

Empirical paper

Open innovation and its effects on economic and sustainability innovation performance



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ABSTRACT

The increasing complexity of products and services, rapidly changing market demands, or growing pressure from various societal groups are trends that require companies to enact new practices to remain competitive. The external search for information and its integration in the context of open innovation is one practice that can lead to increased success. However, the full range of potential open innovation partners has not yet been sufficiently explored, and their effects on innovation performance remain unclear. In this research, we investigated the roles different open innovation partners played in improving economic innovation performance and sustainability innovation performance. Furthermore, we asked whether striving to meet economic and sustainability innovation goals represents a conflict. Drawing on a cross-sectional sample of industrial firms and applying a benchmark approach to identify the relevant performance drivers, we found that, in addition to well-known partners such as universities and customers, increased collaboration with NGOs and intermediaries is beneficial for firms. Moreover, economic innovation performance positively correlates with sustainability innovation performance. This implies that economic and sustainability innovation goals can be reached simultaneously. Thereby, this paper contributes to the open innovation literature by revealing which collaboration partners fit best to strengthen innovation performance, and by clarifying the relationship between economic and sustainability innovation performance.

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Introduction

The increasing complexity of products and services, shorter life cycles, and rapidly changing market demands require new or different capabilities and management practices to successfully develop innovations and sustain a company's competitive advantage. These capabilities include what is called 'organizational intelligence' enabling the company to learn from and about its environment (Lawson & Samson, 2001). The important role of the search for and integration of external knowledge in a corporate's innovation success has been widely acknowledged (Stefan & Bengtsson, 2017). Elmquist, Fredberg and Ollila (2009), Gianiodis, Ellis and Secchi (2010), Huizingh (2011), and Giannopoulou, Yström and Ollila (2011), amongst others, have provided overviews. Whereas some authors consider the concept of open innovation (Chesbrough, 2003; Chesbrough, 2012; Gassmann, Enkel & Chesbrough, 2010)

very promising, others raise criticism with respect to its conceptual ambiguity (Dahlander & Gann, 2010), lack of clarification regarding the parties primarily involved in such processes (Huizingh, 2011), and the collaboration partners' influence on the company's innovation performance (Brettel & Cleven, 2011; Stefan & Bengtsson, 2017). Potential disadvantages of open innovation include loss of control, increased managerial and organizational complexity, and, consequently, increased costs (Manzini, Lazzarotti & Pellegrini, 2017). Despite the existence of various forms of open innovation approaches, we know little about how companies innovate in external collaborations, benefit from their innovations (Stefan & Bengtsson, 2017), and with whom and for what reasons they cooperate with outside partners (Huizingh, 2011). In particular, this applies in the context of sustainability innovations (Hossain, 2010; Mustaqim & Nyström, 2014) referring to the need to re-think and re-design products, processes, and services to meet the requirements of Sustainable Development, which are being demanded by different groups, such as customers, NGOs, and governments (Ketata, Sofka & Grimpe, 2015; Tsai & Liao, 2017).

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Thus, this research investigates the relevance of external partners for achieving economic innovation performance (EIP) as well as sustainability innovation performance (SIP). By including a broader set of external stakeholders qualifying as potential open innovation partners than past research, managers get to know with whom they should strengthen their cooperation to achieve higher EIP and SIP. Furthermore, the paper explores the relationship between EIP and SIP to clarify for managers whether both performance dimensions can be pursued simultaneously or trigger a trade-off. Empirical evidence for the proposed relationships is provided by drawing on empirical field survey data of a cross-sectional sample and applying a benchmarking approach.

Theoretical foundation and hypotheses

Innovation performance

Innovation has been commonly defined as the successful application of new ideas resulting from organizational processes in which different resources are combined (Dodgson, Gann & Phillips, 2014). This combination of various resources is a multi-stage process leading to improved or new products, services, or processes with which firms seek to differentiate themselves on the market (Baregheh, Rowley & Sambrook, 2009). In the context of open innovation, this multi-stage process includes collaboration with external partners (Chesbrough, 2003; Gassmann et al., 2010) representing sources of knowledge that can contribute to corporate innovation projects. Ultimately, such collaborations make sense if they pay off and act as drivers for corporate innovation performance. Traditionally, a strong focus has been placed on the economic performance dimension of innovation activities to evaluate success, measured in terms of revenue and margin growth, market share, or customer satisfaction (Adams, Bessant & Phelps, 2006; Griffin & Page, 1993; Manion & Cherion, 2009). However, the impact of innovation activities on the innovation program's economic success fails to account for other performance aspects such as reductions in environmental pollution or resource efficiency although these sustainability aspects are becoming more and more important due to the given, increasing demands for sustainable products and changing legal requirements. Such sustainability innovations are defined as the creation of products, services, and processes resulting – from a full life-cycle perspective – in less negative environmental and/or increased social impact compared to relevant alternatives and consider the needs of future generations (Hall & Vredenburg, 2003; Kemp & Pearson, 2007). Therefore, the assessment of innovation performance also has to capture environmental and social domains of innovative outcomes. Drawing on prior literature (Ketata et al., 2015; Schöggel, Baumgartner & Hofer, 2014), we conceptualize SIP as the outcome of the firm's innovation activities with respect to (a) sustainable product design (e.g., low-impact material, life-cycle optimization), (b) process efficiency (e.g., reduction of resource input and deployment), (c) environmental pollution (e.g., reduction of pollution, waste, and resource deployment), and (d) social responsibility (e.g., improved health, safety, social, and ethical situations).

