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# A firm-level composite indicator of eco-innovation and its link with marketing innovation in placement: a comparison of two European countries.

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# Innovation and the environment

- Government agendas are increasinglly focused on environmental issues, pressuring companies to reduce the environmental impact of their activities
- Consumers and companies are pushed to strive for a challenging balance between consumption requirements and sustainability
- Innovation is important to orient companies' effort toward the environment in introducing new products, new processes and new marketing and organizational activities.
- Technological innovations have been found to be pivotal in achieving greater efficiency and sustainability (e.g., Mothe and Guyen, 2017; Medrano et al. 2020; Wang et al., 2021).

# Marketing innovations and the environment

- The role of marketing innovation in driving environmental benefits has been largely overlooked by academic research (Medrano et al. 2020)
- De Jesus et al. (2018) highlight the importance of marketing innovations in offering opportunities for new forms of usage or consumption of products and services, new distribution channels or new promotions or price systems that could bring benefits for the environment.
- No studies have focused on understanding to what extend marketing innovations undertaken by firms could really contribute to an enlargement of enviromental benefits

# Positioning and aim of the study

- Four marketing innovations have been identified in innovation literature (Mariadoss et al. 2011; Medrano et al. 2020, OECD, 2005): innovations in **product design and packaging, promotion, placement and price.**
- Among the four, innovation in product design and packaging has been regarded by the marketing literature as the starting point for many companies which start to follow a path towards sustainability in their innovation activities (Mariadoss et al. 2011). It can be innovated without expansive changes to core products or production processes.
- The role of placement innovation with respect to the environment has received little or no attention.

**The present study aims to identify the role that marketing innovation in placement could play to achieve an enlargment of environmental benefits portfolio.**

**Innovation in Placement → eco-innovation?**

# Definition of Eco-innovation

- Eco-innovation is an innovation that results in a reduction of negative environmental impact, no matter whether or not that effect is intended (OECD, 2010)
- **The production, assimilation or exploitation of a product, production process, service or management or business methods that is novel to the organization** (developing or adopting it) **and which results**, throught its life cycle, **in a reduction of enviromental risk, pollution and other negative impacts of resource use** (including energy use) compared to relevant alternatives (Kemp and Pearson, 2007)

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# Eco-innovations by type of environmental impact

- Environmental Benefits (EBs) of innovation may stem directly from the production of a good or service, or they may be related to after-sale consumption or use of a good or service by the consumer (Horbach et al. 2016).
- Literature on innovation has developed a taxonomy of the different EBs that can be achieved due to the introduction of an innovation (OECD 2005; Castellacci and Lie, 2017).
- **EBs within the firms** (internal)
- **EBs** that are **obtained during the consumption or use of goods and services from the end user** (external)

# Our theoretical framework

- **Firm capabilities** play a critical role in the development of innovation-based sustainability strategies (Mariadoss et al., 2011). Based on **resource-based theory, marketing innovations are seen as firm (marketing) capabilities** that can positively influence firm performance (D'Attoma and Ieva, 2020) and corporate environmental orientation (Medrano et al., 2020).
- Pacheco et al. (2018) posit that marketing capabilities are higher order capabilities which enable firms to benefit from their green strategies. Moreover, the EBs stemming from technological innovations can in fact be strengthened by marketing (Choi and Yi, 2018).

# Can a marketing innovation in placement drive environmental benefits portfolio?

- Innovation in placement involves the types of sales channels employed for selling products (e.g., franchising, direct sales, sales through internet or mobile) and modifications in the design of sales channels (OECD, 2005).
- Innovation in placement involves the delivery of products to shops or to end consumers: the delivery can be optimized to reduce pollution, and to generate environmental benefits.

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# Data from Community Innovation Survey- Germany and Portugal

- CIS 2008, 2014, 2020 (*not yet released*) and 2022 (*not yet released*) include special **modules on 'Innovation with environmental benefits'**
- Data from CIS 2014 Surveys related to **Germany** and **Portugal**
- Observation period: **2012-2014** inclusive; the reference period – year 2012
- Statistical Unit: the **firm** (with more than 10 employees)
- We focus on the **manufacturing sector:** 3,250 manufacturing firms for Germany and 3,810 for Portugal;
- and on innovative firms (74% in Germany, 50% in Portugal)
- that have obtained at least one environmental benefit from their innovation activity (*the final samples reduce to 1137 firms for Germany and 1525 firms for Portugal*)

