

Sustainable and Responsible Management

The Journal of Sustainable Business

ISSN 2724-4466



Volume No. 4, Issue No. 1 - 2023

Abruzzese Salute ETS

sustainable-and-responsible-management.org

Journal Information

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ISSN

2724-4466

Online since 18th November, 2020

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Using cluster analysis study to examine social impact bonds

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Abstract

Over the last few years, Social Impact Bonds (SIBs) have become a very popular financial instrument in the field of impact investing. The performance evaluation metric seems to be a critical factor for the future development of the SIB market. For this reason, the work's aim is to identify a holistic risk-return profile adapted for SIBs. I employ a cluster analysis, as an exploratory technique, by gathering together those SIBs sharing similar features in terms of financial return, social risk, and financial risk. The exploratory analysis examined the 34 SIBs completed and shows three distinct and homogeneous groups. The results of the work open up new avenues for future research in the field of SIB performance. Finally, our results represent a basis for the implementation of a forecast model for the risk-return profile of these financial instruments..

Keywords – Social impact bonds; Impact investing; Financial return; Social risk; Cluster analysis

Paper type – Academic Research Paper

Sommario

Negli ultimi anni, i Social Impact Bond (SIB) sono diventati uno strumento finanziario molto popolare nel campo degli investimenti a impatto. Le metriche di valutazione delle performance sembrano essere un fattore critico per il futuro sviluppo del mercato SIB. Per questo motivo, l'obiettivo del lavoro è quello di identificare una relazione rischio-rendimento adatta per i SIB. Mi avvalgo di un'analisi cluster, che consente di raggruppare i SIB che condividono caratteristiche simili in termini di rendimento finanziario, rischio sociale e rischio finanziario. L'analisi ha analizzato 34 SIB completati e mostra tre gruppi distinti e omogenei. I risultati del lavoro aprono nuove strade per la ricerca futura nel campo della performance SIB. Infine, i nostri risultati rappresentano una base per l'attuazione di un modello di previsione per il profilo di rendimento del rischio di questi strumenti finanziari.

Parole chiave – Social impact bonds; Investimenti a impatto; Rendimento finanziario; Rischio sociale; Cluster analysis

Tipo di articolo – Articolo accademico

Article history:

Received 29 March 2023

Received in revised form 22 April 2023

Accepted 28 May 2023

Available online

1 Introduction

Impact investing represents an alternative asset class that considers an alternative way to allocate financial resources (La Torre & Calderini, 2018; Del Giudice & Migliavacca, 2019). In 2007, the term “impact investing” was coined during a conference organized by the Rockefeller Foundation (Bugg-Levine & Emerson 2011). However, it became popular a few years later, after the financial crisis caused by the collapse of the subprime real estate market (Carè & Wendt, 2018; Agrawal & Hockerts, 2019). Some scholars, including Benedikter (2011) and Geobey, Westley, and Weber (2012), argue that investors are considering these new forms of investment to restore their reputation after the 2008 crisis. As a matter of fact, the channeling of capital in impact investing firms has been increasing each year (Weber, 2016). Mudaliar and Dithrich (2019) estimate that, in 2019, the organizations manage USD 715 billion with an annual growth of 43%. Subsequently, impact investing will become an important asset class within the financial markets.

Not only the attention of practitioners but also of scholars is continuously growing towards this new asset class. Impact investing has some peculiar characteristics that make it also an interesting research topic.

The World Economic Forum of 2013 identifies specific characteristics of impact investing “as an investment approach that intentionally seeks to create both financial return and positive social or environmental impact that is actively measured”. This definition shows the unique features of impact investing that distinguish it from Socially Responsible Investing (SRI) (Rizzello & Carè, 2016; Carè & Wendt, 2018). Despite the interest generated in academia, scientific research has not produced a large number of studies, nor has it achieved significant results (Agrawal & Hockerts, 2021). The most recent systematic literature reviews (Agrawal & Hockerts, 2021) highlight that scholars have not provided a precise definition of impact investing. By means of a longitudinal thematic analysis of literature, Agrawal and Hockerts (2021) show that many terms present similar features with impact investing, which has caused confusion among scholars and practitioners. In particular, just like Höchstädter and Scheck (2015) and Carè and Wendt (2018), they point out that the terms “social finance” and “impact investing” are very similar concepts and underline that “social finance” and “social impact investing” are synonyms. They sustain that the “social impact investing” is an “impact investing” initiative with social scope. Agrawal and Hockerts (2021) compare the meaning that authors attribute to “social responsible investing” and “impact investing”. The “social responsible investing” refers to profitable investments that involve many stakeholders in projects with high ESG (Environmental, Social and Governance) factor, that do not necessarily produce a positive social value (Geobey & Weber, 2013; Weber, 2016). Conversely, the “impact investing” has the aim to obtain a measurable and positive social