Open innovation and economic innovation performance

In general, it has been assumed that open innovation activities with a diverse range of collaboration partners positively influence a company's innovation success (Chesbrough, 2003), because firms are limited in their possibilities to internalize all required knowledge and competencies (Michelino, Caputo, Cammarano & Lamberti, 2014). In particular, the use of external knowledge helps to sustain a firm's competitiveness (Brettel & Cleven, 2011). Past

empirical research has demonstrated positive correlations between collaborations with customers, universities and suppliers, and new product development performance (e.g., Brettel & Cleven, 2011; Inauen & Schenker-Wicki, 2011). Stefan and Bengtsson (2017) investigated the effects of appropriability mechanisms and openness depth on two types of innovation performance (efficiency, novelty) across different stages of the innovation process with eight different partners. Their findings show that universities, intermediaries, customers, suppliers, and competitors seem to be beneficial for achieving performance, depending on the different phases of an innovation process. Despite the potential risks associated with open innovation, we propose that firms reporting higher EIP are also engaged in more collaboration activities with external stakeholders. Besides the dominating set of open innovation partners (customers, suppliers, competitors, universities, experts) investigated in past research (e.g., Brettel & Cleven, 2011; Chesbrough, 2003), we draw on the stakeholder approach (Freeman, 1984; Gould, 2012) to identify further potential collaboration partners in the firm's eco-system (intermediaries, NGOs, communes, public institutions) and suggest a positive economic performance impact resulting from their integration into the firm's innovation activities.

Hypothesis 1. Higher economic innovation performance is associated with a higher collaboration intensity with external partners.

Open innovation and sustainability innovation performance

Collaboration with external partners seems to be particularly important with reference to social, organizational, and ethical issues in the context of innovation (Arnold, 2011; Medeiros, Ribeiro & Cortimiglia, 2014; Hossain, 2010). High levels of external integration of customers, suppliers, and research institutions, among others, are the most important competences enabling firms to execute sustainability innovations (Carrillo-Hermosilla, del Río & Könnölä, 2010; de Medeiros et al., 2014; Lee & Kim, 2011; Lozano, 2007), while partners such as local communes, intermediaries, and NPOs can also help to improve the market acceptance of innovation outcomes (Achterkamp & Vos, 2006; Holmes & Smart, 2009; Niinimäki & Hassi, 2011). In addition to the already well-known collaboration partners, such as universities or customers, sustainability innovations might particularly require different expertise and input and call for wider societal acceptance. Therefore, it is also reasonable to consider further partners coming from a company's ecosystem. Based on prior open innovation research (Brettel & Cleven, 2011; Chesbrough, 2003) and the stakeholder approach (Freeman, 1984), an extended list of groups including customers, suppliers, competitors, experts, universities, intermediaries, communes, public institutions, and NGOs qualify as potential collaboration partners to achieve SIP. However, the relevance of additional collaboration partners to SIP has not yet been fully addressed (Hossain, 2010; Mustaquim & Nyström, 2014). Apart from the strategic decision to pro-actively search for innovation partners or collaborate with them in response to increasing pressures, it is not at all clear whether such collaborations pay off or if the role of innovations in fostering greater levels of sustainability is crucial (Crossan & Apaydin, 2010; Dangelico & Pujari, 2010; Horn & Brem, 2013; Snider, Hill & Martin, 2003). While many companies might have gained experience with the open innovation process, managing sustainability innovations might represent a new, but different, challenge. Past research reports that collaboration with external partners is beneficial in terms of sustainability product and service innovations (Arnold, 2017), but the necessary financial and time investments as well as the risks of unbalanced innovation portfolios need to be considered. We propose that those firms that intensively manage open innovation with multiple partners benefit from the collaborations in terms of achieving higher SIP at the program level.

Hypothesis 2. Higher sustainability innovation performance is associated with a higher collaboration intensity with external partners.

Economic innovation performance and sustainability innovation performance

As argued above, economic and the sustainability related outcomes represent separate performance dimensions of the firm's innovation activities. Prior research investigating the relationship between the economic and sustainability performance is inconclusive. For instance, some authors have implied the existence of a neutral or positive relationship, emphasizing that firms have to add social and environmental performance indicators to their profit goals (Elkington, 1997; Vancley, 2004). Others have argued that business decisions on sustainability issues require trade-offs by accepting lower profits and margins to realize sustainability goals (e.g., DiVito & Bohnsack, 2017; Kuckertz & Wagner, 2010). Furthermore, the scholars investigated this relationship at the level of the firm's operating business, not its innovation activities. Thereby, changes in existing products and processes to achieve better sustainability outcomes likely involve additional investments without creating approximating additional revenues or cost savings, resulting in a neutral or negative relationship between the firm's economic and sustainability success. In the innovation process, however, the new products, services, and processes are still under development and can thereby (a) incorporate the ideas, concerns, and knowledge from multiple stakeholders with lower or no adaption costs because no prior investments are cannibalized, and (b) produce innovation outcomes that meet both economic and sustainability goals because both have already been considered in the product designs and the newly ramped up production or service processes before their launch. If economic and sustainability innovation goals can be accomplished with similar open innovation practices and collaboration partners—as proposed in prior hypotheses—it is reasonable to assume a synergy, rather than a trade-off existing between the two innovation performance dimensions.

Hypothesis 3. Sustainability innovation performance and economic innovation performance are positively related.

Research method

Data collection and sampling

To test the proposed hypotheses, we conducted a quantitative field survey study, including a sample of large and medium-sized Austrian companies. Referring to the public company register, we randomly selected a subsample of firms that met our restrictions regarding their size and profit-orientation. We then sent an e-mail to the executives including a brief description of the study and an invitation to participate. The firms that responded and indicated their commitment to take part in the study were instructed to nominate an executive who could answer the performance questions and a knowledgeable informant who was responsible for R&D or innovation and could assess the company's open innovation practices, such as the level of cooperation with external partners. The two informants received different questionnaires electronically, which included questions relevant solely to their areas of expertise and which they could send back separately. This multiple-informant design limited potential common source bias. However, due to the stronger involvement of executives in functional tasks such as R&D and innovation when the firm size was small, 18 executives answered both questionnaires. The final cross-sectional

Table 1
Sample characteristics.

