

Responding to the greatest challenges? Value creation in ecological startups

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ABSTRACT

Massive problems trigger massive entrepreneurial opportunities. For this reason, environmental issues such as earth system processes that have extended beyond their thresholds, or are approaching such thresholds, constitute interesting opportunities, especially for ecological startups, to establish appropriate businesses that create value to address such environmental issues. Our analysis of 212 ecological startups from the United States and beyond reveals the factors shaping the value creation activities of these firms. In particular, we are able to illustrate that technologically-oriented, socially-oriented, and organizationally-oriented value creation by ecological startups requires different alignments in terms of the environmental issues addressed, the sustainability strategy employed, and the sustainability ambition aspired.

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1. Introduction

The desire to achieve ever higher levels of economic development is naturally restrained by what the earth can bear. The transgression of planetary boundaries, which are the natural limits of so-called *earth system processes*, can be seen as one of the greatest dangers not only for the environment as such but for every society worldwide (Steffen et al., 2015). However, global problems often offer opportunities, and especially for entrepreneurs able to provide business solutions by creating value that mitigates those problems. It is a central tenet of the academic discourse around entrepreneurship that the larger the problem, the bigger the opportunity for entrepreneurial action (Kuckertz and Wagner, 2010). This is because where market mechanisms fail, negative ecological effects can create opportunities for sustainable entrepreneurs (Dean and McMullen, 2007). Entrepreneurs might exploit these ecological opportunities to maximize profits or simultaneously create economic, ecological, and social value through business

activity that addresses a critical earth system process (Shane and Venkataraman, 2000; Dean and McMullen, 2007).

Achieving such a goal demands implementing an appropriate business model centered around value creation. The academic discourse has consequently focused on enhancing our understanding of value creation and business models as such (Zott et al., 2011; Foss and Saebi, 2017) and of sustainable business models in particular (Boons and Lüdecke, 2013). What unifies these different perspectives is that the way in which a business model creates value is at the heart of every conceptualization. For sustainable business models this value results from a unique combination of ecological and social benefits (Biloslavo et al., 2018; Schaltegger et al., 2012) that at the same time facilitates generating economic profit. However, it may be difficult to market the business solution of a startup if customers are not willing to pay for the additional social and ecological value created by the more sustainable nature of its products and services. Therefore, startups need to activate and merchandize value creation more intensively for the customer and for the ecological and social environment, which requires they move beyond traditional business models and embrace additional ecological and social value creation.

The present paper addresses the following research question: What factors determine different forms of value creation in ecological startups? Our analysis is based on the self-presentation of 212 ecological startups, some of them explicitly addressing

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planetary boundaries, some with less ambitious aims to create ecological value. To answer the research question, we first analyze how value creation in terms of addressing a planetary boundary along with a sustainability strategy and the sustainability ambition determine the implementation of a business model centered around value creation that could be generally classified as being sustainable. This analysis is elaborated upon in a second step, where we consider the very nature of sustainable value creation, which may be socially-oriented, technologically-oriented, or organizationally-oriented (Boons and Lüdeke-Freund, 2013) and illustrate the factors that shape the utilization of these different types of value creation.

2. Conceptual background

One of the biggest problems of our society is the increasing exploitation of the earth system (Steffen et al., 2015) in spite of the awareness of limits humanity should not exceed because of the negative and harmful effects that doing so would have on humankind. Those limits are referred to as planetary boundaries (Whiteman et al., 2013). The earth system processes are not mutually exclusive but overlap, and crossing one of the boundaries of the earth system process may affect other boundaries (Steffen et al., 2011). Overall, planetary boundaries entail crucial processes that have to be considered in the context of sustainable development (Whiteman et al., 2013). Earth scientists have identified nine crucial areas or pivotal processes that must be respected to ensure humankind can live and develop in a habitable environment (Rockström et al., 2009). The nine planetary boundaries (for most of which, measurable boundary values have been defined) are presented in Fig. 1. Three of the nine processes (illustrated in dark grey in the figure) have already exceeded their critical values, but the others are also very close to doing so (Steffen et al., 2011).

Every organizational activity directly or indirectly, consciously, or unconsciously affects the natural environment (Etzion, 2007). Therefore, every organization should be concerned about how it contributes to the transgression of the planetary boundaries. However, these grand challenges linked to the ecological problems

offer sizable opportunities for ecological entrepreneurs to create and capture value by designing an appropriate business model centered around the creation of such value. Startups tackling the big social and environmental challenges facing humanity, such as the planetary boundaries, and creating benefits for the “common good” (Dyllick and Muff, 2016, p. 166) by focusing on how they could specifically contribute to these problems being solved, these startups can be seen as firms working on “true sustainability” (Dyllick and Muff, 2016, p. 162) within their value creation activities. Truly sustainable startups place value not only on reducing their possible harmful effects on the environment and society but seeking a way to deliver additional meaningful, and positive impacts (Dyllick and Muff, 2016). Environmental economists regard negative effects on the environment as a consequence of market failures (Dean and McMullen, 2007). The transgression of planetary boundaries, reflecting today’s biggest environmental problems (Steffen et al., 2015), may thus also be caused by market failures. From the perspective of entrepreneurship research, market failures can also be understood as entrepreneurial opportunities that individuals can discover and exploit (Shane and Venkataraman, 2000). Ecological startups build their business activity around these opportunities, which they recognize and exploit in order to conserve or preserve the natural environment (Melay and Kraus, 2012), which might also positively affect society in other ways (Gast et al., 2017). Accordingly we designate an organization as an ecological or green (sustainable) startup if it meets the criteria proposed by Dean and McMullen (2007, p. 50) and exploits, “environmentally relevant market failures [that] represent opportunities for achieving profitability while simultaneously reducing environmentally degrading economic behaviors.” We note, however, that some startups exceed those criteria and deliver what Dyllick and Muff (2016, p. 162) term “true sustainability” by delivering a positive impact for the common good by contributing to solving global environmental challenges.