value and positive financial returns (Brandstetter & Lehner, 2015; Carè & Wendt, 2018). They conclude that “social responsible investment” and “impact investing” are different concepts, because they give different relevance to the social results of investment (Agrawal & Hockerts, 2021; Carè & Wendt, 2018). Agrawal and Hockerts (2021) support the statements of Porter and Kramer (2006) that consider the concepts of “venture philanthropy” and “impact investing” to be very similar. Based on this, we have decided to exclude papers that expressly refer to “social responsible investment”. The purpose of this chapter is to identify the main research streams in the field of “social impact investing” and propose future research agendas.

Social Impact Bonds (SIBs) are the most innovative financial instruments in the field of impact investing (Carè & Wendt, 2018). The literature review of Broccardo et al. (2020) showed that social impact bonds will be a key subject in the years to come. SIBs have recently piqued the interest of governments, investors and researchers. They have also been known as Payment for Success bonds or Pay for Benefit bonds, even though such innovative financing instruments are not real bonds in financial terms, but rather contracts on future social results (Clifford & Jung, 2016). Therefore, SIBs involve contracts in which socially motivated investors, like high-net-worth individuals, and institutional investors provide working capital to social sector service providers, allowing them to scale up high- impact social programs. Investors receive financial returns in relation to the social impact achieved and they do not obtain payback if the social goals have not been achieved. This mechanism transfers the risk of not achieving social goals from public administration and taxpayers to investors. SIBs constitute forms of collaboration where commissioners, providers and investors share the risk and pool knowledge and experience in the delivery of services (Maier & Meyer, 2017). SIBs demand commissioners, investors and providers to work collaboratively and flexibly, rather than in the classic public procurement manner (Warner, 2013). Figure1 illustrates the operating scheme of SIBs and the relationships among the various stakeholders. The public commissioner seeks a solution to a specific social problem. The solution is associated to a measurable criterion on the basis of which the commissioner establishes the payment. The provider delivers the social service, which is usually a social enterprise (Carè & Wendt, 2018). The entire operation is organized by an advisor, who enables the impact investor to finance the operation in total transparency. Finally, an independent evaluator certifies the achievement of the predetermined outcomes (Chiappini, 2017; Scognamiglio et al., 2019).

The first SIB in history was implemented to finance a rehabilitation program to reduce the recidivism rate of prisoners in the Peterborough area (UK, 2010). Since then, SIBs have spread all over the world; in fact, today, 137 SIBs are present globally for USD 440 million of capital raised, but only 34 are completed (Impact Bond Database, 2019).

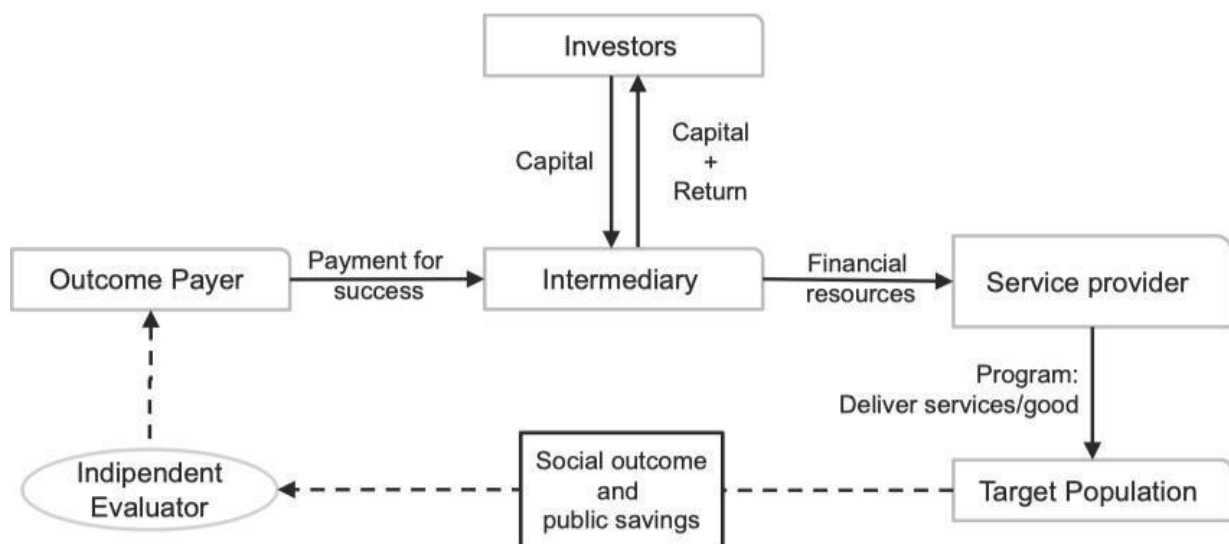
Applications of SIBs span several social areas ranging from employment to education and social

welfare (Arena et al., 2016). The achievement of a pre-determined social outcome is key for the success of a SIB, because it triggers payout to the impact investors involved in such schemes. The risk of not achieving the desired outcome is labeled social risk (Weber, 2016).

