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ORIGINAL PAPER

Mapping Economic Growth and Employment in EU-Funded Research Projects: Trac(k)ing the SDG 8 Trajectory

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Abstract

Research on Sustainable Development Goal 8 (SDG 8) promotes sustained economic growth, full and productive employment, and decent work. This paper presents a complementary approach to standard systematic literature reviews and monitors the intended ex-ante research efforts on SDG 8. We introduce a large-scale research project analysis framework to trace and track the prevalence of SDGs within research funded by the European Union (EU) since 1984, underscoring the EU's significant role in promoting research on sustainable development. Using the publicly available CORDIS database, we identify the extent to which SDG 8 related targets have been represented in the titles and abstracts of projects funded by the EU's Framework Programmes. Our findings reveal that SDG 8-related research projects are dominated by four targets: economic growth, productivity, entrepreneurship and decent work, and full and decent employment.

Keywords Sustainable development goals · SDG 8 · Natural language processing · European framework programmes · Research funding

JEL classification L38 · O22 · O33 · Q01 · O00

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1 Introduction

In 2015, the world witnessed a significant milestone in global development efforts by introducing the Sustainable Development Goals (SDGs), a universal call to action to end poverty, protect the planet, and ensure all people enjoy peace and prosperity by 2030. Researching new insights and methods is an integral and crucial aspect of achieving these ambitions. Following the United Nations (UN, 2015) and Trane et al. (2023), monitoring research attention to each SDG is integral to their successful implementation. The dependence between SDGs should be taken into account. Specifically, various SDGs can be present in the same research project or output, and ignoring this would lead to a misrepresentation of SDG prevalence. In this paper, we focus on the SDG that can be expected to be linked to many other SDGs, namely SDG 8, which promotes sustained economic growth, full -and productive employment, and decent work for all.

Recent literature uses bibliometric research based on publications and technometric research using patent information to monitor SDG research results. The standard approach is to use a systematic literature review (SLR) to summarize the current state of research, identify gaps, and propose future agendas for the key scientific contributions within the field using a replicable, scientific, and transparent process designed to minimize bias (Tranfield et al., 2003). Methods include both quantitative bibliometric databases and qualitative thematic analysis (Xiao & Watson, 2019) using review protocols such as PICO(S), SPIDER, SPAR-4-SLR, PRISMA, and TOPIC+M (Methley et al., 2014; Mohamed Shaffril et al., 2021; Moher et al., 2009; Page et al., 2021). We refer to Mishra et al. (2024) and Ciarli et al. (2022) for such an SLR on SDGs and to Ralph and Arora (2024) for SDG 8 in particular. These approaches analyse finalized research output and, therefore, can be expected to be biased towards positive findings (Scheel et al., 2021). Moreover, given the lengthy peer review process and publication delays, SLRs may fail to provide a timely overview of the current research agenda.

We propose an alternative approach that monitors the intended ex-ante research efforts in funded research projects, providing a complementary view of research activity to a standard SLR. The analysis traces the heterogeneity in past research and tracks whether currently funded projects are aligned with policy objectives. Such an evidence-based approach can be impactful for progress on the SDGs as research and innovation (R&I) policy has developed into a critical instrument in policy frameworks (Bloch & Sørensen, 2015; Abdullaev et al., 2023; Nature Editorial, 2023). However, there is a lack of studies on effective quantification methods and longitudinal analysis of SDG attention in research funding.

Our research aims to fill these gaps, explicitly focusing on SDG 8. We draw on the increasing use of textual data in economics and policy analysis (Ash & Hansen, 2023; Gentzkow et al., 2019) and on the growing literature on the mapping of SDGs in texts or policy documents through natural language processing (NLP) (Smith et al., 2021; Borchardt et al., 2022; Confraria et al., 2024). Based on an existing SDG lexicon, we construct a transparent set of inclusion criteria based on the title and abstract of a research proposal. This leads to a replicable,

scientific, and transparent process to select the funded research projects relevant to SDG 8. We then map the SDGs across the titles and abstracts of research projects funded by the EU Framework Programmes (FPs) from 1984 to 2023. We focus on these programmes for three reasons. First, the CORDIS database, holding information on funded research projects, is publicly and readily available. Second, their growing influence and role in propelling R&I have been well-established and quantified (Aguiar & Gagnepain, 2017; Luukkonen, 1998; Szücs, 2020). Third, the most recent FP, Horizon Europe (HE) (2021-2027), stands out as the world's first research funding programme to formally incorporate the SDGs into its proposal requirements (European Commission, Directorate-General for Research and Innovation, 2021; Nature Editorial, 2023). These factors make the EU FPs an exemplary case for monitoring how intended research efforts align with the SDGs.

Our research questions are sixfold. First, to what extent has the prevalence of SDG 8 targets evolved across the EU FPs? Second, how does SDG 8 rank in comparison to the other SDGs? Third, is this ranking stable over the period 1984–2024? Fourth, how much of SDG 8 research is linked to other SDGs? Fifth, how much heterogeneity exists across the targets of SDG 8? Sixth, is there evidence that the performance of indicators associated with an SDG 8 target predicts the subsequent prevalence of SDG 8 in funded research projects?

To answer these questions, we need to label the presence of SDGs in each funded project. The existing literature identifies two predominant methods for mapping SDGs within textual data: machine learning (ML) techniques and lexicon-based strategies. Recent contributions in ML-based SDG classification systems include Gialitsis et al. (2022), Hajikhani and Suominen (2022) and Vanderfeesten et al. (2022). Despite their potential, these techniques are often criticised for their 'black-box' nature and the substantial volume of training data (Linardatos et al., 2020). Conversely, lexicon-based methods offer an alternative by employing a curated list of words specific to a domain, allowing for direct SDG mapping in text (Bird et al., 2009). Nevertheless, such approaches entail several limitations, as they may inadvertently incorporate the biases of the lexicon's creators and typically assume equal significance for all lexicon terms, potentially oversimplifying the dynamic nature of language (Eisenstein, 2017).