Industry	Percent	Firm size (Revenue, Mio. EUR)	Percent
Automation	21.2%	<10	7.1%
Industrial electronics	8.2%	10–50	21.2%
Construction	8.2%	51–100	12.9%
Automotive	7.1%	101–250	14.1%
Food	7.1%	>250	43.5%
Information technology	5.9%	n/a	1.2%
Professional services	5.9%		
Timber	4.7%		
		Firm size (Number of employees)	Percent
Trade	4.7%	<100	8.2%
Banking and insurance	4.7%	101–250	23.5%
Chemical	3.5%	251–500	17.6%
Logistics	3.5%	501–1000	16.5%
Others	15.4%	>1000	34.1%

N = 85 firms.

sample included 152 informants from 85 firms. Additional sample characteristics are summarized in Table 1.

Measures

To capture the constructs, we used multi-item measures for all variables and applied established scales wherever possible. The informants were requested to rate each item on a five-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree).

The level of collaboration with different partners was measured by three to four items for each involved party, drawing on the items described by Brettel and Cleven (2011). Each item evaluated the degree to which the individual partners were integrated into the firm's innovation activities. For collaboration partners that had not been investigated in the past, we developed additional items to assess the level of cooperation with intermediaries, local communities, public institutions, and NGOs, closely following the scale format used in past studies.

EIP was measured using six items described by Griffin and Page (1993) and Manion and Cherion (2009), which measured the impact of the innovation activities carried out during the previous three years on the innovation program's economic success, such as revenue, profitability, and market share. The SIP captured the degree to which the firm's innovation program activities had improved the firm's sustainability success during the previous three years. We developed a new scale that we could use to assess the multi-dimensional concept of SIP. Based on the conceptual work of Schöggel, Baumgartner and Hofer (2014) and Ketata et al. (2015), we defined four dimensions for SIP—product sustainability, resource efficiency, environmental pollution, and social responsibility—and developed two items to capture each dimension.

Properties of scales

We tested the multi-item scales for validity and reliability. The internal consistency was assessed by examining the Cronbach's alpha coefficients, which ranged from 0.60 to 0.92 and were acceptable. The unidimensional nature of the scales was supported by the results of the principal component analyses (varimax rotation), which extracted one factor with an eigenvalue greater than one for each construct. An additional principal component analysis that included all cooperation items of all collaboration partners reproduced the intended factor structure without cross-loadings higher than 0.40. Similarly, a principal component analysis including all items of EIP extracted one unidimensional factor. To calculate the overall economic performance score, we calculated the mean of the corresponding items. The same approach

Table 2
Scales, Scale Properties, Means, and Standard Deviation.

Variables	Items	α	Min	Max	Mean	s.d.	Informant	Source
Sustainability Innovation Performance (SIP)			1.75	4.50	3.39	.54		Conceptually based
SIP – Environmental Pollution	2	.85	1.00	5.00	3.36	.81	EXEC	on Schöggel et al.
SIP – Resource Efficiency	2	.82	1.00	5.00	3.67	.71	EXEC	(2014); Ketata et al.
SIP – Social Responsibility	2	.60	1.00	5.00	3.34	.74	EXEC	(2015)
SIP – Product Sustainability	2	.61	1.00	5.00	3.12	.75	EXEC	
Economic Innovation Performance	6	.81	1.50	5.00	3.79	.64	EXEC	Griffin and Page (1993); Manion and Cherion (2009)
Cooperation Customers	3	.87	1.33	5.00	3.87	.99	RDI	Brettel and Clevén (2011)
Cooperation Suppliers	4	.80	1.00	5.00	3.44	.68	RDI	Brettel and Clevén (2011)
Cooperation Competitors	3	.90	1.00	5.00	2.18	1.10	RDI	Brettel and Clevén (2011)
Cooperation Experts	4	.92	1.00	5.00	3.54	.93	RDI	Brettel and Clevén (2011)
Cooperation Universities	4	.88	1.00	5.00	3.62	1.15	RDI	Brettel and Clevén (2011)
Cooperation Intermediaries	3	.91	1.00	4.67	2.93	1.24	RDI	Based on Brettel and Clevén (2011)
Cooperation Communes	3	.90	1.00	5.00	2.72	1.28	RDI	Based on Brettel and Clevén (2011)
Cooperation Public Institutions	3	.80	1.00	5.00	3.46	1.02	RDI	Based on Brettel and Clevén (2011)
Cooperation NGOs	3	.71	1.00	3.67	2.23	.91	RDI	Based on Brettel and Clevén (2011)

α , cronbach alpha; s.d., standard deviation; Exec, executive; RDI, responsible R&D/innovation manager.

was taken to assess SIP, for which the four conceptual dimensions were extracted. The scores of the four dimensions were aggregated to calculate the overall SIP measure. The scales, corresponding properties, means, and standard deviations are reported in Table 2.

Analysis

The proposed relationships were tested by applying a benchmarking approach. Benchmarking is an established procedure that is commonly used to identify success factors (e.g., Cooper, Edgett & Kleinschmidt, 2004), so we considered it an appropriate method to explore what top-performing companies do differently compared to their less successful peers. Benchmarking is used to identify factors (e.g., open innovation management practices) that are believed to be responsible for achieving superior outcomes compared to the actual performance outcomes (Ralston, Wright & Kumar, 2001). This helps firms better identify what practices to apply in order to improve their outcomes.

To define the benchmark group, we selected firms falling in the top 20%-quantile of the performance measure EIP and, thereby, identified the most successful firms, which are hereafter referred to as the benchmark firms. For the definition of the benchmark group for SIP, the same procedure was applied. For each variable, the scores of the benchmark firms were then aggregated. The group means for each variable are the benchmark scores. By replicating this procedure for the firms falling into the bottom 20%-quantile, we provided a meaningful comparison for the benchmark scores with firms referred to as low-performing firms. Finally, we calculated the mean of all constructs over all firms within the sample to gain an additional score for the entire population.