The risk issue represents one of the main controversial points related to the use of SIBs on a larger scale and, at the same time, it is still underexplored (Scognamiglio et al., 2019; Carè & Welch, 2018). It is clear that the complexity of the SIBs model increases the probability of SIBs failing.

Thus, the study sought to explore the relationship between social risk and financial return within the context of SIBs, by clustering analysis. In more detail, I implement k-mean cluster analysis (Pham et al., 2004) in order to obtain three homogeneous clusters of completed 34 SIBs. Within these clusters, the SIBs present a similar profile of risk-return.

Figure 1 - SIB model



Source: Carè et al. (2020)

2 Literature review

2.1 Social Impact Bond and performance

SIBs represent one of the most debated form of financial innovation within the impact investing field (Fraser et al., 2016). Similar to impact investors, SIB investors expect both social and financial returns (O'Donohoe et al., 2010; Glänzel & Scheuerle, 2016). Financial returns are generally, but not exclusively, expressed in terms of Internal Rate of Return (IRR) that may be fixed or variable in relation to the social performance achieved with the SIB intervention. Social returns are expressed in terms of pre-determined levels of expected social impact. An independent evaluator measures the achievement of these thresholds, which determine outcome payments to investors. Financial returns are obtained by the SIB investors, only if social impact has been achieved (Nicholls & Tomkinson, 2015a). Thus, the central element to the concept of social risk is whether social outcomes are achieved.

This type of risk has been recently explored by academics and practitioners in the impact investing field. More in detail, there is not a common understanding of the concept of social risk¹ in the impact investing literature (Lehner, 2016). Recent contributions suggested that social risk is expressed in terms of not reaching the intended impact (Brandstetter & Lehner, 2015) or as the likelihood that a given allocation of capital will generate the expected social outcomes irrespective of any financial returns or losses (Nicholls & Tomkinson, 2015b).

In the specific context of SIBs, the term social risk is used to identify the possibility that the expected social outcome is not achieved (Disley & Rubin, 2014; Gustafsson-Wright et al., 2015; Arena et al., 2016; Maier & Meyer, 2017) due to unpredictable events (Chiappini, 2017) that may occur during the implementation of SIBs. However, the financial architecture of SIBs is peculiar and thus requires a more in-depth investigation of financial and social risk. In this vein, the systematic study of Scognamiglio et al. (2018) explored and segmented the concept of social risk in the specific field of SIBs. This study provided identification of social risk factors that could affect the success of a SIB. Scognamiglio et al. (2018) identified those social risk factors by performing literature review and organizing them in a preliminary model, based on a methodology introduced by Serrano-Cinca and Gutiérrez-Nieto (2013).

2.2 Cluster analysis

Cluster analysis is, by excellence, an unsupervised learning technique, that identifies the complex relationships between variables, without imposing any restriction. Consequently, the initial dataset

doesn't need the distinct specification of a target variable (the dependent variable) and, respectively, of predictor ones (independent variables). All variables have the same importance, because the analysis's goal is not to predict a certain value, but instead to identify the presence of specific patterns or correlations among variables, to include the different variables or cases into more homogenous groups.

Unlike other data mining techniques, we don't have to establish a predetermined set of classes, or to introduce a training stage based on a collection of past data. The entities' clustering is based exclusively on the similarities identified in the variables' structure. According to Romesburg (2004), this technique represents "a mathematical microscope for looking at the relations of similarity among a given set of objects. It cannot be used for making statistical inferences about these relations to a larger population. Any inferences a researcher makes by studying the tree are made by using reasoned analogy rather than by using formal statistical methods".

The cluster analysis is different with the factor analysis, because in the clustering analysis group's objects, meanwhile in the factor analysis is primarily concerned with grouping the variables. In additional information, factor analysis makes the grouping based on the patterns of variation (correlation) in the data whereas cluster analysis makes grouping on the basis of distance (proximity) (Müller & Hamm, 2014). Then, cluster analysis focuses on the examination of the interdependencies between variables, its finality consisting in gathering similar entities into more homogenous groups, named clusters.