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# Innovations with environmental benefits (EBs)in the CIS questionnaire 2014

- An innovation with environmental benefits is a new or significantly improved product (good or service), process, organisational method or marketing method that creates environmental benefits compared to alternatives.
- The environmental benefits can be the primary objective of the innovation or a by-product of other objectives.
- **INTERNAL** vs **EXTERNAL** environmental benefits

**13.1 During the three years 2012 to 2014, did your enterprise introduce a product (good or service), process, organisational or marketing innovation with any of the following environmental benefits?**

| | Yes | No |
|---|---|---|
| ***Environmental benefits obtained <u>within your enterprise</u>*** | | |
| Reduced material or water use per unit of output | ☐ | ☐ |
| Reduced energy use or $CO_2$ 'footprint' (reduce total $CO_2$ production) | ☐ | ☐ |
| Reduced soil, noise, water or air pollution | ☐ | ☐ |
| Replaced a share of materials with less polluting or hazardous substitutes | ☐ | ☐ |
| Replaced a share of fossil energy with renewable energy sources | ☐ | ☐ |
| Recycled waste, water, or materials for own use or sale | ☐ | ☐ |
| ***Environmental benefits obtained during the consumption or use of a good or service <u>by the end user</u>*** | | |
| Reduced energy use or $CO_2$ 'footprint' | ☐ | ☐ |
| Reduced air, water, soil or noise pollution | ☐ | ☐ |
| Facilitated recycling of product after use | ☐ | ☐ |
| Extended product life through longer-lasting, more durable products | ☐ | ☐ |

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# How Eco-innovation by type of EBs is commonly summarized in empirical studies?

- A large body of literature used to assess eco-innovation through a binary measure (e.g., Horbach, 2016) → ***loss of valuable information regarding the eco-innovation intensity***
- A count measure is also used to capture to some extent the simultaneous adoption of more types of eco-innovations (e.g. Ghisetti et al. , 2015; D'Attoma & Pacei, 2020) → ***potential double counting problem***
- Multinomial outcome resulting from a cluster based strategy (e.g., D'Attoma & Ieva, 2022; Caravella & Crespi, 2020) → **difficulty in cluster interpretation/lack of comparability by countries**

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# Stage 1: The construction of the multidimensional eco-innovation indicator

- The ten EBs are used to build up the eco-innovation indicator at the **firm level** using a PCA based strategy
- The variables exploited for the PCA are first transformed in order to take into consideration if the EI firm is more or less focused on a single EB (Caravella & Crespi, 2020)
- The rule is separately applied to the two groups of EBs (internal /external)

$$EB^{*}_{int\,,k,i} = \frac{EB_{int\,,k,i}}{\sum_k EB_{int\,,k,i}}$$

$$EB^{*}_{ext\,,k,i} = \frac{EB_{ext\,,k,i}}{\sum_k EB_{ext\,,k,i}}$$

# Stage 1: The construction of the multidimensional eco-innovation indicator

- PCA was conducted on the transformed variables (**GERMANY**)

| Eigenvalues of the Correlation Matrix | | | | |
|---|---|---|---|---|
| | Eigenvalue | Difference | Proportion | Cumulative |
| 1 | 1.57337174 | 0.29486480 | 0.1573 | 0.1573 |
| 2 | 1.27850694 | 0.11199893 | 0.1279 | 0.2852 |
| 3 | 1.16650800 | 0.07814655 | 0.1167 | 0.4018 |
| 4 | 1.08836145 | 0.02696796 | 0.1088 | 0.5107 |
| 5 | 1.06139350 | 0.02659057 | 0.1061 | 0.6168 |
| 6 | 1.03480293 | 0.11093021 | 0.1035 | 0.7203 |
| 7 | 0.92387271 | 0.06233161 | 0.0924 | 0.8127 |
| 8 | 0.86154110 | 0.09050080 | 0.0862 | 0.8988 |
| 9 | 0.77104030 | 0.53043896 | 0.0771 | 0.9759 |
| 10 | 0.24060134 | | 0.0241 | 1.0000 |

