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## Abstract

The European food industry is a key area for the circular economy. Our study explores the drivers for European companies to innovate with circular benefits in the food industry, finding a lack of significant research in this area.

Based on Community Innovation Survey (CIS) 2014 database, our results confirmed the hypotheses, showing that the innovation performance of companies is significantly related to circular innovation. The size of European food enterprises in terms of turnover is also significantly associated with circular innovation.

The research's most important findings are that company location, openness of the research system, and overall prevalence of environmentally related processes significantly explain the variance in circular innovation among countries.

## Introduction

The traditional European food industry is a slow area for innovation. At the same time, the innovations that have been introduced are quite frequently accompanied by solutions that satisfy the "reduce" requirement, a fundamental feature of the circular economy.

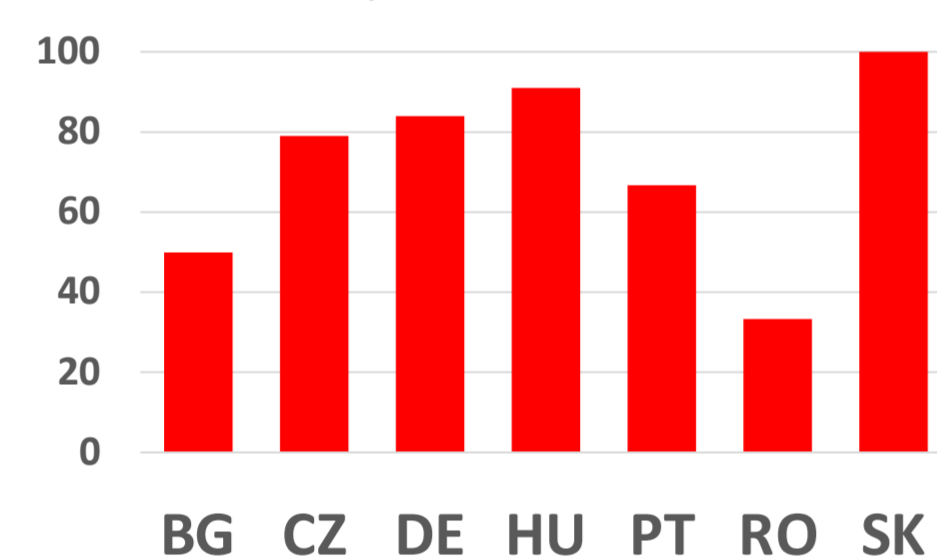


Figure 1. Ratio of Implemented innovations with circular benefits

The "reduce" principle is an essential part of the implementation of circular economy. To achieve this goal, it is necessary to minimize the consumption of raw materials, energy, water, and polluted air in order to cut down on the quantity of waste that is produced and the number of resources that are used.

The European food system is being redesigned based on circularity principles, which can bring environmental benefits for Europe and the world [1]. This transition to a circular economy in the food sector aims to obtain environmental benefits, including cost savings and market expansion [2].

Scientists have been diligently working for years to develop innovative solutions that can address the pressing challenge of producing sufficient quantities of food to feed a growing global population, while simultaneously minimizing the environmental impact and damage caused to the planet [3]

Our research explores the drivers for European companies to innovate with circular benefits in the food industry. We find that there is a lack of research in this area, and our results contribute significantly to the literature on empirical research on innovation adaptation.

## Materials and Methods

To conduct our research, we used the Community Innovation Survey (CIS) database by EUROSTAT. The purpose of the CIS is to offer information on the innovativeness of different business economy sectors, to enable the investigation of innovation drivers or impediments, and to evaluate the effects of innovation. We chose to collect data for 2014 because it is the only survey that includes questions on the circular benefits of innovation. We have selected the NACE Rev. 2 - Statistical classification, divisions 10 to 12, "Manufacture of food products, beverages and tobacco products".

We employed multilevel analysis using JMP Pro 17. Using this procedure, one may analyse data that contains intricate patterns of variability, with a particular emphasis on nested causes of such variability. In our case enterprises are nested into countries, therefore the multilevel analysis is hands up and justified.

## Results

Our results confirm our hypotheses, which are packaged in research questions. Accordingly:

- The innovation performance of a company is significantly related to circular innovation (Estimate: 0.47; Prob>|t|: <.0001\*)
- The size of European food companies in terms of turnover is significantly related to circular innovation (Estimate: 0.11; Prob>|t|: 0.0004\*)
- Neither the proportion of university graduates nor the number of environmental audits carried out regularly is significantly associated with circular innovation. Both have an impact only through the innovations implemented.
- The coefficient of environmental audit by innovations implemented is positive and significant (Estimate: 0.24; Prob>|t|: <.0001\*).
- The effect of the ratio of university graduates by innovations implemented is negative and significant (Estimate: -0.02; Prob>|t|: 0.0023\*)

In addition to fixed effects, random effects are the most important findings of the research which are as follows:

- The mere fact that companies are located in different countries explains 1.3% of the differences in the emergence of circular innovation.
- The most influential random effect is the openness of the research system, which explains 69% of the variation in circular innovation across countries. (The openness, excellence and attractiveness of research systems is measured as the combination of international scientific co-publications per million population, as well as the number of scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country).
- Differences in the overall prevalence of environmentally related processes explain 3.6% of the variance in circular innovation.



Figure 2. Average number of innovation by countries

## Discussion & Conclusions

Overall, the findings from our study provide a comprehensive understanding of the key factors influence the adoption and implementation of circular innovation in the European food industry. These insights can inform policymakers, industry associations, and individual companies as they work to foster a more sustainable and circular economic system within the food sector.

The study revealed a strong **positive relationship** between a company's overall **innovation performance** and its engagement in **circular practices**. This suggests that companies with a robust culture and a track record of successful new product development and process improvements are more likely to embrace the principles of circularity.

The **size** of European food companies, measured by their annual turnover, was also found to be a significant factor in determining the level of circular innovation. Larger companies, with greater financial resources, economies of scale, and market influence, may have an advantage in investing in the research, development, and implementation of circular business models.

Furthermore, the study highlighted the importance of **environmental auditing** in driving circular innovation. The frequency of environmental audits, when coupled with a commitment to implementing innovative solutions, was shown to have a positive impact on a company's adoption of circular practices.

The research on the factors influencing the emergence of circular innovation has provided valuable insights into the role of geographical context.

The most significant finding is the outsized influence of the openness of the research system. Factors such as the accessibility of knowledge, the availability of research funding, and the collaborative networks within the innovation ecosystem, was found to explain a substantial share of the variation across countries.

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