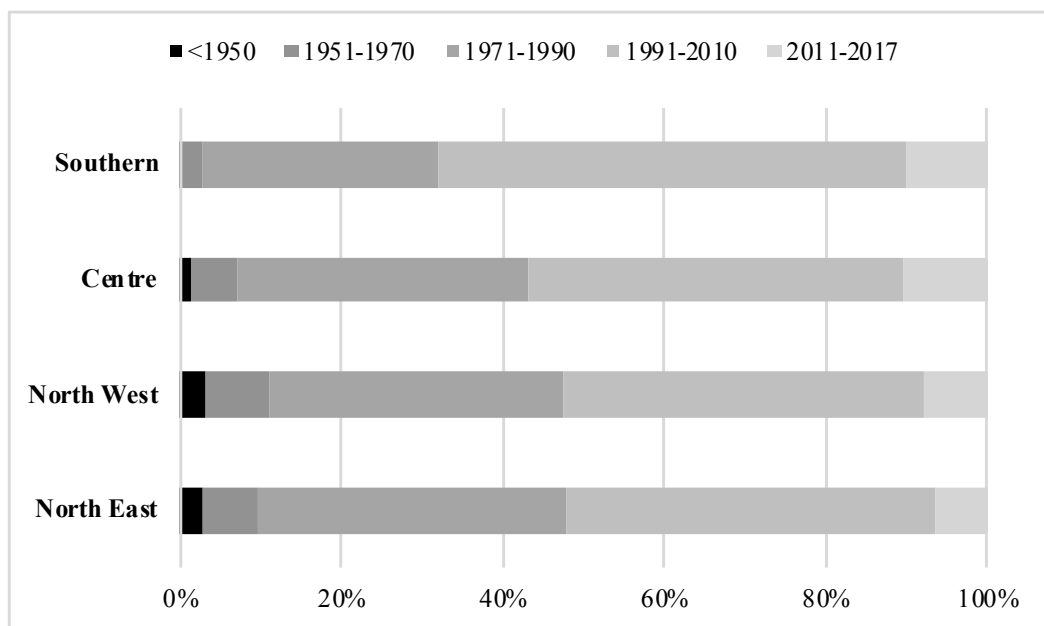
Source: authors' elaboration on dataset

After having outlined the general features of the companies with legality rating, the study analyzes the two main dimensions under investigation, respectively the legality rating and the access to credit.

The results of the distribution of the different degrees of legality rating are shown (table 4). The comparison between Italy as a whole and Southern Italy displays that the performance of this cluster is perfectly in line with the national results.

Almost the 70% of companies, have a low degree of legality rating (from "*" to "*++").

Table 4: Degrees of legality rating

Degree of legality rating	Italy (relative frequency)	Southern Italy (relative frequency)
*	10%	10%
*+	32%	32%
*++	24%	25%
**	15%	15%
**+	8%	7%
**++	5%	5%
***	6%	6%
Total	**100%**	**100%**

Source: authors' elaboration on dataset

The analysis of the creditworthiness of the companies with legality rating, and conversely, the likelihood of bankruptcy, highlights a common cross-Region trend (chart 3).

About 70% of companies stay in the "grey zone": it means that their creditworthiness has to be evaluated case by case.

Chart 3: Likelihood of bankruptcy of companies with legality rating
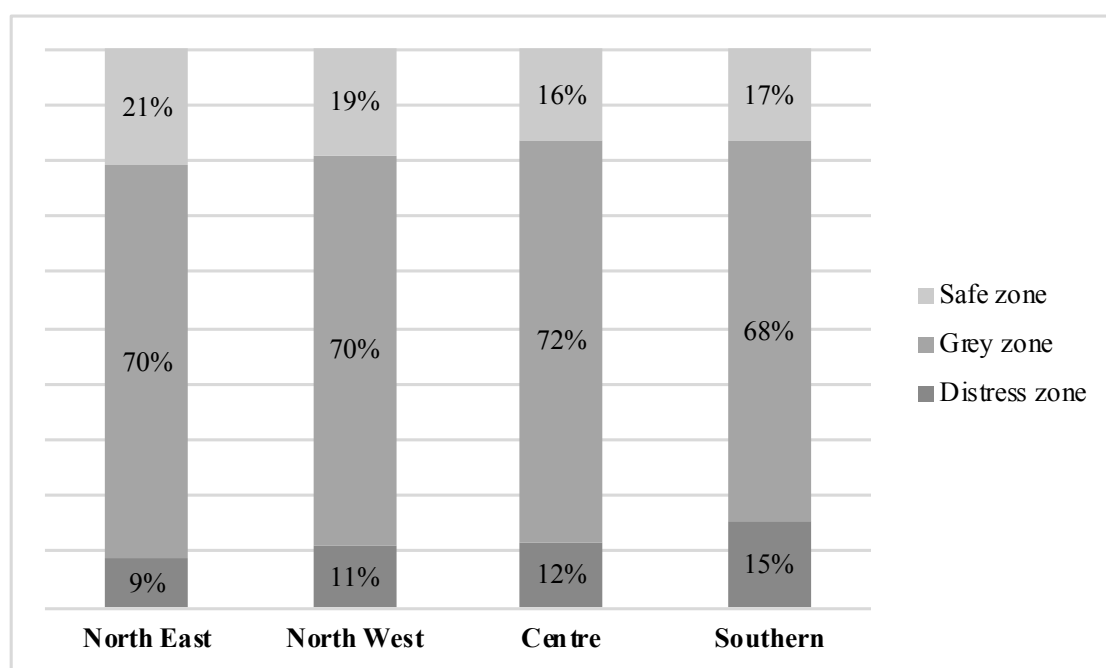
Source: authors' elaboration on dataset

The second part of the research focuses on the Southern Italy context.
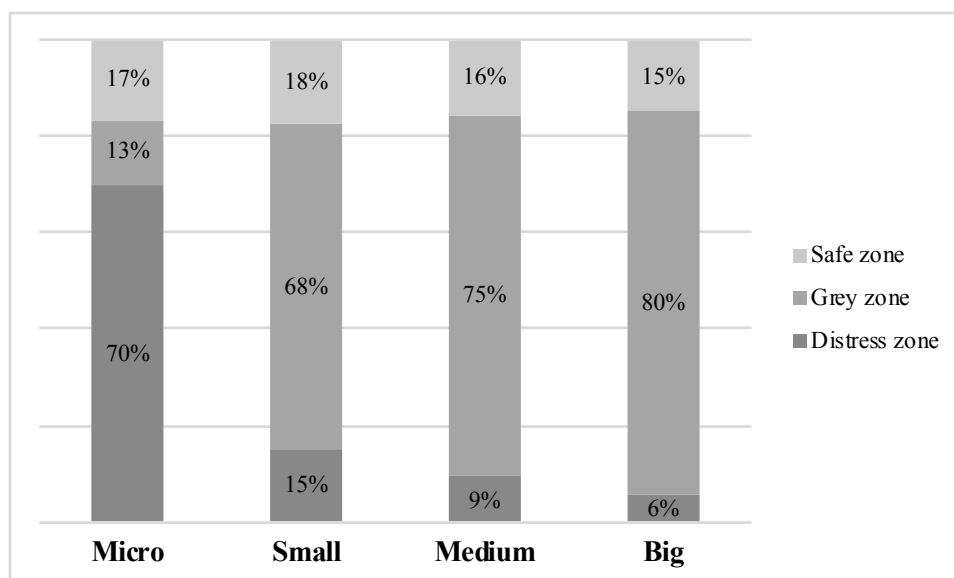
The joined analysis between size-class and likelihood of bankruptcy shows that the higher the size-class the lower the number of companies in the distress zone (chart 4).

Chart 4: Size-class and likelihood of bankruptcy in Southern Italy (companies with legality rating)

Source: authors' elaboration on dataset

In order to assess the access to credit of the companies with legality rating, and so their creditworthiness, a deepening on the Z' score in Southern Italy is necessary.

A brief descriptive statistics report of the Z' score within the sample the resulting areas of solvency are proposed (tables 5 and 6).

Table 5: *Z' score of companies with legality rating (sample of Southern Italy)*

Descriptive Statistics Report	
Mean	2,168
Median	1,916
Std. Deviation	1,483
Coefficient of variation	0,684
Range	29,689
Minimum	-2,694
Maximum	26,994
Kurtosis	85,190
Skewness	6,9213

Source: authors' elaboration on dataset

Table 6: Solvency and distress of companies with legality rating (sample of Southern Italy)

Zone	Absolute frequency	Relative frequency (%)
Distress	256	15
Grey – possible distress	1086	64
Grey – potential solvency	65	4
Safe	282	17
Total	**1689**	**100**

Source: authors' elaboration on dataset

The Z' score curve shows a leptokurtic shape (positive kurtosis) and is positively skewed.

In general, only the 15% of the companies is in the distress zone. However, it is remarkable that most of the companies are in "grey zone", and notably in the area in which the Z' score is lower than the cut off point, so that the likelihood of distress arises.

In the figure below is represented the Z' score curve of sample, with the indication of the cut off point, that separates the areas of possible distress (Z' score lower than the cut off) and potential solvency (Z' score higher than the cut off) (figure 2).

Figure 2: Z' score curve (sample of Southern Italy)
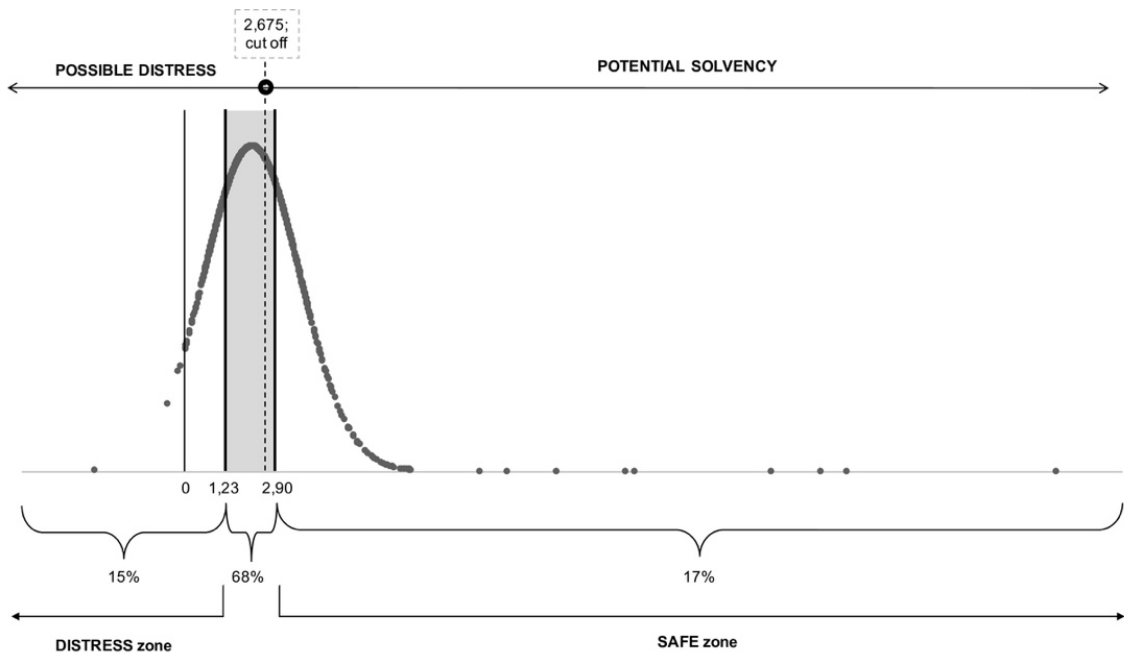
Source: authors' elaboration

The study has required to test the validity of the "legality-creditworthiness matrix", introduced in the methodology, referring to the context of Southern Italy (chart 5).

First of all, it can be observed that within the sample a positive relationship between legality rating and creditworthiness does not exist: higher degrees of legality rating are not directly linked to higher values of Z' scores.

In general, the sample is characterized by the presence of companies with low degrees of legality rating (lower than "**") (67% of the total) and with a value of Z' score between 1,23 and 2,90, equivalent to the "grey" zone in terms of likelihood of bankruptcy.

Specifically, the 40% of the companies present a situation of uncertainty in terms of creditworthiness ("grey" zone) combined with a degree of legality rating equal to "*+" or "*++".

The best and the worst cases respectively pertain to the 0,9% of the total (16 cases) and to the 1,5% of the total (25 cases).