| Eigenvectors | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Prin1 | Prin2 | Prin3 | Prin4 | Prin5 | Prin6 | Prin7 | Prin8 | Prin9 | Prin10 |
| ecomat_carav | ecomat_carav | -.037268 | 0.155161 | -.681050 | 0.165341 | 0.230490 | 0.526335 | 0.028544 | -.137685 | -.086540 | 0.354901 |
| ecoeno_carav | ecoeno_carav | -.654485 | -.032508 | 0.047466 | 0.033885 | -.170544 | -.250831 | 0.287763 | -.045625 | 0.315010 | 0.539509 |
| ecopol_carav | ecopol_carav | 0.308931 | 0.378869 | -.251320 | -.179182 | -.483340 | -.394075 | -.252552 | 0.123935 | -.235082 | 0.377405 |
| ecosub_carav | ecosub_carav | 0.325505 | -.015396 | 0.263458 | 0.584700 | 0.331780 | -.306723 | -.043908 | -.385922 | -.096898 | 0.343680 |
| ecorep_carav | ecorep_carav | 0.067833 | 0.140824 | 0.576388 | -.138279 | -.309646 | 0.610439 | -.075835 | -.201082 | -.098847 | 0.315834 |
| ecorec_carav | ecorec_carav | 0.275437 | -.551765 | 0.010232 | -.497215 | 0.335917 | -.017623 | -.123005 | 0.187784 | 0.119064 | 0.441181 |
| ecoenu_carav | ecoenu_carav | -.258169 | 0.365494 | 0.252830 | 0.011161 | 0.458308 | -.006603 | -.027409 | 0.580822 | -.412361 | 0.132204 |
| ecopos_carav | ecopos_carav | 0.245591 | 0.555846 | 0.070831 | -.114871 | 0.242896 | 0.017319 | -.010266 | 0.065712 | 0.740789 | -.004262 |
| ecorea_carav | ecorea_carav | 0.343348 | 0.068901 | 0.007042 | -.127588 | -.029359 | -.016557 | 0.910289 | 0.049330 | -.167575 | 0.027572 |
| ecoext_carav | ecoext_carav | 0.208682 | -.243958 | 0.005324 | 0.549173 | -.308976 | 0.192660 | 0.017431 | 0.628381 | 0.240393 | 0.098880 |

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# Stage 1: The construction of the multidimensional eco-innovation indicator

- PCA was conducted on the transformed variables (**PORTUGAL**)

**Autovalori della matrice di correlazione**

| | Autovalore | Differenza | Proporzione | Cumulativa |
|---|---|---|---|---|
| 1 | 1.89722010 | 0.53145811 | 0.1897 | 0.1897 |
| 2 | 1.36576200 | 0.14968695 | 0.1366 | 0.3263 |
| 3 | 1.21607504 | 0.09274850 | 0.1216 | 0.4479 |
| 4 | 1.12332655 | 0.04066786 | 0.1123 | 0.5602 |
| 5 | 1.08265869 | 0.10982783 | 0.1083 | 0.6685 |
| 6 | 0.97283086 | 0.12291325 | 0.0973 | 0.7658 |
| 7 | 0.84991762 | 0.12738931 | 0.0850 | 0.8508 |
| 8 | 0.72252831 | 0.09322899 | 0.0723 | 0.9230 |
| 9 | 0.62929931 | 0.48891780 | 0.0629 | 0.9860 |
| 10 | 0.14038152 | | 0.0140 | 1.0000 |

**Autovettori**

| | Prin1 | Prin2 | Prin3 | Prin4 | Prin5 | Prin6 | Prin7 | Prin8 | Prin9 | Prin10 |
|---|---|---|---|---|---|---|---|---|---|---|
| ecomat_carav | 0.218803 | 0.144067 | -.054644 | -.237836 | 0.785380 | -.152525 | 0.348409 | -.060196 | -.070674 | 0.318944 |
| ecoeno_carav | 0.416645 | -.486181 | 0.151746 | -.079534 | -.100682 | -.267840 | -.309899 | -.109663 | 0.428087 | 0.432997 |
| ecopol_carav | 0.295959 | 0.422197 | -.396334 | -.079727 | -.078340 | 0.198941 | -.563503 | 0.086416 | -.299004 | 0.332564 |
| ecosub_carav | -.037554 | 0.471351 | 0.561766 | 0.157494 | -.298585 | -.280710 | 0.143634 | -.259217 | -.190213 | 0.379574 |
| ecorep_carav | 0.103474 | -.127971 | 0.320672 | 0.442218 | 0.190079 | 0.761058 | 0.037121 | 0.016079 | 0.034124 | 0.237462 |
| ecorec_carav | -.575335 | -.228369 | -.366728 | -.008731 | -.169228 | 0.035008 | 0.224600 | 0.092743 | -.035915 | 0.626156 |
| ecoenu_carav | 0.423695 | -.255520 | 0.011797 | 0.156509 | -.208862 | -.160077 | 0.327589 | 0.576127 | -.470420 | 0.027887 |
| ecopos_carav | 0.297903 | 0.393974 | -.319722 | 0.142447 | -.256474 | 0.084261 | 0.430664 | 0.100861 | 0.603703 | 0.023327 |
| ecorea_carav | -.247012 | 0.171544 | 0.050589 | 0.525472 | 0.316320 | -.358432 | -.312722 | 0.498004 | 0.235881 | 0.030027 |
| ecoext_carav | -.136143 | 0.154884 | 0.398855 | -.624025 | -.059349 | 0.212105 | -.044748 | 0.557428 | 0.205707 | 0.073684 |

