Green-oriented Crowdfunding Campaigns:

Their Characteristics and Diffusion in Different Institutional Settings

Abstract: In this paper, we investigate how the institutional setting affects the diffusion of green crowdfunding campaigns across countries. To this aim, we develop and test two competing hypotheses about the association between country environmental sustainability orientation and the diffusion of green campaigns. To identify green campaigns, we develop an original machine-learning algorithm. We apply this algorithm to the population of 48,598 campaigns presented on Kickstarter between July 1, 2009 and July 1, 2012. By means of econometric estimates, we show that green campaigns differ from others along several dimensions and are more diffused in countries with a limited environmental sustainability orientation. Implications for research, practice, and policy are discussed.

Keywords: Crowdfunding, green, environmental performance index, institutional settings, classifier, random forest

1. INTRODUCTION

An increasing body of research has shown that *green* entrepreneurial initiatives, defined as initiatives that have an environmental mission as their primal goal (Thompson, Kiefer, and York, 2011; Ortas, Burritt, and Moneva, 2013), face significant challenges in accessing financial resources (Ridley-Duff, 2009; Fedele and Miniaci 2010; Ghosh and Nanda, 2010; Lehner, 2013; Petkova, Wadhwa, Yao, and Jain, 2014; Gaddy, Sivaram, Jones, and Wayman, 2017). In this scenario, crowdfunding animated the academic debate as a new, distinct avenue for green entrepreneurial initiatives to obtain financial resources. Scholars in this field have shown that different from other entrepreneurial financial actors, backers of a crowdfunding campaign are not necessarily moved by profit motivations alone and select ideas based on their desire to help others and to support causes they care for (Gerber and Hui, 2013; Belleflamme, Lambert, and Schwienbacher 2014). Moving from these arguments, a number of prior studies has investigated the relation between green initiatives and crowdfunding, focusing on the likelihood of success of crowdfunding campaigns with an environmental focus (e.g., Bartenberger and Leitner, 2013; Bonzanini, Giudici, Patrucco, 2015; Hörisch, 2015; Candelise, 2016; Lam and Law, 2016; Calic and Mosakowski, 2016). Comparatively, little attention has been given to the likelihood of launching green initiatives on crowdfunding platforms and to the contextual factors that might affect this tendency (one notable exception is the work by Cumming, Leboeuf, and Schwienbacher, 2017). The aim of this study is to contribute to filling this gap.

For this purpose, we take inspiration from the view that the institutional setting contributes to inform the behavior of individuals and notably of entrepreneurs (Bruton, Ahlstrom and Han-Lin, 2010). Particularly, we consider the *environmental sustainability orientation* of the institutional settings in a given country. We define the *environmental sustainability orientation* as the presence of formal (i.e., policy and regulation) and informal (i.e., norms, values, beliefs and

practices) institutions[1], that are concerned not only with the current level of economic and non-economic well-being but also with its sustainability over time i.e. the ability to pass natural, physical, human, and social resources to future generations (Stiglitz, Sen and Fitoussi, 2010). We argue that the environmental sustainability orientation of the institutional settings influences both entrepreneurs' willingness to launch a green-oriented entrepreneurial initiative and their inclination to use crowdfunding to finance such initiatives. In countries where the institutional setting has a stronger environmental sustainability orientation, one may expect that there are more green-related business opportunities. Moreover, as green initiatives are more legitimized, entrepreneurs may be more inclined to resort to crowdfunding to finance their green initiatives as they anticipate a greater likelihood of success of their campaigns. However, in these countries, entrepreneurs may also find it easier to finance their green initiatives through traditional channels. The ease of traditional channels may have a direct negative effect on their inclination to use crowdfunding. Moreover, because of adverse selection, green crowdfunding campaigns may be perceived by potential backers as having low quality, which makes entrepreneurs even more reluctant to finance their green initiatives through crowdfunding. Considering that opposed forces are at work, it is difficult to argue a priori whether countries' environmental sustainability orientation of the institutions is positively or negatively associated with the diffusion of green-oriented crowdfunding campaigns launched in those countries. In this paper, we investigate the relative explanatory power of these competing hypotheses.

Answering this research question raises a serious methodological problem: identifying green-oriented campaigns. Often prior studies have accomplished this task by either focusing on a limited number of campaigns and providing a subjective evaluation of their green orientation

[1] Informal institutions refer to "socially shared rules, usually unwritten, that are created, communicated, and enforced outside officially sanctioned channels" (Helmke and Levitsky, 2006: 5), while formal institutions are "rules and procedures that are created, communicated, and enforced through channels widely accepted as official" (Helmke and Levitsky, 2004: 727).

(Calic and Mosakowxki, 2016) or using the classification of green campaigns provided on crowdfunding platforms (e.g., Hörisch, 2015). These strategies have important drawbacks. The subjective evaluation of green campaign based on the textual description of the project has the advantage of being very precise (Kononenko and Bratko, 1991), particularly if made by a sufficient number of researchers, as in the case of Calic and Mosakowski (2016). However, this approach is only applicable to a limited sample of campaigns, due to the considerable time required to perform the evaluation. At the same time, using the classification of green campaigns provided on the platform has the clear advantage of relying on an easy to access and publicly available classification of green campaigns. However, it entails the risk of overlooking an important share of green-oriented campaigns. Consider, for instance, a movie made with environmental sustainable techniques or a piece of art created with the intent of warning people about an environmental threat. It is hard to argue that these initiatives are not green, but it is hard as well to argue that these campaigns are labeled green by the platforms, considering that platforms typically provide a single label to a campaign (see e.g., Mollick, 2014). An interesting step forward is the approach by Cummings et al. (2017). They implemented a computer-based text analysis technique aimed at searching for a predefined set of related keywords in the project description. In this paper, we considerably improve this methodology by employing a robust machine-learning algorithm to create a classifier of green-oriented campaigns, based on the project descriptions posted on the crowdfunding platform. Compared to the keywords-based algorithm implemented in (Cumming et al., 2017), the machine-learning approach offers a great advantage. Indeed, the set of most informative keywords used to discriminate between green and non-green campaigns is automatically extracted from a training corpus of labeled descriptions of crowdfunding projects. Therefore, keywords are not selected in advance, but they are learnt from the specific textual domain.

We apply the machine-learning algorithm to the population of 48,598 crowdfunding campaigns launched on Kickstarter in the period between July 1, 2009 and July 1, 2012, of which 5,000 campaigns are used as the training corpus. We found that approximately 9.5% of all the campaigns presented on Kickstarter were identified as green initiatives. By means of a set of econometric estimates, we found that these campaigns significantly differ from the others along several dimensions. Specifically, we found that green crowdfunding campaigns have a larger capital goal, provide more information (both visual and verbal), are launched by creators with significantly larger amounts of social capital developed within the crowdfunding platform (Colombo et al., 2015), and lower levels of external social capital (Mollick, 2014). More importantly, we show that green campaigns are proportionally more common in countries presenting a *lower* environmental sustainability orientation.

The paper is organized as follows. Section 2 discusses the theoretical background and develops hypotheses. In section 3, we present data, methodology and descriptive statistics. Next, we present the main results. The last section concludes the paper and discusses the implications for practice, policy, and future research.

2. CONCEPTUAL BACKGROUND AND HYPOTHESES

Similar to other forms of entrepreneurial activity, green-oriented ventures require significant initial investments. However, raising external finance has proven even more difficult for green ventures than for other ventures (Agrawal, Catalini, Goldfarb, 2010; Fedele and Miniaci 2010; Ridley-Duff 2008). These difficulties arise from a combination of greater information asymmetries (Ghosh and Nanda, 2010; Petkova et al., 2014), more uncertain returns due to higher policy risk (Foxon and Pearson, 2008; Bürer and Wüstenhagen, 2009), and longer payback periods (Hargadon and Kenney, 2012; Gaddy et al., 2017). In this regard, crowdfunding has gradually

emerged as a potential alternative means for green entrepreneurial initiatives to acquire financial resources.

The authors engaged in this line of research have focused their attention mostly on the behavior of potential backers of crowdfunding projects and relatedly on the success of green crowdfunding campaigns. Specifically, they have moved from the observation that, particularly in reward-based crowdfunding, backers' motivations shift from monetary returns to values and beliefs that are supportive of nature preservation and societal benefits (Belleflamme, Lambert and Schwienbacher, 2014). This literature has already provided interesting, albeit not conclusive, evidence in relation to whether green entrepreneurial initiatives present higher or lower fundraising capability. This literature has also identified several potential drivers of the success of green campaigns, including quality, creativity and legitimacy of the project (Bonzanini et al., 2015; Hörisch, 2015; Candelise, 2016; Vasileiadou et al., 2016; Lam and Law, 2016; Calic and Mosakowski, 2016).