To additionally validate the benchmark results as well as to test the relationship between SIP and EIP, we analyzed the relationships between the open innovation practices and the performance measures by calculating the Pearson correlations.

The different performance levels of these three groups in terms of their overall SIP and EIP and its sub-dimensions are depicted in Fig. 1. The benchmark results are depicted in Figs. 2–4. In these figures, each collaboration partner is described, the results of the comparison between the benchmark group (TOP), the low-performing comparison group (LOW) and the entire population (ALL) are displayed, and the correlation coefficients are shown. The results are separated for the EIP (in red on the right side) and the SIP (in green on the left side).

Results and discussion

Open innovation and economic innovation performance

The benchmark results referring to EIP indicate that the difference between the top- and low-performers is rather large on average ($\Delta = 1.3$). As can be seen in Fig. 1, the biggest gaps can be identified for the financial outcomes whereby the differences between the achieved customer satisfaction and image advantage are smaller. As shown in Figs. 2–4, the EIP benchmark group collaborated with most of the innovation partners more intensively than the companies with lower levels of performance, except for competitors ($\Delta = -0.1$) and experts ($\Delta = -0.3$). One reason the low-performers form closer collaborations with external experts could be the lack of internal expertise.

Regarding the open innovation collaboration with the various partners and EIP, several correlations were found to be significant. The benchmark group collaborated closely with customers ($\Delta = 0.8$ in comparison to the low performers), and the correlation with the EIP is highly significant ($r = 0.33$; $p < .001$). The results are similar with regard to universities as collaboration partners ($\Delta = 0.7$; $r = 0.25$; $p \leq 0.01$). These results correspond to those of Brettel and Clevén (2011) and Stefan and Bengtsson (2017). Interestingly, the collaboration with NGOs does not seem to be very intensive, but the benchmark group outperforms the followers ($\Delta = 0.4$), and the positive correlation is significant ($r = 0.22$; $p \leq 0.05$). With respect to the remaining partners (suppliers, competitors, experts, intermediaries, communities, and public institutions), no significant correlations were found. Therefore, the data provides partial support of hypothesis 1 for the stakeholder groups customers, universities, and NGOs.

Open innovation and sustainability innovation performance

With regard to SIP, the results shown in Fig. 1 indicate the difference between the top- and low-performers is rather large ($\Delta = 1.5$). The SIP benchmark group especially outperforms their peers with respect to the product sustainability, indicated by the biggest gap between top and low-performer. The top performer also report the highest levels of reduction in environmental pollution and increased resource efficiency. As can be seen, in Figs. 2–4, the companies with the highest levels of SIP performance collaborate with every partner more extensively than their counterparts with low levels of performance.

Five out of nine correlations between the management practices and the performance were statistically significant. Customers

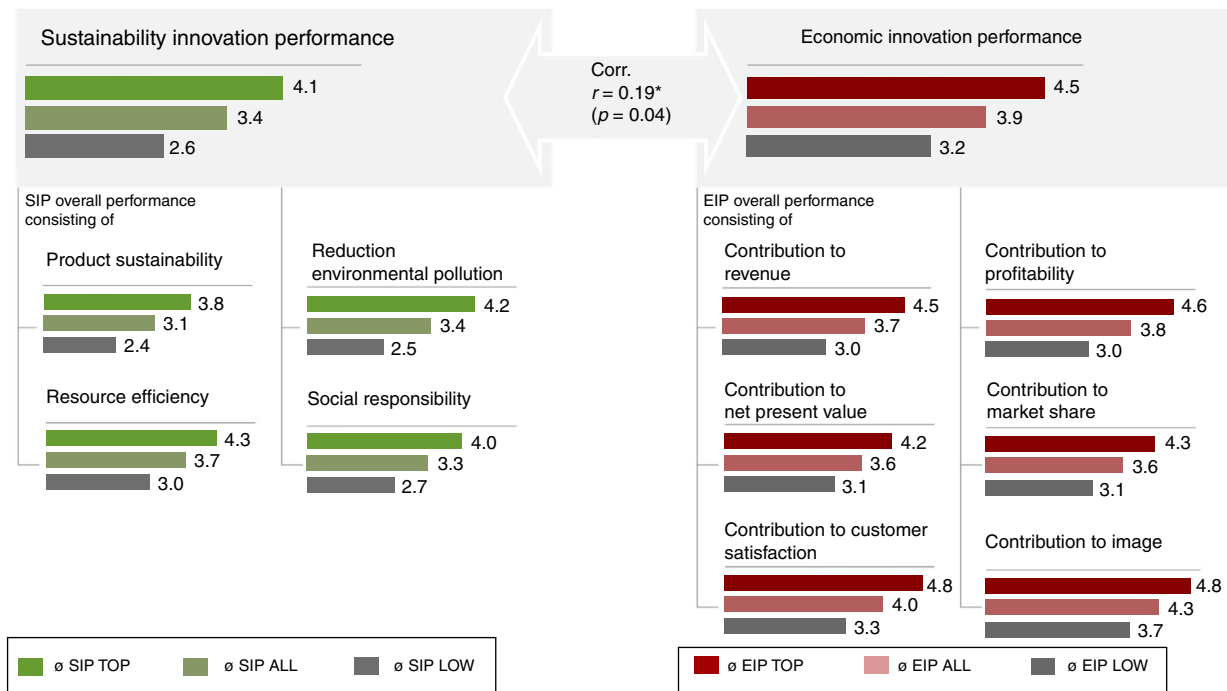


Fig. 1. Performance dimensions of SIP and EIP (Source: Author's study). Note: SIP, sustainability innovation performance; EIP, economic innovation performance; Top, top performer; Low, low performer; top performer calculated as mean of top 20%-quantile; similar for low performer calculated as mean of bottom 20%-quantile; $n = 85$; r , correlation coefficient (Pearson); p , probability level. $^{\dagger}p \leq .10$; $^*p \leq .05$; $^{**}p \leq .01$; $^{***}p \leq .001$ (one-tailed).