In order to exploit the opportunities arising from the transgression of planetary boundaries, entrepreneurs need to design appropriate business models that can define the way in which value is created and captured. Accordingly, a business model centered around value creation needs to be capable of adapting to external or internal changes so that the company can survive in the long-term (Teece, 2010; Wirtz et al., 2016).

Entrepreneurial solutions to problems affecting earth system processes require innovation not only in relation to products and services but also in the ways entrepreneurs or organizations provide value for customers (Schaltegger et al., 2012). Innovative business models and appropriate value creation are necessary because solutions tackling planetary boundaries largely affect natural assets such as oxygen production, for which consumers are not used to paying (Dorfman, 1993). Value creation promoting sustainability is needed to realize sustainability in companies and organizations and in the way they conduct their business. Schaltegger et al. (2016, p. 6) aim to show the logic of value creation in a company while addressing economic and ecological or social needs. In other words, the business model for sustainability can be defined as “describing, analyzing, managing, and communicating (i) a company’s sustainable value proposition to its customers, and all other stakeholders, (ii) how it creates and delivers this value, (iii) and how it captures economic value while maintaining or regenerating natural, social, and economic capital beyond its organizational boundaries.”

How value creation translates into a business model for sustainability is therefore dependent on the overall understanding of the impact a firm can have. Entrepreneurs can take a sustainable approach to value creation by exploiting ecological opportunities such as planetary boundaries to create sustainable value — that is,

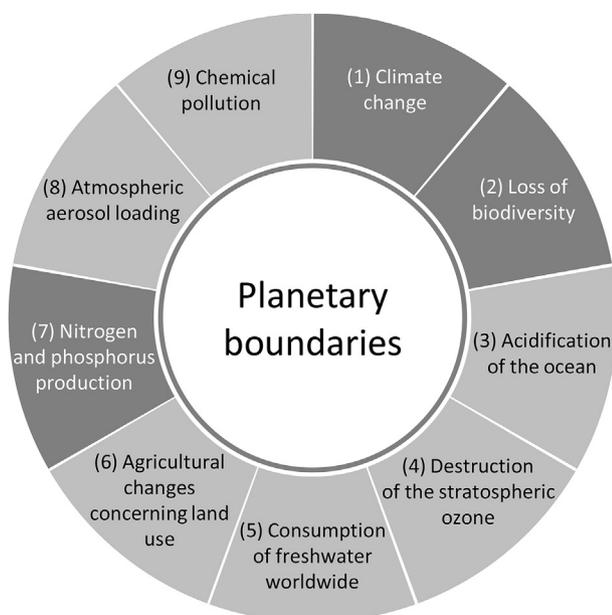


Fig. 1. The nine planetary boundaries based on Steffen et al. (2011), Steffen et al. (2015) and Whiteman et al. (2013) – dark grey boundaries are beyond their critical threshold.

economic, ecological, and social value — through their business solutions (Shane and Venkataraman, 2000; Dean and McMullen, 2007). In doing so, they need to take a holistic view of value creation and create benefits for the environment and society alike (Bocken et al., 2015).

The holistic approach may be applicable in the context of ecological startups, where, besides capturing value and earning profit, value creation is based on the improvement created for the ecological environment and society as well as for customers (Abdelkafi and Täuscher, 2016). The (sustainable) value creation thus reflects the needs and interests of customers relating to the product and/or service of the startup and the (sustainability-orientated) firm processes involved (Boons et al., 2013). To create value on the customer side, “innovation [is needed] that establishes or increases the consumer’s valuation of the benefits of consumption (i.e., use value)” (Priem, 2007, p. 220). As a consequence, the consumers might accept an even higher price of the (more sustainable) product or service if it demonstrates a new and clear advantage or if the goods are perceived by customers to be better than (less sustainable) alternatives available (Priem, 2007).

In sum, solutions to environmental problems can have the potential to provide economically, socially, and environmentally sustainable benefits (Dean and McMullen, 2007). The environment benefits when companies reduce or minimize their negative influences on the environment (Abdelkafi and Täuscher, 2016). Addressing transgressions of the planetary boundaries may therefore be seen as an opportunity for ecological entrepreneurs to tackle this challenge by creating economic benefits and additional value for the ecological environment and for society.

Even when ecological startups adopt a sustainable approach to value creation, their understanding of how far-reaching an impact the startup could have on the ecological environment and society might differ, and this understanding is reflected in the startup’s sustainability strategy (Stubbs and Cocklin, 2008). Ecological startups can pursue three different sustainability strategies with different degrees of sustainability orientation, ranging from (1) offsetting harm that the startup causes through conducting its business, (2) doing no harm by rethinking and redesigning the value chain of the product or service, and (3) returning greater positive effects to the environment than there were before, that is, an enterprise could, “put back more than it takes” (Stubbs and Cocklin, 2008, p. 108). Ecological startups that have a higher-level sustainability strategy may create more value for the ecological environment and society because of their holistic approach. If a startup does not adequately consider sustainability, its sustainability efforts will not be realized in the firm (Schaltegger et al., 2012).