Many SDG lexicons exist due to their specific domain focus (Rivest et al., 2021; Vanderfeesten et al., 2020; Wang et al., 2023). We use the most recently published SDG lexicon developed by the EU Joint Research Centre, namely Borchardt et al. (2022). This lexicon is also operationally used by the SDG mapper of the European Commission (EC)[1]. A multidisciplinary team of SDG experts created this lexicon by combining their insights with manual mapping and iterative validation. The lexicon comprises 3,253 keywords that encapsulate the diversity of each SDG, including 231 terms dedicated explicitly to all thematic aspects of SDG 8. Importantly, this lexicon's expert-driven creation and rigorous methodology make it an ideal tool for our study.

[1] See https://knowsdgs.jrc.ec.europa.eu/sdgmapper.

Using this lexicon, we make four notable contributions. First, to our knowledge, we are the first to systematically map funded research projects to the SDGs. Second, we respond to the need for indicators to track government efforts towards SDGs, as Kim (2018) highlighted. Third, we conduct a longitudinal analysis of the evolution and dynamics of EU research funding for SDG 8 over the past 40 years, offering insights into funding trends. To see whether the EU prioritises certain SDGs over others, as suggested by the literature (Confraria et al., 2024; Forestier & Kim, 2020; Yang et al., 2020), this analysis mainly includes comparing these trends over the different SDG 8 targets, as well as the other SDGs. Fourth, we explore the relationship between macroeconomic conditions and EU funding for SDG 8 research in the subsequent FPs.

The remainder of this paper is organised as follows: Sect. 2 contextualises the role of the EU FPs in achieving SDG 8 and offers a historical depiction of events, political entities, and macroeconomic indicators that may have influenced SDG 8's integration into the FPs. Section 3 describes the dataset used in this study. Section 4 introduces the lexicon and used methodologies. Section 5 presents the results of our analyses. Finally, Sect. 6 concludes.

2 Role of Research and Innovation Policy in Achieving SDG 8

Research and innovation are among the many channels through which the EU wishes to contribute to sustained economic growth, full and productive employment, and decent work. Research and development (R&D) funding plays a role in achieving this objective, depending on the priorities put forward and the European Commission's (EC's) assessment. However, other instruments, such as the European Social Fund, are crucial in promoting decent work through large-scale investment plans. The European Social Fund provides financial support to EU member states to combat youth unemployment and promote social inclusion, making it a significant channel through which the EC explicitly aims to promote SDG 8 in the EU (Petri et al., 2023).

Historically, the EC's priority-setting in the FPs was primarily based on a top-down approach (Reillon, 2017). Several years before the start of a new edition, the EC consults with working groups to identify the major themes on which research funding should be focused (EC, 2021). The biennial Work Programmes formulate calls for proposals to address these themes. The calls set the budget and, more importantly, describe the specific topics for which scientists or companies can submit research applications. Each topic includes a specific objective, scope and expected impact that proposals should aim to meet. In the recent FPs, other funding sources have also been included, such as the European Research Council and Marie Sklodowska-Curie actions. These instruments work through a bottom-up approach, where applicants decide on the subject they want to study without directives from the EC (Reillon, 2017).

Figure 1 illustrates this research funding process. The EC publishes calls for proposals in which scientists (research institutions) and companies respond with specific research proposals. Top-down instruments ensure these proposals

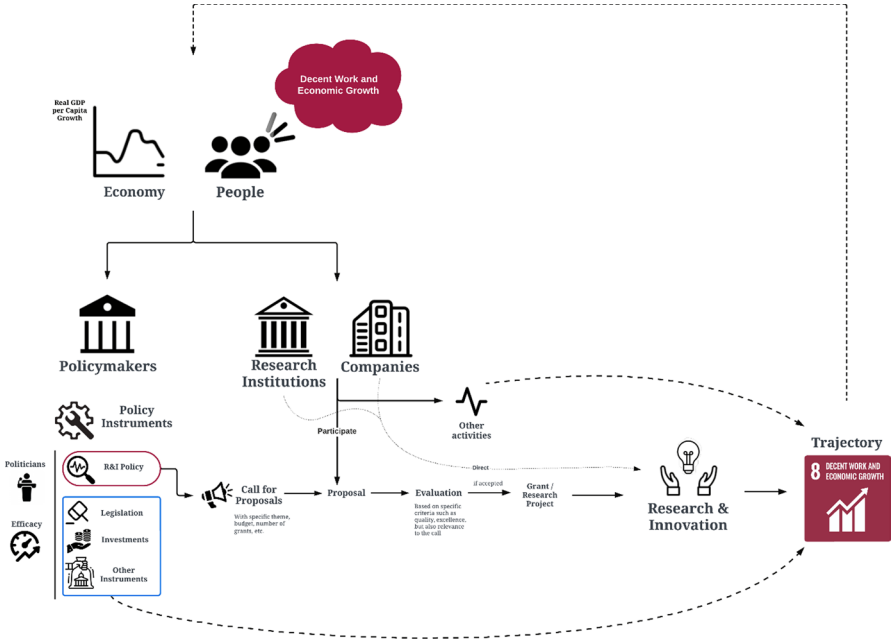


Fig. 1 Flowchart showing how research and innovation policy contributes to the SDG 8 trajectory. This flowchart schematically represents how policymakers, research institutions, companies, and individuals interact to contribute to the SDG trajectory, explicitly focusing on R&I policy. Authors' own elaboration.

align with the EC's priorities, while bottom-up instruments allow applicants to address relevant themes. Subsequently, evaluators appointed by the EC assess these applications based on criteria such as scientific excellence (quality), implementation, and social relevance (impact). Applications are sorted based on these evaluations, and grants are awarded according to the predetermined budget or the minimum number of grants specified for each topic (EC, 2024).

These aspects of the funding process are micro-drivers of how SDG 8 is funded. The preferences of the EC, the research proposals by the applicants, and the assessment of the evaluators strongly influence the number and topics of SDG 8 projects we will observe in our subsequent analyses. Furthermore, the proposals' quality, the applicants' excellence, and their affiliations also play essential roles (Piro et al., 2020). Larger macro-drivers influence these micro-drivers. Following Abma-Schouten et al. (2023), we acknowledge the social context (People) where research occurs as a primary macro-driver for SDG research funding. As shown by Ciarly et al. (2022), significant regional differences in the most frequently researched SDGs exist. We expect the UN's SDG indicators themselves to be another significant macro-driver. Both scientists and the EC are likely influenced by official SDG 8 indicators such as youth unemployment, resource inefficiency, and productivity.