In contrast, the issue regarding the diffusion of green initiatives on crowdfunding platforms has been explored less, leaving open the question of what are the factors that explain the presence of green entrepreneurial initiatives on crowdfunding platforms. To our knowledge, the only contribution on this issue is Cumming et al.'s (2017) work on clean-tech campaigns. They hypothesize that the levels of diffusion of clean-tech crowdfunding campaigns across countries reflect countries' informal institutional characteristics. Accordingly, clean-tech initiatives should be more common in countries with specific cultural characteristics, such as long-term orientation (i.e., care about future generations) and low individualism (i.e., propensity to accept that others will benefit from positive externalities, without paying). The latter characteristics are indeed found to be significantly associated with the probability of observing a clean-tech campaign on the Indiegogo crowdfunding platform.

We build on this argument by observing that the characteristics of both formal and informal institutions at country-level affect individuals and organizations (Crossland and Hambrick, 2011) as well as entrepreneurs (Williams and Vorley, 2015). Accordingly, we expect the diffusion of green crowdfunding initiatives in a country to reflect the environmental sustainability orientation of its formal and informal institutions. In particular, the environmental sustainability orientation of institutions influences entrepreneurial behavior in two different ways. Namely, the environmental sustainability orientation influences both the willingness to launch a green-oriented entrepreneurial initiative and the decision to use crowdfunding to finance such initiative.

First, in countries characterized by a strong environmental sustainability orientation of institutions, there generally are more business opportunities for developing green technologies, products and services, as internal market demand is likely to be greater. Indeed, consumers have a more positive attitude toward green purchases, and their positive inclination is magnified by the existence of generous public subsidies.[2] Moreover, in these countries, entrepreneurs interested in launching green initiatives are more legitimate (Aldrich and Fiol, 1994). Legitimacy is defined here as the congruency between the values, norms and expectations of a society and the activity and outcome of an organization (Dowling and Pfeffer, 1975). As it has been widely discussed by the literature (Dowling and Pfeffer, 1975; Oliver, 1991; Lounsbury and Glynn, 2001; Zimmerman and Zeit, 2002; Zott and Hui, 2007), legitimacy enables entrepreneurs to obtain easier access to external resources (such as financial and human capital). Accordingly, in these countries green entrepreneurs, being more legitimate, will have relatively easier access to the resources needed to survive and grow (Zimmerman and Zeit, 2002), both in early and later stages of a firm's development (Navis and Glynn, 2010). Based on these arguments, one would expect that a

[2] See, e.g., the tax exemptions as well as various driving privileges (like such as the use of bus lanes, exemption from parking fees in city centrers, and battery charging at zero cost) of environmental policies in Norway.

relatively higher share of entrepreneurs should launch green initiatives in countries where institutions have a strong sustainability orientation.

Moreover, operating in an institutional setting that makes green initiatives more legitimate may also influence entrepreneurs' decision to use crowdfunding to obtain the finance needed for their green projects. First, given that green-oriented initiatives are more diffused in legitimized contexts (Aldrich and Fiol, 1994), information asymmetries around these initiatives are comparatively lower (Pollock and Rindova, 2003). Hence, a greater number of backers would likely finance the campaign if entrepreneurs decided to collect money through crowdfunding (Ahlers et al., 2015). Second, when entrepreneurs of green initiates are legitimized to operate in the market, they are more likely to find local backers whose motivations are aligned with theirs (Calic and Mosakowski, 2016). As highlighted by prior literature, being able to attract local backers is a key determinant for the success of a crowdfunding campaign (Agrawal et al., 2014; Giudici, Guerini, Rossi-Lamastra, 2017). Thus, entrepreneurs launching green initiatives may anticipate a relatively higher probability of successfully collecting money through a crowdfunding campaign when operating in countries characterized by institutions with a strong environmental sustainability orientation. These two arguments support the view that entrepreneurs interested in running green initiatives may increasingly use crowdfunding to finance their projects when located in countries characterized by a strong environmental sustainability orientation.

In sum, we expect that in these countries, there are more green initiatives, and entrepreneurs launching these initiatives are more inclined to use crowdfunding. Thus, we derive our first hypothesis:

H1. *The probability of presenting a green campaign is higher in countries where institutions have a strong sustainability orientation.*

However, there are also reasons to expect that in countries where institutions have a strong sustainability orientation, a relatively lower share of entrepreneurs of green initiatives use crowdfunding. First, given that in these countries green entrepreneurs are more legitimized to operate in the market, they find it easier to access other sources of funding, such as direct governmental subsidies[3] (Harmon and Cowan, 2009), as well as specialized banks, credit institutions, and venture capital funds dedicated to support green entrepreneurial ventures (Hörisch, 2015). In this context, a higher availability of traditional sources of capital lowers the need for alternative sources of capital, including crowdfunding (Mollick and Nanda, 2015). Second, because of the easier access of green entrepreneurial initiatives to traditional providers of finance (Pollock and Rindova, 2003), potential backers of crowdfunding campaigns may perceive that only green initiatives of relatively lower quality will be present on crowdfunding platforms (Hildebrand et al., 2017). Accordingly, because of this adverse selection, they will be reluctant to finance green campaigns. Anticipating such an outcome, entrepreneurs would then abstain from using crowdfunding when seeking external finance for their green initiatives. These arguments lead us to our second hypothesis:

H2. *The probability of presenting a green campaign is lower in countries where institutions have a strong sustainability orientation.*

In sum, the formulation of two contrasting hypotheses leaves it to the empirical analysis to test whether the relationship between the probability to find a green entrepreneurial initiative on a crowdfunding platform and the environmental sustainability orientation of the institutions of the country where the initiative is proposed.

[3] For instance, the presence of incentives, in the form of an environmental policy (e.g., carbon policy) or of a technology policy (e.g., renewable energy policy) has been shown to be crucial in the adoption of green technologies (Kerr and Newell 2003 and Popp et al., 2011, among others).

3. METHODOLOGY

3.1 The context of the study

For this study, we develop an original dataset including all the projects presented on Kickstarter from July 1, 2009 to July 1, 2012. Kickstarter is among the largest crowdfunding providers worldwide (Colombo, Franzoni and Rossi-Lamastra, 2015), and data coming from this platform have been used in several prior studies (e.g., Pitschner and Pitschner, 2014; Mollick, 2014; Colombo et al., 2015; Butticè, Colombo, and Wright, 2017; Courtney Dutta, and Li, 2017).

Kickstarter is a *reward-based* crowdfunding platform. In other words, Kickstarter does not allow entrepreneurs to offer financial rewards, neither in the form of equity shares nor as an interest rate, in exchange to backers' support. By contrast, the platform advises creators to offer products, services and gadgets. Some rewards, associated with small contributions, are typically symbolic (e.g., "a thankful message from the creator"). Others comprise the offer of a gadget, such as a T-shirt or a key ring with the project logo. Finally, some rewards involve the pre-purchase of the product or service, and occasionally the participation in the co-creation of the product. On *Kickstarter,* entrepreneurs can cash in the money only if the capital pledged at the closure of the campaign is greater than the funding goal (these are called on the platform "successful campaigns"). However, there is no upper limit to the amount of money an entrepreneur can collect during a campaign. Thus, campaigns may raise more than 100% of the amount requested.

Kickstarter has the declared mission *to bring creative project to life*; thus, it is no surprise that many projects posted on the platforms are related to visual art (Boeuf, Darveau, Legoux 2014). However, as we will show in the descriptive statistic section, there is also a significant number of projects related to technology and product design. Overall the platform hosts projects coming from 13 different industries (called in Kickstarter, categories). These industries include art, comics, crafts,

dance, design, fashion, film, food, games, journalism, music, photo, publishing, technology, and theater.

3.2. Dependent variable: Classifying green campaigns

To test the hypotheses presented in section 2 we resort to econometric estimates where the dependent variable is a dummy, indicating whether a crowdfunding campaign relates with a green entrepreneurial initiative or not. Accordingly, our first methodological concern is the design of a robust procedure to identify green vs. non-green campaigns.