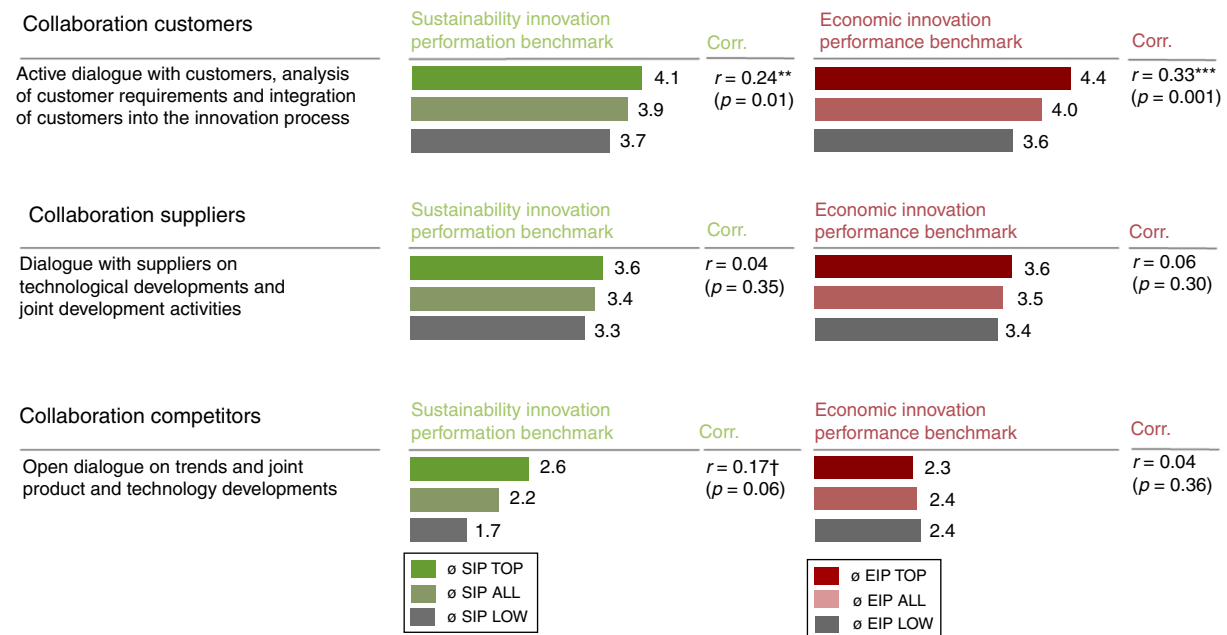


Fig. 2. Results Benchmark Study (Source: Author's study). Note: SIP, sustainability innovation performance; EIP, economic innovation performance; Top, top performer; Low, low performer; top performer calculated as mean of top 20%-quantile; similar for low performer calculated as mean of bottom 20%-quantile; $n = 85$; r , correlation coefficient (Pearson); p , probability level. $^{\dagger}p \leq .10$; $^*p \leq .05$; $^{**}p \leq .01$; $^{***}p \leq .001$ (one-tailed).

are considered the most highly preferred collaboration partners, and the correlation is significant ($r = 0.24$; $p \leq 0.01$); for innovating with intermediaries, the result is similar ($r = 0.26$; $p \leq 0.01$). In this context, intermediaries are organizations supporting companies in their search for partners for innovation projects, providing information about industry trends and technological developments, and are seen by the companies as partners who

support them by communicating their innovation activities to members of the community. As we expected, our results showed that NGOs play important roles even though the results revealed the collaboration is not that intensive; still, the correlation is significant ($r = 0.27$; $p \leq 0.01$). These results echo those reported by Adamczyk, Bullinger and Moeslein (2011), who emphasized that companies worldwide need to recognize the power of open