Chart 5: Legality-creditworthiness matrix in Southern Italy
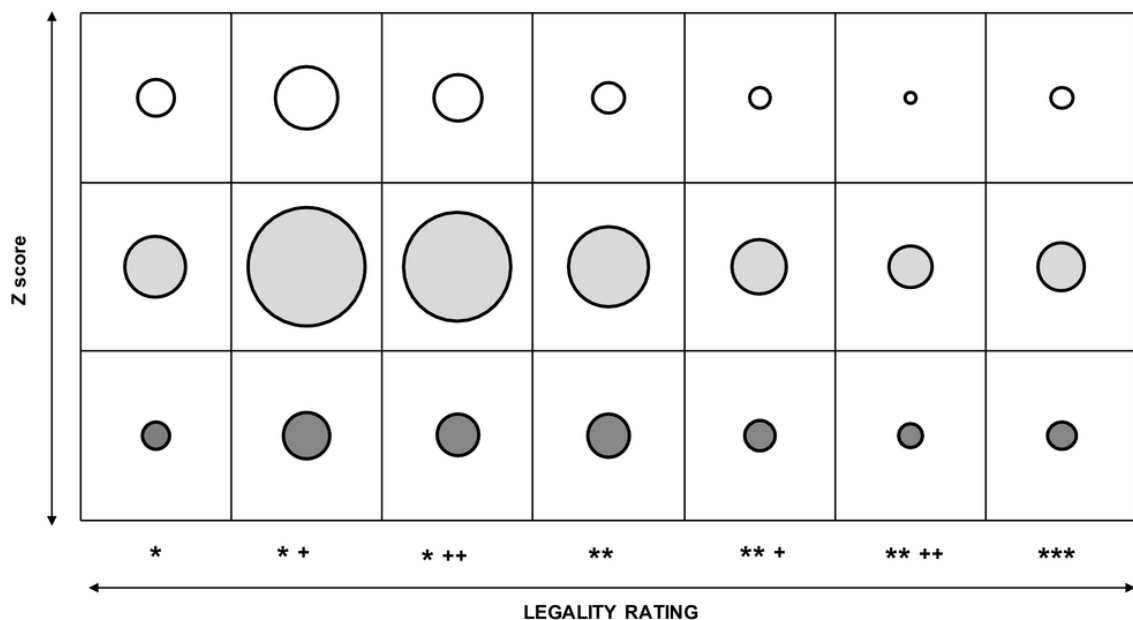
Source: authors' elaboration

The last part of the study investigates the performance of the "safe" companies (Z′ score higher than 2,90) in the Southern Italy.

This analysis assesses the trend of the average values of payables to banks[24] in the period 2012-2017 linked to each degree of legality rating (chart 6).

Chart 6: *Payables to banks for "safe" companies (sample of Southern Italy) – Average values*
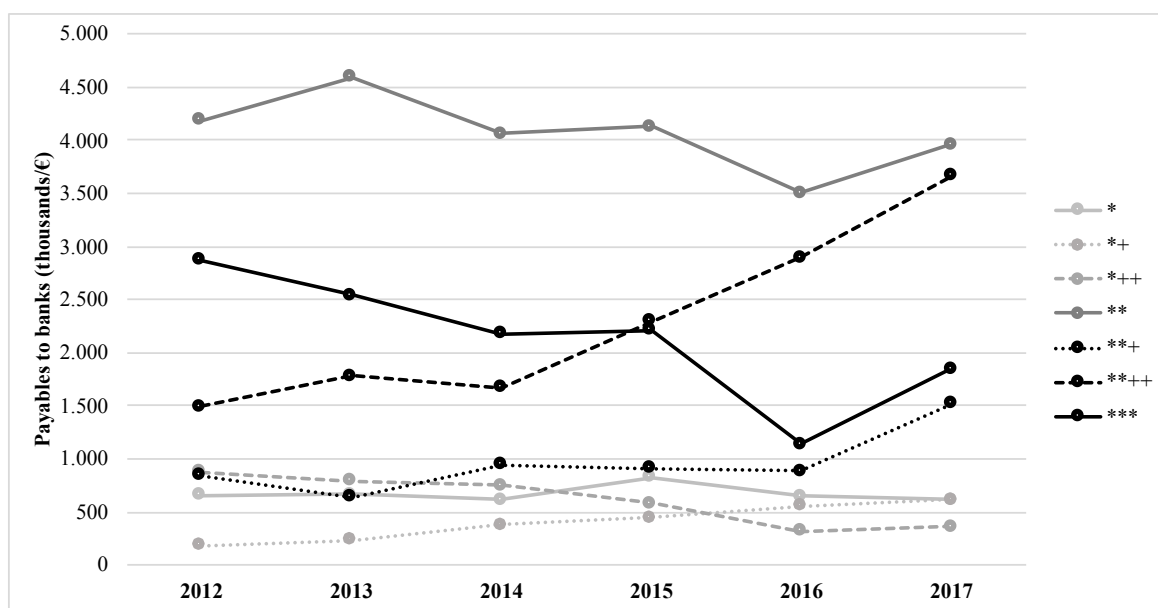
Source: authors' elaboration on dataset

The findings suggest that higher degrees of legality rating are linked to higher amounts of payables to banks, from which it emerges that the banks grant loans of greater amount to companies with higher legality rating.

In particular, between 2016 and 2017, and so starting from the year in which the legality rating was conferred for the first time or renewed, all the growth rates of the amounts of payables to banks for "safe" companies in the Southern Italy arose, except for those linked to a legality rating equal to "*" (chart 7).

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[24] The payables to banks are given by the sum of those due within and beyond the financial year.

Chart 7: Payables to banks for "safe" companies (sample of Southern Italy) - Δ 2016-2017
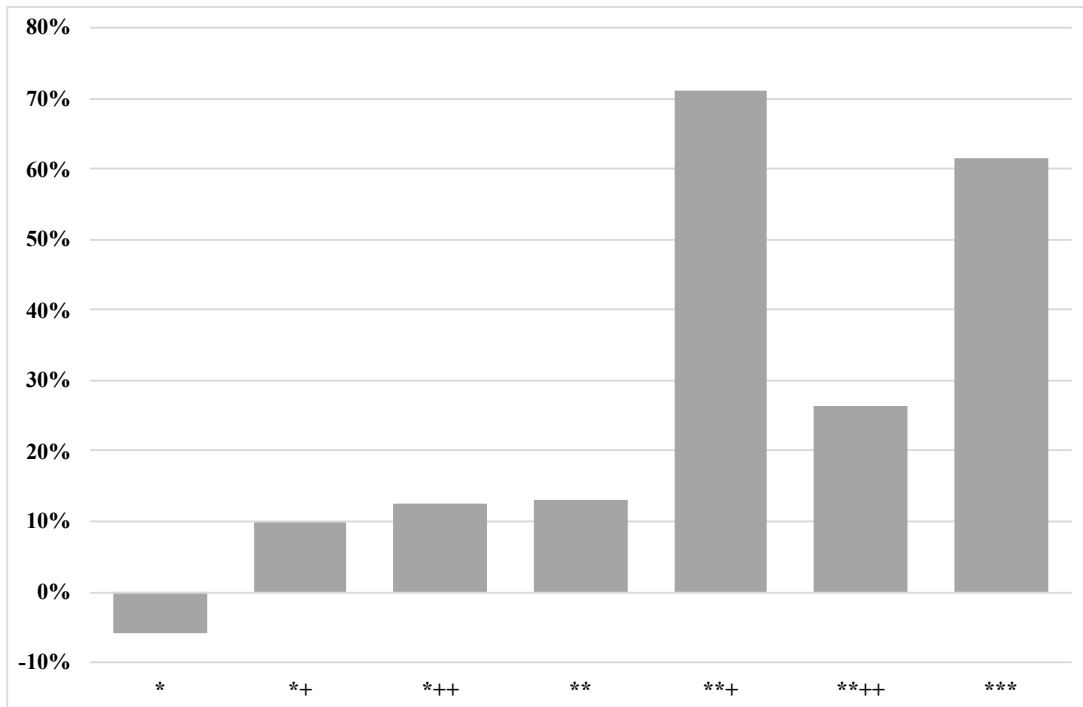
Source: authors' elaboration

Discussion and conclusion

In reference to the companies with legality rating, the analysis has been structured into three parts: the general overview of the companies at national level; a focus on the Southern Italy; the bank exposure of the "safe" companies in the Southern Italy.

At national level, common cross-Region trends emerge in relation to the geographical distribution of companies, company's year of foundation and creditworthiness.

It means that the distribution of companies is almost equally divided both among the four Groups of Regions and among the five-time intervals of foundation as well as all the Regions show the same distribution of companies across the three zones of likelihood of bankruptcy.

Furthermore, the distribution of the different degrees of legality rating noticed for the companies of Southern Italy fits the national distribution.

Matching these elements, it could be concluded that the case of Southern Italy can be considered as a good proxy of the Italian scenario.

The first point of the focus on Southern Italy examines the relationship between size-class and creditworthiness. As illustrated in the findings section, the higher the size-class the lower the number of distressed companies. In particular, it should be underlined that the micro businesses are featured by the highest percentage of distressed firms (70%).

It derives that companies could increase their size-class in order to reduce the likelihood of bankruptcy and, by consequence, improve their access to credit.

From the assessment of the Z' score within the sample of Southern Italy, a positive performance emerges, since only the 15% of companies are distressed.

However, this is just a partial result because it is significant that only the 21% of companies within the sample are featured by solvency (actual or potential), while in the remaining 79% of the cases there is a situation of distress (actual or potential).

Notably, the companies in the "grey" zone (68% of the total) are composed by a high prevalence of cases in possible distress (64% of the total) and only a short percentage in potential solvency (4% of the total).

In consideration of the relative predominance of this cluster, to which is linked an uncertainty in terms of likelihood of bankruptcy, and so theoretically unpredictable creditworthiness, it derives that the final assessment on the access to credit for these firms has to be expressed case by case.

The application of "legality-creditworthiness matrix" within the sample of Southern Italy shows the absence of a direct relationship between the two variables. In fact, as illustrated before, the distribution of companies is gathered in the central part on the left of the matrix, where the degrees of legality rating are low and the creditworthiness is uncertain.

The empirical evidence may lead to conclude that, being equal the creditworthiness, it could be useless to increase the legality rating to obtain higher access to credit.

In line with this consideration, great attention should be given to the following combinations of variables: low degrees of legality rating (from "*" to "*++") and safe zone (top left of the matrix); high degrees of legality rating (from "**+" to "***") and distress zone (bottom right of the matrix). Both of these types of firms, representing the 17% of the total, may not be motivated to improve their variable with worse values, respectively the legality rating in the first case and the creditworthiness in the second one.

This situation could outline possible inefficiencies.

The cases in the bottom right of the matrix are referred to companies that despite having a high legality rating, are clearly distressed. Even if this situation affects just a small portion of the sample (4,1% of the total), it brings out a paradox: companies with high legality standards without access to credit by banks.

Conversely, the cases in the top left of the matrix (12,8% of the total), are referred to companies that despite their elevated creditworthiness, show a low-grade legality. This situation is absolutely anomalous because these firms, already in the safe zone, could not be interested in increasing their legality rating.

Exactly for this reason, the third part of the analysis assesses the performance of the "safe" companies in Southern Italy.

The performance is measured by the average values of payables to banks across the period 2012-2017.

As exposed in the findings section, the trend analysis shows that highest amounts of loans (deriving from a higher bank exposure) are granted to companies with high legality rating. Moreover, this result is not merely valid for the last year (2016-2017), but even across the time, so well before the legality rating was conferred for the first time or renewed.

The focus on the growth rate of payables to banks during the last year (Δ 2016-2017) remarks the banks' aptitude to prefer high standards of legality, being equal the good creditworthiness.

In light of these considerations, although the awarding of legality rating is not tied to corporate's solvency requirements, the empirical analysis shows that it is *de facto* considered by banks as qualitative rating in granting loans.

Even if the best and the worst cases attempt to few companies within the sample, they could be used as starting point to develop the future research on the topic. In particular, the distinguishing features of these firms could be examined in order to assess the characteristics of "virtuous" and "bad" examples. This kind of investigation could be performed by using a case-study approach.

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Chapter 3

This chapter proposes the paper *"Company's distress and legality under the magnifying glass of artificial intelligence: the contribution of decision trees to identify best practices"*, presented at the Sinergie-SIMA Management Conference 2020 *"Grand challenges: companies and universities working for a better society"* and was chosen by the Scientific Committee as selected paper to be published in Sinergie Italian Journal of Management.

This work examines whether and how artificial intelligence may facilitate the joint comprehension of corporate distress and corporate legality.

Regarding the dissertation as a whole, this chapter shows the application of an AI methodology to explore *legality within companies* and *companies within legality* that declares the transition *from utopia to eutopia*.

Company's distress and legality under the magnifying glass of artificial intelligence: the contribution of decision trees to identify best practices[25]

Abstract

Objectives. *The aim of the study is to examine whether and how artificial intelligence (AI) may facilitate the joint comprehension of corporate distress and corporate legality. The main subjects of investigation are both represented by the valuation of company's distress and by the legality rating (LR), which is a measure of the company's degree of legality. LR's adoption*

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allows firms to benefit from some advantages when accessing to credit. For this reason, LR is related to the company's creditworthiness, and by consequence, to the company's distress.

Methodology. *The dataset is composed by companies in possession of legality rating. AI is used as methodological approach. Decision trees allow to automatically identify combination of variables from the dataset that explains the two target variables, zone of discrimination and cut off, according to a different perspective, that is not considered by Z' score.*

Findings. *AI allows to identify a new "basket" of variables, different from those employed by the Altman's Z' score, that determine the company's distress. The experiments test the "ability" of the algorithm to identify a combination of variables to predict the target. It is possible to analyze in which way these variables get along with each other in order to produce with accuracy the correct identification of the target variable.*

Research limits. *The methodology needs to be adapted determining plausible interval for the variables identified by the decision trees. The dimensionality of the dataset can benefit from resampling the variables for the proposed methodology which, at the state of the art, suffer from problems of skewness.*

Practical implications. *The AI methodology is able to process large amounts of records within a given dataset, so allowing to test the effectiveness of LR in the assessment of creditworthiness.*

Originality of the study. *The recognition and composition of the new variables can be interpreted as a tool to strengthen the comprehension of company's distress.*

Introduction

The aim of the study is to examine whether and how artificial intelligence (AI) may facilitate the joint comprehension of *distress* (Vulpiani, 2014) and *legality* within the business context.