Over the years, scholars have used several approaches to identify green crowdfunding campaigns. In some cases, they have relied on human-based subjective evaluations of the green-orientation of crowdfunding campaigns (e.g., Calic and Mosakowxki, 2016); in other cases, they have used the classification of green campaigns provided on the crowdfunding platforms (e.g., Hörisch, 2015). Unfortunately, these research designs appear to be ineffective for our purposes for different reasons. Using a subjective evaluation of green campaigns based on the textual description of the projects is a very precise classification method (Kononenko and Bratko, 1991), which unfortunately can be used only when dealing with a limited sample of campaigns, due to the considerable time required to perform the evaluation. At the same time, using the platform classification of green campaigns entails the risk of overlooking a large number of green-oriented campaigns, considering that platforms typically provide a single label for each campaign (see, e.g., Mollick, 2014). Recently, Cummings et al. (2017) implemented a text analysis technique aimed at searching, in the project description, a predefined set of pertinent keywords. This approach is easily scalable to large datasets; however, it potentially introduces a bias in the classification because of the use of a dictionary of keywords arbitrarily defined by the authors. In this paper, we build on Cumming and colleagues (2017) and make an important step forward. In accordance with

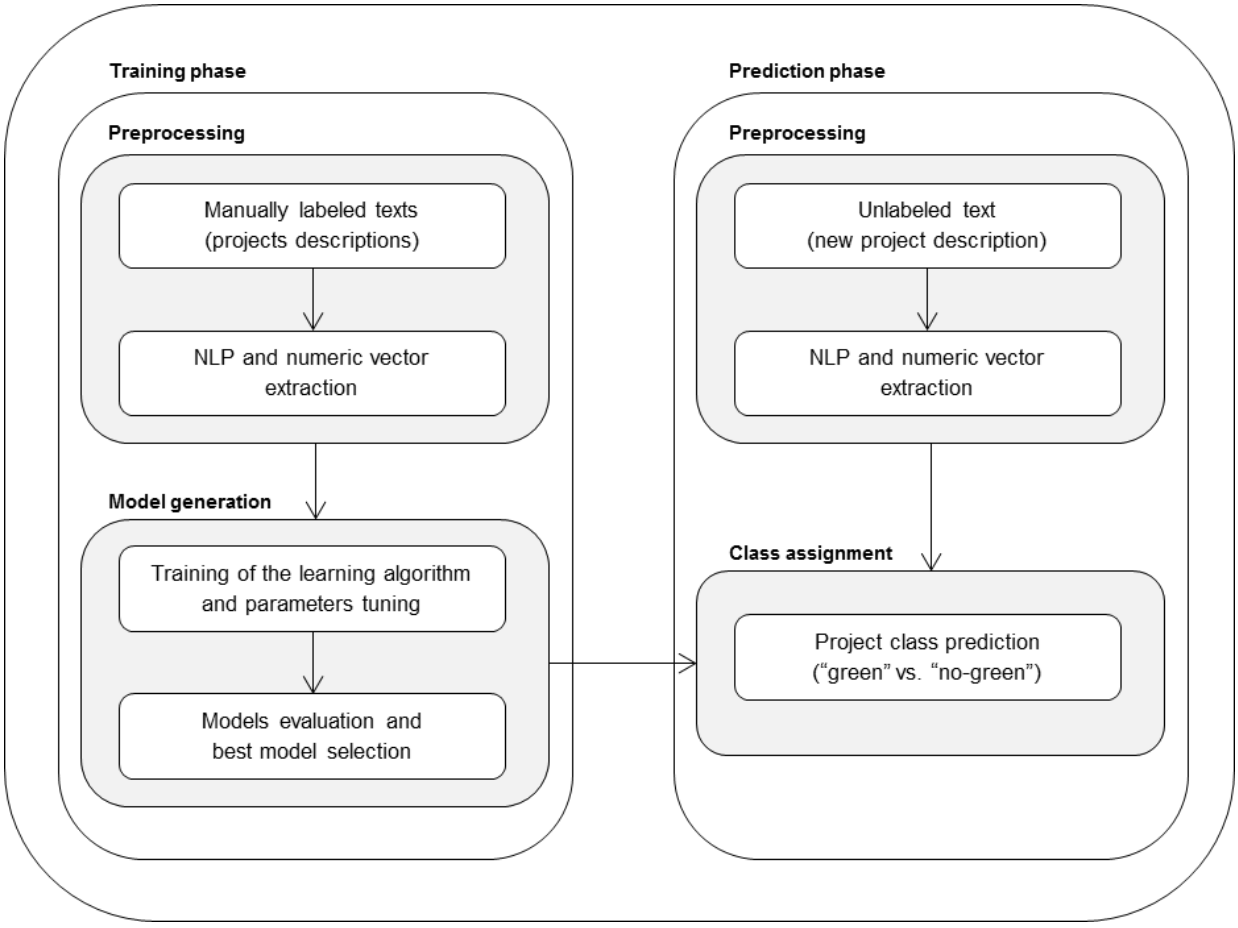
their approach, we analyze campaigns' textual description to create a dummy variable (*green*) that is used to discriminate between green and non-green campaigns. However, unlike previous studies, we resort to a machine-learning algorithm to define automatically the dictionary of keywords used to discriminate between green and non-green campaigns. Automatically extracting the keywords from the corpus of projects' descriptions rather than relying on a predetermined list of keywords has the advantage of reducing the risk of introducing biases in the creation of the variable, considering that it is much easier for an analyst to characterize a concept extensionally, i.e., to select instances of it, rather than intentionally, i.e., to describe the concept in words, or to describe a procedure for recognizing its instances (Sebastiani, 2002).

Specifically, we resorted to text classification, that is the process of automatically assigning documents to one or more predefined categories based on their content (Yang, 1999). Text classification can be naturally modeled as a supervised learning task in which a decision function is first derived by applying a machine-learning method on a set of labeled documents (training set) and then is applied to predict the category of incoming texts whose class is unknown. To this aim, a suitable representation must be designed to convert textual data into numeric vectors. A widely used approach is the bag-of-words model (Sebastiani, 2002) in which a document is regarded as a collection of terms that represent the explanatory variables (or predictors), and a numeric vector is created containing the frequency of each term in the document.

The general framework for projects classification adopted in this study is depicted in Figure 1. In the first phase, a training corpus of labeled documents was created by randomly selecting a subset of campaigns from the entire sample of projects and manually tagging their descriptions as "green" or "non-green". In so doing, we referred to the definition provided by Lehner (2013, p.2), which defined as green those initiative "that have an environmental mission as their primal goal". Manual tagging has been made on a set of 5,000 documents by two research assistants separately.

When differences in the tagging arose (less than 5% of the cases), one of the authors classified the document and then discussed the tagging with the research assistants until agreement was reached. The output of this initial phase was a set of 5,000 manually tagged texts. Each labeled text was then transformed using traditional natural language processing (NLP) filters, explained in Appendix 1 and was converted into a numeric vector as described above. A machine-learning algorithm was finally trained to determine the optimal classification function, which was subsequently used to predict the class of the remaining projects in the sample.

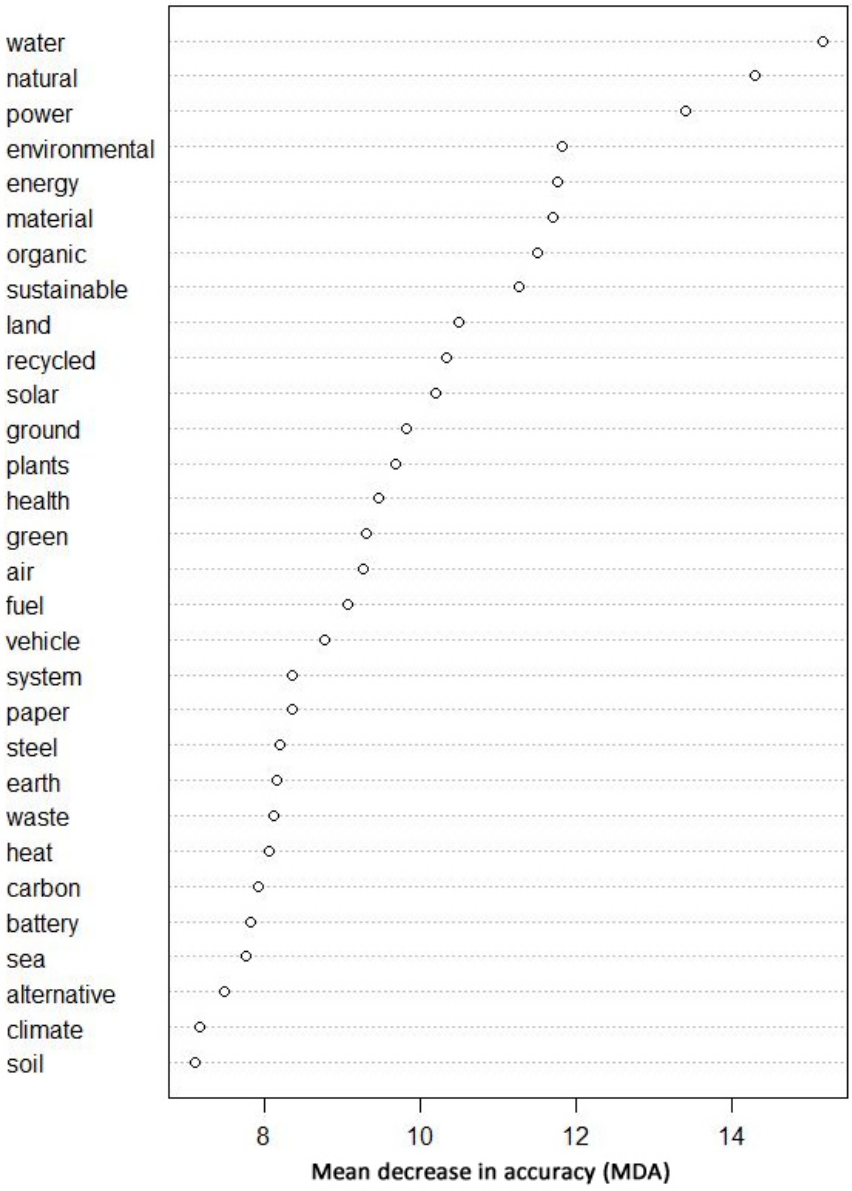
Figure 1. Projects classification framework