3 Data

Our study maps the presence of SDGs in research projects funded under the EU FPs and coordinated by research-oriented organisations. Our primary data source is the CORDIS database, a public repository of all EU-funded research projects and their results. It provides detailed project information, participant information, and information about project outcomes, allowing users to study their impact. This section details the variables we focus on, the methods to obtain them, and the data cleaning and filtering processes.

3.1 Data Retrieval

For each project funded by the FPs, we aim to retrieve seven variables crucial for our analysis:

1)	Title of the project	Input for the SDG mapping procedure
2)	Abstract of the project	
3)	Name of the project's coordinator	
4)	Country of the project's coordinator	Project characteristics
5)	Received EU budget	
6)	Scientific disciplines identified in the project (EuroSciVoc[2])	Used for selecting projects coordinated by research organisations
7)	Primary activity type of the project's coordinator	

For all research projects funded from FP7 onwards, this information was readily available in the publicly provided data dumps from the CORDIS database. Variables one to five are available for the projects funded under FP5-FP6. At the same time, FP1-FP4 did not include the received EU budget, presumably because FP5 marked the budget transition from European currency units to euros.

For FP1-FP6, we obtain the scientific disciplines using the SEDIA and SPARQL application programming interfaces (APIs) provided by the EC to create an updated version of the CORDIS database for these research projects.

The primary activity type (variable seven) assigns a project coordinator to one of five organizations: higher education institutions (HES), research organisations (REC), private companies (PRC), public research organisations (PUB), or others (OTH). We will use this variable to subset the data as we focus on projects led by research coordinators, specifically those classified as HES or REC (Enger & Castellacci, 2016). This variable was readily available in the data dumps for FP7-HE but not for earlier funded projects. For FP6-funded research projects, we used the eCORDA database provided by BELSPO, which included this activity-type variable

[2] EuroSciVoc is a multilingual taxonomy that systematically categorises the primary fields of science. This classification is derived and regularly updated, using research projects funded from FP1 through HE, utilizing semiautomatic NLP techniques. Its foundational structure aligns with the main scientific disciplines as outlined in the 2015 Frascati Manual by the Organisation for Economic Co-operation and Development (OECD), forming its top-level or 'parent' categories. (OECD, 2015)

for each project. However, for research projects funded under FP1-FP5, we still require a method to assess the activity of their coordinators. To solve this, we developed the following algorithm to predict if their coordinators are HES or REC:

(1) From FP6-HE, 16,364 unique entities coordinated research projects. Of these, 5,454 entities (33.33%) were labelled as HES or REC, indicating they were research-oriented. These entities coordinated 77.57% of the research projects.
(2) FP1-FP5 saw 14,640 unique coordinators. Of these, 3,054 (20.86%) could be directly matched to participants from FP6-HE, while 11,586 remained unmatched.
(3) We used the 'rapidfuzz' Python package[3] with a cutoff score of 93 to match these remaining coordinators. This method was able to match an additional 1,770 coordinators.
(4) Through steps two and three, we matched 4,259 coordinators (30.26%), representing 60% of the research projects funded in this period. Of these coordinators, 2,290 were classified as HES or REC. There remain 9,816 coordinators unidentified.
(5) To reduce this list, we developed a vocabulary in 14 European languages, including terms like 'university', 'research', and 'institute'. This approach, tested on the FP7-HE dataset[4], classified an additional 1,978 research-oriented organizations. Now, only 7,838 coordinators remain.
(6) To reduce this number, we focused on the 1,593 recurring coordinators because our main concern was the concentration of SDG8 research among specific entities.
(7) Next, we developed a second vocabulary comprising corporate indicators (e.g., 'Ltd', 'Inc', 'Plc', 'Llc', 'Lp') in multiple languages. This vocabulary was used to categorize 1,048 of the 1,593 recurring coordinators as non-research-oriented, reducing the list of unidentified (recurring) coordinators to only 545.
(8) For these remaining organizations, we used a combination of manual validation and OpenAI's GPT-4[5] to gauge their research orientation. This led to the identification of another 135 research-oriented organisations.

[3] rapidfuzz is a Python library designed for efficient string matching. It utilizes advanced algorithms to identify similarities between sequences, crucial for our study's fuzzy matching process. We employed rapidfuzz to align organization names across various FPs, effectively identifying similar entities despite minor variances in spelling or format.

[4] This strategy's effectiveness was validated using the FP7-HE dataset. Our approach achieved a recall (true positive rate) of 82.21%, a specificity (true negative rate) of 93.01%, and an F1 score of 79.60%.

[5] For the classification of ambiguous cases, we employed prompt engineering with OpenAI's GPT-4. The system prompt used was: "You are a classifier tasked with determining whether a given organisation name (or sometimes just a name) relates to a research oriented organization. Your output should be a binary classification: Return 1 if the entity is classified as a research-oriented organisation, and 0 if it is not. You take into account your own knowledge. So, if you are not sure about a name at all or cannot predict if it is in fact research oriented, you return NaN. You will receive a list of names. Your task is to generate an output in JSON format, listing each name with its corresponding classification (1 or 0)". This approach allowed us to efficiently process the large quantity of remaining coordinators.

Ultimately, this approach enabled us to classify 30% of coordinators during FP1-FP5 as research-oriented, covering about 61% of the projects funded during this period.

3.2 Project Selection and Data Cleaning

The concatenation of the public CORDIS data dumps resulted in 124,676 research projects from 1984 to November 2023. The initial phase of our data-cleaning process included removing entries with missing critical variables, such as the project's abstract, title, and EuroSciVoc classification. After these steps, our refined dataset consisted of 98,027 research projects from 1984 to 2023.