Furthermore, value creation is dependent on the degree of sustainable effort the ecological startup has already contributed (Baumgartner and Ebner, 2010), which for the purposes of this study we term the sustainability ambition. Inspired by Baumgartner and Ebner (2010), four different sustainability ambition levels can be distinguished, and they differ in terms of the extent to which sustainability issues have already been successfully implemented ranging from ‘beginning’ to ‘sophisticated’. The concept of a sustainability ambition reflects two issues about the sustainability development: First, sustainability efforts need to be considered in their institutional setting, as the extent of implementation refers to for instance national (legal) requirements. Second, sustainability development is a dynamic target. As politicians, customers and other stakeholders become increasingly aware of the need to consider the planetary boundaries for instance, and adapt regulations and expectations accordingly, this also dynamically defines if value creation of a startup should be considered elementary or sophisticated.

At the beginning level, a startup realizes the basic implementation of sustainability concerns in the company and fulfills the minimum requirements of applicable sustainability laws and regulations. At the next level, it might incorporate economic, social, and environmental concerns on a larger scale. To maintain a satisfactory level of further sustainability improvement requires the more comprehensive integration of, and interaction between, all stakeholders, so sustainability issues should be addressed within the company’s processes and communications. The highest sustainability ambition can only be realized through the extensive and sophisticated implementation of sustainability aspects throughout the startup and its complete environment (Baumgartner and Ebner, 2010). Ecological startups with a higher sustainability ambition may create more value for the ecological environment and the society because of the level of sustainability already achieved within the company and the resulting ecological and social benefits. In other words, the sustainability ambition may have a positive impact on value creation.

In light of the recognition of ecological opportunities (possibly grounded in the transgression of planetary boundaries), the understanding of the impact a firm can have (via its sustainability strategy) and considering the current level of sustainability achievement (the sustainability ambition), startups might opt for different forms of value creation to deliver sustainability. Boons and Lüdeke-Freund (2013) differentiate three generic types of value creation for sustainability with different focuses: (1) technological, (2) social, and (3) organizational value creation. Technologically-oriented value creation aims to maximize input efficiency, eliminate waste through circularity, or substitute components with renewables. Meeting these objectives demands new or different designs for the products and the production processes of the startup. Socially-oriented value creation focuses on the creation of social value by moving from ownership to the provision of functionality, the adoption of a stewardship role, or encouraging sufficiency. Social value is created by offering opportunities to people who are unable to solve their problems unaided. Organizationally-oriented value creation achieves sustainability by way of changes on an organizational level, including the development of scalable business solutions and the commitment to social or environmental objectives (Bocken et al., 2014). Those objectives focus on a broader view of the structures and processes within a company, on comprehensive values and also maintain the direction of the firm by integrating sustainability issues (Boons and Lüdeke-Freund, 2013) and increasing the responsibility taken by the firm (Bocken et al., 2014).

According to Teece (2010) a business model defines the way in which to create and capture value. Value creation can therefore be seen as a very important element of a business model (Bocken et al., 2014) and this also applies to ecological startups. Furthermore, business models incorporate the different components a startup must address. Boons and Lüdeke-Freund (2013) combine two approaches proposed respectively by Osterwalder (2004) and Doganova and Eyquem-Renault (2009) to illustrate these different components of a business model, such as the value propositions, the customer relationships, the cost and revenue structure, and the supply chain processes. The interplay of these components is essential to create and capture (sustainable) value in a startup (Boons and Lüdeke-Freund, 2013).

The understanding of the startup of how its value creation can contribute toward sustainability (as reflected in its decision to address a planetary boundary, to aspire to a high sustainability strategy, and its current sustainability ambition) might require different types of value creation for sustainability (see Fig. 2).

While the literature review reveals how value creation reflects a startup’s consideration of the planetary boundaries, the perspective

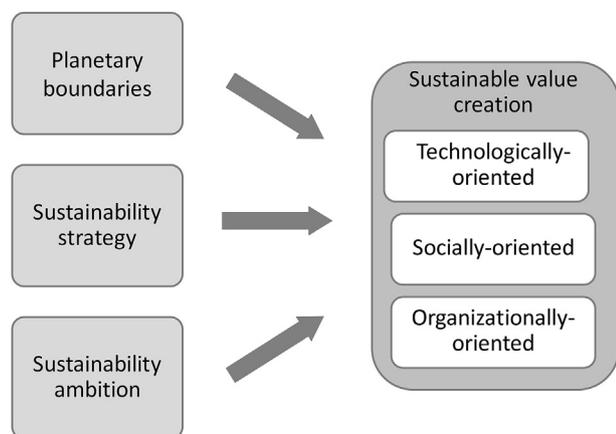


Fig. 2. Proposed research model.

on the sustainable impact a startup might have, and its current progress in that endeavor, we do not know how ecological startups translate these factors into appropriate value creation. This lacuna will be addressed by studying value creation at the heart of the business models of 212 ecological startups.

3. Method

3.1. Data

For the purpose of the study, we constructed a dataset of ecological startups with the help of the *CrunchBase* database provided by *TechCrunch* (Mandl et al., 2016), which aims to extensively cover the global startup ecosystem, including investors and startups. To identify ecological startups, researchers selected all startups in the categories “green tech” and “environmental” that were founded after 2000 and were registered as active during the period of initial data collection in March 2016. We excluded every startup for which no website was provided, whose website could not be identified through additional internet searches, or whose website was not available in English, leading to an initial sample of 219 ecological startups. During further data collection efforts from March 2016 to September 2016, the websites of seven of those startups closed down, leading to a final sample size of 212. Apart from name, website, and category, other information elicited from *CrunchBase* included location, founding date, financial information, and investment history. Although other researchers have provided evidence for the quality of this data source (e.g., Mandl et al., 2016), we checked the quality of the *CrunchBase* data by comparing them with information from other databases. Because, for instance, the age of the company provided by *CrunchBase* correlated almost perfectly with age information drawn from the *ORBIS* database ($r = 0.991$, $p \leq .001$), it was considered safe to conclude that *TechCrunch* provides reliable data.