Unlike other empirical methods of analysis, this method produces acceptable results even with small samples. In fact, Müller and Hamm (2014) identifies a rule of thumb equal to 2^k , where k are the attributes. Within the field of the methods of cluster analysis, the most used is the non-hierarchical k-means, because it does not require any hypotheses on the data distribution (Pham et al., 2004).

The K-means algorithm gives the simple or flat condition, because it just gives a single set of clusters, with no particular organization or structure within them. But it can be used to the cases for more distantly data related to the others. So hierarchical clustering is the opposite of it.

The K-means algorithm is a popular data clustering algorithm. To use it requires the number of clusters in the data to be pre-specified. Finding the appropriate number of clusters for a given data set is generally a trial-and-error process made more difficult by the subjective nature of deciding what constitutes correct one. A new method to select the number of clusters for the K-means algorithm has been proposed in the paper. The new method is closely related to the approach of K-means clustering because it takes into account information will be the mirror of the performance of the algorithm. The proposed method can suggest multiple values of K to users for cases when different clustering results could be obtained with various required levels of detail (Pham et al., 2004).

Since, cluster analysis is an exploratory technique, allows the comparisons between all SIBs in the

sample, classifying them into a certain group, according to the similarities identified. The core principle of this technique is that of minimization of the variance between the components of a group, simultaneously with the maximization of the variance across groups.

3 Research Methodology

My research hypothesis is that is possible to group the SIBs on basis of social risk variables that are identified by Scognamiglio et al (2018). These groups should show different mean IRR.

Cluster analysis was used as a based method to reach the goal of this study. To get the number of clusters, this study does several repeated attempts to see the difference in the means distance between the initial of each cluster. K-means clustering was used in this research to get the detail of characteristics for each cluster. Discriminant analysis was also used in this study to assess the capacity of the variables to predict the classification of enterprises within clusters. To make sure that the result was appropriate, it used canonical discriminant analysis for the verification of the data. The attributes employed are the social risk factor (Table 1) and financial return.

I consider the social risk factors of Scognamiglio et al. (2018) as social risk attributes. There are three risk factors: program process, players and social outcome evaluation. Each factor is divided into several sub-factors. Below is a brief description of how factors and evaluation criteria are composed. As for the program feature, the duration of the program is directly proportional to the social risk (Dorfleitner et al., 2021). Instead, the presence of a pilot phase reduces the social risk, because it is possible to redefine the social outcomes on the basis of experimental data (Dear et al., 2016). Regarding the players, the presence of specialized operators reduces the social risk.

As for the social outcome evaluation, the sub-factors that reduce social risk are a small number of outcome evaluations. Table 2 shows the social risk factors values of the score model of Scognamiglio et al. (2018).

Table 1 - Social risk factors

Social risk factor	Social risk sub-factor	Options
Program process	Program features	Duration of program
		Pilot phase
		Empirical evidence
		Policy variation
Players	Service provider	Number of service providers
		Worker/target number relation
		Number of similar projects developed
		Years of experience of the service provider
	Intermediary	Intermediary present
		Years of experience
	Independent evaluator	Independent evaluator present
Social outcome evaluation	Evaluation	Methodology
		Number of outcomes

Source: The table reports the social risk variable identified by Scognamiglio et al. (2018)

Table 2 - Social risk factor values

Risk category	Risk factor	Sub-factor	Options	Score
Program process	Program features	Duration of program	More than 5 years	1
			From 3 to 5 years	2
			Less than 3 years	3
		Pilot phase	Yes	1
			No	2
		Empirical evidence	Evidence on large scale	1
			Evidence on small scale	2
			No evidence	3
Players	Service provider	Number of service providers	Yes	1
			No	2
			More than 5	3
		Worker/target number relation	One-to-one	1
			Not more than one to ten	2
			More than one to ten	3
		Number of similar projects developed	More than 10	1
			From 5 to 10	2
			Not more than 5	3
		Years of experience of service provider	More than 10	1
			From 5 to 10	2
			Not more than 5	3
	Intermediary	Intermediary present	Yes	1
			No	2
		Years of experience	More than 10	1
			From 5 to 10	2
			Not more than 5	3
Social outcome evaluation	Evaluation	Methodology	Independent evaluator present	1
			Not	2
			Experimental design that controls for both observed and unobserved variables	1
			Live but non- experimental counterfactual	2
			Constructed counterfactual with no live control	3
		Number of outcomes	Multiple	4
			No counterfactual	5
			From 1 to 3	1
			From 3 to 5	2
			More than 5	3

Source. The table reports the social risk factor value of Scognamiglio et al. (2018)

4 Data analysis

4.1 Samples

I used the entire population of 34 SIBs that were concluded by 2020. The sample was not randomly selected. In more detail, SIBs must be closed, and they have to comply with the requirements of the transparency and verifiability of information.