Next, we removed research projects for which the activity type of the coordinator needed to be identified and only kept research projects coordinated by a research-oriented organisation. Our final dataset comprises 72,536 research projects, or 58.18%, funded over all FPs from 1984 to November 2023. Figure 2 shows the number of projects per FP. Analysing the aggregate number of funded research projects, indicated by combining the coloured and dotted bars, reflects an expansion in the scope and importance of FPs within the EU's R&I policy (Nepelski & Van Roy, 2021; Szücs, 2020). Specifically, with the transition to FP7, the EC called for a renewed and more ambitious scope for their FPs to address global challenges (European Commission, 2006). Additionally, the observed reduction in the number of projects from the FP5 to FP6 is attributed to an increase in the size of research projects, which in turn drew more partners and larger budgets (Breschi & Malerba, 2011). Additionally, we note a higher share of removed projects for the initial FPs (FP1-FP5). This is linked to the previously mentioned data-cleaning process, the imputation of activity types of coordinators, and the increase in research projects coordinated by universities in later FPs (Cavallaro, 2024).

4 Methodology

This section explains how we calculated the prevalence of the SDGs in the title and abstract of the funded research projects.

4.1 SDG-Adjusted Text Preprocessing

Following Borchardt et al. (2022), our analysis incorporates an extensive preprocessing phase. To detect every keyword in our corpus of research projects (title and abstract), our text preprocessing protocol treats the research projects and the lexicon words. The process starts by replacing hyphens with spaces across all texts to unite word forms. Subsequently, each document is tokenised into individual words, which are converted to lowercase to eliminate any variations coming from capitalisation. We remove all non-alphabetic and non-numeric characters to refine the texts further, removing punctuations and special characters that could obscure keyword detection.

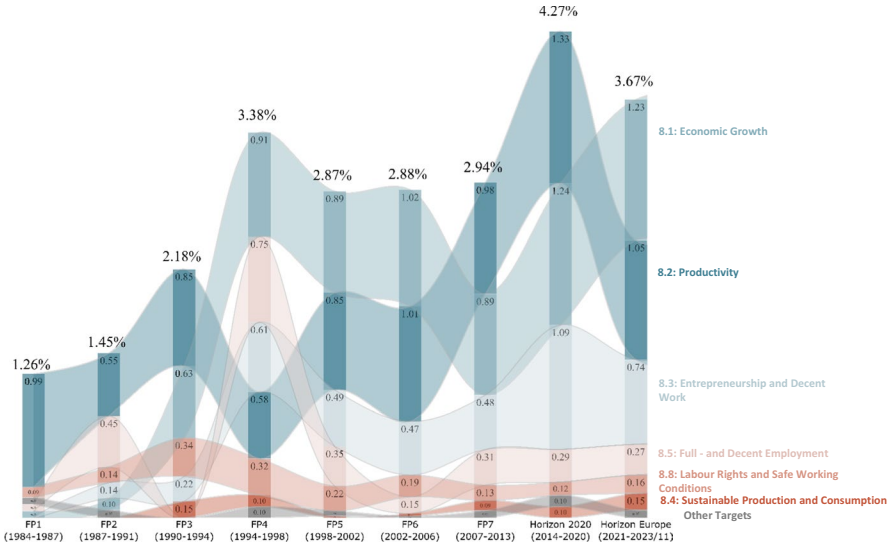


Fig. 2 Prevalence of SDG 8 projects in the EU FPs, decomposed by its targets. This figure shows the contribution of each SDG 8 target to the overall engagement with SDG 8 across various FPs. The prevalence of SDG 8 projects is quantified as the percentage of all projects aligned with this goal in each programme. By normalising the contribution of each project to account for overlapping targets, we show the contribution of each target to the total prevalence of SDG 8 in research projects.

Furthermore, stopwords[6] are deleted from the text to retain only the most significant words. Finally, we apply the Porter stemming algorithm, created by Porter (1980), reducing words to their root form. For example, variations like "economics," "economical", and "economic" are all stemmed from the root "econom". This allows us to boost the probability of detecting a keyword from our lexicon, as it effectively deals with plurals or other word variations. One significant limitation of the Porter stemming algorithm is its tendency for over-stemming, where words are reduced too much, and under-stemming, where the reduction is insufficient. A key example for our lexicon is the word 'productivity', which is reduced to 'product' when subjected to Porter stemming. This clearly illustrates where the stemming algorithm 'overstems' and productivity loses its semantic meaning. To address this, we iteratively identified words in our lexicon susceptible to over-stemming or under-stemming and excluded them from the stemming process[7]. As a result, phrases like 'improve productivity' are now processed correctly as 'improv productivity'.

[6] Stopwords are high-frequency words that do not add additional semantic information, while reducing the probability of detecting keywords (Bird et al., 2009). We used the list of stopwords from the NLTK library in Python, but filtered out some that were important in our lexicon, including 'all', 'being', 'under', 'up', and 'out'.

[7] The words that we withheld from the stemming process were as follows: AIDS, R&D, biodiversity, cohesion, communal, communication, communities, community, course, decarbonisation, decision, decisions, defence, digitalization, disbursement, disposed, diversity, drinking, early, enterprise, enterprises, environmental, Erasmus, erosion, exceed, exceeding, exceeds, exposed, farm-to-fork, financial, gas, generated, generating, generation, generations, industrialization, intensities, intensity, intercontinental, international, intolerance, invasive, loans, management, mitigation, modernisation, multidimensional, nonag-

In the supplementary appendix, we present a word cloud that vividly illustrates the robustness of our SDG 8 lexicon. It is generated from the mapping of SDG 8 in the research projects, showing the frequency of each word's detection in the abstract and title of the funded research projects. The most prominent terms identified are 'technological innovation', 'unemployment', 'entrepreneurship', 'economic development', and 'economic growth'. The varied sizes of the words in the cloud demonstrate that no single keyword dominated our lexicon.

4.2 Mapping Research Projects to SDGs

We map research projects to SDGs based on the presence of an SDG keyword in either the title or the abstract of the funded research project. Adopting the methodological framework of Borchardt et al. (2022), we utilize their established lexicon as part of a binary classification strategy for SDG relevance. We create dummy variables $x_{i,s}$ that are 1 if in project i a keyword of the lexicon for SDG s is present. Formally, this can be represented as:

$$x_{i,s} = I\left(\sum_{q \in \boldsymbol{Q}_s} f_{i,q} \geq 1\right), \tag{1}$$

where $f_{i,q}$ is the count of keyword q in the title and the abstract of project i, $\boldsymbol{Q}_s$ is the list of keywords for SDG s, and $x_{i,s}$ is the binary indicator, which is 1 when at least one keyword of SDGs i mentioned in the title and the abstract of the research project.