To create the variables from the startups' websites, a codebook (available upon request) was established (Hruschka et al., 2004). Having drafted an initial theory-driven codebook (DeCuir-Gunby et al., 2011), one of the authors and a research assistant then undertook the “iterative process of coding, reliability assessment, codebook modification, and recoding” (Hruschka et al., 2004, p. 312). The codebook was structured following the guidance of MacQueen et al. (1998), who recommend the structure be as simple and stable as possible, which provides a good grounding for the complex and dynamic process of revising the codebook. Accordingly, the codebook details the variable, the code, a short and full definition, and at least one example. Coding rounds for each

concept were conducted separately for each of 24 randomly chosen startups (>10% of the entire sample) that were not included in the coding of the entire sample. After each coding round, the interrater reliability was determined using Cohen's kappa (Cohen, 1960). When the process did not result in at least substantial agreement, the codebook was reviewed and revised, and the subsample was recoded. To prevent familiarization with the sample, researchers took substantial breaks between coding rounds. Achieving a substantial interrater reliability required 3.25 coding rounds on average and resulted in an average kappa of .8.

As suggested by Colquitt and Zapata-Phelan (2007), having established substantial interrater reliability, one researcher coded the first half of the sample and a research assistant coded the second half of the sample. The coding was based on the information available from the landing page, the offer page (service or product description), and the “about us” page of the startups. The sustainability approach of a company is typically incorporated in the mission and strategy statements (De Clerq and Voronov, 2011), and because the sample had self-selected the green tech or environmental categories on *CrunchBase*, the companies considered were likely to present their own perception of their sustainability logic on their website.

3.2. Independent variables

Planetary boundary is a binary variable indicating whether the ecological startup addresses explicitly (1) or not at all (0) one or more of the nine earth system processes in its business offering (Steffen et al., 2011). While it might be possible that a startup only partially addresses a particular planetary boundary, researchers decided against coding this additional step in order to be able to illustrate the *dominant* approach to value creation in a given ecological startup.

Sustainability strategy is an ordinal variable indicating the strategy a company pursues with its business offering with regard to sustainability, ranging from 1 (offsetting harmful activities in one area in another) to 2 (being sustainable in terms of doing no harm) to 3 (being restorative) (Stubbs and Cocklin, 2008).

Sustainability ambition is an ordinal variable referring to the degree of ecological sustainability a company has achieved ranging from 1 (beginning), 2 (elementary), 3 (satisfying) to 4 (sophisticated) inspired by Baumgartner and Ebner (2010).

3.3. Dependent variables

The first dependent variable (*sustainable value creation (any)*), employed in a logistic regression model, is a binary variable describing whether an ecological startup accords with any of the sustainable value creation types introduced by Boons and Lüdeke-Freund (2013).

The second dependent variable (*sustainable value creation types*), employed in a multinomial logistic regression model, elaborates on this description. It is a nominal variable referring to sustainable value creation types that classifies them as either technologically-oriented, socially-oriented, or organizationally-oriented value creation, or none of those. Where raters could not identify one of these three value creation types, the firm was categorized in both dependent variables as having no value creation for sustainability, regardless of whether it categorized itself as “green tech” or “environmental” on the *CrunchBase* database.

3.4. Control variables

We included four control variables in our analysis that might have affected the choice of value creation pursued by an ecological

startup. The natural logarithm of the age of the firm was included because certain business models and an appropriate form of value creation might depend on the sustainability ambition of the firm. To account for national-level trends, we controlled whether firms in the sample originated from the USA (0) or the rest of the world (ROW:1). There were three reasons for focusing on the USA: first, the sample is dominated by US ecological startups (60%); second, the USA offers the most developed market for venture capital which might shape the kind of value creation that ecological startups try market to potential investors; and third, the growing skepticism of the need for more ecological solutions in US society. Moreover, whether a startup is backed by a venture capitalist (VC) might affect its choice of value creation as well, as venture capitalists might prefer certain value creation types over others (0: not VC backed; 1: VC backed). Based on a similar rationale, we also controlled for the number of funding rounds an ecological startup completed. All information required to build the control variables was drawn from the *CrunchBase* database. An overview of all variables explored in this investigation is presented in [Table 1](#).

3.5. Analytical approach

To address the research question, two analytical steps were conducted. The first was a logistic regression model testing the existence of value creation for sustainability in ecological startups. The second step was a multinomial logistic regression model to scrutinize the relationships between the three main concepts and the value creation types for sustainability.

A logistic regression model “analyzes the relationship between multiple independent variables and a categorical dependent variable and estimates the probability of occurrence of an event by fitting data to a logistic curve” ([Park, 2013](#), p. 155). Depending on the form of the dependent variable, different models can be distinguished: One way is a binary logistic regression model analyzing one dichotomous dependent variable with categorical or continuous independent variables. Another is a multinomial logistic regression model that is used when the dependent variable consists of more than two categorical variables (polytomous) ([Park, 2013](#)). Accordingly, ordinal-scaled or nominal-scaled polytomous variables can be used ([Peng et al., 2002](#)). A multinomial regression model can be seen as an “extension of the binary (or dichotomous) logistic regression [...] and has an added advantage in that it provides multiple interpretations for an independent variable” ([Monyai et al., 2016](#), p. 129/130).

4. Results

[Table 2](#) includes the description of the sample and the respective means, standard deviations, and correlations for the independent variables. Correlations are not excessively high and the variance inflation factors each proved to be substantially below the usual threshold ([Neter et al., 1996](#)) suggesting multicollinearity is not an issue with the data. 40% of the ecological startups in the sample originate from countries other than the United States, the majority of them being financed by a VC (90%). 77% rely on value creation for sustainability, but only 37% address a planetary boundary.