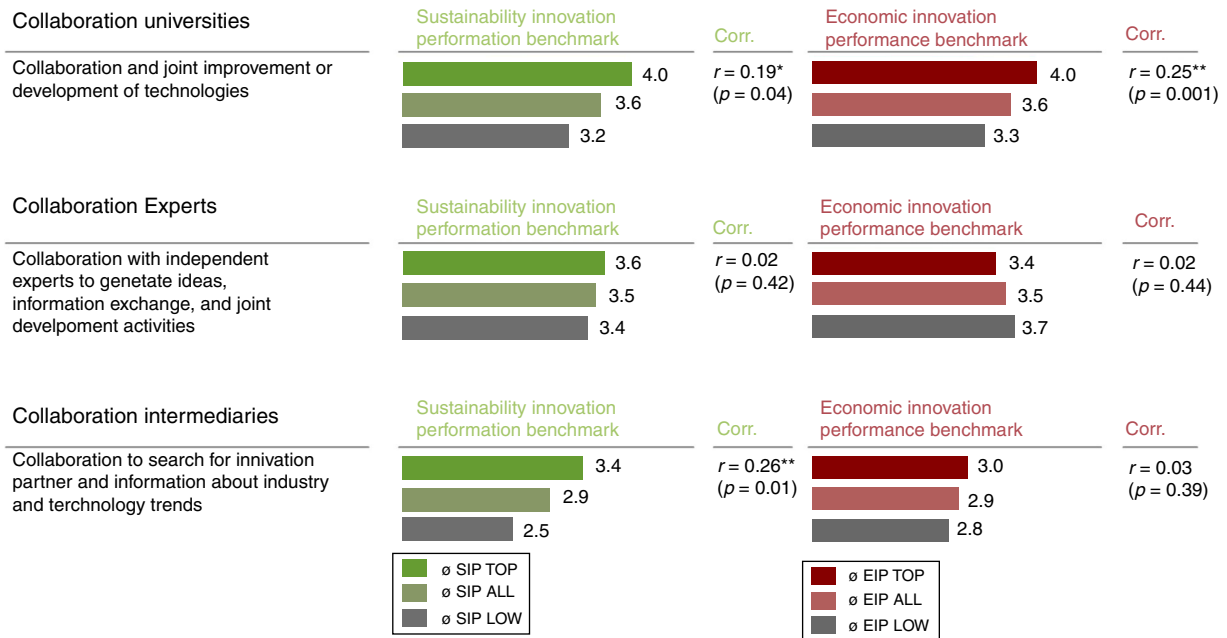


Fig. 3. Results Benchmark Study (Source: Author's study). Note: SIP, sustainability innovation performance; EIP, economic innovation performance; Top, top performer; Low, low performer; top performer calculated as mean of top 20%-quantile; similar for low performer calculated as mean of bottom 20%-quantile; $n = 85$; r , correlation coefficient (Pearson); p , probability level. $^*p \leq .10$; $^{**}p \leq .05$; $^{***}p \leq .01$; $^{****}p \leq .001$ (one-tailed).

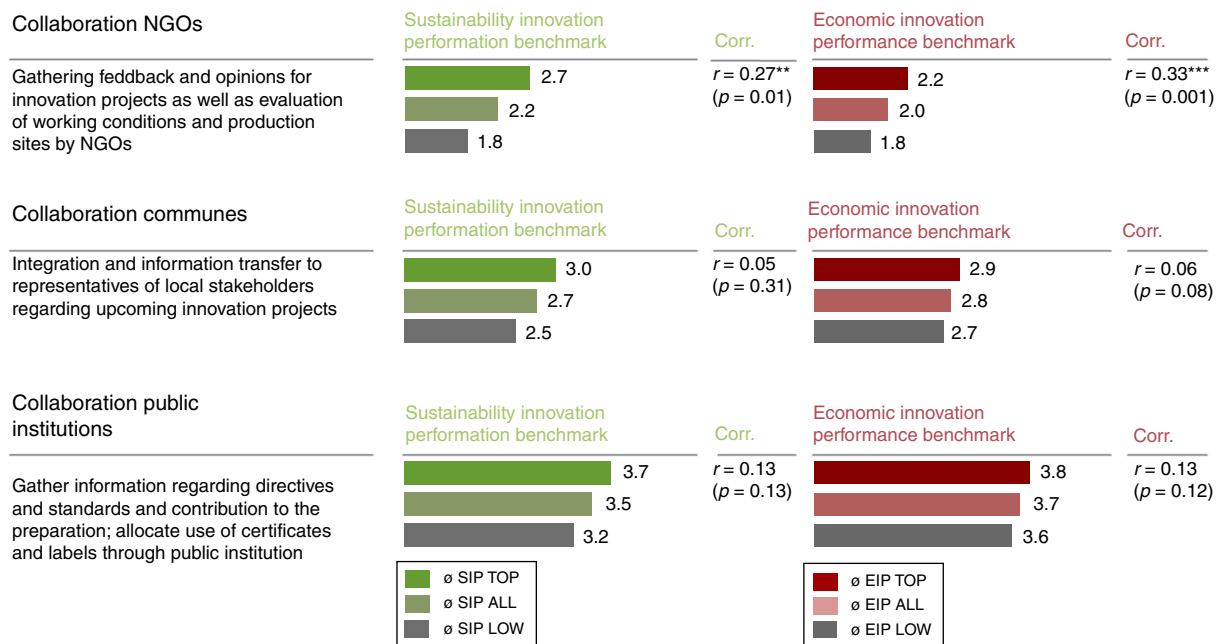


Fig. 4. Results Benchmark Study (Source: Author's study). Note: SIP, sustainability innovation performance; EIP, economic innovation performance; Top, top performer; Low, low performer; top performer calculated as mean of top 20%-quantile; similar for low performer calculated as mean of bottom 20%-quantile; $n = 85$; r , correlation coefficient (Pearson); p , probability level. $^*p \leq .10$; $^{**}p \leq .05$; $^{***}p \leq .01$; $^{****}p \leq .001$ (one-tailed).

innovation platforms and use collaborative networks, such as the 'open planet ideas' and collaboration platforms created by Sony and WWF, to fuel sustainability innovation. Moreover, the exchange with universities ($r = 0.19$; $p \leq 0.05$) and competitors ($r = 0.17$; $p \leq 0.10$) is of relevance for SIP. Although the correlation is weak, one surprising result was that competitors seem to be relevant for open innovation activities. These results support the assumption that the complexity of sustainability innovations and

that most companies have limited experience with their development and commercialization requires additional expertise and the creation of new synergies. However, with respect to the remaining partners (suppliers, experts, communes, and public institutions), no significant correlations were found. Hence, the data provides partial support for hypothesis 2 for the collaboration groups customers, universities, intermediaries, NGOs, and, with limitations, competitors.

Economic innovation performance and sustainability innovation performance

Supporting hypothesis 3, the analysis revealed a positive and significant correlation ($r = 0.19$; $p \leq 0.05$) between EIP and SIP. This means striving for economic and sustainability related innovation goals at the same time does not represent a contradiction but a synergy.

Conclusions and future research

In the current study, we focused on the questions of if and how collaboration with external partners influenced a company's EIP and SIP. Whereas the well-known concept of open innovation has frequently been used in recent empirical studies, we wanted to enlarge the concept within the context of sustainability innovations, and expanding the list of potential stakeholders as collaboration partners.