4.3 Relative Measure

We also consider the portion of SDG 8 in the number of research projects associated with the SDGs. When computing this share, it is essential to avoid overweighting projects that are mapped to multiple SDGs. Indeed, preliminary findings of our SDG mapping revealed that 8,705 projects, representing 12%, were associated with two or more SDGs, $\sum_{u=1}^{17} x_{i,u} > 1$. Ignoring this fact leads to a double-counting of projects, which skews the analysis towards more generic or broadly used SDGs. Consequently, in the case of multiple SDGs in a research project, we recommend adjusting for the number of SDGs mentioned in the project by quantifying the prevalence of SDGs in project i as the inverse of the number of SDGs present in the title and the abstract of that project. Formally, the subscriptions relative to SDG classification $\tilde{x}_{i,s}$ is given by:

Footnote 7 (continued)

riculture, obesity, off grid, offensive, pollution, preparedness, procurement, procurements, productivity, provision, refugee, refugees, regulation, release, remittance, remittances, responsibilities, responsibility, rights, sanitation, sanitised, status, universal, universities, university, unreliable, urbanisation, waste to energy. These words are included in the SDG word list without stemming.

$$\tilde{x}_{i,s} = \frac{x_{i,s}}{\sum_{u=1}^{17} x_{i,u}} \text{ for } \sum_{u=1}^{17} x_{i,u} \geq 1 \text{ else } \tilde{x}_{i,s} = 0. \tag{2}$$

4.4 Validation

Using publicly available data, we map research projects to SDGs using a keyword-based approach and a transparent and replicable text-mining pipeline. Alternative approaches exist using different lexicons or a Machine Learning (ML) model. In the Supplementary Appendix, we provide several data-driven arguments to show the validity of our implementation choices.

First, we consider our approach an improvement of the SDG Mapper developed by the Joint Research Centre of the EC. This tool uses a keyword-based approach based on the vocabulary of Borchardt et al. (2022). After extensive testing, we identified two significant drawbacks of the SDG Mapper. First, the text preprocessing shows inaccuracies. For instance, it does not detect the keywords when they are mentioned between quotes (‘’ or “”) or when they include a compound modifier (e.g., socio-economic development). Because of the lack of transparency, it is only by reverse engineering that these errors can be identified. Second, the API of the SDG Mapper is inefficient and runs slowly, taking approximately 4 seconds to process a single research project of about 300 words. Extrapolating this to our complete dataset of 72,536 research projects means the total processing time would be around 82 hours, making the SDG Mapper practically unusable for large-scale text analysis. In contrast, our script completes the same task in approximately 15 minutes.

Second, we find that the classification obtained using the Borchardt et al. (2022) vocabulary is highly associated with the classification resulting from other popular SDG lexicons, such as the University of Auckland (UoA) lexicon (Wang et al., 2023), the Elsevier lexicon (Bedard-Vallee, 2023), and the Sustainable Development Solutions Network lexicon (SDSN, 2017). Our supplementary appendix shows these correlations in the top left four rows and columns of a heatmap. The high correlation between lexicon-based approaches contrasts with the results obtained using the more advanced machine learning models such as SDG BERT (Sadick, 2023), RoBERTa SDG (Nothnagel, 2023), and the SDGs. Many BERTs model from the Aurora Universities Alliance (Vanderfeesten et al., 2022). The bottom right three rows and columns in that same heatmap demonstrate that these advanced models have a low correlation between them. Not only are these approaches opaque, but they also produce widely divergent results.

Finally, we observe a low correlation between the ML-based approach and all considered lexicon-based approaches, irrespective of the lexicon involved. An explanation for this systematic discrepancy is that the ML models are not trained on the abstracts and titles of research proposals and lack the versatility to make accurate predictions on this other type of data. The lexicon-based approach suffers less from this drawback, as detecting one SDG keyword is sufficient to assign the SDG label to the research proposal. A further explanation can be that these model-based SDG

8 classifications capture different dimensions of SDG 8 and that, depending on the focus of the SDG 8 analysis, one model can be preferred over another. A similar observation was made by Berg et al. (2022) in the context of ESG scores.

5 Results

The SDG mapping leads to an SDG characterization of each research project. A longitudinal analysis of these SDG labels allows us to answer our research questions about the cross-sectional and time-series heterogeneity on the prevalence and interconnectedness of SDG 8 in EU-funded research.

5.1 Time Series Trends in SDG Prevalence

The SLR of Ralph and Arora (2024) highlights a significant increase in SDG 8-related research publications since 2000. Our research question delves into the evolution of the prevalence of SDG 8 across all EU FPs. This evolution is particularly interesting due to its potential impact on sustainable economic development. We also include the percentage of projects not associated with any SDG, referred to as "No SDG projects", and how this has changed in association with key policy events. These events include the definition of 'sustainable (economic) development' in the Brundtland Report (Brundtland, 1987), the definition of 'decent work' in 1998 by the International Labour Organization (ILO, 1999), the introduction of the SDGs by the UN in 2015 (UN, 2015), and the formal incorporation of the SDGs into proposal requirements for HE (European Commission, 2021).

The SDG prevalence, obtained by averaging our dummy-based metric, is a testament to the impact of the R&I policy. In Table 1, we report the time series of both the SDG prevalence and the proportion of "No SDG projects" from FP1 (1984-1987) through HE (2021—November 2023). We include two-sided t-tests to detect significant shifts across consecutive programmes, with statistically significant changes at the 5% level highlighted in grey. The table highlights that the prevalence of most SDGs in EU-funded research projects has continuously increased. This suggests a growing recognition of the role of R&I policy in addressing global challenges, corroborating the literature.