At this purpose, the two main subjects of investigation, cited above, are represented on the one hand by the company's *degree of legality*, and on the other hand by the valuation of *company's distress*.

This inquiry employs the framework offered by the *legality rating* (*LR*), in order to measure the company's *degree of legality*. In particular, only the Italian companies in possession of *LR* compose the sample used in this investigation. For this reason, the contribution of the *LR* must be seen in the broader framework of the research introduced below.

The following of the paper shows that *LR*'s intrinsic peculiarities open up to some considerations on *distress*.

LR was introduced by the Italian legal system with the Legislative Decree n.1/2012. It measures the company's compliance, with standards of legality, along a scale of values - from "*" to "***" - in relation to the different levels of legality achieved by the company.

The current Italian regulatory framework provides that the companies, in possession of *LR*, can benefit from some advantages when accessing to credit both from public administrations and banks. Conversely, it follows that public administrations and banks evaluate the presence of *LR* when granting loans to firms, so allowing them to take advantage of favored conditions.

This perspective paves the way to the evaluation of the access to credit that, on one side, is strictly linked to the assessment of *creditworthiness*, and, on the other side, it is related to the company's *distress*, since the lower the likelihood of bankruptcy the higher the *creditworthiness*.

This study evaluates the financial performance of the Italian companies, in possession of *LR*, by examining their *distress*, according to a *bankruptcy prediction model*. Then, Altman's *Z' score* is employed as a *benchmark* to identify two *best practices*: the *zone of discrimination* and the *cut off*.

The «zone of discrimination» allows classifying the companies into three zones, in relation to the values of Z' score: *safe zone*, *grey zone*, and *distress zone*. The variable «cut off», equally basing on the values of *Z' score*, divides the companies into those belonging to the zone of *possible distress* or to the zone of *potential solvency*.

Thus, both variables derive from Altman's *Z' score*, where the former deals with certainty, since it identifies the companies with a sure and well-defined financial profile (namely, *solvent*, *insolvent*, and *to be determined*), while the latter is related to uncertainty. Notably, the *cut off* represents an explanation of uncertainty, as it allows a better understanding of the conduct of companies falling into the *grey zone*, defined by the *zone of discrimination*. In other words, the *cut off* offers a further meaning to the *actual* financial behavior, by establishing a demarcation line of the financial behavior, even if *potential*, and whenever the *zone of discrimination* is *grey*.

Then it is proposed the use of *decision trees*, a well-established artificial intelligence methodology (Quinlan, 1993; Mitchell, 1997; Witten, 2011).

With the employment of *decision trees*, it is possible to automatically identify combination of variables from the dataset (from 2 to 7, out of 101 variables) that explains the two target variables, *zone of discrimination* and *cut off*, according to a different perspective, that is not considered by *Z' score*, and that seems plausible from a technical point of view. In fact, all new variables are able to catch up different sides of the company's financial profile and so they are translatable into a model to understand the company's financial health.

Moreover, the methodology proposed allows the representation of *decision processes* according to *paths* on the *tree's* branches or through a set of easily browsable *rules* (Anderson *et al.*, 2015; Masías *et al.*, 2015).

In a nutshell, the AI methodology allows to identify a new «basket» of variables, different from those employed by the Altman's *Z' score*, that determine the distress' zones of discrimination.

Moreover, it is possible to analyze in which way these variables get along with each other in order to produce with a given *accuracy* the same result, that is the correct identification of the target variables. So, the recognition and composition of these new variables can be interpreted as a tool to strengthen the comprehension of *company's distress*.

The paper is organized as in the following. Section 2 - *Background* - reports on the *LR*, the *valuation of company's distress*, Altman's Z score, that represent our benchmark for the further analysis, and some preliminary considerations on the sample dataset employed afterwards. Section 3 - *Methodology and data* contains a detailed description of the artificial intelligence methodology employed. Section 4 - *Experiments* reports on the two experimental settings, describing, respectively, how decision tree identifies *zone of discrimination* and *cut off* targets. The final Section discuss the results and depict the conclusion.

Background

The valuation of company's distress

Despite the absence of a universal definition of *distress*, analysts usually differentiate the *financial distress* from the *operational distress* (Vulpiani, 2014). As known, whereas the former occurs when the values of equity and debt show the potential or likelihood of default, the latter is related to sporadic events (*e.g.*, economic downturn, employee turnover, and so forth) or to the direct consequence of financial distress.

Bankruptcy, in fact, is recognized as the last *threshold of distress* (Pratt S. P., 2010; Damodaran A., 2002). Financial distress is usually considered the last step before bankruptcy as it happens when it is impossible to generate revenues or income and meet or pay the financial obligations.

In order to assess the degree of severity of *business distress*, bankruptcy prediction models run as useful tools.

The bankruptcy prediction models are divided into three categories:

- accounting-ratio-based models;
- market-based models;

- hybrid models.

The *accounting-ratio-based* models work with information and data collected from the financial statements; the *market-based* models use the *debt/equity ratio* (D/E), which are specific for each company, in order to measure the distance to default on the basis of the asset volatility; finally, the *hybrid* models combine different aspects of the two previous models.

Among the *accounting-ratio-based* models fall both the Altman Z-score and the Ohlson O-score.

Altman's *Z-score*, and its subsequent variants, belongs to the *accounting-ratio-based* set of models. In the following a detailed description of Altman's *Z score* is provided since it represents the benchmark of the experimental setting of the artificial intelligence methodology proposed in this work.

The first formulation of Altman's *Z-score* dates back to 1968 (Altman, 1968) and it is expressed by the following overall *index* (Z), that is a linear combination of five variables:

$$Z = 1,2\,X_1 + 1,4\,X_2 + 3,3\,X_3 + 0,6\,X_4 + 0,999\,X_5$$

Where:

X_1= Working Capital/ Total Assets;

X_2= Retained earnings/ Total Assets;

X_3= Earnings Before Interest and Taxes (EBIT)/ Total Assets;

X_4= Market Value of Equity/ Book Value of Total Liabilities;

X_5= Sales/ Total Assets

A brief explanation of the variables is provided (Altman E., 2000).

The variable X_1, the working capital/total assets ratio, is a measure of the net liquid assets of the in relation to the total capitalization. Working capital is defined as the difference between current assets and current liabilities.

The retained earnings/total assets ratio (variable X_2), reports the total amount of reinvested earnings and/or losses of a firm over its entire life. In addition, this ratio measures the leverage of a firm: the higher the ratio the lower the use of debt, as the financing occurs through retention of profits.

A measure of the true productivity of the firm's assets is offered by the EBIT/total assets ratio (variable X_3). This evaluation is independent of any tax or leverage factors. It is useful to remember that insolvency occurs when the fair valuation of the firm's assets is lower than the total liabilities.

The market to book ratio (variable X_4) assesses the market value of equity, referred to all shares of stock, preferred and common, on the total liabilities, both current and long term. It measures the reduction of value of the firm's assets before the insolvency state (when liabilities exceed the assets).

Lastly, the variable X_5 is the capital-turnover ratio. It shows the ability of the firm's assets in generating sales and it is strictly linked to the management's capacity in dealing with competitive conditions.

In this early model, the zones of discrimination are determined by the following *Z-score* values:

Tab. 3: Zones of discrimination for Z-score

Zone	Z score
Distress	< 1,80
Grey	1,80 < Z' score < 2,99
Safe	> 2,99

Source: Altman, 1968

The values of the *Z score* must be compared with its critical point, the *cut-off point* (2,675), which divides the zone of *possible distress* from the zone of *potential solvency*. When the values of *Z score* are above the *cut-off* point, firms are considered as potentially *healthy*; while, in case of values of *Z score* below the *cut-off point*, the companies go through a possible *distress*.

This first Altman model, however, was suitable only for publicly traded firms, and so it was not applicable to not listed companies. In order to address this issue, a new *Z-score* (Z′) was set up in 1983 (Altman 1983). The main novelty of this second model pertains to the variable X_4, as originally it was based on *stock price* data: in fact, in order to catch up the features of companies with shares not traded on the stock market, the market value of equity is replaced by the book value of equity. The substitution of the book value of net worth for the market value allows to derive a discriminant function for privately held firms.

As consequence of this pivotal change, all the coefficients and their limit-scores changed, so arriving at the following formula of *Z′ score*:

$$Z' = 0{,}717\ X_1 + 0{,}847\ X_2 + 3{,}107\ X_3 + 0{,}420\ X_4 + 0{,}998\ X_5$$

Where:

X_1= Working Capital/ Total Assets;

X_2= Retained earnings / Total Assets;

X_3= Earnings Before Interest and Taxes (EBIT)/ Total Assets;

X_4= Book Value of Equity/ Total Liabilities;

X_5= Sales/ Total Assets

The aforementioned changes are reflected in the identification of new zones of discrimination:

Tab. 4: Zones of discrimination for Z′ score

Zone	Z′ score
Distress	< 1,23
Grey	1,23 < Z′ score < 2,90
Safe	> 2,90

Source: Altman, 1983

It should be noted that for the *Z' score*, the *cut-off point* remains unchanged (2,675) if compared to the previous model.

As consequence, the uncertainty zone, the so-called *grey zone*, can be better interpreted by dividing it into the zone of *possible distress* (1,23<Z' score<2,675) and the *zone of potential solvency* (2,675<Z' score<2,90).

Tab. 5: Z'-score: interpretation of the "grey" zone

Zone		Z' score
Distress		< 1,23
Grey	Possible distress	1,23 < Z' score < 2,675
	Potential solvency	2,675 < Z' score < 2,90
Safe		> 2,90

Source: authors' elaboration

However, even this second model suffered from a lack: the unsuccessful application to non-manufacturing firms. For this reason, a further revision occurred: the asset turnover (X_5) is removed in order to minimize the industry effect.

As a result, Altman's model for non-production enterprises is the following (Altman, Hartzell, Peck, 1995, p. 3):

$$Z'' = 6.56\ X_1 + 3.26\ X_2 + 6.72\ X_3 + 1.05\ X_4$$

Where:

X_1 = Working Capital/ Total Assets

X_2 = Retained earnings / Total Assets

X_3 = Earnings Before Interest and Taxes (EBIT)/ Total Assets

X_4 = Book Value of Equity/ Total Liabilities

In this third model, the zones of discrimination are so determined:

Tab. 6: Zones of discrimination for Z''-score

Zone	Z'' score
Distress	< 1,1
Grey	1,1 < Z' score < 2,60
Safe	> 2,60

Source: Altman *et al.* 1995

A summary of the different Z-score models by Altman is shown in the following table.

Tab. 7: Altman Z-score models

				Cut-off scores		
Model	Applicable to	Formula	Variables	Safe zone	Grey zone	Distress zone
Altman, 1968	Publicly traded firms	$Z = 1,2\ X_1 + 1,4\ X_2 + 3,3\ X_3 + 0,6\ X_4 + 0,999\ X_5$	X_1= *Working Capital/ Total Assets* X_2= *Retained earnings/ Total Assets* X_3= *EBIT/ Total Assets* X_4= *Market Value of Equity/ Book Value of Total Liabilities* X_5= *Sales/ Total Assets*	Z > 2.99	1.80 < Z < 2.99	Z < 1.80
Altman, 1983	Not listed firms	$Z' = 0,717\ X_1 + 0,847\ X_2 + 3,107\ X_3 + 0,420\ X_4 + 0,998\ X_5$	X_1= *Working Capital/ Total Assets* X_2= *Retained earnings/ Total Assets* X_3= *EBIT/ Total Assets* X_4= *Book Value of Equity/ Total Liabilities* X_5= *Sales/ Total Assets*	Z' > 2.90	1.23 < Z' < 2.90	Z' < 1.23
Altman et al., 1995	Non-manufacturing firms	$Z'' = 6.56\ X_1 + 3.26\ X_2 + 6.72\ X_3 + 1.05\ X_4$	X_1= *Working Capital/ Total Assets* X_2= *Retained earnings / Total Assets* X_3= *EBIT/ Total Assets* X_4= *Book Value of Equity/ Total Liabilities*	Z'' > 2.60	1.1 < Z'' < 2.60	Z'' < 1.1

Source: authors' elaboration

In this inquiry, *Z' score* is used as corporate bankruptcy prediction model, as it well adapts to private companies, which, in fact, compose the sample under investigation.

The other *accounting-ratio-based* bankruptcy prediction model is the Ohlson O-score. It dates back to 1980 (Ohlson, 1980) and, relying on an econometric approach, it is the result of a nine-factor combination. Ratios are aimed to catch up four significant factors: size, financial structure, performance and liquidity. They are coefficient-weighted and directly obtained from companies' financial statements.