A variety of machine learning techniques have been effectively applied to text categorization; among these, the Random Forest algorithm (Breiman, 2001) attracted our interest due to its accuracy, efficiency, scalability and robustness. Random forest has shown great

potential in several domains, ranging from risk assessment in social lending (Malekipirbazari and Aksakalli, 2015) to bank failure predictions (Barboza et. al, 2017) and optimal investor portfolios estimation (Laborda and Laborda, 2017). In addition to the predictive ability, however, two other core features fostered its use in the present study. On the one hand, unlike other machine-learning algorithms, it requires little effort for tuning its parameters, as illustrated in Appendix 1. On the other hand, it generates internal estimates of variable importance, such as the mean decrease in accuracy (MDA), which measures the impact of the predictors individually and in multivariate interactions. Indeed, in our study, useful insights were achieved by analyzing the words that, among others, contributed most to the accurate discrimination between green and non-green campaigns. Not surprisingly, terms such as “water”, “natural”, “environmental” and “sustainable” emerged as the most influential according to the best classification model. The list of the 30 most relevant words used in the learning process is provided in Figure 2.

Figure 2. Most relevant terms for projects classification



3.3. Main independent variable: Assessing countries environmental sustainability orientation

The assessment of the environmental sustainability orientation of the institutions of different countries is a complex task, as it requires the analysis of countries' well-being over time and involves the measurement of the stocks of exhaustible resources that are passed on to future generations. Such resources are extremely varied and include not only physical capital (machines and buildings) and human capital (in the form of education and research) but also the quality of the institutions and the quantity and quality of natural resources. The task is further complicated

by the interactions that exist between the socio-economic and environmental models followed by different countries (Stiglitz et al., 2010).

Current approaches can be divided into several categories: large dashboards, composite indices, indices that comprise correcting GDP in different ways, and indices that measure overconsumption of current resources (Stiglitz et al., 2010). Among these different approaches, capturing sustainability with a single index has the undeniable advantage to facilitate our understanding and communication of economic phenomena and to enable better informed policy decisions. In fact, although often criticized for the arbitrary character of the procedures used to weight their various components, composite indices are today quite commonly used in a variety of management and policy domains (de Sherbinin et al., 2013).

As for our choice of a composite measurement of sustainability, the Environmental Performance Index (EPI) seemed particularly well-suited for the current work. It is a publicly available index used in several previous studies. More importantly, as highlighted by Thomakos and Alexopoulos (2016), the EPI reflects the aggregate result from the implementation of measures and policies on a wide range of different environmental issues, and it covers changes related to the social, technological and economic spheres. As such, it represents a highly desirable choice to measure the environmental sustainability orientation of a country's formal and informal institutions.

Specifically, the EPI covers 180 countries and comprises more than 20 indicators reflecting national-level data (for instance, trend in carbon intensity or access to drinking water). These indicators can be composed to provide scores on nine key environmental aspects (for instance, air or water resources quality). In turn, those nine scores can be further aggregated into two composite indices measuring a country relative performance with respect to two main sustainability goals: protection of human health and protection of the ecosystem. Finally, these

two indices are combined to obtain a single value, the EPI score, for each country (Table 1). Scores are given on a scale of 0 to 100 with zero being the worst observed value and 100 the best observed one (Hsu et al., 2016).

Table 1. EPI: top-30 countries

Rank	Country	Score
1	Finland	90.68
2	Iceland	90.51
3	Sweden	90.43
4	Denmark	89.21
5	Slovenia	88.98
6	Spain	88.91
7	Portugal	88.63
8	Estonia	88.59
9	Malta	88.48
10	France	88.20
11	New Zealand	88.00
12	United Kingdom	87.38
13	Australia	87.22
14	Singapore	87.04
15	Croatia	86.98
16	Switzerland	86.93
17	Norway	86.90
18	Austria	86.64
19	Ireland	86.60
20	Luxembourg	86.58
21	Greece	85.81
22	Latvia	85.71
23	Lithuania	85.49
24	Slovakia	85.42
25	Canada	85.06
26	United States of America	84.72
27	Czech Republic	84.67
28	Hungary	84.60
29	Italy	84.48
30	Germany	84.26

3.4. Control variables

Several pieces of information have been collected from Kickstarter and included as control variables in our econometric models. This information regards the crowdfunding campaign, its creator, and the country of reference.

As for the crowdfunding campaign, we kept track of its duration (*campaign_duration*) and of its target capital (*target_capital*, in US$). Specifically, the logarithm of the *target_capital* was used in the econometric specification, due to the high skewness of its distribution. Moreover, we collected information about the number of visuals (videos plus images) contained within the project description (*visuals*) and the number of links to external websites containing further information about the project (*external_information*). Prior literature has often used these measures as a proxy of the unobserved quality of the campaign (Mollick, 2014; Colombo et al., 2015). In addition, by mean of categorical variables, we coded the location of campaign (*location_country*), the category of the project according to Kickstarter taxonomy (*category*) and the date when the campaign was launched. Finally, we created a set of dummy variables indicating whether the crowdfunding campaign was located in one of the most active metropolitan areas for VC investments. Specifically, we created four dummy variables; the first (*d_SanFrancisco*) assumes the value one when the campaign was located in the San Francisco Bay Area; the second (*d_NewYork*) is equal to 1 when the campaign was located in the New York area; the third dummy variable (*d_Boston*) assumes a value equal to one for campaigns located in the Boston area; finally, the fourth variable (*d_London*) assumes a value equal to one for campaigns located in London, which is the largest VC hub in Europe (Bertoni, Colombo and Quas, 2015).

Referring to the project creator, we took inspiration from prior literature, and we collected information about creator's social capital. Similar to Mollick (2014), we created a measure of social capital external to the crowdfunding platform. Particularly, we used the log of the number of creator's Facebook friends (*ext_social_capital*) and we kept track separately of creators with no

Facebook account (*d_nofacebook*). Moreover, we added information about the social capital developed by a creator within the crowdfunding platform. In line with Butticè and colleagues (2017), we computed this measure by using the log of the number of comments that the creator had posted on backed campaigns at the point of the launch of the focal campaign (*internal social capital*). In addition, we created a dummy variable (*d_education*) to keep track whether a creator had obtained a degree. For creating this variable, we collected creators' biographies posted on Kickstarter. We then developed an ad hoc content analysis algorithm, based on a search for characterizing terms in the creator's bio. In particular, we looked into the bio posted on Kickstarter to check whether the creator reported words related to higher education (e.g. bachelor, degree, etc.). We then tested the goodness of this methodology on a random sample of 2,000 bios. To this aim, we asked two research assistants to read each of these bios to determine whether the creator reported to have at least a degree before the campaign. The algorithm performed well in approximately 90% of the cases.

Finally, as for the country of reference, we computed a variable (*CF_activity*), which measures the total number of crowdfunding campaigns launched in each country.