While prior studies have investigated effects of openness on economic innovation performance of firms (for an overview see e.g., Stefan & Bengtsson, 2017), our research provides evidence for the use of open innovation in the context of sustainability innovation. The results additionally showed that it can be essential to involve both partners directly associated with the company, such as customers or universities, and other stakeholders in the broader ecosystem, such as intermediaries or NGOs who might have a mutual interest in improving the outcome of companies, particularly with respect to sustainability. Moreover, their involvement could help companies overcome market failures and provide specific information and knowledge beneficial for the firm's innovation activities. For the development of the open innovation approach for sustainability, it seems to be appropriate and meaningful to emphasize a broader stakeholder approach. In addition, we provided empirical evidence supporting the assumption that EIP and SIP do not imply trade-off decisions in terms of investing resources when it comes to the innovation activities of the firm. For managers, this means that goals which appear to be divergent at first sight could be reached simultaneously.

However, this study also has its limitations. We developed a new measure to capture the SIP of the firm's innovation program, which needs further validation in future empirical research. The sample is also limited to firms located in Austria. To generalize the findings, additional data from other regions are necessary. An extended data base may also allow to capture further more detailed sectoral differences that we could not explore. Although common method bias concerns were addressed by collecting data from multiple respondents within the firms, additional secondary data to back the subjective ratings of the firm's economic and sustainability innovation performance would be necessary to improve the rating validity. However, this was not possible in our case due to the size of the participating firms. This approach would require to draw on a sample of MNE for which this kind of secondary data is more likely available through public records.

The findings presented in this paper have opened up significant opportunities for future research. First, the newly established scale to measure SIP can be used to drive future research on success factors for sustainability innovation. Second, opportunities exist to conduct a more detailed investigation of open innovation practices and its suitability for sustainability innovation, e.g., examine how expertise on different sustainability issues can be in-sourced rather than brought in through outside-in processes. Third, it would be interesting to additionally analyze how company factors influence the internal acceptance and implementation of open innovation for sustainability innovation. For instance, the organizational culture might influence whether open innovation

activities are accepted (Brettel & Cleven, 2011; Wiener, Gattringer & Strehl, 2017) and whether sustainability concerns can be successfully enter the firm's innovation activities (Globocnik, Rauter & Baumgartner, 2017). Since the strategic orientation of the firm and how the strategic intention of the management is communicated internally and externally is an important economic innovation performance driver (Bart & Pujari, 2007), future research may also investigate how the formal strategy impacts sustainability innovation performance.

References

- Achterkamp, M. C., & Vos, J. F. J. (2006). A framework for making sense of sustainable innovation through stakeholder involvement. *International Journal of Environmental Technology and Management*, 6(6), 525–538.
- Adamczyk, S., Bullinger, A. C., & Moeslein, K. M. (2011). Commenting for new ideas: Insights from an open innovation platform. *International Journal Technology Intelligence and Planning*, 7(3), 232–249.
- Adams, R., Bessant, J., & Phelps, R. (2006). Innovation management measurement: A review. *International Journal of Management Reviews*, 8(1), 21–47.
- Arnold, M. (2011). The role of open innovation in strengthening corporate responsibility. *International Journal of Sustainable Economy*, 3(3), 361–379.
- Arnold, M. (2017). Fostering sustainability by linking co-creation and relationship management concepts. *Journal of Cleaner Production*, 140(Part 1), 179–188.
- Baregheh, A., Rowley, J., & Sambrook, S. (2009). Towards a multidisciplinary definition of innovation. *Management Decision*, 47(8), 1313–1339.
- Bart, C., & Pujari, A. (2007). The performance impact of content and process in product innovation charters. *Journal of Product Innovation Management*, 24, 3–19.
- Brettel, M., & Cleven, N. J. (2011). Innovation culture, collaboration with external partners and NPD performance. *Creativity and Innovation Management*, 20(4), 253–272.
- Carrillo-Hermosilla, J., del Río, P., & Könnölä, T. (2010). Diversity of eco-innovations: Reflections from selected case studies. *Journal of Cleaner Production*, 18(10–11), 1073–1083.
- Chesbrough, H. (2003). *Open innovation. The new imperative for creating and profiting from technology*. Boston: Harvard Business School Press.
- Chesbrough, H. (2012). Open innovation: Where we've been and where we're going. *Research-Technology Management*, 55(4), 20–27.
- Cooper, R. G., Edgett, S. J., & Kleinschmidt, E. J. (2004). Benchmarking best NPD practices – II. *Research-Technology Management*, 47(3), 50–59.
- Crossan, M. M., & Apaydin, M. (2010). A multi-dimensional framework of organizational innovation: A systematic review of the literature. *Journal of Management Studies*, 47(6), 1154–1191.
- Dahlander, L., & Gann, D. M. (2010). How open is innovation? *Research Policy*, 39(6), 699–709.
- Dangelico, R. M., & Pujari, D. (2010). Mainstreaming green product innovation: Why and how companies integrate environmental sustainability. *Journal of Business Ethics*, 95(3), 471–486.
- de Medeiros, J. F., Ribeiro, J. L. D., & Cortimiglia, M. N. (2014). Success factors for environmentally sustainable product innovation: A systematic literature review. *Journal of Cleaner Production*, 65, 76–86.
- DiVito, L., & Bohnsack, R. (2017). Entrepreneurial orientation and its effect on sustainability decision tradeoffs: The case of sustainable fashion firms. *Journal of Business Venturing*, <http://dx.doi.org/10.1016/j.jbusvent.2017.05.002>
- Dodgson, M., Gann, D., & Phillips, N. (2014). *The oxford handbook of innovation management*. Oxford: Oxford University Press.
- Elkington, J. (1997). *Cannibals with forks – The triple bottom line of 21st century business*. Oxford: Capstone Publishing Ltd.
- Elmquist, M., Fredberg, T., & Ollila, S. (2009). Exploring the field of open innovation. *European Journal of Innovation Management*, 12(3), 326–345.
- Freeman, R. E. (1984). *Strategic management: A stakeholder approach*. Boston, MA: Pitman.
- Gassmann, O., Enkel, E., & Chesbrough, H. (2010). The future of open innovation. *R&D Management*, 40(3), 213–222.
- Gianiodis, P. T., Ellis, S. C., & Secchi, E. (2010). Advancing a typology of open innovation. *International Journal of Innovation Management*, 14(4), 531–572.
- Giannopoulou, E., Yström, A., & Ollila, S. (2011). Turning open innovation into practice: Open innovation research through the lens of managers. *International Journal of Innovation Management*, 15(3), 505–524.
- Globocnik, D., Romana, R., & Baumgartner, R. J. (2017). Synergy or conflict? Sustainability vs. economic innovation performance, and the role of organizational culture. In *Proceedings of the 24th innovation and product development management conference* (pp. 1–25). ISSN 1998-7374.
- Gould, R. W. (2012). Open innovation and stakeholder engagement. *Journal of Technology Management and Innovation*, 7(3), 1–11.
- Griffin, A., & Page, A. L. (1993). An interim report on measuring product development success and failure. *Journal of Product Innovation Management*, 10(4), 291–308.
- Hall, J., & Vredenburg, H. (2003). The challenges of innovating for sustainable development. *MIT sloan management review*. Fall, 2003, 61–68.