The O-score is given by the following model:

O-score = - 1.32 - 0.407 o_1 + 6.03 o_2 - 1.43 o_3 + 0.08 o_4 - 2.37 o_5 - 1.83 o_6 - 0.285 o_7 - 1.72 o_8 - 0.52 o_9

Where:

o_1 = Total Assets, inflation adjusted;

o_2 = Total Liabilities/Total Assets;

o_3 = Net Working Capital/Total Assets;

o_4 = Current Liabilities/Current Assets;

o_5 = Net Income/Total Assets;

o_6 = EBITDA/Total Liabilities;

o_7 = 1 if net income was negative for the last two years, 0 otherwise;

o_8 = 1 if equity book value is negative, 0 otherwise;

$o_9 = \dfrac{Net\ Income_t - Net\ Income_{t-1}}{|Net\ Income_t| + |Net\ Income_{t-1}|}$

The formula to convert the O-score into a probability of default is:

$$Probability\ of\ Default = \frac{e^{O-score}}{1 + e^{O-score}}$$

Legality rating: general features

The legality rating (LR) is a measure of the degree of legality valid only within the Italian legal system.

It is a voluntary rating, granted on application by a party. The competent authority for its release is the Italian Competition Authority (AGCM).

Only companies that cumulatively meet the following requirements can request the rating:

- operational headquarters in Italy;
- a minimum turnover of two million euros in the last financial year closed in the year prior to the request for rating, referring to the single company or group to which it belongs and resulting from a financial statement approved and published in accordance with the law;
- at the date of the LR request, the registration in the business register for at least two years.
- compliance with the other substantive requirements by the Regulation.

The base score is "*", one star, and to obtain it, the company must comply with all the substantive legislative requirements. These basic requirements refer both to the legal persons requesting the rating and to the natural persons belonging to them, and in the case of a collective enterprises, these requirements must be held also by the natural persons holding majority shareholding, even if relative.

Basic requirements include the absence of: personal and patrimonial prevention measures; personal and patrimonial precautionary measures; penal sentences of conviction; plea bargaining for tax offenses pursuant to Legislative Decree 74/2000, for offenses pursuant to Legislative Decree 231/2001, for certain crimes against the Public Administration, against property and for offenses relating to social security; criminal proceedings for mafia crimes; convictions in relation to provisions of the Authority and the European Commission for serious antitrust violations, which have become unassailable or confirmed by a final judgment in the two years preceding the rating

request; measures for unfair commercial practices confirmed with a final judgment in the two years preceding the rating request; declaratory findings in relation to: payment of taxes and fees and violations regarding the remuneration, social security and insurance obligations confirmed with a final judgment in the two years preceding the rating request; compliance with the provisions of law relating to the protection of health and safety in the workplace, which have become unassailable or confirmed by a final judgment in the two years preceding the rating request.

The base score may be increased by a "+" for each additional requirement that the company meets. The additional requirements are:

a) the adoption of protocols or legal agreements aimed at preventing and contrasting the infiltration of organized crime into the legal economy, signed by the Ministry of the Interior or by the Prefectures with business and professional associations;

b) the use of payment tracking systems also for sums of amounts lower than those established by law;

c) the adoption of a function or organizational structure, also in outsourcing, which carries out the control of compliance of company activities with regulatory provisions applicable to the company or of an organizational model pursuant to legislative decree 8 June 2001, n. 231;

d) the adoption of processes aimed at guaranteeing forms of Corporate Social Responsibility also through adherence to programs promoted by national or international organizations and the acquisition of sustainability indexes;

e) the registration in a list of suppliers not subject to mafia infiltration attempts (white list);

f) the adoption of self-regulatory ethical codes adopted by trade associations or provision of mediation clauses in contracts with its customers, when not mandatory by law, for the resolution of disputes or adoption of protocols between associations of consumers and business associations for the implementation of joint conciliations;

g) the adoption of organizational models for the prevention and contrast of corruption.

The achievement of three "+" involves the attribution of an additional star, up to a maximum score of "***" (i.e., three stars).

Tab. 1: Legality Rating - Requirements

Purpose	Requirements
Request of LR	Cumulatively: • operational headquarters in Italy • turnover ≥ € 2 million • registration in the business register for at least two years
"*" Achievement	Compliance with the other substantive requirements
"+" Increasement	Compliance with an additional requirement
"*" Increasement	Compliance with three additional requirements

Source: authors' elaboration

The possible combinations of LR in relation to their requirements are summarized in the following table.

Tab. 2: Legality Rating scores

Rating	Requirements
*	Basic requirements
*+	Basic requirements and 1 additional requirement
*++	Basic requirements and 2 additional requirements
**	Basic requirements and 3 additional requirements
**+	Basic requirements and 4 additional requirements
**++	Basic requirements and 5 additional requirements
***	Basic requirements and 6 additional requirements

Source: authors' elaboration

LR lasts two years from issue, is renewable on request and is free of charge.

Company's distress and legality rating

LR's adoption allows firms to benefit from some advantages when accessing to credit. In fact, both the public administrations and banks, when granting loans, consider the company's *LR*.

As regards the methods by public administrations for considering the *LR* when granting loans, the possession of *LR* is translated into at least one of the following rewarding systems:

   a) preference in the ranking;

   b) attribution of additional points;

   c) share reserve of the financial resources allocated.

As regards the access to bank credit, the potential benefits recognized by banks in presence of *LR* are:

   a) reduction of the investigation time;

   b) better economic conditions when requesting or renegotiating the loan;

   c) reduction of investigation costs.

In relation to the access to bank credit, the Italian legal system establishes that Italian financial institutions should consider LR among the parameters to assess the company's creditworthiness.

In fact, Italian banks should define and formalize internal procedures to regulate the use of LR. Financial institutions take LR into account to determine the loans' conditions of disbursement when relevant with respect to the firms' economic and financial performance.

In light of these considerations, LR is related to company's creditworthiness, and by consequence, to the company's distress. In fact, the higher the creditworthiness the lower the likelihood of bankruptcy.

Methodology and data

Since LR is a measure of the degree of legality valid only within the Italian legal system, the *dataset* employed is exclusively composed by Italian companies. In particular, qualitative and quantitative information of 6.005 Italian companies have been extracted from Bureau van Dijk AIDA. All the companies under investigation are in possession of *legality rating*.

The sample includes the companies whose legality rating was conferred for the first time or renewed by the Italian Competition Authority (AGCM), updated at 12/10/2018. The list of companies is publicly available on the AGCM website.

As said above, in order to better grasp the peculiarities of the Italian business context, this research uses the Altman's *Z' Score* as corporate *bankruptcy prediction model*. This choice originates from the main intrinsic features of *Z' score*, illustrated in the previous section: it is suitable for not listed companies. This characteristic allows to fit the features of the companies within the sample.

The data to calculate the *Z' score* refer to the 2016 financial year.

The companies have been classified into four geographical areas (*North East*, *North West*, *Centre*, *South and Insular*), according to the NUTS 1 (Nomenclature of Territorial Units for Statistics at the first level - subdivision for Groups of Regions), based on the Region of the operational headquarters. In absence of this information, the Region of the legal headquarters has been chosen.

The *size-class* considers three parameters and defines four categories of companies: *micro*, *small*, *medium* and *big*[26].

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[26] This classification is borrowed from the Italian Legislative Decree n. 139/2015 that distinguishes the limited companies (*società di capitali*) based on quantitative parameters.

Tab. 7: Size-classes

| Size-class	Parameters (at least two out of three)		
	Total Assets	**Sales Revenues**	**Employees**
Micro	≤ € 175.000	≤ € 350.000	≤ 5
Small	≤ € 4.400.000	≤ € 8.800.000	≤ 50
Medium	≤ € 20.000.000	≤ € 40.000.000	≤ 250
Big	> € 20.000.000	> € 40.000.000	> 250

Source: authors' elaboration

In this study, in order to evaluate the company's distress, the Altman Z' score has been chosen. In fact, as illustrated in the section "*The valuation of company's distress*", this model is suitable for not listed firms, and due to this feature, it fits the companies within the sample.

The *cut off* corresponds to a *Z' score* equal to 2,675. Compared to this value, companies with a higher *Z' score* fall into the *potential solvency*, while companies with a lower *Z'* fall into the *possible distress*. However, it is undisputed that when *Z' score* is lower than 1,23 companies are surely in the *distress zone* and when *Z' score* is higher than 2,90 companies are surely in the *safe zone*. Consequently, the *cut-off* analysis allows to better understand the performance of companies with a *Z' score* from 1,23 and 2,90, that fall into the *grey zone*. In other terms, the *cut-off* could be interpreted as a measure of explanation of uncertainty.

In the following figure, in relation to the *Z' score* values, the joint application of the two variables under investigation (*zone of discrimination* and *cut-off*) is illustrated. For the sake of simplicity, and without referring to the sample of companies under investigation, the values of *Z' score* are represented by a Gaussian distribution.

Fig. 5: Variables zone of discrimination and cut-off
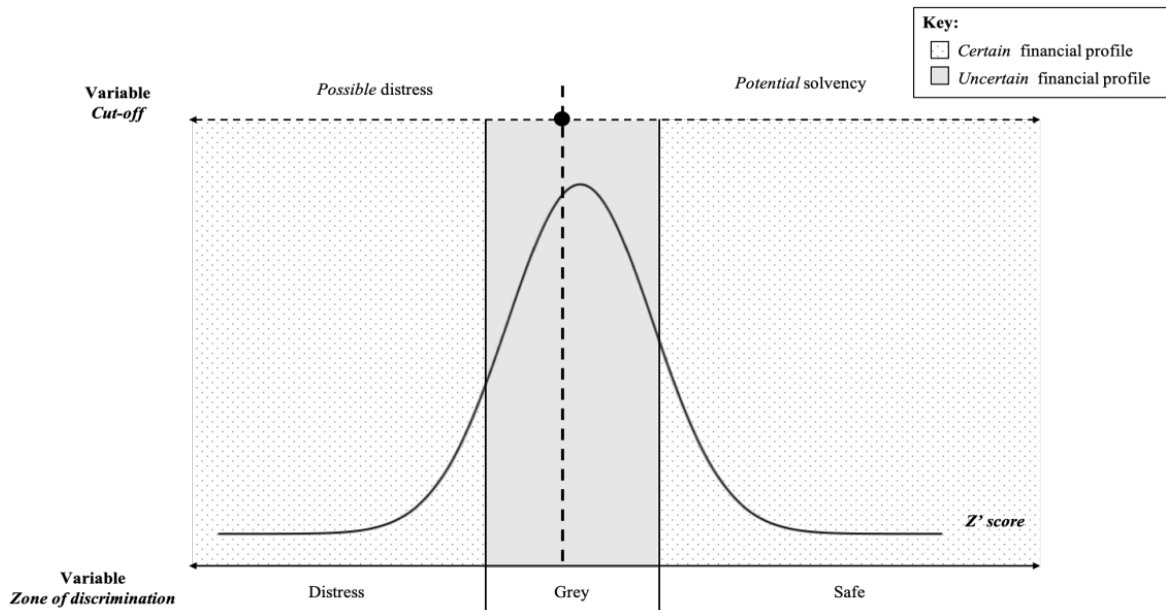
Source: authors' elaboration

After having illustrated the main features of the sample and the criteria referring to the profiling of the *zone of discrimination* and the *cut-off*, it appears suitable to highlight the key concepts related to the AI methodology used in the research.

Decision tree is a classification scheme, widely employed both to represent and run *decision processes* (Anderson et al., 2015), that generates a *tree* and a set of *rules* from a given dataset (Witten and Frank, 2011). It represents a useful graphical tool as it allows for intuitive understanding about the problem and can aid decision-making since it is interpretable through *if-then rules* by any professional, including trainees, even if she is not trained in computer applications. People could refer to rules generated by the *decision tree* in order to take decisions since such rules are based on a short-ordered list of *features* (also known as *attributes*).

Experiments introduced below, employ an implementation of *C4.5 decision tree* algorithm, developed by Quinlan (1993). *C4.5* classifies instances, i.e., companies' records, by sorting them down from the *root* to some *leaf nodes*, providing the classification of the *instances* according to the values of a given *target attribute* (e.g. *cut-*

off that can assumes two values: *possible distress* and *potential solvency*). Nodes of the *decision trees* specify tests of some features describing the instances, such as *Redditivita_del_totale_attivo_ROA_%_2016* at the root node of the decision tree in Fig. 6. Branches descending from nodes correspond to one of the possible values the attribute may assume; for instance, in the case of the *tree depicted in Figure*, the *root attribute* may assume two sets of possible values, those ≤21,54% and those > 21,54%. The same process is repeated for the sub-tree rooted at the new node. Looking at Fig. 1, after testing *Redditività* at the root node, C4.5 jumps on the right and left branches, based on the two sets of value the root feature may assume, and, if it is the case, it tests other variables (e.g., *Totale_Debiti_%_2016* on the left branch) otherwise it stops. The process is repeated until a *leaf node* is reached, where the class label is present, such as in the *tree* represented in Fig. 7 where it is corresponds to *possible distress* and *potential solvency*.

The *feature selection*, i.e., which *feature/attribute* is to be tested at each node of the tree, plays a chief role for *decision tree* construction. In the experiments introduced below, it has been employed *Information Gain* (Mitchell, 1997). *InfoGain* is strictly related to *Entropy* (Mitchell, 1997), an index of the purity of a dataset, since it just represents the expected reduction in entropy that results from the partition of the examples according to this attribute.