3.5. Descriptive statistics

Overall, among the 48,598 crowdfunding campaign posted on Kickstarter during the considered time window, 9.63% have been classified as green (4,682 projects). These projects include, among others, a new solar thermal panel to heat water without using any fossil fuel, a documentary to raise awareness about the environmental damages connected to the fishing industry, and a book to inspire children to maintain, plant and protect trees. The number of green crowdfunding campaigns increased steadily semester by semester. In Table 2, we report the share and the absolute number of green campaigns over time, together with the total number of crowdfunding campaigns presented in the same time period.

Table 2. Statistics of green campaigns over time

Semester	Number of campaigns	Number of green campaigns	Number of non-green campaigns	Share of green campaigns (%)
2009h2	1,017	84	933	8.3%
2010h1	3,328	262	3066	7.9%
2010h2	6,022	409	5613	6.8%
2011h1	10,978	884	10094	8.1%
2011h2	12,356	1,197	11159	9.6%
2012h1	14,897	1,846	13051	12.4%

In the second half of 2009, only 8% of the campaigns (84 of 1,017) were related to a green project. This share remained stable in the first year and a half and then increased in the second semester of 2011 to 9.7% (1,197 of 12,356). The share of green campaigns increased again up to 12.4% in the first semester of 2012, indicating an increasing recourse of crowdfunding to seek the money for green-related projects.

In Table 3, we report the number of green crowdfunding campaigns across categories. In absolute terms, “Film and Video” is the project category including the most green crowdfunding campaigns (938). The category “Art” follows with 638 campaigns. With no surprise, there is a limited number of campaigns related to green projects in the category “Dance” (25 campaigns) and “Crafts” (21 campaigns). Proportionally, “Food” is the category hosting the largest share of green campaigns, with approximately 40% of the campaigns green-oriented, e.g., related to the production of food with low environmental impact techniques. A significant share of campaigns is related to green projects also in the categories “Technology” and “Design”, where 38% of the campaigns are green-oriented. In contrast, only a limited share of green projects is included in the categories “Comic” (8%), “Theater” (3%) and “Dance” (3%).

Table 3. Comparison between green and non-green campaigns across Kickstarter categories

	N° campaigns	Green campaigns	Non- green campaigns	Share of green campaigns (%)
Art	4,358	638	3,720	14.6%
Comics	1,182	61	1,121	5.2%
Crafts	153	21	132	13.7%
Dance	761	25	736	3.3%
Design	1,567	611	956	38.9%
Fashion	1,154	167	987	14.5%
Film & Video	14,030	938	13,092	6.7%
Food	1,423	575	848	40.4%1
Games	1,688	406	1282	24.0%
Journalism	249	23	226	9.2%
Music	12,350	251	12,099	2.0%
Photography	1609	178	1431	11.1%
Publishing	4,485	372	4,113	8.3%
Technology	870	334	536	38.4
Theater	2,719	82	2,637	3.0%
Total	48,598	4,682	43,916	9.6%

Green campaigns significantly differ from others along several dimensions. Green campaigns attract an average of 237 (s.d. 2053) backers and are able to collect an average of $18,467 (s.d. 174,036), compared to the 56 backers (s.d. 256) and $3,887 (s.d. 16,422) of non-green campaigns. These statistics suggests that backers of green crowdfunding projects on average pledge larger amounts of money compared to the backers of non-green campaigns ($77.91 vs. $70.67). This result is consistent with Cumming et al. (2017) and supports the view that crowdfunding is an important source of funding for green-oriented projects, with backers even willing to pledge more money to this category of projects. Table 4 reports additional descriptive statistics for green and non-green campaigns. Green campaigns have a higher target capital ($18,288 vs. $10,157), display a larger amount of visuals (4.02 vs. 1.72), and provide more external links (1.89 vs. 1.65). No

significant difference is detected about the campaign duration. Interestingly, green campaigns are presented by creators with lower levels of external social capital (Mollick, 2014) compared to the creators of non-green campaigns. In contrast, green campaigns creators have on average a higher level of internal social capital (Butticè et al., 2017). Finally, green campaigns are more often presented by creators who hold a university degree.

Table 4. Comparison between green and non-green campaigns

	Non-green campaigns	Green campaigns	Statistical test[a]
Observation	43,916	4,682	
target_capital	10,157.99	18,288.38	**
	(180,089.2)	(68,370.3)	
external_information	1.65	1.89	**
	(1.49)	(1.53)	
visuals	1.72	4.02	**
	(2.46)	(5.37)	
duration	39.22	38.82	
	(0.07)	(0.20)	
external_social_capital	24.28	9.87	**
	(1.040)	(1.014)	
internal_social_capital	2.63	3.89	**
	(1.04)	(1.14)	
d_education	0.04	0.05	**
	(0.001)	(0.003)	

Legend: a) t-test or proportion-test depending on variable distribution

Table 5 illustrates the geographical distribution of green campaigns. It is no surprise that the majority of green campaigns is located in the U.S. (4,177 of 4,682). The second most common location for green campaigns is Canada, while in Europe, the most common location is Great Britain. However, when looking at the share of green crowdfunding campaigns, Kenya is at the top of the ranking. In that country, of 24 projects, 8 are green-related. In contrast, only 6.4% of the crowdfunding campaigns in Germany are green. If one looks at the EPI in different countries, an

interesting statistic emerges. Indeed, the index is significantly and *negatively* correlated with the share of green campaigns in each country (-0.3481, significant at 5%). In other words, when a creator decides to launch a campaign on Kickstarter, the probability that this campaign is green is higher when the campaign is located in countries with a lower value of the environmental performance index.

Table 5. Statistics of green campaigns across countries

	Number of campaigns	Number of green campaigns	Share of green campaigns	EPI Index
US	44,941	4,177	0.09	84.72
CA	285	53	0.19	85.06
GB	237	28	0.12	87.38
DE	102	7	0.07	84.26
IN	76	12	0.16	53.58
IT	75	8	0.11	84.48
FR	69	6	0.09	88.2
CN	63	13	0.21	65.1
AU	61	14	0.23	87.22
JP	59	10	0.17	80.59
MX	57	13	0.23	73.59
IL	51	5	0.10	78.14
ZA	45	12	0.27	70.52
ES	32	1	0.03	88.91
HT	30	4	0.13	43.28
TH	29	2	0.07	66.54
CZ	28	0	0.00	84.67
NL	27	0	0.00	82.03
AR	25	2	0.08	79.84
ID	24	7	0.29	65.85
KE	24	8	0.33	62.49
BR	23	7	0.30	78.9
IE	23	2	0.09	86.6
TR	23	5	0.22	67.68
PE	22	6	0.27	72.95
EG	21	1	0.05	66.45
NZ	21	6	0.29	88
IS	20	2	0.10	90.51
DK	18	3	0.17	89.21

NP	18	4	0.22	50.21
SE	18	3	0.17	90.43
KR	17	2	0.12	70.61
PR	17	1	0.06	88.63
TZ	16	3	0.19	58.34
Other	2001	255	0.13	

4. MAIN RESULTS

4.1 The association between the environmental sustainability orientation of countries' institutions and the probability of presenting a green campaign

To test the hypotheses presented in section 2, we run a set of logit estimates with robust standard errors that account for possible biases due to heteroscedasticity and used the probability of observing a green (vs. non-green) campaign on the platform Kickstarter, as the dependent variable. Table 6 reports the results of our estimates. First, we consider control variables (see Model I). The multivariate analysis confirms the results illustrated in the previous section. Green crowdfunding campaigns have larger target capital, provide more visuals in the description and include a larger number of external links. Conversely, green crowdfunding campaigns are not significantly different from their non-green counterparts in terms of duration. Green crowdfunding campaigns are launched by creators with a significantly larger level of social capital developed within the crowdfunding platform, but a lower level of external social capital. In addition, the analysis shows that green crowdfunding campaigns are more likely launched by creators who have obtained a university degree, even if the coefficient of this variable is only weakly significant. We controlled also for the category of the focal campaign on Kickstarter and the timing when the campaign was launched. The results related to the category of the campaign should be compared to the baseline of a project belonging to the category "Food". Coefficients are negative and significant for all categories except for "Design" and "Technology", which show a positive and significant coefficient. Thus, compared to the baseline of a campaign belonging to the

food category, campaigns in the technology and design categories have a higher probability of being green, while for campaigns belonging to all the other categories, this probability is lower. The results related to the timing of the campaign should be interpreted compared to the baseline that a campaign was launched in the first semester of 2012. All coefficients are not statistically significant, thus suggesting that campaigns launched in 2012 are no more likely to be green, in contrast to the result shown in the univariate analysis. The econometric analysis also shows that the probability of launching a green campaign is lower when the campaign is located in the San Francisco Bay Area or in the New York Area, compared to somewhere else. A possible explanation is that creators in these areas may resort to other funding sources to finance their green projects. Finally, the overall country crowdfunding activity is negatively associated with the probability of presenting a green campaign.