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# Stage 1: The construction of the multidimensional eco-innovation indicator

- **Variables' weights** based on the PCA results:

$$W_k = \sum_{j=1}^{m} \left| L_{kj} \right| \cdot \lambda_j$$

- $W_k$: the weight of the k-th EB indicator
- j : the retained component
- m : the number of retained components
- $\lambda_j$ : the proportion of explained variance of the $j-th$ component
- $L_{kj}$ : the loading value of the $k-th$ EB indicator on the component j

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# Stage 1: The construction of the multidimensional eco-innovation indicator

$$CEI_i = \sum_{k=1}^{K} EB_{\mathrm{ik}}\ W_k^*$$

- $\sum_{k=1}^{K} w_k^* = 1,\ 0 \leq w_k^* \leq 1$ for all k=1,…,K and i=1,…,N.
- $W_k^*$ = scaled weights
- The index was standardized to a scale of 0 to 1 :

$$CEI_{i,norm} = \frac{(CEI_i - CEI_{minimum})}{(CEI_{maximum} - CEI_{minimum})}$$

# Stage 2: The fractional response model

- CEI is a continuous variable bounded in [0,1]
- Fractional response model (Papke and Wooldridge, 1996)

$$E(y_i|x_i) = G(\boldsymbol{x_i\beta})$$

$[(x_i, y_i): i = 1,2, \dots N]\ ; 0 \leq y_i \leq 1$

$G(\cdot)$ as a known function satisfying $0 < G(z) < 1, \forall\ z \in R$
$G(\cdot) = \Phi(\boldsymbol{x_i\beta})$

- We use the fracreg STATA command
- The parameter estimates are obtained using a quasi-likelihood method:

$$lnL = \sum_{i=1}^{N} y_i ln\ G(\boldsymbol{x_i\beta}) + (1 - y_i)[1 - G(\boldsymbol{x_i\beta})]$$

# Results: The role of placement marketing innovation strategies on eco-innovation in Germany and Portugal

| Country | MARKETING INNOVATION | Marginal effect (std. Err) | Z | P>\|Z\| |
|---|---|---|---|---|
| **Germany** | **PLACEMENT** | 0.0127 (0.0049) | 2.59*** | 0.010 |
| **Portugal** | **PLACEMENT** | 0.0048 (0.0028) | 1.70* | 0.089 |

**** 1% Significance, ** 5% Significance, * 10% Significance*

***Source**: own elaboration of CIS 2014 data.*

**Control variables related to regulatory push-pull factors, demand-pull factors, technology push factors and firm-specific factors were also included in the models but they are not displayed due to space limitations.**

# Concluding remarks

- Our work offers empirical evidence on the role of innovation in placement in environmental benefits of innovation
- Thanks to the construction of the composite indicator and to the CIS data, we were able to capture relevant and extensive information about eco-innovative activity. This information would be lost if binary or count type variables are used to measure eco-innovation
- Eco-innovation calls for the introduction of breakthrough technologies or the improvement of available solutions including non-technological ones
- Companies are called to consider introducing a product placement innovation as it could represent a meaningful step toward sustainability.

# Possible future research avenues on marketing innovation and EBs

- Studying the synergies across marketing innovations (interactions)
- Testing different measures of environmental performance of innovation
- Focusing on the role of consumer environmental awareness in the relationship between marketing innovation and environmental benefits
- Use of the new CIS 2020 (march 2023?) and CIS 2022 releases (?)

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