To test the existence of sustainable value creation types in ecological startups, we ran the logistic regression models presented in [Table 3](#). The control model classifies 76.9% of the cases correctly and suggests that value creation types for sustainability are particularly employed by ecological startups that do not originate in the USA but are financed by a VC.

The picture changed once the independent variables were entered into the equation. All control variables missed conventional levels of significance, and the model fit improved substantially. The full model classifies 84% of all cases correctly and explains 47% of the variance in the dependent variable. This supports the assumption that value creation for sustainability exists in ecological startups. Firms creating value through their business model by addressing a planetary boundary are more likely to do so with value creation for sustainability (1.74**). The sustainability strategy (2.02**) and sustainability ambition (0.55**) of the ecological startup correlate with the probability of employing value creation for sustainability as well.

Building on this initial analysis and in order to paint a more detailed picture, we explored the relationships affecting value creation by addressing planetary boundary, sustainability strategy, sustainability ambition, and the resulting sustainable value creation types, and ran a multinomial regression comparing those firms with no sustainable value creation as a base outcome to the three different value creation types: technologically-oriented, socially-oriented, and organizationally-oriented value creation. [Table 4](#) displays the results of this multinomial regression analysis.

First, a controls-only model was run, which returned some significant relationships but did not explain much of the variance in the dependent variable (McFadden's R^2 : .03). When the independent variables were entered into the equation at the second step, the model displayed a good fit (McFadden's R^2 : .23) and some interesting variations could be observed regarding the impact of

Table 1
Description of all variables explored in the investigation.

Variables	Description
<i>Independent variables</i>	
Planetary Boundary	Binary variable indicating whether the startup addresses explicitly (1) or not at all (0) one or more of the nine earth system processes in its business offering (Steffen et al., 2011).
Sustainability strategy	Ordinal variable indicating the strategy the startup pursues with its business offering with regard to sustainability, ranging from 1 (offsetting harmful activities in one area in another) to 2 (being sustainable in terms of doing no harm) to 3 (being restorative) (Stubbs and Cocklin, 2008).
Sustainability ambition	Ordinal variable indicating the degree of achieved ecological sustainability efforts of the startup ranging from 1 (beginning), 2 (elementary), 3 (satisfying) to 4 (sophisticated) (Baumgartner and Ebner, 2010).
<i>Dependent variables</i>	
Sustainable value creation (any)	Binary variable describing whether an ecological startup accords with any of the sustainable value creation types (Boons and Lüdeke-Freund, 2013).
Sustainable value creation types	Nominal variable classifying sustainable value creation types as either technologically-oriented, socially-oriented or organizationally-oriented value creation types or none of these.
<i>Control variables</i>	
AGE_logged	Natural logarithm of the age of the firm.
Country	Startup originating from the USA or the rest of the world (ROW) (0: US; 1: ROW).
VC backed	Startup backed by a VC or not (0: not VC backed; 1: VC backed).
Number of funding rounds	Number of funding rounds completed by the startup.

Table 2
Descriptive statistics and correlations.

Variable	Mean	SD	1	2	3	4	5	6	7	8
1. AGE_logged	1.72	.58	–/–							
2. Country (0: USA; 1: ROW)	.40	.49	-.18**	–/–						
3. VC backed (0: no; 1: yes)	.90	.31	-.19**	.05	–/–					
4. No. funding rounds	1.67	1.52	.05	-.12	.37**	–/–				
5. Planetary boundary (0: no; 1: yes)	.37	.49	.09	-.03	.07	-.02	–/–			
6. Sustainability strategy	–/–	–/–	.01	.15*	.23**	.04	.36**	–/–		
7. Sustainability ambition	–/–	–/–	.16*	.08	.07	-.01	.29**	.46**	–/–	
8. Sustainable value creation (any)	.77	.42	.07	.15*	.14*	.02	.35**	.39**	.40**	–/–

n = 212. Pearson product-moment correlation coefficients, point-biserial correlation coefficients where appropriate.

**p ≤ .01.

*p ≤ .05.

Table 3
Logistic regression models – sustainable value creation (any).

	Control Model	Full Model
	Coef. (SE)	Coef. (SE)
CONSTANT	–1.00 (.76)	–1.58† (.91)
<i>Control variables</i>		
AGE_logged	.58 (.30)	.36 (.37)
Country (0: USA; 1: ROW)	.84* (.38)	.85† (.46)
VC backed (0: no; 1: yes)	1.23* (.55)	.26 (.63)
No. funding rounds	–.06 (.12)	.05 (.14)
<i>Independent variables</i>		
Planetary boundary (0: no; 1: yes)		1.74** (.67)
Sustainability strategy		2.02** (.65)
Sustainability ambition		.55** (.18)
<i>Model fit</i>		
Chi-square	11.85*	79.62***
Log-likelihood	217.38	149.62
Nagelkerke's R ²	.08	.47

n = 212.

***p ≤ .001.

**p ≤ .01.

*p ≤ .05.

†p ≤ .1.

the three theoretically grounded independent variables on the type of value creation chosen. Technologically-oriented value creation results from value creation through addressing a planetary boundary (2.03**), an explicit sustainability strategy (1.86**), and a high sustainability ambition (0.52**). In contrast, socially-oriented value creation seems not to address planetary boundaries (n.s.), but does rely on an explicit sustainability strategy (2.14**) and sustainability ambition (0.65**). Finally, organizationally-oriented value creation also seems to address planetary boundaries (2.34**) and relies on a sustainability strategy (3.68**) but does not require a high sustainability ambition (n.s.).