Experiments performed have been tested using different evaluation metrics (Fawcett, 2006). As first evaluation metric, *accuracy* has been employed. It measures how often *decision tree* makes the correct prediction, calculating the ratio between the number of *correct predictions* and the total number of predictions. *Accuracy* does not distinguish *false positive* and *false negative* cases. For such a kind of evaluation the *confusion matrix* was employed, showing a detailed breakdown of correct and incorrect classifications for each class; such type of information would otherwise be lost just looking at the *overall accuracy*.

Precision score estimates how many cases are actually needed so that the *decision tree* assigns an extraction target, while *recall* allows for determining how many cases are found to be true by the *decision tree,* out of all the cases that are true.

Empirical section

Preliminary considerations on the sample

This paragraph reports on some preliminary considerations on the *features* of the sample dataset employed.

An analysis from descriptive statistics has allowed to explore some macro aspects, such as *legality rating, zone of discrimination* and *cut off* with respect to four geographic areas.

Companies are classified for *geographic area,* and in comparison to this variable, other variables are assessed. First and foremost, the sample's geography shows an uneven composition: the number of firms belonging to the *Centre* and to the *North East,* is respectively 24% lower than the average and 16% higher than the average.

In relation to the *LR,* cross-Region trends arise: the most recurring *LR* is "*+", present in almost one third of the sample, while the higher the *LR* ("**++" or "***") the lower the diffusion within the sample (about 5%).

Moreover, in all geographic areas, the *LR* featured by "*" (and its variants - "*+" and "*++") amounts to the two thirds of the whole sample.

The relative frequency of each *LR*-class, assessed by geographic area, does not differ significantly from the average value. It derives that the four geographic areas show the same *LR's* order of distribution.
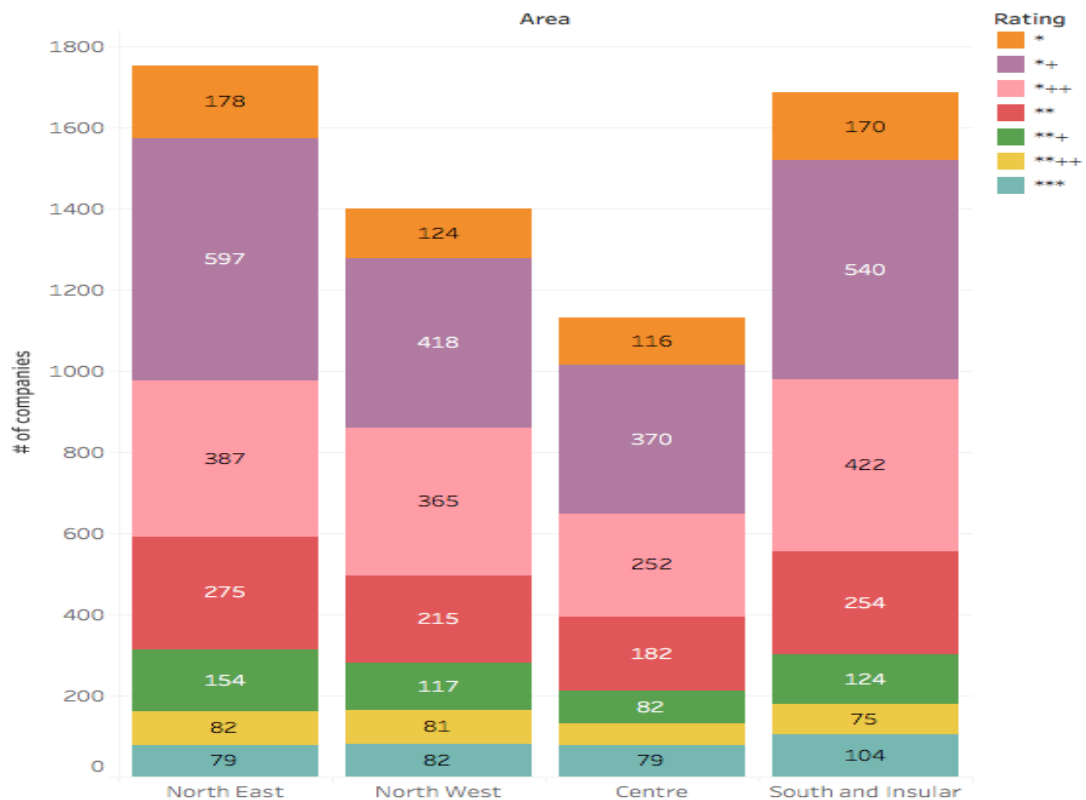
Source: authors' elaboration

Secondly, a common cross-geographical trend emerges also in relation to the *zones of discrimination* (as derived from Z' score). It means that in all four areas, there are the same percentages for each zone of discrimination: *safe zone* - around 20%; *grey zone* - around 70%; *distress zone* - around 10%. It is relevant to note that a consistent portion of the sample is composed by companies featured by an uncertain financial profile.

Moreover, the *distress zone* mainly pertains to the South (37%), while the *safe zone* is significantly present in the North East.

In the following chart, these considerations are expressed in relation to absolute frequencies.

Fig. 2: Zone of discrimination vs geographic area
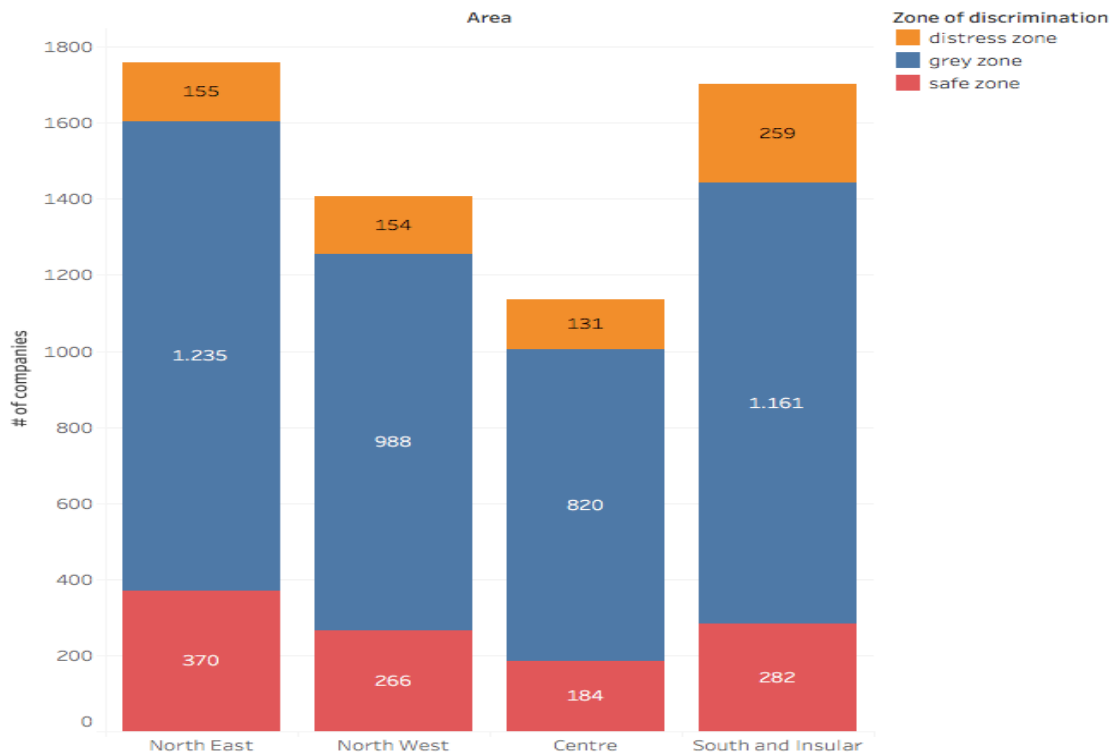
Source: authors' elaboration

An additional analysis leads to the comparison between *cut-off* and geographic area.

It is useful to remind that the *cut-off* point (Z' score equal to 2,675) allows dividing the companies featured by a *possible distress* from the companies featured by a *potential solvency*.

Regional differences emerge: while in the North East the *potential solvency* is less than one third of the *possible distress*, in the South, the *possible distress* is four times the *potential solvency*.

Furthermore, an overall analysis of the sample shows that the *possible distress* is prevailing in the South (about 30%), whereas the *potential solvency* mainly depicts the North East (34%).

Fig. 3: Cut off vs geographic area
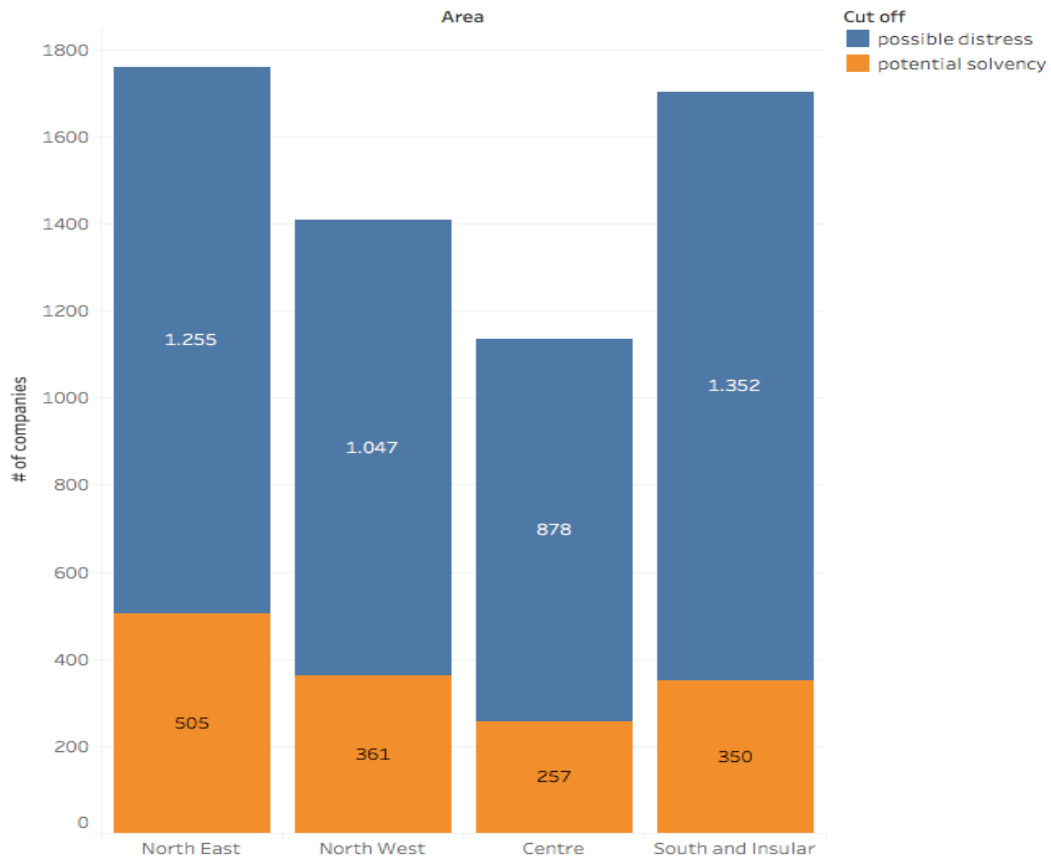
Source: authors' elaboration

Lastly, the assessment of companies' *size-class* shows the clear predominance of small companies as such typology includes approximately two thirds of the sample. Moreover, *small* and *medium* firms together compose about 90% of the sample.

Size-classes are distributed in the same order across geographic areas, namely *small*, followed by *medium*, then *big*, and lastly *micro*. Despite maintaining the same order, however, the geographical areas show a different companies' concentration in relation to the *size-classes*: *big* companies are gathered in the North West (16% of the regional total); *medium* companies are gathered in the North East (32% of the regional total); *small* and *micro* companies are gathered in the South (respectively, 65% and 2% of the regional total).

The same territorial differences are also maintained in the analysis of the deviations from the average values for each *size-class*. Compared to the total of big companies, North West and South register respectively +5% and -5% than the average for this size-class; in relation to the total of medium companies, North East and South show respectively +2% and -2% than the average for this size-class. Conversely, regarding the total of small companies, North West and South mark respectively -6% and +7% than the average for this *size-class*; lastly, for the total of micro companies, Centre and South display divergent dynamics (respectively -1% and +1% than the average for this size-class).