Scrutinizing the evolution of the proportion of "No SDG projects", we observe the impact of the Brundtland Report. Following its release in 1987, there were two consecutive significant decreases in this proportion, dropping to approximately 66% in FP2 (1987–1991) and nearly 58% in FP3 (1990–1994). However, this percentage saw an unexpected and significant increase in FP4 (1994–1998), after which it stabilized around 61% until FP6 (2002–2006). What stands out are the two consecutive and significant declines in H2020 (2014–2020) and HE to about 52%. These drastic changes seem to be driven by three key factors—the formal introduction of the SDGs in 2015, the focus of H2020 on addressing societal challenges (Reillon, 2017), and the incorporation of the SDGs into the proposal requirements of HE.

Zooming in on SGD 8, we observe a general increase in its prevalence throughout the FPs. During FP1, the proportion of research projects focusing on decent work and economic growth was initially small, accounting for only 1.26%. Subsequently, it saw a consistent upward trend, culminating in a peak during FP4 with a value of 3.37%. This increase coincides with the EC's renewed focus on sustainable economic growth (Kastrinos & Weber, 2020). During the early 2000 s and 2010 s, SDG 8 maintained a steady share of research projects before significantly increasing to 4.27% during H2020, then decreasing again to 3.7% in HE.

This recent decrease reflects a divergence from the current literature. Ralph and Arora's (2024) SLR indicates that the prevalence of SDG 8 broader research continues to grow, with no apparent decline in related publications. This divergence may be attributed to our focus on research efforts executed in research projects rather than finished research products. SLRs often fail to capture the current research agenda and may only identify this decrease several years later. Additionally, Borchardt et al. (2022) highlight an increasing focus on decent work and economic growth within EU policy documents, which they attribute primarily to the socio-economic repercussions of the COVID-19 pandemic and subsequent economic recovery efforts. Overall, these differences suggest that global research trends, ongoing research efforts, and the EU's funding strategy and global policy regarding SDG 8 are not aligned.

Let us consider the other SDGs, which also reveal insightful trends. Notably, SDG 3 on good health and well-being is consistently among the most prevalent SDGs throughout the FPs. Representing about 8.5% of research projects, health research and research on quality of life have always been priorities in the EU's R&I funding policy (Reillon, 2017). Similarly, SDG 1 and SDG 2 have remained consistently prevalent around the same, but with slightly higher variability and at a lower level.

In contrast, SDGs 4 (Quality Education), 5 (Gender Equality), 9 (Industry, Innovation, and Infrastructure), 10 (Reduced Inequalities), 11 (Sustainable Cities and Communities), 13 (Climate Action), and 16 (Peace, Justice, and Strong Institutions) show a continuously upwards sloping trend. Among these, the most remarkable is the significant rise in emphasis on SDG 13, particularly moving from H2020 to HE, when its prevalence nearly doubled from 5.76% to 11%. This surge indicates a clear shift in the EU's R&I policy priorities towards more research projects on climate change, reflecting the global urgency for environmental sustainability. Importantly, this growing emphasis on goal 13 was not observed by Borchardt et al. (2022) in the EU's policy documents, highlighting the need for alignment between the EU's global policy priorities and research policy priorities.

The evolution of the prevalence of SDGs 6 (Clean Water and Sanitation), 7 (Affordable and Clean Energy), 12 (Responsible Consumption and Production), and 15 (Life on Land) exhibits a U-shaped pattern. This indicates that their prevalence was higher in the earlier programs, declined, and is now increasing again. Initially, it accounted for about 7% of projects in FP1-FP3, a high percentage due to the oil crises and the Euratom energy collaboration. However, this share decreased to around 3.5% during FP4-FP6 before rising significantly since the 2010s (FP7-HE), reflecting the growing demand for renewable energy.

Table 1 Prevalence of the SDGs in the EU FPs

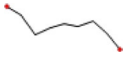
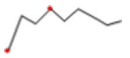
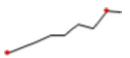
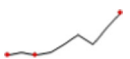
	FP1	FP2	FP3	FP4	FP5	FP6	FP7	H2020	HE	
No SDG	69.75	66.28	58.51	61.36	62.91	61.77	63.72	58.64	52.13	
		(− 2.07)	(− 4.71)	(2.27)	(1.72)	(− 1.3)	(2.8)	(− 10.73)	(− 9.34)	
SDG 1 (Poverty)	0.18	0.34	0.63	1.42	1.17	0.94	0.9	1.24	1.11	
		(0.88)	(1.23)	(3.4)	(− 1.18)	(− 1.25)	(− 0.31)	(3.48)	(− 0.89)	
SDG 2 (Hunger)	1.98	1.86	3.15	2.48	2.12	2.62	1.88	2.19	2.88	
		(− 0.26)	(2.47)	(− 1.54)	(− 1.33)	(1.83)	(− 3.34)	(2.27)	(3.04)	
SDG 3 (Health)	5.59	9.43	8.58	10.2	8.83	10.19	9.24	8.42	8.8	
		(4.03)	(− 0.86)	(2.22)	(− 2.53)	(2.57)	(− 2.21)	(− 2.96)	(0.95)	
SDG 4 (Education)	0.12	0.62	1.16	1.74	1.82	2.77	2.44	4.09	3.93	
		(2.24)	(1.74)	(1.98)	(0.32)	(3.54)	(− 1.43)	(9.68)	(− 0.58)	
SDG 5 (Gender)	0	0.07	0	0.07	0.26	0.48	0.27	0.64	1	
		(1.0)	(− 1.0)	(2.0)	(2.57)	(1.97)	(− 2.25)	(5.8)	(2.71)	
SDG 6 (Clean Water)	1.32	1.65	2.33	2.43	2.73	2.03	1.22	1.16	1.74	
		(0.75)	(1.43)	(0.27)	(1.0)	(− 2.5)	(− 4.24)	(− 0.52)	(3.28)	
SDG 7 (Energy)	7.04	5.57	7.46	3.97	3.6	3.29	5.62	6.58	8.85	
		(− 1.68)	(2.26)	(− 5.53)	(− 1.04)	(− 0.92)	(8.4)	(4.13)	(5.84)	
SDG 8 (Decent Work)	**1.26**	**1.45**	**2.18**	**3.38**	**2.87**	**2.88**	**2.94**	**4.27**	**3.67**	
		(0.44)	(1.64)	(3.01)	(− 1.59)	(0.04)	(0.26)	(7.38)	(− 2.24)	