5. Discussion

The goal of our study is to understand how ecological startups design appropriate value creation. The results show that the majority of the ecological startups (more precisely 77%) create sustainable value as they employ value creation for sustainability. In other words, most entrepreneurs exploit ecological opportunities not only to maximize profit, which would require traditional value creation, but also to create economic, ecological, and social value by integrating these values within their business model for sustainability (Shane and Venkataraman, 2000; Dean and McMullen, 2007; Schaltegger et al., 2012).

Table 4
Multinomial logistic regression model – sustainable value creation types.

	Technologically-oriented value creation (SE)	Socially-oriented value creation (SE)	Organizationally-oriented value creation (SE)
CONSTANT	–1.50 (.82)	–2.18 (.98) *	–2.37** (1.07)
<i>Controls</i>			
AGE_logged	.63* (.32)	.43 (.39)	.27 (.44)
Country (0: USA; 1: ROW)	.79* (.39)	.84 (.48)	.99 (.53)
VC backed (0: no; 1: yes)	1.31* (.59)	.42 (.69)	.20 (.85)
No. funding rounds	–.10 (.13)	.02 (.14)	.09 (1.6)
<i>Independent Variables</i>			
Planetary boundary (0: no; 1: yes)		2.03** (.68)	.53 (.77)
Sustainability strategy		1.86** (.66)	2.14** (.68)
Sustainability ambition		.52** (.19)	.65** (.21)
<i>Model Fit</i>			
Chi-square	15.02	113.32***	
Log-likelihood	310.70	344.05	
McFadden's R ²	.03	.23	

n = 212.

Base outcome: No sustainable value creation.

***p ≤ .001.

**p ≤ .01.

*p ≤ .05.

Another interesting finding is that not every ecological startup employing sustainable value creation addresses a planetary boundary to create and capture value. Only 37% of the ecological startups with value creation activities promoting sustainability addressed a planetary boundary and can therefore be seen as having a truly sustainable value creation (Dyllick and Muff, 2016), which means that 63% are tackling other “green tech” or “environmental” problems and might be exploiting other ecological opportunities. We offer three possible explanations for this finding.

First, the ecological startups might not be adequately communicating their contribution to making the world a better place. As a result, their sustainable value creation approach might not be seen directly by prospective customers who attach importance to sustainable products and services and would be willing to pay more for the additional sustainability value created. Consequently, opportunities to create and capture (additional) value are lost or cannot be exploited adequately by such ecological startups. An alternative and second explanation for the low proportion of startups tackling a planetary boundary issue might be a low level of consciousness around the severity of the consequences of the transgressions of planetary boundaries. Entrepreneurs may have the feeling that ecological problems such as climate change or loss of biodiversity are problems that are too large to be positively impacted by business activity. Ecological startups may thus address other smaller and, from their perspective, more manageable ecological challenges. Consequently, the problem of planetary boundaries and the urgent need to stay within them should be publicized more widely than it is currently. This could be further supported by incentive systems, such as special funds implemented by governments to foster the sustainable value creation activities of ecological startups. Third, another reason for the low proportion of startups addressing planetary boundaries might be the absence of the necessary general framework to tackle large-scale global problems. Ecological startups, as a driving force for realizing sustainability in the economy (Rauter et al., 2017), should address such ecological challenges by providing appropriate business solutions, but a regulatory framework and international laws may be needed to achieve a shift toward worldwide sustainable development. In other words, ecological entrepreneurs cannot solve these problems on a global scale only by creating ecological and social value and by implementing value creation for sustainability. Political society and organizations must also be mobilized to tackle these challenges and to provide appropriate frameworks to do so going forward (see e.g., Gast et al., 2017; Whiteman et al., 2013).

Furthermore, we provide empirical evidence that startups employ three different types of value creation for sustainability (technologically-oriented, socially-oriented, and organizationally-oriented forms) depending on the influences on the value creation activities with regard to the understanding of the sustainable impact a startup can have (Boons and Lüdeke-Freund, 2013; Bocken et al., 2014). The design of value creation varies according to whether a planetary boundary is addressed and according to the sustainability ambition. A sustainability strategy is, however, present in every type of value creation, which will be discussed in more detail below.

Fig. 3 presents the results of the multinomial regression model: Depending on the design of sustainable value creation, the types of value creation in ecological startups are shaped by and may result in a technologically-oriented, socially-oriented, or organizationally-oriented value creation type. The results show that all three types of value creation for sustainability are applied in the examined ecological startups. Accordingly, those startups pursue different approaches when reacting to or solving ecological problems.

Our findings show that when ecological startups address a

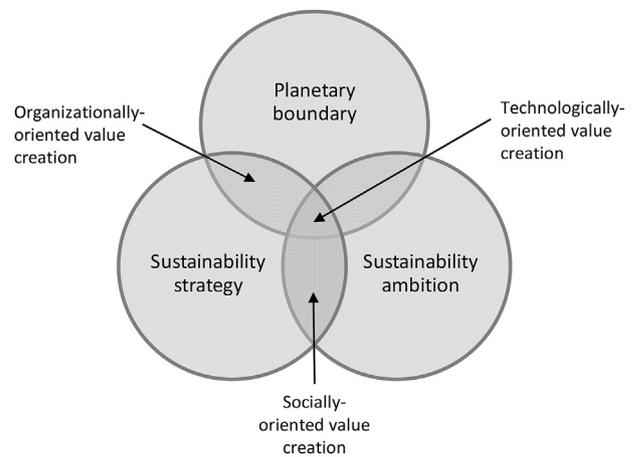


Fig. 3. Value creation types for sustainability in ecological startups based on this study's empirical analysis.