Fig. 4: Size-class vs geographic area
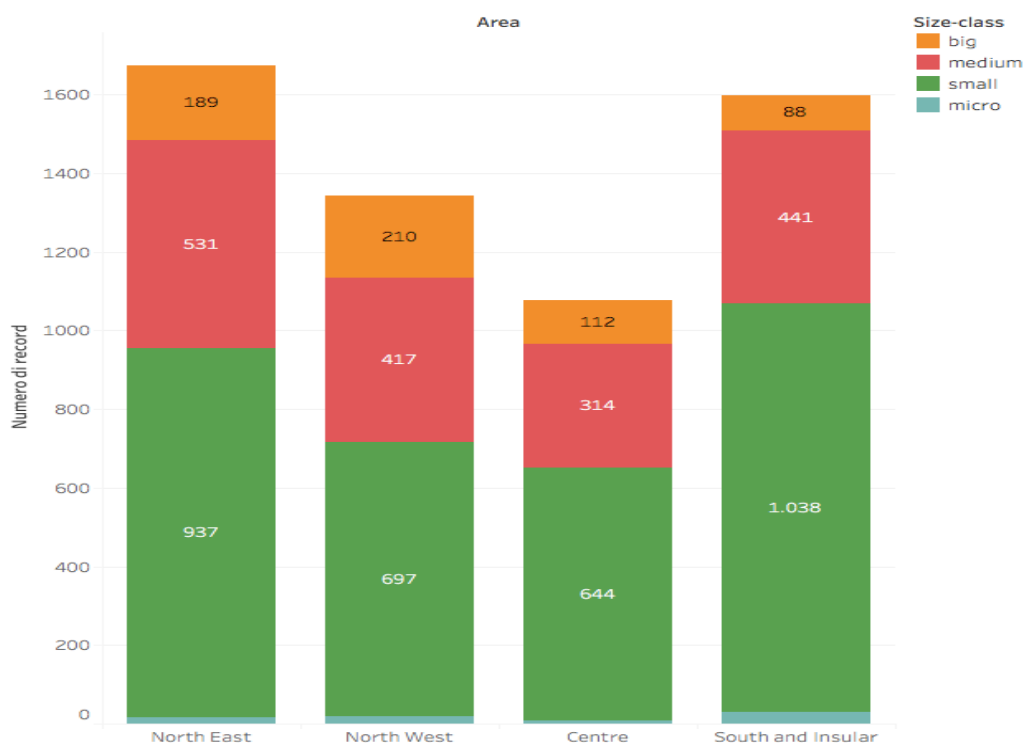
Source: authors' elaboration

The inquiry is composed by two experiments aimed at analyzing two different target variables, respectively the «zone of discrimination» (experiment 1) and «cut off» (experiment 2).

In this Section, for each experiment, the experimental setting, the *if-then* rules, the metrics, and the *decision trees* are illustrated.

The rules shown in both the experiments are those generated in the training phase and, therefore, the counts refer to this step. It may be appropriate to generate everything in the test phase so as to align with the measurement metrics.

Experiment 1

The first experiment assesses the «zone of discrimination» as target variable, whose values, in relation to Z' score, may be: *safe zone*, *grey zone*, and *distress zone.*

The goal of the experiment is to test the "ability" of the algorithm to identify a combination of variables to predict the target without considering the variables "cut off" and "z score" in the dataset.

The experimental setting for the first experiment is described in the following table.

Tab. 8: Experimental setting (experiment 1)

Number of initial records	6005
Number of records after the elimination of "NA" values	5726
Target variable	Zone of discrimination
Values of target variable	DISTRESS ZONE GREY ZONE SAFE ZONE
Features of experimental setting	The variables "cut off" and "z score" are eliminated in order to test the "ability" of the algorithm to identify a combination of variables to predict the target.
Data partition for training and testing	Training set: 4580 Test set: 1146 Total: 5726
Feature selection method	Gain ratio
Pruning method	Minimal Description Length

Source: authors' elaboration

This experiment identifies eight *if-then* rules (R), and of consequence the *best practices*, that generate the respective *decision tree*.

Before illustrating each rule and its outcome, in the following table an explanation of the financial meaning of the variables involved in the first experiment is proposed.

It should be specified that the symbol "$" in the name of the variable has to be considered as part of the syntax of the programming language at the basis of the algorithm. It is referred neither to the dollar in economic terms nor to the monetary value of the variable. The financial meaning of each variable is explained in the second column.

Tab. 9: Financial meaning of the rules (experiment 1)

Variable	Financial meaning
$Totale_Debiti_%_2016$	Total Debt % (Total Debt/Total liabilities and equity)
$Redditivita_del_totale_attivo_ROA_%_2016$	ROA (*Return On Assets*)
$RISULTATO_OPERATIVO_migl_EUR_2016$	EBIT
$Immobilizzazioni_%_2016$	Non-current assets % (Non-current assets/Total Assets)
$Ricavi_vendite_e_prestazioni_migl_EUR_2016$	Sales

Source: authors' elaboration

R1 is featured by two variables, "*$Totale_Debiti_%_2016$*" and "*$Redditivita_del_totale_attivo_ROA_%_2016$*". The outcome of the first rule is the prediction of the *safe zone*.

R2 is featured by four variables that predict the *distress zone*. The variables are: "*$RISULTATO_OPERATIVO_migl_EUR_2016$*", "*$Immobilizzazioni_%_2016$*", "*$Totale_Debiti_%_2016$*", and "*$Redditivita_del_totale_attivo_ROA_%_2016$*", that is ROA.

R3 predicts the *safe zone* thanks to five variables: "*$TOTALE_ATTIVO_migl_EUR_2016$*", "*$Redditivita_del_totale_attivo_ROA_%_2016$*", "*$RISULTATO_OPERATIVO_migl_EUR_2016$*", "*$Immobilizzazioni_%_2016$*", "*$Totale_Debiti_%_2016$*", "*$Redditivita_del_totale_attivo_ROA_%_2016$*".

Five variables ("*$Ricavi_vendite_e_prestazioni_migl_EUR_2016$*", "*$TOTALE_ATTIVO_migl_EUR_2016$*","*$Redditivita_del_totale_attivo_ROA_%_2016$*", "*$RISULTATO_OPERATIVO_migl_EUR_2016$*", "*$Immobilizzazioni_%_2016$*", "*$Totale_Debiti_%_2016$*", "*$Redditivita_del_totale_attivo_ROA_%_2016$*") feature R4, which predicts the *distress zone.*

R5 has six variables ("*$Ricavi_vendite_e_prestazioni_migl_EUR_2016$*", "*$TOTALE_ATTIVO_migl_EUR_2016$*","*$Redditivita_del_totale_attivo_ROA_%_2016$*", "*$RISULTATO_OPERATIVO_migl_EUR_2016$*", "*$Immobilizzazioni_%_2016$*", "*$Totale_Debiti_%_2016$*", and "*$Redditivita_del_totale_attivo_ROA_%_2016$*") that predict the *grey zone.*

R6 is featured by four variables "*$Redditivita_del_totale_attivo_ROA_%_2016$*", "*$RISULTATO_OPERATIVO_migl_EUR_2016$*", "*$Immobilizzazioni_%_2016$*", "*$Totale_Debiti_%_2016$*" that predict the *safe zone.*

R7 has three variables, namely "*$Immobilizzazioni_%_2016$*", "*$Totale_Debiti_%_2016$*", and "*$Redditivita_del_totale_attivo_ROA_%_2016$*", that predict the *distress zone.*

Lastly, R8 identifies one rule, "*$Redditivita_del_totale_attivo_ROA_%_2016$*", which predicts the *safe zone.*

In order to better explain the results expressed above, a brief summary of the *if-then* rules, their outcomes, the record count and the number of correct is presented in the following table.

Tab. 10: If-then rules (experiment 1)

	if-then rules (best practices)	Outcome	Record count	Number of correct
R1	**IF** $Totale\_Debiti\_\%\_2016$ <= 18.204271574863533 **AND** $Redditivita\_del\_totale\_attivo\_ROA\_\%\_2016$ <= 22.86	SAFE ZONE	112	95
R2	**IF** $RISULTATO\_OPERATIVO\_migl\_EUR\_2016$ <= -374.7615 **AND** $Immobilizzazioni\_\%\_2016$ <= 76.30784360563888 **AND** $Totale\_Debiti\_\%\_2016$ > 18.204271574863533 **AND** $Redditivita\_del\_totale\_attivo\_ROA\_\%\_2016$ <= 22.86	DISTRESS ZONE	106	71
R3	**IF** $TOTALE\_ATTIVO\_migl\_EUR\_2016$ <= 1138.336 **AND** $Redditivita\_del\_totale\_attivo\_ROA\_\%\_2016$ <= 15.934999999999999 **AND** $RISULTATO\_OPERATIVO\_migl\_EUR\_2016$ > -374.7615 **AND** $Immobilizzazioni\_\%\_2016$ <= 76.30784360563888 **AND** $Totale\_Debiti\_\%\_2016$ > 18.204271574863533 **AND** $Redditivita\_del\_totale\_attivo\_ROA\_\%\_2016$ <= 22.86	SAFE ZONE	101	65
R4	**IF** $Ricavi\_vendite\_e\_prestazioni\_migl\_EUR\_2016$ <= 1633.301 **AND** $TOTALE\_ATTIVO\_migl\_EUR\_2016$ > 1138.336 **AND** $Redditivita\_del\_totale\_attivo\_ROA\_\%\_2016$ <= 15.934999999999999 **AND** $RISULTATO\_OPERATIVO\_migl\_EUR\_2016$ > -374.7615 **AND** $Immobilizzazioni\_\%\_2016$ <= 76.30784360563888 **AND** $Totale\_Debiti\_\%\_2016$ > 18.204271574863533 **AND** $Redditivita\_del\_totale\_attivo\_ROA\_\%\_2016$ <= 22.86	DISTRESS ZONE	101	55
R5	**IF** $Ricavi\_vendite\_e\_prestazioni\_migl\_EUR\_2016$ > 1633.301 **AND** $TOTALE\_ATTIVO\_migl\_EUR\_2016$ > 1138.336 **AND** $Redditivita\_del\_totale\_attivo\_ROA\_\%\_2016$ <= 15.934999999999999 **AND** $RISULTATO\_OPERATIVO\_migl\_EUR\_2016$ > -374.7615 **AND** $Immobilizzazioni\_\%\_2016$ <= 76.30784360563888 **AND** $Totale\_Debiti\_\%\_2016$ > 18.204271574863533 **AND** $Redditivita\_del\_totale\_attivo\_ROA\_\%\_2016$ <= 22.86	GREY ZONE	3731	2997
R6	**IF** $Redditivita\_del\_totale\_attivo\_ROA\_\%\_2016$ > 15.934999999999999 **AND** $RISULTATO\_OPERATIVO\_migl\_EUR\_2016$ > -374.7615 **AND** $Immobilizzazioni\_\%\_2016$ <= 76.30784360563888 **AND** $Totale\_Debiti\_\%\_2016$ > 18.204271574863533 **AND** $Redditivita\_del\_totale\_attivo\_ROA\_\%\_2016$ <= 22.86	SAFE ZONE	202	139
R7	**IF** $Immobilizzazioni\_\%\_2016$ > 76.30784360563888 **AND** $Totale\_Debiti\_\%\_2016$ > 18.204271574863533 **AND** $Redditivita\_del\_totale\_attivo\_ROA\_\%\_2016$ <= 22.86	DISTRESS ZONE	109	82
R8	IF $Redditivita\_del\_totale\_attivo\_ROA\_\%\_2016$ > 22.86 **AND** TRUE	SAFE ZONE	118	113
Total			**4580**	**3617**

Source: authors' elaboration

In order to give a complete illustration of the first experiment, its metrics are outlined in two tables.

Tab. 11: Metrics - Part 1 (experiment 1)

Zone of discrimination	GREY ZONE	SAFE ZONE	DISTRESS ZONE
GREY ZONE	736	35	33
SAFE ZONE	115	95	1
DISTRESS ZONE	85	2	44

Source: authors' elaboration

Tab. 12: Metrics - Part 2 (experiment 1)

Correct classified	875
Wrong classified	271
Accuracy	76,353%
Error	23,65%
Cohen's Kappa	0,406

Source: authors' elaboration

The result of the first experiment is represented in the *decision tree* below.

Fig. 6: Decision tree (experiment 1)
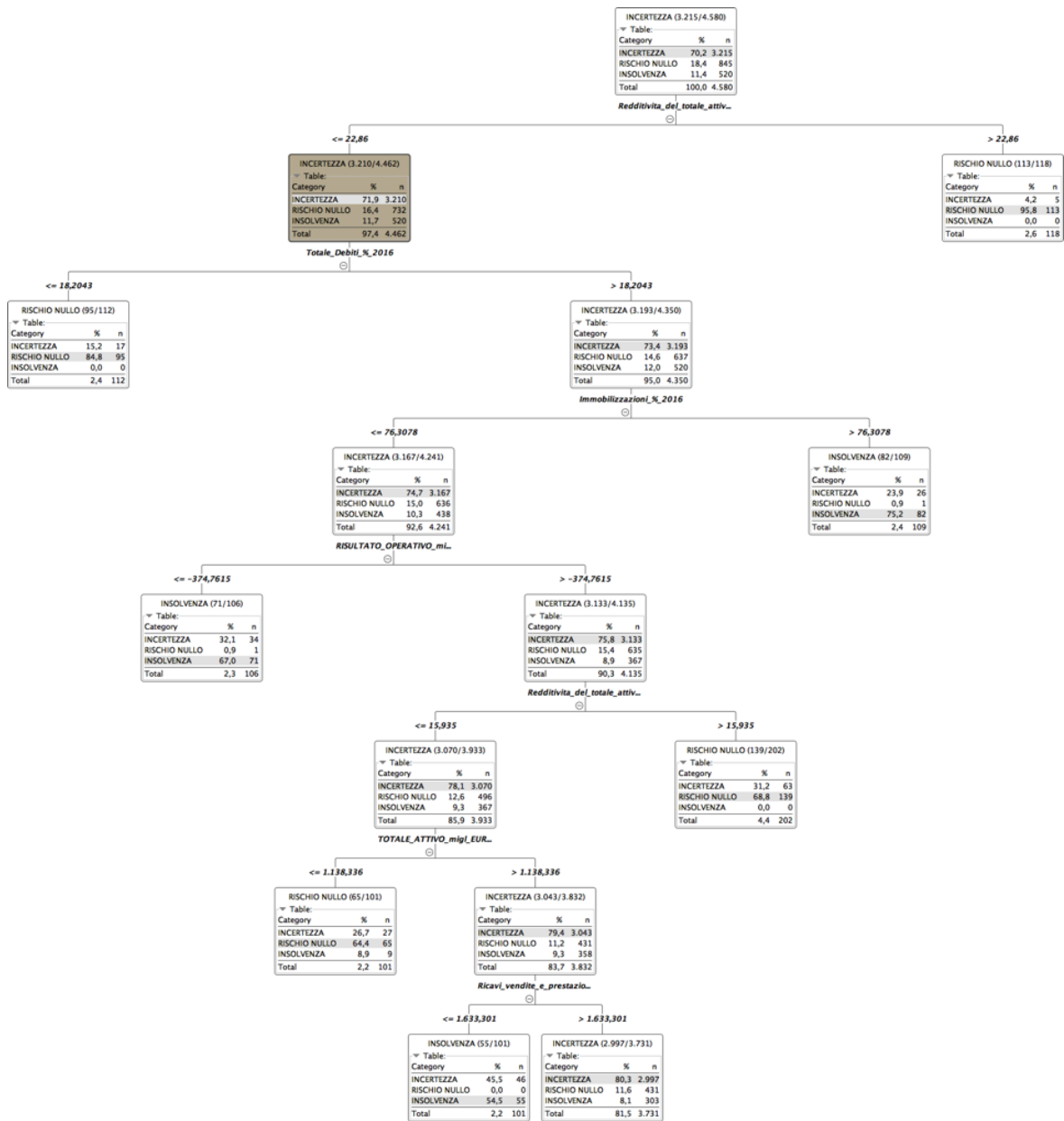
Source: authors' elaboration