Table 1 (continued)

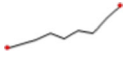
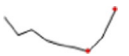
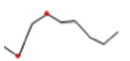
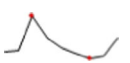
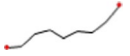
	FP1	FP2	FP3	FP4	FP5	FP6	FP7	H2020	HE	
SDG 9 (Industry, Infrastructure)	4.33	4.89	5.53	6.4	5.63	6.81	6.45	8.37	10.1	
		(0.74)	(0.84)	(1.47)	(− 1.76)	(2.7)	(− 1.0)	(7.61)	(4.15)	
SDG 10 (Equality)	1.74	1.65	1.75	1.99	2.38	2.49	1.95	3.07	3.38	
		(− 0.2)	(0.21)	(0.73)	(1.41)	(0.36)	(− 2.45)	(7.46)	(1.23)	
SDG 11 (Sustainable Cities)	0.66	1.38	2.47	2.57	2.69	1.99	2.07	3.1	3.48	
		(1.96)	(2.39)	(0.24)	(0.42)	(− 2.56)	(0.4)	(6.77)	(1.51)	
SDG 12 (Production and Consumption)	4.99	3.65	4.07	3.19	2.83	2.68	2.29	3.42	5.75	
		(− 1.85)	(0.65)	(− 1.79)	(− 1.14)	(− 0.51)	(− 1.7)	(7.02)	(7.47)	
SDG 13 (Climate)	2.1	1.38	3.54	2.69	2.36	3.29	4.55	5.76	11	
		(− 1.56)	(4.25)	(− 1.86)	(− 1.12)	(3.13)	(4.67)	(5.66)	(12.58)	
SDG 14 (Life Water)	1.02	0.69	1.79	2.11	1.82	1.86	1.31	1.11	1.51	
		(− 1.02)	(3.04)	(0.92)	(− 1.14)	(0.19)	(− 2.98)	(− 1.87)	(2.43)	
SDG 15 (Life Land)	2.95	3.1	5.72	3.95	3.3	2.88	2.41	2.62	4.01	
		(0.24)	(3.83)	(− 3.1)	(− 1.88)	(− 1.35)	(− 2.0)	(1.42)	(5.23)	
SDG 16 (Peace, Justice , Institutions)	0.06	0.34	0.82	0.9	1.07	1.34	1.36	1.79	1.97	
		(1.72)	(1.91)	(0.31)	(0.93)	(1.39)	(0.12)	(3.57)	(0.96)	
SDG 17 (Partnerships)	0.6	1.72	2.23	2.57	1.52	2.56	1.78	1.85	1.76	
		(2.87)	(1.08)	(0.88)	(− 4.0)	(4.07)	(− 3.54)	(0.52)	(− 0.5)	

Table 1 (continued)

	FP1	FP2	FP3	FP4	FP5	FP6	FP7	H2020	HE	
Multiple SDGs	4.57	5.3	9.4	10.36	7.94	10.02	9.47	13.34	18.93	
		(0.94)	(4.71)	(1.26)	(− 4.54)	(4.04)	(− 1.28)	(12.63)	(10.46)	

The prevalence is calculated as the percentage of projects that mention each SDG theme. We applied two-sided t-tests to evaluate the statistical significance of the variation in proportions across consecutive programmes, with changes significant at the 5% level of significance denoted in grey. The t-statistics are presented in parentheses. SDG 8 is put in bold

5.2 Relative Popularity of SDG 8

The literature increasingly reveals that policymakers prioritise SDGs based on their national realities (Confraria et al., 2024; Forestier & Kim, 2020; Yang et al., 2020). However, Ciarly et al. (2022) show that due to national differences in science funding budgets, research on some SDGs has been neglected, especially those not aligned with the national priorities of wealthier countries. This has led to growing calls for governments to adopt to a more global perspective. SDG advocates cite HE, the first R&I funding programme to formally incorporate the SDGs, as the prime example of how this shift can and should be implemented (Nature Editorial, 2023). Our goal in this section is threefold. First, we aim to determine whether HE has indeed adopted a more global perspective in addressing the SDGs. Second, we study how and if SDG 8 is prioritized within the FPs, comparing its ranking with other SDGs. Third, we examine if this ranking is stable over time.

To compare and rank the prevalence between the SDGs, we recommend using the relative metric, as outlined in Sect. 4.3. It differs from the previous measure by adjusting for overweighting projects mapped to multiple SDGs, and ensures we make a fair assessment of the contribution each SDG makes to a research project. This adjustment is necessary because the proportion of research projects mentioning multiple SDGs has nearly doubled, from 10% in FP7 to almost 19% in HE (see Table 1). We call the aggregation of this metric the relative prevalence, calculated by averaging at the FP level but only for projects mentioning at least one SDG. This method ensures that the relative prevalence sums to 100% in each FP.

In Table 2, we report the time-series of the relative prevalence of each SDG from FP1 until HE. As in Table 1, we include two-sided t-tests to detect significant shifts across consecutive programmes, with statistically significant changes at the 5% level highlighted in grey. Our results show that goals 3, 7, 9, and 13 dominate FPs to varying degrees of importance. More specifically, in the earlier (FP1-FP3) − 05 and mid (FP4-FP7) were dominated by SDG 3, we see a shift from SDG 3 to SDG 13 in H2020, and especially HE. Conversely, SDG 9's relative prevalence and ranking have remained consistent, while goal 7 exhibits the same U-shaped pattern, found in Sect. 5.1. What is most striking is that we do not observe a more global perspective after incorporating the SDGs into HE, contrary to the predictions of SDG advocates (Nature Editorial, 2023). For the past 40 years, the same four SDGs get about half of the funding to SDG projects. Except for SDG 13, the more globally oriented SDGs identified as neglected by Ciarly et al. (2022), such as SDG 1 (No Poverty) and SDG 2 (Zero Hunger), also appear to be overlooked in the FPs.