- Holmes, S., & Smart, P. (2009). Exploring open innovation practice in firm-nonprofit engagements: A corporate social responsibility perspective. *R&D Management*, 39(4), 394–422.
- Horn, C., & Brem, A. (2013). Strategic directions on innovation management – A conceptual framework. *Management Research Review*, 36(10), 939–954.
- Hossain, M. (2010). Open innovation: So far and a way forward. *World Journal of Science Technology and Sustainable Development*, 10(1), 30–41.
- Huizingh, E. K. R. E. (2011). Open innovation: State of the art and future perspectives. *Technovation*, 31(1), 2–9.
- Inauen, M., & Schenker-Wicki, A. (2011). The impact of outside-in open innovation on innovation performance. *European Journal of Innovation Management*, 14(4), 496–520.
- Kemp, R., & Pearson, P. (2007). Final report MEI project about measuring eco-innovation. Deliverable 15. Retrieved from <http://www.oecd.org/env/consumption-innovation/43960830.pdf>
- Ketata, I., Sofka, W., & Grimpe, C. (2015). The role of internal capabilities and firms' environment for sustainable innovation: Evidence for Germany. *R&D Management*, 45(1), 1–16.
- Kuckertz, A., & Wagner, M. (2010). The influence of sustainability orientation on entrepreneurial intentions – Investigating the role of business experience. *Journal of Business Venturing*, 25(5), 524–539.
- Lawson, B., & Samson, D. (2001). Developing innovation capability in organisations: A dynamic capabilities approach. *International Journal of Innovation Management*, 5(3), 377–400.
- Lee, K.-H., & Kim, J.-W. (2011). Integrating suppliers into green product innovation development: An empirical case study in the semiconductor industry. *Business Strategy and the Environment*, 20(8), 527–538.
- Lozano, R. (2007). Collaboration as a pathway for sustainability. *Sustainable Development*, 15(March), 370–381.
- Manion, M. T., & Cherion, J. (2009). Impact of strategic type on success measures for product development projects. *Journal of Product Innovation Management*, 26, 71–85.
- Michelino, F., Caputo, M., Cammarano, A., & Lamberti, E. (2014). Inbound and outbound open innovation: Organization and performances. *Journal of Technology Management & Innovation*, 9(3), 65–82.
- Manzini, R., Lazzarotti, V., & Pellegrini, L. (2017). How to remain as closed as possible in the open innovation era: The case of Lindt & Sprüngli. *Long Range Planning*, 50, 260–281.
- Mustaquim, M. M., & Nyström, T. (2014). Designing information systems for sustainability – The role of universal design and open innovation. pp. 1–16. *Lecture notes in computer sciences* (Vol. 8463).
- Niinimäki, K., & Hassi, L. (2011). Emerging design strategies in sustainable production and consumption of textiles and clothing. *Journal of Cleaner Production*, 19(16), 1876–1883.
- Ralston, D., Wright, A., & Kumar, J. (2001). Process benchmarking as a market research tool for strategic planning. *Marketing Intelligence & Planning*, 19(4), 273–281.
- Schöggl, J.-P., Baumgartner, R. J., & Hofer, D. (2014). A checklist for sustainable product development: Improving sustainability performance in early phases of product design. In I. Horváth, & Z. Rusák (Eds.), *Proceedings of the tenth international symposium on tools and methods of competitive engineering, Budapest, Hungary* (pp. 563–576).
- Snider, J., Hill, R. P., & Martin, D. (2003). Corporate social responsibility in the 21st century: A view from the world's most successful firms. *Journal of Business Ethics*, 48, 175–187.
- Stefan, I., & Bengtsson, L. (2017). Unravelling appropriability mechanisms and openness depth effects on firm performance across stages in the innovation process. *Technological Forecasting & Social Change*, 120, 252–260.
- Tsai, K.-H., & Liao, Y. C. (2017). Sustainability Strategy and eco-innovation: A moderation model. *Business Strategy and the Environment*, 26, 426–437.
- Vanclay, F. (2004). The triple bottom line and impact assessment: How do TBL, EIA, SIA, SEA and EMS relate to each other? *Journal of Environmental Assessment Policy and Management*, 6(3), 265–288.
- Wiener, M., Gattringer, R., & Strehl, F. (2017). Participation in inter-organisational collaborative open foresight. A matter of culture. *Technology Analysis & Strategic Management*, <http://dx.doi.org/10.1080/09537325.2017.1376045>