Experiment 2

The second experiment assesses the «cut off» as target variable, whose values, in relation to Z' score, may be: *potential solvency*, or *possible distress.*

The goal of the experiment is to test the "ability" of the algorithm to identify a combination of variables to predict the target without considering the variables "zone of discrimination" and "z score" in the dataset.

The experimental setting for the second experiment is described in the following table.

Tab. 13: Experimental setting (experiment 2)

Number of initial records	6005
Number of records after the elimination of "NA" values	5726
Target variable	Cut off
Values of target variable	POTENTIAL SOLVENCY POSSIBLE DISTRESS
Features of experimental setting	The variables "Z score" and "Zone of discrimination" are eliminated in order to test the "ability" of the algorithm to identify a combination of variables to predict the target.
Data partition for training and testing	Training set: 4580 Test set: 1146 Total: 5726
Feature selection method	Gain ratio
Pruning method	Minimal Description Length

Source: authors' elaboration

This experiment identifies nine *if-then* rules (R), and of consequence the *best practices*, that generate the respective *decision tree*.

An explanation of the financial meaning of the variables involved in the second experiment is proposed in the following table. In relation to the use of the symbol "$" in the name of the variable, the same considerations of the previous experiment are applied.

Tab. 14: Financial meaning of the rules (experiment 2)

Variable	Financial meaning
$Totale_Debiti_%_2016$	Total Debt % (Total Debt/Total liabilities and equity)
$Redditivita_del_totale_attivo_ROA_%_2016$	ROA (*Return On Assets*)
$TOTALE_ATTIVO_migl_EUR_2016$	Total Assets
$Total_debiti_oltre_l_esercizio_migl_EUR_2016$	Total debt due beyond the financial year
$Incidenza_costo_del_lavoro_%_2016$	Personnel costs % (Personnel costs/Sales)

Source: authors' elaboration

R1 is featured by two variables, "$Totale_Debiti_%_2016$" and "$Redditivita_del_totale_attivo_ROA_%_2016$". The outcome of the first rule is the prediction of the *potential solvency*.

R2 has three variables, namely "$TOTALE_ATTIVO_migl_EUR_2016$", "$Redditivita_del_totale_attivo_ROA_%_2016$", "$Totale_Debiti_%_2016$", that predict the *potential solvency*.

R3 predicts the *potential solvency* thanks to three variables: "$Totale_Debiti_%_2016$", "$TOTALE_ATTIVO_migl_EUR_2016$", "$Redditivita_del_totale_attivo_ROA_%_2016$".

Five variables feature R4: "$Total_debiti_oltre_l_esercizio_migl_EUR_2016$", "$Incidenza_costo_del_lavoro_%_2016$","$Redditivita_del_totale_attivo_ROA_%_2016$", "$Totale_Debiti_%_2016$", "$TOTALE_ATTIVO_migl_EUR_2016$". The outcome of the fourth rule is the prediction of the *potential solvency*.

R5 has five variables that predict the *possible distress*. The variables involved are: "$Total_debiti_oltre_l_esercizio_migl_EUR_2016$","$Incidenza_costo_del_lavoro_%_2016$", "$Redditivita_del_totale_attivo_ROA_%_2016$", "$Totale_Debiti_%_2016$", and "$TOTALE_ATTIVO_migl_EUR_2016$".

R6 predicts the *possible distress*. In order to produce this outcome, four variables are involved: "$Incidenza_costo_del_lavoro_%_2016$", "$Redditivita_del_totale_attivo_ROA_%_2016$","$Totale_Debiti_%_2016$","$TOTALE_ATTIVO_migl_EUR_2016$".

R7 is featured by three variables "$Redditivita_del_totale_attivo_ROA_%_2016$", "$Totale_Debiti_%_2016$", and "$TOTALE_ATTIVO_migl_EUR_2016$". The outcome is the prediction of the *potential solvency*.

R8 has two variables, "$Redditivita_del_totale_attivo_ROA_%_2016$" and "$Totale_Debiti_%_2016$", that predict the *potential solvency*.

Lastly, R9 is featured by one variable, "$Redditivita_del_totale_attivo_ROA_%_2016$", which predicts the *potential solvency*.

In the following table, in relation to the second experiment is presented a brief summary of the *if-then* rules, their outcomes, their record count and their number of correct.

	if-then rules (best practices)	Outcome	Record count	Number of correct
R1	**IF** $Totale_Debiti_%_2016$ <= 18.196832168335906 **AND** $Redditivita_del_totale_attivo_ROA_%_2016$ <= 21.54	POTENTIAL SOLVENCY	125	116
R2	IF $TOTALE_ATTIVO_migl_EUR_2016$ <= 1241.238 **AND** $Redditivita_del_totale_attivo_ROA_%_2016$ <= 16.055 **AND** $Totale_Debiti_%_2016$ > 18.196832168335906 **AND** $Redditivita_del_totale_attivo_ROA_%_2016$ <= 21.54	POTENTIAL SOLVENCY	149	99
R3	**IF** $Totale_Debiti_%_2016$ <= 25.066864783615408 **AND** $TOTALE_ATTIVO_migl_EUR_2016$ > 1241.238 **AND** $Redditivita_del_totale_attivo_ROA_%_2016$ <= 16.055 **AND** $Totale_Debiti_%_2016$ > 18.196832168335906 **AND** $Redditivita_del_totale_attivo_ROA_%_2016$ <= 21.54	POTENTIAL SOLVENCY	101	63
R4	**IF** $Total_debiti_oltre_l_esercizio_migl_EUR_2016$ <= 318.2925 **AND** $Incidenza_costo_del_lavoro_%_2016$ <= 4.276964813170087 **AND** $Redditivita_del_totale_attivo_ROA_%_2016$ <= 13.614999999999998 **AND** $Totale_Debiti_%_2016$ > 25.066864783615408 AND $TOTALE_ATTIVO_migl_EUR_2016$ > 1241.238 **AND** $Redditivita_del_totale_attivo_ROA_%_2016$ <= 16.055 **AND** $Totale_Debiti_%_2016$ > 18.196832168335906 **AND** $Redditivita_del_totale_attivo_ROA_%_2016$ <= 21.54	POTENTIAL SOLVENCY	137	79
R5	**IF** $Total_debiti_oltre_l_esercizio_migl_EUR_2016$ > 318.2925 **AND** $Incidenza_costo_del_lavoro_%_2016$ <= 4.276964813170087 **AND** $Redditivita_del_totale_attivo_ROA_%_2016$ <= 13.614999999999998 **AND** $Totale_Debiti_%_2016$ > 25.066864783615408 **AND** $TOTALE_ATTIVO_migl_EUR_2016$ > 1241.238 **AND** $Redditivita_del_totale_attivo_ROA_%_2016$ <= 16.055 **AND** $Totale_Debiti_%_2016$ > 18.196832168335906 **AND** $Redditivita_del_totale_attivo_ROA_%_2016$ <= 21.54	POSSIBLE DISTRESS	157	119
R6	**IF** $Incidenza_costo_del_lavoro_%_2016$ > 4.276964813170087 **AND** $Redditivita_del_totale_attivo_ROA_%_2016$ <= 13.614999999999998 **AND** $Totale_Debiti_%_2016$ > 25.066864783615408 **AND** $TOTALE_ATTIVO_migl_EUR_2016$ > 1241.238 **AND**	POSSIBLE DISTRESS	3497	3085

	$Redditivita_del_totale_attivo_ROA_%_2016$ <= 16.055 **AND** $Totale_Debiti_%_2016$ > 18.196832168335906 **AND** $Redditivita_del_totale_attivo_ROA_%_2016$ <= 21.54			
R7	**IF** $Redditivita_del_totale_attivo_ROA_%_2016$ > 13.614999999999998 **AND** $Totale_Debiti_%_2016$ > 25.066864783615408 **AND** $TOTALE_ATTIVO_migl_EUR_2016$ > 1241.238 **AND** $Redditivita_del_totale_attivo_ROA_%_2016$ <= 16.055 **AND** $Totale_Debiti_%_2016$ > 18.196832168335906 **AND** $Redditivita_del_totale_attivo_ROA_%_2016$ <= 21.54	POTENTIAL SOLVENCY	112	66
R8	**IF** $Redditivita_del_totale_attivo_ROA_%_2016$ > 16.055 **AND** $Totale_Debiti_%_2016$ > 18.196832168335906 **AND** $Redditivita_del_totale_attivo_ROA_%_2016$ <= 21.54	POTENTIAL SOLVENCY	177	134
R9	**IF** $Redditivita_del_totale_attivo_ROA_%_2016$ > 21.54	POTENTIAL SOLVENCY	125	120
Total			4580	3881

Source: authors' elaboration

In order to give a complete illustration of the first experiment, its metrics are outlined in two tables.

Tab. 16: Metrics - Part 1 (experiment 2)

Cut off	POSSIBLE DISTRESS	POTENTIAL SOLVENCY
POSSIBLE DISTRESS	807	57
POTENTIAL SOLVENCY	113	169

Source: authors' elaboration

Tab. 17: Metrics - Part 2 (experiment 2)

Correct classified	976
Wrong classified	170
Accuracy	85,166%
Error	14,83%
Cohen's Kappa	0,572

Source: authors' elaboration

The result of the second experiment is summarized in the *decision tree* below.

Fig. 7: Decision tree (experiment 2)
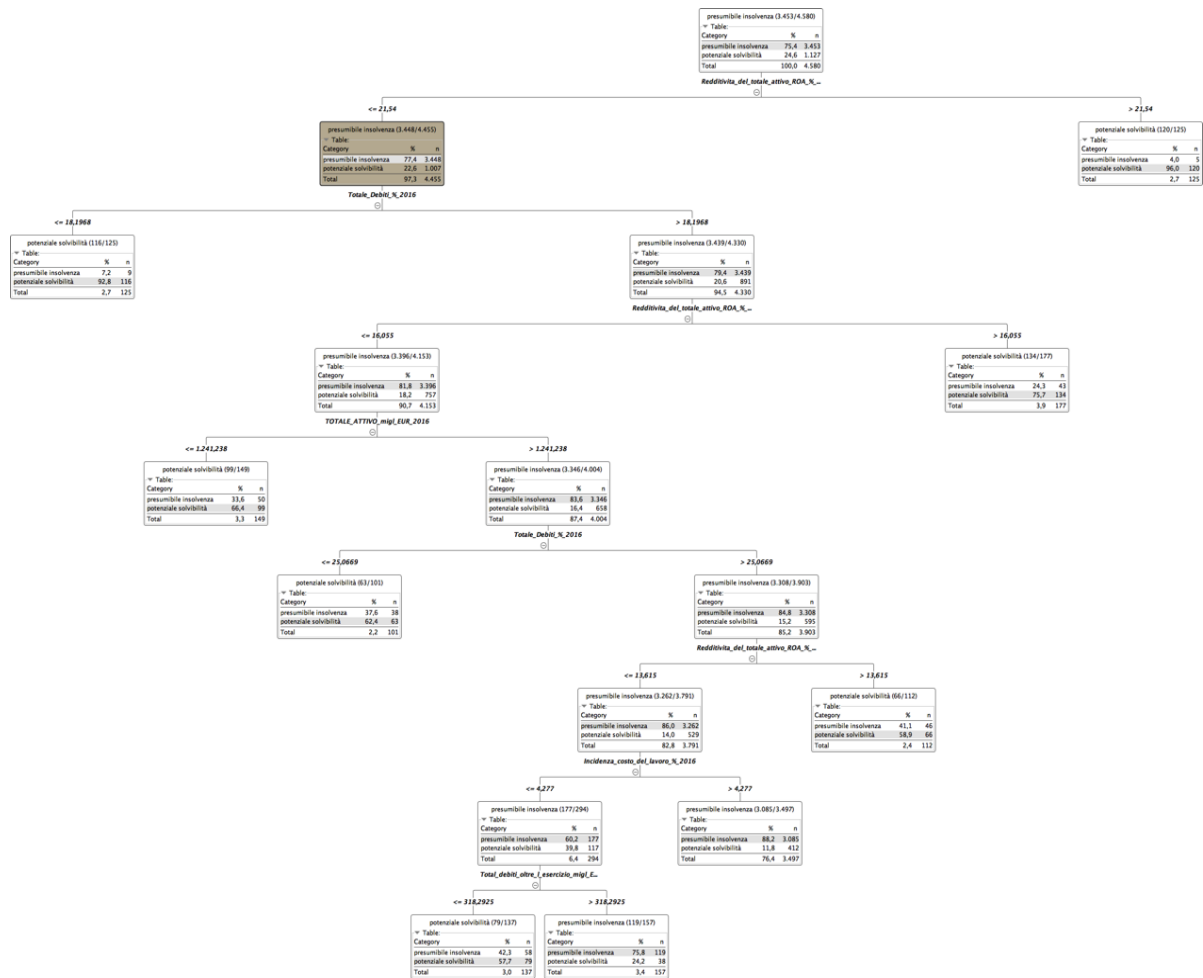
Source: authors' elaboration

Conclusion

The experiments performed show the existence of an algorithm able to identify a combination of variables to predict a target one without considering other two variables, respectively "cut off" and "z score" (experiment 1) and "zone of discrimination" and "z score" (experiment 2), in the dataset.