In model II, we add the EPI variable as a proxy of the environmental sustainability orientation of the institutions of a focal country. The analysis confirms a negative and significant association between the value of EPI in the focal country and the probability of presenting a green campaign. This effect is also large in magnitude. For instance, a campaign located in Turkey, which represents the 10^{th} percentile of the EPI distribution in our sample (99^{th} overall position according to EPI), is 64% more likely to be green compared with a campaign located in the UK, which corresponds to the 90^{th} percentile of the EPI distribution (13^{th} overall position according to EPI). At the mean value of all other variables, the predicted probability of a campaign being green increases from 6% to 11%. This result suggests a possible crowding out effect. When a country puts environmental issues at the top of its priorities, formal and informal institutions are oriented toward sustaining green projects. In this context, the need for crowdfunding is lower, as traditional sources of funding are available to creators. In contrast, when creators are located in countries with a limited green orientation, it is difficult for them to find traditional sources of

funding. In this scenario, they are more inclined to use crowdfunding to collect the money required for their projects.

Table 6. Main model

green	I	II
EPI		-0.0068**
		(0.003)
int_social_capital	0.0771***	0.0769***
	(0.008)	(0.008)
ext_social_capital	-0.071***	-0.074***
	(0.011)	(0.011)
d_nofacebook	-0.445***	-0.461***
	(0.074)	(0.073)
moreinfo	0.1130***	0.1148***
	(0.016)	(0.016)
ln_visual	0.4504***	0.4513***
	(0.012)	(0.012)
ln_target	0.1883***	0.1886***
	(0.007)	(0.007)
duration	0.0001	-0.001
	(0.001)	(0.001)
d_education	0.0479	0.0526
	(0.039)	(0.039)
CF_activity	-0.004**	-0.003
	(0.002)	(0.003)
d_2009	0.0240	-0.0214
	(0.076)	(0.076)
d_2010	0.2253	0.0194
	(0.029)	(0.029)
d_2011	-0.001	-0.033
	(0.019)	(0.020)
art	-0.084***	-0.091***
	(0.031)	(0.032)
comics	-0.763***	-0.763***
	(0.062)	(0.063)
crafts	-0.010***	-0.007
	(0.138)	(0.137)
dance	-0.623***	-0.618***
	(0.085)	(0.085)
design	0.3801***	0.3744***
	(0.038)	(0.038)
fashion	-0.161***	-0.165***

	(0.047)	(0.047)
film	-0.517***	-0.531***
	(0.027)	(0.028)
games	-0.061***	-0.052***
	(0.039)	(0.040)
journalism	-0.236**	-0.230**
	(0.122)	(0.122)
music	-0.889***	-0.887***
	(0.033)	(0.033)
photo	-0.200***	-0.201***
	(0.047)	(0.048)
publishing	-0.381***	-0.316***
	(0.033)	(0.034)
tech	0.555***	0.565***
	(0.046)	(0.047)
d_SanFrancisco	-0.032	-0.014
	(0.046)	(0.046)
d_Boston	0.0230	0.0377
	(0.066)	(0.066)
d_NewYork	-0.1286***	-0.1288***
	(0.028)	(0.028)
d_London	0.2498	0.2501
	(0.163)	(0.163)
Country_dummy	YES	YES
cons	-2.3143***	-1.9532***
	(0.118)	(0.241)
N° observations	48,598	48,598
Pseudo R^2	0.2105	0.2186

4.2 Robustness checks

To assess the robustness of our results and avoid biased interpretation, we performed additional analyses. First, we controlled for possible biases due to outliers. Following extant research on the topic (Wainer, 1976), we winsorized continuous variables included in our estimates at the top and bottom 1%. The results are consistent with those included in the main model. As a further control, we performed a 1%, 5%, and 10% trimming of the data to remove extreme values from the estimates. The results again are consistent (available from the authors upon request). Second, we

excluded campaigns located in the U.S. to avoid the risk that the analysis was biased by the large number of campaigns located in the country. The results of this check (Table 7, column I) are in line with those of the main model, thus suggesting that the association is not driven by the large number of campaigns in the U.S. Third, we focused our analysis on crowdfunding campaigns launched in the U.S., and we differentiated among U.S. states (column II). In this case, considering that the EPI index is calculated at the country level, we resorted to another indicator to serve as a proxy for the environmental sustainability orientation of institutions. Specifically, we used the 2017's Greenest States ranking, which considers 20 different pieces of information at the U.S. state level about i) Environmental Quality, ii) Eco-Friendly Behaviors and iii) Climate-Change contribution. In contrast with the EPI, the Greenest States ranking reports first the U.S. state with the highest environmental sustainable orientation. To make the results of this model easily comparable with those of the main models, we included in the model specification a variable equal to *50-Greenest States ranking, such that a* higher environmental sustainable orientation was associated with the larger values of this variable. Also in this case, we found support for the robustness of the results. Indeed, the coefficient of the Greenest State Ranking variable again is negative and significant at 1%.

Table. 7 Robustness checks model

green	I	II
EPI	-0.006**	
	(0.003)	
Greenest States		-0.0101***
		(0.002)
int_social_capital	0.0924***	0.0625***
	(0.033)	(0.009)
ext_social_capital	-0.086*	-0.0756***
	(0.050)	(0.013)
d_nofacebook	-0.617*	-0.4871***
	(0.331)	(0.081)
moreinfo	0.0704	0.1257***
	(0.062)	(0.018)

ln_visual	0.4436***	0.4173***
	(0.053)	(0.015)
ln_target	0.1719***	0.1911***
	(0.032)	(0.008)
duration	-0.001	-0.0001
	(0.002)	(0.001)
d_education	0.0895	0.0489
	(0.127)	(0.044)
CF_activity	-0.007	
	(0.0044)	
CF_activity_US		0.0002**
		(0.000)
d_2009	0.40577*	0.0075
	(0.255)	(0.084)
d_2010	0.1442	-0.0194
	(0.118)	(0.032)
d_2011	0.1035	-0.0282
	(0.081)	(0.021)
art	0.1781	-0.1054***
	(0.157)	(0.035)
comics	-0.5800*	-0.8428***
	(0.323)	(0.069)
crafts	0.1871	-0.1647
	(0.733)	(0.154)
dance	-0.4204	-0.7468***
	(0.320)	(0.096)
design	0.6619***	0.3552***
	(0.182)	(0.042)
fashion	0.4695*	-0.2056***
	(0.270)	(0.053)
film	-0.2370	-0.6577***
	(0.144)	(0.031)
games	0.1744	-0.1289***
	(0.196)	(0.044)
journalism	0.0245	-0.3230**
	(0.343)	(0.140)
music	-1.0910***	-0.9949***
	(0.226)	(0.036)
photo	-0.1356	-0.2775***
	(0.173)	(0.055)
publishing	0.1344	-0.4605***
	(0.165)	(0.038)
tech	0.5033**	0.4755***
	(0.202)	(0.052)

d_SanFrancisco		-0.355***
		(0.0685)
d_Boston		0.0571
		(0.1298)
d_NewYork		-0.267***
		(0.0063)
d_London	0.2563	
	(0.1599)	
Country_dummy	YES	
State_dummy		YES
cons	-1.7836***	-2.7042***
	(0.480)	(0.105)
N° observations	3657	44941
Pseudo R2	0.1838	0.2098

5. CONCLUSION

In this paper, we studied how country-level, institutional settings might affect the emergence of green initiatives on crowdfunding platforms. Using data collected from Kickstarter and other public sources, we show that the probability of presenting a green campaign is, indeed, lower in countries with higher values of the EPI index. This supports the view that in countries where institutions have a strong sustainability orientation, green entrepreneurial initiatives might find easier access to traditional sources of funding, such as specialized credit institutions, public subsidies or dedicated VC funds. Also, it is indicative that traditional sources of capital might be, in fact, preferred by entrepreneurs, to avoid adverse selection on crowdfunding platform (where potential backers would expect to find only initiatives of relatively lower quality).

Conversely, the two arguments of higher legitimacy (hence easier access to the resources that are necessary to grow) and higher opportunities of finding local backers in countries whose institutions presents a strong sustainability orientation, are not supported by our data.