planetary boundary issue, follow a sustainability strategy, and display a high sustainability ambition, they usually implement a technologically-oriented value creation (see Fig. 3). As the concept of planetary boundaries originates from the natural sciences (Rockström et al., 2009), and one approach to preventing transgressions of those boundaries may be technological innovations in the environmental or agriculture sciences, which might explain the implementation of technologically-oriented value creation in ecological startups. As for sustainability strategy, it may be seen as a long-term and lofty vision or as a guiding idea that effects how an ecological startup implements sustainability within its business solution, independent of the type of value creation adopted, and it may therefore also be found in technologically-oriented value creation. A high sustainability ambition enhances the probability that a technologically-oriented value creation will be applied, which may be explained by the need to have sustainability experience and significant knowledge of how to create sustainable value through new technologies in practice. This sustainability experience may be required as a first step to realizing technologically-oriented value creation leading to more sustainable products and process innovations, as well as in realizing and fostering sustainability in the whole startup.

The ecological startup Reterro (2018) is a good example from our sample of a firm implementing a technologically-oriented value creation. The company focuses on process and product improvements by using a clean and green remediation thermal technology to decontaminate soil. The startup addresses the planetary boundary of chemical pollution of the soil (Rockström et al., 2009) caused by the handling of toxic materials, as in the percolation of motor fuels into the ground around filling stations. Reterro addresses this problem by milling and machining the contaminated soil and by eliminating the negative environmental impacts. As a consequence, this may have effects on other planetary boundaries such as the loss of biodiversity in the close surroundings of such filling stations by decontaminating and revitalizing the ground. In doing so, the startup pursues a high-level sustainability strategy because its technological business solution aims to create sustainable benefits (i.e., economic benefits through the cost-effective and permanent decontamination of the soil) as well as ecological and social benefits (the cleaning of contaminated soil and the realization of new productive uses of the sites). All these points create value that benefits customers of the startup. Creating such sustainable value required the startup to acquire considerable sustainability experience and knowledge of contaminated soil

handling processes as the first step in developing, testing, and implementing an appropriate technology, and it therefore had to reach a high sustainability ambition in the process.

Socially-oriented value creation may be seen as a way of controlling or steering the potential negative impact of consumers (Bocken et al., 2014) to promote a greener and more sustainable environment. To do so, ecological startups may need to address human thought processes, the possible psychological constraints of customers who do not want to do anything to resolve ecological problems, and how consumers could be persuaded to contribute to solving ecological problems through their actions. When ecological startups do not address a planetary boundary, but do have a sustainability strategy and a high sustainability ambition, they usually apply a socially-oriented form of value creation (see Fig. 3). One reason ecological startups with socially-oriented value creation do not address a planetary boundary could be that they address other environmental problems, in areas where it might be easier to influence consumers' behavior and their potential to act to promote greater sustainable value creation. Tackling a planetary boundary directly and having a huge impact on one of the world's biggest ecological problems might be too difficult for customers to understand. As a result, ecological startups with a socially-oriented value creation might address smaller problems to illustrate and convey the influence customers could have on creating a more sustainable environment. The sustainability strategy may be seen as a guiding idea that influences the implementation of sustainability within the business solution of the startup, but without relying on a specific type of value creation, and it may therefore also be found in socially-oriented value creation. A high sustainability ambition enhances the probability of an ecological startup applying a socially-oriented value creation because the startup needs to know, as a first step, which psychological parameters it must address and how those might be changed to influence people's actions so that they can contribute to the creation of sustainable value and foster sustainable development. Therefore, the ecological startup needs to have sustainability experience and knowledge of those psychological parameters to implement them in practice in its socially-oriented value creation.

A good example from our sample of an ecological startup with socially-oriented value creation is *Allgreenup* (2018). This ecological startup focuses on both environmental and social issues by creating a smartphone app inviting users to collect points and rewards by undertaking sustainable actions such as cycling instead of driving a car, recycling waste, or car sharing. Value for customers can thus be created by encouraging them to become part of a special movement or community and to be rewarded for this effort. Furthermore, they might see a benefit for themselves through their active contribution to making the world a better place. The startup does not address a specific planetary boundary directly but does try to tackle other (smaller) ecological problems that in turn may affect planetary boundaries such as climate change by reducing the carbon footprint of the clients of the startup. *Allgreenup* wants to create ecological value by informing people of what they can do to reduce their own CO₂-emissions, for example, and how they can behave more sustainably. The startup has a high-level sustainability strategy as it wants to create a more sustainable world through its app by trying to convince people that everybody can do something for a more sustainable world if they integrate their sustainable actions in their daily life. *Allgreenup* has a high sustainability ambition, as designing the app required a deep understanding of what kinds of actions people could pursue to bring more sustainability to their lives and have a positive effect on the environment. Therefore, some experience may be needed to successfully launch such an initiative.

In addition to socially-oriented value creation, organizationally-

oriented value creation can also be found among ecological startups. Organizationally-oriented value creation focuses on the integration of sustainability issues within the company (Boons and Lüdeke-Freund, 2013), on social or environmental objectives, and, as a result, on increasing corporate responsibility (Bocken et al., 2014). In organizationally-oriented value creation, sustainability needs to be part of every process from the outset. Our findings show that ecological startups that tackle a planetary boundary and have a sustainability strategy, but that do not have a high sustainability ambition usually apply organizationally-oriented value creation (see Fig. 3). The focus on tackling a planetary boundary may be a way to foster greater responsibility in the startup, which may increase the probability of organizationally-oriented value creation being implemented in an ecological startup. The sustainability strategy may be seen as the long-term vision affecting how an ecological startup implements sustainability within its business solution, regardless of the type of value creation adopted, and it may therefore also be found in organizationally-oriented value creation. Organizationally-oriented value creation is not based on a high sustainability ambition, which may be because sustainability is considered right from the outset and sustainability thinking guides the whole ecological startup. It is not essential for sustainability efforts to have been achieved, because sustainability is seen as the overall orientation within the startup and its processes, and not as an add-on project that has to be delivered.