Two different settings of *if-then rules* feature the experiments: the first one identifies eight rules, which are able to predict the values of the *zone of discrimination*, while the second one determines nine rules whose outcome is related to the values of the *cut off*. Despite the different target typical of each experiment and the different combination of variables involved, the key role of the variable "*$Redditivita_del_totale_attivo_ROA_%_2016$*", that is ROA (*Return On Assets*), emerges in both cases. In fact, in both experiments ROA is at the root node of the decision tree.

It should be noted that ROA corresponds with the variable X_3 ((EBIT)/ Total Assets) of the Altman's Z' score, to which is connected the highest weighting coefficient within the linear combination. This means that both the AI algorithms and the Altman's Z' score-model confer a pivotal role to the same variable.

ROA (or EBIT/ Total Assets) represents a profitability ratio that suggests how a company can conduct the business activity, regardless of the form of financing. In other words, this ratio depicts the ability of a company to create value through internal assets: the higher the ROA, the greater the ability to enhance the resources. It derives that ROA gives stakeholders an idea on management's efficiency at using assets to generate earnings.

Both experiments share another variable, which differently from the previous one, is not mentioned in the Altman's Z' score-model. This variable is "*$Totale_Debiti_%_2016$*", that is total debt %, equal to total debt on total liabilities and equity.

This ratio is related to the company's financial structure and it expresses the weight of the total debt on the invested capital. According to another perspective, this ratio is complementary to the financial-independence index, equal to equity on invested capital. This comparison allows to examine the relationship between risk capital (equity) and debt capital, considering the relationships existing between the remuneration of the former and the cost of the latter. Therefore, equal invested capital,

the higher the total debt the lower the equity, and so, in the financing decision, the higher use of third-party capital rather than own capital.

From this brief explanation of the financial meaning of this variable emerges that despite its absence within Altman's Z' score-model, it works as a good predictor of the features associated with the company's financial structure. For this reason, it is plausible that it is a measure to represent both the target variables ("zone of discrimination" and "cut off").

However, both experiments are marked by the presence of other variables missing in Altman's Z' score-model.

In particular, the first experiment also includes the following variables:

"*$Ricavi_vendite_e_prestazioni_migl_EUR_2016$*", that is sales,

"*$RISULTATO_OPERATIVO_migl_EUR_2016$*", that is EBIT, and

"*$Immobilizzazioni_%_2016$*", that represents the non-current assets ratio.

Sales and EBIT are both items of the income statement and so pertain to the analysis of the company's economic situation. They express two different sides of profitability: while sales refer to the value of a company's sales of goods and services, where the revenue or income process begins, on the other hand, EBIT is a company's net income before income tax expense and interest expenses have been deducted. Although EBIT is also present in the ROA formula, in this case it is considered its absolute value. It represents a good indicator to analyze the performance of a company's core operations without considering the impact on profit of the costs of the capital structure and tax expenses.

Non-current assets ratio is given by the weight of non-current assets (fixed, intangible, and financial) on total assets, and it indicates the long-term uses involved in business operations to generate income.

This ratio pertains to the assessment of the financial position and is complementary to the current assent ratio. This means that, equal total assets, the higher the fixed assets the lower the current assets, and so the higher the amount of assets that not expected to be consumed or converted into cash in the short period.

The second experiment considers three variables not included within Altman's Z′ score-model: "$TOTALE\_ATTIVO\_migl\_EUR\_2016$" (total assets), "$Total\_debiti\_oltre\_l\_esercizio\_migl\_EUR\_2016$" (Total debt due beyond the financial year), and "$Incidenza\_costo\_del\_lavoro\_\%\_2016$" (personnel costs ratio).

These variables pertain to two different sides of evaluation: the first two are related to the financial assessment, while the second to the economic analysis.

Total assets represent the total amount of invested capital, and so give a measure of the resources with economic value that are able to generate cash flow, reduce expenses or improve sales. Total assets are given by the sum of non-current assets (fixed, intangible, and financial) and current assets, which are the short-term resources expected to be converted into cash within one year.

Total debt due beyond the financial year represents the non-current liabilities, and so the liabilities to be paid in the medium-long period.

The personnel costs ratio is given by the personnel costs (salary and wage expenses) on sales. Personnel costs are included within the operating costs, a negative component that contribute to determine the operating result. It derives that, equal the sales, the higher the personnel cost the lower the operating result and, of consequence, the net income.

In light of this scenario, the contribution of the study is the identification of two algorithms able to determine two settings of *if-then* rules that produce the same outcomes obtainable through the application of the Altman's Z′ score model, without using it.

It derives that thanks to the combination of a new set of variables, it is possible to understand, with a given accuracy, the company's financial health, and conversely, the *company's distress*, regardless of Altman's Z′ score.

The current development of the research reveals that the methodology still needs to be adapted determining plausible interval for the variables identified by the decision trees. In fact, the dimensionality of the dataset can benefit from resampling the

variables for the proposed methodology which, at the state of the art, suffer from problems of skewness.

However, the identified algorithms are a powerful tool that strengthen the comprehension of companies' financial profile. Since they work with large amounts of data, they are even more significant.

This assumes a remarkable value in relation to the peculiarities of the sample under investigation, as all the companies are in possession of LR.

In consideration of the link between LR and company's *distress,* the AI methodology is able to process large amounts of records within a given dataset, so allowing to test the effectiveness of LR in the assessment of *creditworthiness*.

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Conclusion

The contributions to the research presented in the three chapters have been aimed at offering an *excursus* across the investigation of how the issue of legality deals with the private sector, and in particular with complex organizations, as companies are.

First of all, in order to understand the relationship between legality and companies, the research shows that *legality within companies* and *companies within legality* are neither abstract concepts nor two separate entities out of both regulation and business contexts.

This major finding is bolstered by the existence of tools to promote the culture of legality within the private sector, and specifically, "company rating" (*rating d'impresa*) and "legality rating" (*rating di legalità*).

In relation to these ratings, as explained in the first chapter, it appears suitable to note that the knowledge of their nature allows to enhance the legislator's intent. In fact, even if the existence of these ratings is provided for by law, their adoption is not mandatory, but absolutely voluntary. Therefore, their lack does not entail negative consequences for companies. Moreover, in order to achieve the rating, the company produces a self-declaration about the compliance to normative requirements and its extra-effort in support of legality. Then, the company's request is examined by a third-party, which collects information on the firm and decides whether to grant or reject the request.

In light of these considerations, the role of company's disclosure emerges. Briefly, the greater the disclosure the higher the rating.

It should be noted that providing external disclosure about business activity means to give relevant and potentially confidential information to evaluators, and consequently, to be exposed to vulnerabilities.

So, since companies voluntarily subject themselves to a third-party assessment in order to obtain the rating (taking the risk of rejection upon themselves), the legal system has provided some advantages for these companies.

This awareness leads to remark the pivotal role of the incentives that induce companies to operate within the framework of legality.

At this purpose, the research has been focused on the examination of the companies' advantages deriving from the adoption of these ratings, notably the legality rating (LR), which qualifies companies towards market and supply chains. The main benefit of LR's adoption is a better access to bank credit and public funding. As shown in the second and third chapters, the research underlines the first kind of advantages and at this aim, it explores the issue of LR and credit.

But, as long as the access to credit is strictly linked to company's creditworthiness, it derives that the awarding of LR cannot leave out of consideration the company's solvency requirements, and by consequence, the company's distress. In fact, the higher the creditworthiness the lower the likelihood of bankruptcy.

The most innovative contribution to the research is surely the adoption of an AI methodology applied to joint comprehension of corporate distress and corporate legality (chapter 3). In fact, AI allows to identify a new "basket" of variables, different from those employed by a financial model already theorized by literature (Altman's Z' score), that determines the company's distress.

It means that the performed experiments show the existence of an algorithm able to automatically identify - with accuracy - a combination of variables from a given dataset in order to explain the target variables according to a completely new perspective, different and not used by financial models to predict the distress.

This finding derives from the use of *decision trees*, a well-established AI methodology, that allow the representation of *decision processes* according to *paths* on the *tree's* branches or through a set of easily browsable *rules*.

In particular, two settings of *if-then* rules are determined: they produce the same outcomes obtainable through the application of the Altman's Z' score model, without using it, and for this reason they can be used to understand the company's financial health. The recognition and composition of the new variables help to strengthen the comprehension of company's distress.

A useful tool to reinforce the knowledge about companies' financial profile is represented by the *decision tree* (DT). In particular, both the identified AI algorithms and the Altman's Z' score-model confer a pivotal role to the variable ROA (*Return On Assets*), a profitability ratio that suggests how a company can conduct the business activity, regardless of the form of financing. Moreover, the findings show that despite the absence of the variable "total debt %" (total debt on total liabilities and equity) within Altman's Z' score-model, it works as a good predictor of the features associated with the company's financial structure. Furthermore, both experiments are marked by the presence of other variables (sales, EBIT, non-current assets ratio, total assets, total debt due beyond the financial year, and personnel costs ratio) missing in Altman's Z' score-model, able to catch up distinguishing financial features, which together let to seize the company's financial health. For this reason, since DTs work with large amounts of data, they are even more significant.

The originality of the research is represented by *the contribution of artificial intelligence* to explore *legality within companies* and *companies within legality*: as this methodology is able to process large amounts of records within a given dataset, it allows to test the effectiveness of LR in the assessment of creditworthiness.

This finding paves the way to *new horizons* for the research. Thanks to AI, *decision processes* are streamlined and decision-making is interpretable through *if-then rules*. So, decisions may be easily taken by virtue of rules generated by the *decision tree*, based on a short-ordered list of features.

The practical implications related to this finding may be addressed to different actors. For example, banks may use a methodology, different from Altman's Z' score-model, to monitor the companies' financial profile. In detail, financial institutions may perform comparative evaluations when granting loans to companies in possession of legality rating: the financial health of this kind of companies may be assessed *vis-à-vis* the financial profile of the other companies asking for bank credit. In addition to

company's individual financial assessment, banks may benefit from a set of rules to monitor the comprehensive financial *status* of the above-mentioned companies.

Also, companies may be recipients of this research's achievement. The management can monitor both the companies requesting for legality rating (the companies' list is freely available on AGCM website) and their financial performance. So, from a competition perspective, by virtue of an AI methodology, the management may make a self-evaluation of its own company in relation to a set benchmark. It derives that a virtuous circle is triggered by avoiding a downward competition.

Moreover, the Legislator may take advantage of AI methodology to assess the coherence of law provisions on legality rating with their concrete impacts. It means to test the effectiveness of LR in the assessment of creditworthiness and potentially make amendments to align the regulation's intent with real bank-company relationship.

In conclusion, the research path has been twisted and turned through the three chapters in order to illustrate, with crescendo intensity, the possible passage *from utopia to eutopia*.

While in the first chapter, *legality within companies* and *companies within legality* appear to pertain to *utopia*, that is a "no-place", since the relationship between legality and companies is explained at theoretical level, this idea changes across the other chapters and abates. As long as evidence on the topic is provided, *utopia* is slowly replaced by *eutopia*.

In fact, in the second chapter the analysis catches up some practical implications of the research and *eutopia* starts to dawn.

Then, with the introduction of AI in research, *eutopia* reaches its maximum expression. Substantially, the application of AI methodology to explore *legality within companies* and *companies within legality* declares the transition *from utopia to eutopia*.

AI methodology, applied for the first time to a dataset composed by Italian companies in possession of legality rating in order to jointly understand company's distress and legality, shows the existence of a "good place" in which the theorization of these concepts is entirely reflected in reality.