The data was provided by the Government Outcomes Lab database. For each SIB, the risk factors indicated by Scognamiglio et al. (2018) were calculated. Specifically, I calculated: Program Process, Players, and Social outcome evaluation.

4.2 Findings

In this section, I will explain the characteristics of the three clusters which are based on 14 attributes, that explain the profile risk-return of SIBs. Table 3 reports the minimum distance between initial clusters as a criterion to select the best number of clusters (Zapata et al., 2018). The values of Table 3 sustain that the groups could be three, because after three groups the minimum distance decreases slowly (Zapata et al., 2018). Table 4 reports the means and standard deviation of attributes for the three groups. The cluster analysis shows a direct relationship between the financial return (IRR) and the social risk factors. The 3 clusters present differences in terms of financial return and social risk. Cluster 1 has the lowest level of social risk and the lowest financial return (IRR = 0.03%). Social risk is broken down by the series many factors (Scognamiglio et al., 2019). Cluster 1 values are the lowest in the sample. is result seems to be in line with the efficiency of the markets. The values of clusters 2-3 (the riskiest clusters and with the highest yields) have very close financial returns and social risk factors values, which makes economic interpretation of the results difficult.

In conclusion, the social impact bond market appears to be efficient, but these findings cannot be considered definitive as the size of the market is too limited. The validation procedure is necessary for the reliability of the results obtained from the cluster analysis (Sharma & Wadhawan, 2009). The author calculated the Wilk's Lambda discriminant analysis to test if the means of groups are different (Pham et al., 2004; Büyüköztürk & Çokluk-Bökeoğlu, 2008; Garson, 2012). The values of lambda are between 0 and 1 and small lambda values identify that group averages are different (Büyüköztürk & Çokluk-Bökeoğlu, 2008; Garson, 2012). In our case, Wilk's lambda is 0.032 (p-value 0.000), than the means of groups are different.

Table 3 - Minimum distance criterion

Cluster	Minimum distance between initial cluster
2	9.790
3	8.050
4	8.050
5	7.950
6	7.044
7	6.950
8	6.944
9	6.850
10	6.843

Source: our elaboration

Table 4 - Characteristics of cluster based on mean and standard deviation

Attributes	Group 1		Group 2		Group 3	
	mean	s.d.	mean	s.d.	mean	s.d.
IRR	0.03%	0.02%	0.045%	0.04%	0.05%	0.04%
Duration of program	5	2	6	2	7	2
Pilot phase	1	0.5	1	1	0	1.25
Empirical evidence	3	0.5	2	1	1	1.25
Policy variation	2	0.75	1	1.25	1	1.5
Number of service providers	6	0.75	3	1.25	2	1.5
Worker/target number relation	5	0.5	2	1	1	1.25
Number of similar projects developed	3	0.5	2	1	2	1.25
Years of experience of service provider	6	0.75	2.5	1.25	2	1.5
Intermediary present	3	0	2	0.5	1	0.75
Years of experience	6	0.75	3	1.25	2	1,5
Independent evaluator present	1	1	1	0.5	0	0.75
Methodology	2	0.5	4	1	5	1.25
Number of outcomes	5	1.25	3	1.2	2	1

Source: our elaboration

5 Conclusions

The objective of this paper is to apply quantitative methodologies to the context of Social Impact Bonds. Starting from the social risk factor of Scognamiglio et al. (2018), I measured the relationship between social risk and financial return by adopting the cluster analysis. In particular, social risk factors identified by Scognamiglio et al. (2018) were used as attributes to create the clusters. The results showed an inverse relationship between risk and return. Indeed, the clusters with higher average values in social risk factors have a higher IRR. The results so far obtained are encouraging but present methodological limitations that are insurmountable at the moment. A very small data sample was used, which nevertheless represents the entire population of the concluded SIBs. For further research, more reliable evaluations could be obtained by resorting to larger samples.

Moreover, while several scholars had pointed out the main characteristics of SIBs, their enabling factors and the main opportunities that come from their implementations, it had remained unclear how to evaluate their level of social risk. I have attempted to address this knowledge gap through this work. At the same time, this work contributes to the field of alternative methodological approaches for sustainable finance.

From a more practical point of view, this work could potentially contribute to the development of the entire SIB market by allowing both practitioners and policymakers to understand the areas from which uncertainty arises and thus help the development of more focused risk management practices and more standardized SIBs schemes.

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