Géocorail (2018) from our sample perfectly illustrates how an ecological startup can focus on organizationally-oriented value creation to address a planetary boundary. In this case, by tackling the negative consequences of the planetary boundary climate change, such as the rise in sea levels and the attendant destruction of coastal areas and sea beds worldwide. *Géocorail* offers a method to capture and restore sea beds and coastal areas by providing an eco-friendly process relying on the formation of minerals (sedimentary retention). The startup addresses a planetary boundary by preventing coastal areas from being destroyed and dissipated by the action of the sea. This may also affect other planetary boundaries such as the loss of biodiversity in the sea by preventing the destruction of the sea bed and rebuilding it and the associated ecosystem. *Géocorail* pursues a high-level sustainability strategy and mission as it wants to create sustainable value (in that the outcome is economical in being delivered via a cheap and simple solution). It also intends to contribute ecological and social value to the environment and society by solving the problem of the destruction of coastal areas using only material found on the seashore to create the *Géocorail* aggregate. Through the effective use of the applied materials the startup can create value for its customers by saving costs and contributing to ecological projects. A high sustainability ambition may not be essential in this ecological startup because it has implemented sustainability as a guiding idea since its inception, and therefore sustainability can be seen as integral to the ecological startup.

Finally, our results show that a sustainability strategy (Stubbs and Cocklin, 2008) can be found in every type of value creation supporting sustainability (technological, social, and organizational), independent of whether a planetary boundary is addressed and of whether an ecological startup has a high sustainability ambition. The sustainability strategy might therefore be a necessary condition of the realization of value creation for sustainability, independent of the type of value creation chosen (technologically-oriented, socially-oriented, or organizationally-oriented). Furthermore, the sustainability strategy as a holistic approach to value creation can be illustrated and marketed through an ecological startup's value creation to support sustainability. This might be a good way to demonstrate to potential customers the sustainability strategy underpinning the value creation activities

and to convince them that the startup is truly sustainable (Abdelkafi and Täuscher, 2016) and that its proposed solutions may therefore be better than those of its competitors.

Implications for practitioners arising from these findings center on the need to become aware of the important influence of value creation on the design of an appropriate business model for sustainability. Our findings indicate ecological startups should think about establishing a clear sustainable branding message, that could make their value creation efforts targeting customers even more effective and thus increase their business success and consequently their positive ecological impact. Such an impact might be achieved by clearly identifying and communicating the sustainable impact to all stakeholders, including those without a voice, and by engaging in a multi-directional dialogue on how customers and other stakeholders can engage in the delivery of the created value as it contributes to the universal goal of a sustainable world.

6. Limitations and avenues for future research

Some limitations of this study illuminate promising avenues for future research. The narrow definition of ecological startups offers a strength in terms of comparability but might also be viewed as too narrow. The startups self-selected one of the two categories *green tech* or *environmental* provided by *CrunchBase*. Nevertheless, there is no focus on only technologically-orientated value creation, as might be expected in ecological startups within this category, instead organizationally-oriented and even socially-oriented value creation types are also evident. Therefore, the definition of ecological startups could be extended or broadened, and other categories should also be included for future research projects to explore all kinds of sustainable startups addressing ecological challenges. Similarly, our conceptualization of planetary boundaries addressed could be considered rather abstract and future research could act on this by including, for instance, specific planetary boundaries or those planetary boundaries already clearly transgressed to identify the effect on value creation among ecological startups.

The self-selection of the startups could give rise to another limitation: The self-representation might be affected by impression management and, in our particular case, by “greenwashing” to convince potential customers and investors of the merits of the ecological startups. Startups, however, might not always be aware of the concept of planetary boundaries or that it is beneficial for the enterprise to convey how its business activity affects those boundaries. An interesting path for future research might be to confront startups with the concept and interview their founders to elicit how they perceive their role with regard to the planetary boundaries. Moreover, the geographical distribution of startups covered in *CrunchBase* leans toward the USA and it might thus be informative to consider alternative databases covering other regions in future research. Another limitation might lie in the precise assignment to the three types of sustainable value creation. These were considered for the purposes of this study to be independent so as to explore the polytomous dependent variable using the multinomial regression model. Overlaps between the archetypes might exist (Boons and Lüdeke-Freund, 2013) or a development from one type of value creation to another type may be possible and even constitute a growth strategy. Such a transformation should be explored in more detail in future research studies, which would also require longitudinal data, as the current cross-sectional data comes with its own limitations, particularly with regard to causality.

7. Conclusion

The impending transgression of planetary boundaries forces us

to rethink our role in conserving and preserving the environment. Our first contribution lies in showing that ecological startups recognize the opportunity to create sustainable value by addressing environmental challenges, some of them responding to the biggest challenges related to the transgression of the planetary boundaries, while others find other ecological opportunities that contribute to preserving the environment. Second, we contribute to understanding the mechanisms of how startups push for the shift toward sustainable development by providing illustrative examples of how ecological startups design value creation. Third, we contribute to this stream of research by analyzing how three types of value creation that are well established in the literature make different use of sustainability strategies and different forms of value creation in building a viable business. Our results indicate that value creation and the business model should be aligned, and that ecological startups must be aware of the relationship between them. Only then can truly sustainable value creation be delivered and will global ecological problems be tackled by ecological startups.

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