All in all, this study contributes to the literature in several respects. First, our results add to the debate on the role of crowdfunding as an alternative source of funding for environmentally sustainable projects (e.g., Hörisch, 2015; Belz and Binder, 2017). Specifically, our data suggests that crowdfunding is particularly used to finance green initiatives located in countries where institutions are less oriented toward environmental sustainability and that it helps to relax the constraints that make it difficult for green entrepreneurs to access the external resources (notably finance) required to successfully develop their projects. Second, this paper contributes to the broader literature on the reasons driving creators to resort to crowdfunding (e.g., Gerber & Hui, 2013), by showing that also country-level dimensions influence the creator's motivation to present a campaign. More specifically, the paper contributes to the nascent debate on how country-level institutional and socio-cultural aspects influence the choice of launching a crowdfunding campaign (e.g., Cumming, et al., 2017), through the influence they exert on the behavior of both creators and backers. In this respect, our results suggest a negative relationship between a country sustainability orientation and a creator's preference for crowdfunding. The final important contribution of this work is methodological. Often, prior literature on crowdfunding has disregarded the actual content of the campaign in their analysis (Bogers, Cincotti, Nielsen, Testa, 2017; Nielsen and Reisch, 2016). In this paper, we overcome this limitation by using the campaign description as the main informative sources in combination with an easily scalable machine-learning algorithm to classify green vs. non-green crowdfunding campaigns. Given the amount of textual information provided in a crowdfunding campaign, we advise scholars to introduce similar methodologies in their studies, particularly when they are interested in emerging fields, such as nanotechnologies, self-driving vehicles or the Internet of things, which generally are not well covered by standard classification.

We acknowledge that this paper is not exempt of limitations. First, we used cross-section multivariate analysis to investigate the association between green-oriented crowdfunding campaigns and the environmental sustainability orientation of institutions at the country level. However, our analyses do not provide any compelling evidence about neither the casual linkage nor the mechanisms underlying this relationship. We call for further studies that, by using a different research design, can overcome this limit. Second, our paper focuses on the use of crowdfunding to finance green-oriented campaigns in different institutional settings. By contrast, it does not provide evidence about the likelihood of success of these campaigns. As prior literature has provided inconclusive results on the topic, we call for further studies to provide robust quantitative-based evidence on the issue and its underling mechanisms. Finally, we limit our analysis to campaigns posted on Kickstarter. Using data from a single platform raises some caution about the generalizability of our results. Kickstarter is a reward-based generalist platform, so it is not clear whether our findings extend to other forms of crowdfunding (e.g., equity crowdfunding and peer-to-peer lending) or to specialized green-oriented platforms (e.g., the platform "Greenfunding"). Developing a data set including crowdfunding campaigns from multiple platforms would allow future studies to observe whether our results are context-specific rather than generalizable to any platform type.

These limitations withstanding, we believe that our paper has interesting implications for policymakers and practitioners. First, policymakers in countries where institutions have limited sustainability orientation, should consider that local entrepreneurs are inclined to use crowdfunding to overcome the funding gap they suffer. Moving from this evidence, policymakers in these countries can define economical measures to sustain these green initiatives. For instance, they may focus on providing support to entrepreneurs in the process of designing and running their crowdfunding campaigns. Similarly, they can promote tools to advertise and share green-

oriented campaigns among citizens. Such tools would help to increase the public awareness about the campaigns, their legitimacy, and ultimately their chances of obtaining the required funding. Policy makers in these countries may also use crowdfunding as a privileged source of information to have an outlook on green emerging trends and define funding priorities according to the backer's reaction to different campaigns. Conversely, policymakers operating in countries with a strong environmental sustainability orientation should consider the results of this paper to inform the debate about the use of crowdfunding for supporting green projects. Often policymakers in countries with a strong environmental sustainability orientation have agreed that crowdfunding is an important source of funding for green initiatives[4] and have developed ad hoc measures to support these campaigns[5]. However, our analysis shows that only a limited share of entrepreneurs resorts to crowdfunding when seeking money for their green initiatives possibly driven by an adverse selection process existing for these initiatives. In light of our results, we advise policymakers to re-design direct forms of support to green oriented crowdfunding initiatives presented in these countries to expunge the risk of subsidizing lower quality projects. Finally, the results of this paper are relevant also for practitioners. In countries with limited environmental sustainability orientation, creators interested in running a green initiative should consider that many others preceded them. Considering that closed crowdfunding campaigns typically remain accessible on the platform websites (Butticè, Orsenigo & Wrigth, 2017), predecessors' experiences may become an important source of hints for prospect creators to increase the chances of success for their campaigns. More generally, the significant number of creators who use crowdfunding for financing green initiatives in these countries creates interesting market opportunities. For

[4] See, e.g., https://www.theneweconomy.com/energy/crowdfunding-could-create-a-greener-world, accessed on November 3, 2017.

[5] For instance, the program "Public Spaces Community Places" resulted from the joint effort of the Michigan Economic Development Corp. (MEDC) and a local crowdfunding platform proposes that civic projects (many of which green-oriented) that reach success in a crowdfunding campaign will get a matching public grant up to 50,000$.

instance, advisors and consulting companies that support creators in designing a crowdfunding campaign (e.g., to write an appealing description in English) may find fertile ground to establish their businesses in these countries. Similarly, the results of this work are also relevant for practitioners in countries with a strong environmental sustainability orientation. Creators in these countries should be aware that presenting a green-oriented campaign may be a double-edged sword. On the one hand, green-oriented campaigns may engender an advantage for creators; creators would face less competition due to the share of green campaigns limited. On the other hand, considering that creators in these countries typically do not use crowdfunding for financing green-oriented initiatives, backers may perceive their projects as being of low quality and avoid financing them. Creators informed of the results of this paper should put in place actions to limit the negative side effect related to the perceived low quality of their campaigns (e.g., writing a convincing description that stresses the high quality of the initiative and providing more numerous and informative external links). In this way, they will fully benefit from the lower level of competition.

Overall, our paper has provided important insights about the use of crowdfunding to finance green-oriented initiatives. Considering that crowdfunding is still an expanding field, it seems likely that more green-oriented initiatives will resort to it in the future, making this funding method an important source of funding for this category of projects, particularly in countries where institutions have limited environmental sustainability orientation.

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APPENDIX

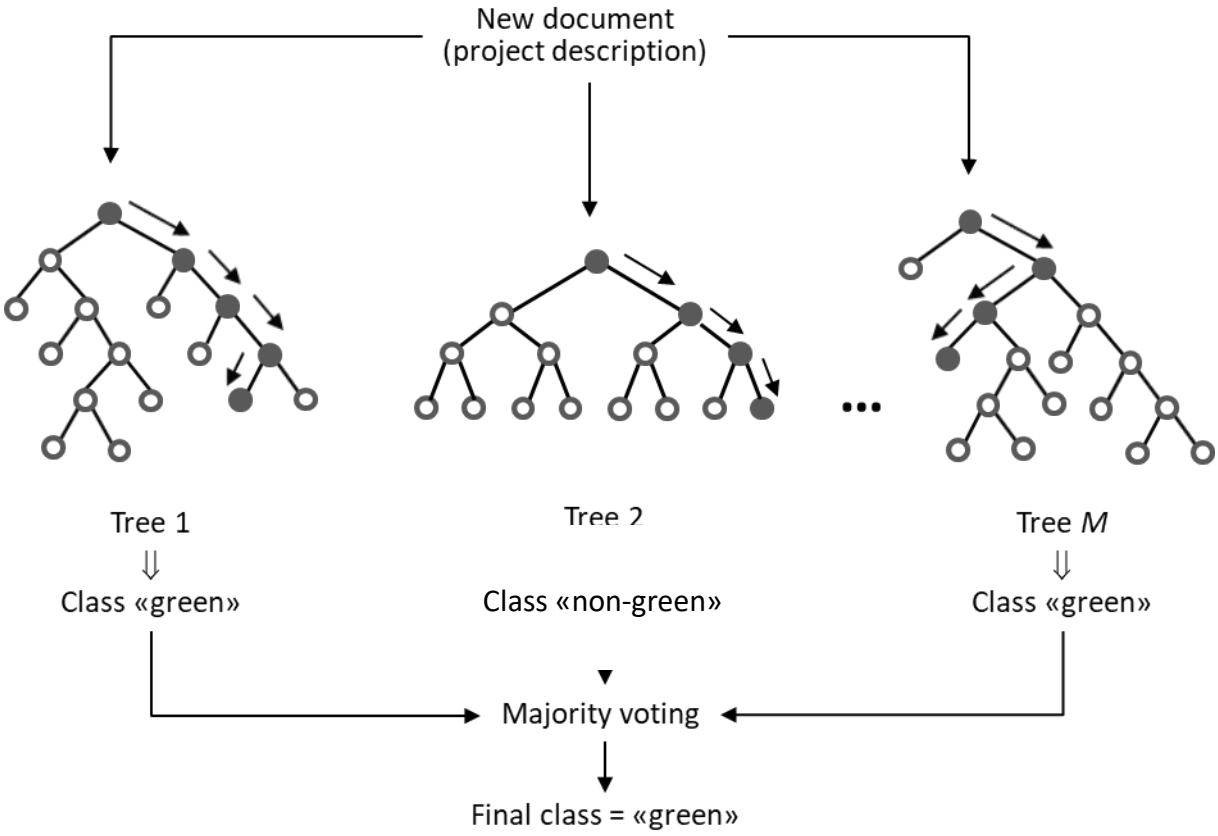
Appendix A1- Discrimination between green and non-green projects via text classification

The classification of the projects encompassed several steps. First, we collected a set S of documents used for training. These consisted in the descriptions of 5,000 campaigns randomly selected from the entire sample of 48,598 projects, which were manually labeled as "green" (26%) and "non-green" (74%). Textual data were then tokenized and represented as vectors of terms according to the bag-of-words model. Indeed, each description was converted into a multi-dimensional feature vector, where each dimension contains the frequency of occurrence of the corresponding word. Before tokenization, classical NLP filters were applied. Specifically, we dropped punctuation and numbers, converted all upper-case to lower-case letters and performed stop word removal, with the aim of discarding English-specific functional terms that are highly frequent but useless for text classification. Another common filter known as stemming was not applied since we observed a mild degradation of the prediction performance when the root of the words was employed in place of their original form. A final filter was instead used to remove the terms occurring in less than five documents; this led to a final dataset comprising 5,000 labeled examples and 1,243 explanatory variables (words).

For supervised learning, we resorted to the Random forest algorithm, which represents a powerful extension of decision trees (Breiman et al., 1984). Random forest (RF) is an ensemble technique that grows a collection of binary classification trees to vote for the most popular class. According to the RF paradigm, random perturbations are introduced in the learning procedure with the purpose of enhancing the effectiveness of classical decision trees, which usually suffer from high variance. Specifically, several classification trees are independently built on different subsets of data comprising examples randomly selected from the training set (bootstrapped instances), to reduce the complexity of the model and the risk of overfitting. Moreover, to further

diversify the decision trees and avoid correlation in the bootstrapped samples, the recursive partitioning of the nodes in a tree is based on a random subset of candidate explanatory variables, for which the best split is determined. Once the forest of random trees is learnt, the classification of new examples is performed through a majority voting scheme: indeed, each new example receives a label by traversing each tree from the root node to one of the leaves, and the most popular label is assigned as the final prediction, as illustrated in Figure 3.

Figure 3. Random forest class prediction based on majority voting scheme



Random forest models depend on three parameters: the number of trees in the forest (M), the maximum number of variables to select in individual trees (p) and the maximum number of their leaves (g). In our computational setting, as recommended in (Breiman, 2001), we set $p = \sqrt{n}$, where n is the total number of variables in the dataset, and $g = 1$, thus leaving the trees to

grow at their maximum depth. The number of trees was instead set to M=200, since at this value, we reached a satisfactory and stable out-of-bag estimate of the generalization error (4.8%).

Once the RF model was built with this fixed set of parameters, it was used to classify the remaining 43,598 projects; among these, 3,633 (9%) were labeled "green" and the rest 39,965 (91%) as "non-green".

The Random forest algorithm used in the present study can be summarized as follows:

1) For $i = 1, \dots, M$:
   a. Draw a bootstrap sample of documents from the original training dataset S.
   b. Build a classification tree on the bootstrapped sample by recursively repeating the following steps for each node, until its maximum size is reached:
      i. Randomly select p variables out of the n predictors.
      ii. Select the best split based on one of the p variables and divide the current node into two children nodes.
2) Output the set of trees generated.
3) Combine the trees predictions to assign the class to out-of-sample documents based on the majority voting principle.

To obtain an insight into the Random forest outcome, we investigated the variable importance according to the mean decrease in accuracy (MDA), which, in our case, measures the impact of each word on the quality of the model. The idea behind MDA is to permute the values of each variable and evaluate at what extent the permutation affects the prediction error. For irrelevant terms, permutation should have little or no effect; in contrast, permuting the values of informative words should significantly decrease the accuracy of the model. The result of this analysis is shown in Figure 2, where the terms at the top of the list appeared as the most influential, being associated with the largest drop in accuracy. As we might expect, the most relevant terms are highly pertained to green campaigns, mainly devoted to promoting innovative ideas addressing environmental and natural elements, new materials or novel green technologies for transportation or energy supply.

Appendix A2- Examples of green projects

Green project 1:

Traditional solar thermal panel design has not changed much since their conception and have a bad name for being expensive, too large, inefficient, obtrusive and have a very long payback time, to mention just a few of the shortfalls.

My idea, when I started on this project 8 years ago, was to make them cheaper, smaller and longer lasting enabling a shorter payback period, aesthetically pleasing ie designing them to lie virtually flat and invisible on a roof or in the garden without the use of a mounting frame to angle them at 45 degrees. They are also dual purpose enabling the same panel design to heat both swimming pool and domestic hot water. The specially designed concave/convex Polycarbonate dome cover allows the sun's rays to penetrate the water tube chamber more effectively whatever the time of day or year, and the 12 volt air circulatory fan allows a multi-layer water tube system to be incorporated by circulating the hot air around the lower tubes. This ensures that the heat around the tubes is evenly distributed and together with having a far greater volume of water circulating through the tubes, a much higher flow rate can be achieved which is extremely beneficial especially for heating large volumes of water such as swimming pools.

Using some of the patented design features of the panel, I then incorporated them into a design for the solar oven again making it cheap to manufacture, long lasting and portable. […]

Green project 2:

The documentary explores the forces threatening our commercial fishing industry and depicts how our choices as consumers impact markets and drive change. Finally, we hope the solutions featured in this film will spark a movement to improve food safety, save jobs and protect the marine environment.

We will take our audience on a global journey. Preserving species, thriving fishermen, and feeding the world are all possible. This film spells out to consumers where their fish comes from, who is catching it, and how it lands on their plate. But it goes even further. To show how and why we must change the way we currently supply seafood in the United States today. […]

Green project 3:

Our vision is to be a leader in creating a healthy and robust urban forest by inspiring and engaging citizens to maintain, plant and protect trees. We believe this project can provide parents and educators a way to start cultivating the stewards of tomorrow's urban forest.

The point of this project is to create and publish a charming and unique children's book, which reflects both the spirit of Pittsburgh as well as the organizational mission of the company. The book will be geared specifically toward a 4th and 5th grade audience, but it can be enjoyed and is engaging to tree lovers of any age! Although it will have a unique Pittsburgh flair, it is our intention to keep the messages of stewardship universally accessible, in order to create an educational tool that can be used anywhere. […]

Appendix A3. Greenest US states rank

	Greenest US states rank	Ratio green campaign over total
Alabama	34	0,141
Alaska	25	0,141
Arizona	42	0,179
Arkansas	44	0,141
California	43	0,157
Colorado	28	0,208
Connecticut	7	0,116
Delaware	45	0,110
Florida	17	0,135
Georgia	37	0,107
Hawaii	49	0,237
Idaho	38	0,208
Illinois	13	0,131
Indiana	32	0,124
Iowa	14	0,134
Kansas	18	0,157
Kentucky	41	0,113
Louisiana	47	0,105
Maine	11	0,168
Maryland	24	0,127
Massachusetts	4	0,239
Michigan	8	0,126
Minnesota	2	0,142
Mississippi	22	0,072
Missouri	10	0,127
Montana	50	0,239
Nebraska	30	0,141

Nevada	35	0,211
New Hampshire	29	0,220
New Jersey	33	0,121
New Mexico	40	0,173
New York	12	0,117
North Carolina	21	0,156
North Dakota	20	0,153
Ohio	26	0,115
Oklahoma	48	0,105
Oregon	9	0,187
Pennsylvania	31	0,142
Rhode Island	15	0,132
South Carolina	16	0,123
South Dakota	6	0,163
Tennessee	23	0,083
Texas	39	0,137
Utah	19	0,222
Vermont	1	0,196
Virginia	46	0,150
Washington	3	0,176
West Virginia	27	0,089
Wisconsin	5	0,134
Wyoming	36	0,220