Zooming in on SDG 8, it becomes evident that this goal not a particular priority in the EU's R&I funding strategy. Throughout the FPs, funding research on decent work and economic growth can be seen as a median priority, but with varying degrees of importance. Specifically, in the earlier programmes, SDG 8 was ranked relatively low as the 10th to 12th most important SDG. However, from FP4 to H2020, it consistently ranked as the fifth or sixth most important SDG. As of November 2023, the first stage of HE indicates that SDG 8 has significantly decreased in relative prevalence, now ranking as only the ninth most important SDG in the FP. These results strike a middle ground between Borchardt et al. (2022), who

indicate that SDG 8 is the most prevalent SDG in EU policy documents, and Ciarli et al. (2022), whose bibliometric trend analysis finds SDG 8 to be one of the least prevalent SDGs, particularly in higher-income countries.

5.3 SDG 8 Interlinkages

Research projects that promote sustained economic growth, full and productive employment, and decent work for all, often also relate to other SDGs through overarching topics such as inclusive/decent work (Standing, 2011), mental well-being at work, or a brain healthy economic system (Eyre et al., 2024; Lawlor et al, 2024). Since they are 'integrated and indivisible' (UN, 2015), many of the SDGs and targets are interconnected by design. The projects with multiple SDGs attached to them (see last row of Table 1) shed light on the SDG interlinkages, which Fronza et al. (2023) describe as the complex network of interactions existing within and between the SDGs.

Today's literature mainly focuses on uncovering these interlinkages, answering whether actions to meet one specific SDG will improve progress towards another (synergies) or hamper progress towards another (trade-offs) (Allen et al., 2019; Dawes, 2022; Fronza et al., 2023). In scientometric research, distinguishing between synergies and trade-offs is, however, a complex task and falls outside the scope of this paper.

Following Ciarly et al. (2022), we define a link between two SDGs when a research project is mapped to both. This approach helps us to address our fourth research question regarding the extent to which SDG 8 research projects are linked to other SDGs. Table 3 provides a detailed overview of the top interlinked SDGs from FP1 to HE. For each SDG and the population of projects ("All projects"), the table lists (i) The average number of other SDGs it is connected to, (ii) The three most frequently linked SDGs, (iii) The average number of disciplines involved, (iv) The top discipline, and (v) And the average consortium size.

The table reveals three key insights. First, SDG 8 projects tend to attract larger-than-average consortia, with consortium sizes nearly doubling throughout the FPs. Second, SDG 8 consistently ranks within the top 5 interlinked SDGs, mentioning on average about one other SDG across all FPs, except for FP1. Third, goals 1, 3, 7, 9, 10, 12, 13, and 17 (Partnerships) are linked most to SDG 8 research projects, with particularly strong connections to SDGs 7, 9, and 12, similar to the findings of Ciarly et al. (2022) regarding publications.

To help us understand how and when these interlinkages occur, the table explicitly reports the co-occurrence of SDGs across funded projects. In addition, we provide here some example titles to help frame their interconnectedness. SDG 1 is the most co-occurring with SDG 8 only once, during FP4. Their co-occurrences are evident in project titles such as "Inclusion Through Participation", "Trade, Inequality, and European Unemployment", and "Youth Employment and Social Exclusion". SDG 3 was another major contributor to SDG 8 research projects in the earlier programmes but has since declined in relevance. Project titles like "Research Network on Detection and Prevention of Injuries due to Occupational Vibration Exposures"

Table 2 Relative prevalence of the SDGs in the EU FPs

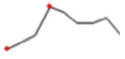
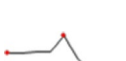
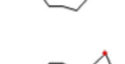
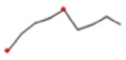
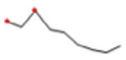
	FP1	FP2	FP3	FP4	FP5	FP6	FP7	H2020	HE	
SDG 1 (Poverty)	0.36	0.63	0.93	2.18	1.92	1.47	1.46	1.69	1	
		(0.67)	(0.72)	(3.24)	(− 0.71)	(− 1.36)	(− 0.04)	(1.38)	(− 3.97)	
SDG 2 (Hunger)	5.57	4.25	5.78	4.46	4.59	4.75	3.55	3.41	3.75	
		(− 1.02)	(1.36)	(− 1.58)	(0.23)	(0.28)	(− 2.78)	(− 0.57)	(1.02)	
SDG 3 (Health)	17.5	25.87	18.64	23.29	21.96	23.86	22.91	17.39	15.38	
		(3.28)	(− 3.11)	(3.01)	(− 1.09)	(1.58)	(− 0.99)	(− 9.04)	(− 2.82)	
SDG 4 (Education)	0.4	1.53	2.38	3.35	3.74	5.44	5.07	7.22	5.57	
		(1.9)	(1.17)	(1.61)	(0.75)	(3.0)	(− 0.78)	(6.3)	(− 3.75)	
SDG 5 (Gender)	0	0.1	0	0.15	0.44	0.77	0.51	0.93	1.23	
		(1.0)	(− 1.0)	(1.94)	(1.97)	(1.67)	(− 1.54)	(3.74)	(1.57)	
SDG 6 (Clean Water)	3.84	3.79	3.86	3.88	5.41	3.35	2.03	1.59	2	
		(− 0.04)	(0.07)	(0.02)	(2.69)	(− 3.76)	(− 3.81)	(− 2.42)	(1.73)	
SDG 7 (Energy)	19.75	14.73	14.52	7.96	7.99	6.72	12.15	11.99	12.83	
		(− 2.19)	(− 0.11)	(− 5.27)	(0.03)	(− 1.74)	(9.14)	(− 0.32)	(1.36)	
SDG 8 (Decent Work)	**3.35**	**3.25**	**3.46**	**5.59**	**5.58**	**5**	**5.35**	**6.26**	**4.14**	
		(− 0.09)	(0.23)	(3.06)	(− 0.01)	(− 0.96)	(0.77)	(2.86)	(− 5.93)	
SDG 9 (Industry, Infrastructure)	11.73	12.09	9.99	12.1	11.82	13.36	13.16	14	13.23	
		(0.19)	(− 1.25)	(1.87)	(− 0.31)	(1.72)	(− 0.28)	(1.73)	(− 1.27)	

Table 2 (continued)

	FP1	FP2	FP3	FP4	FP5	FP6	FP7	H2020	HE	
SDG 10 (Equality)	4.54	4.39	3.17	3.64	5	4.75	4.18	5.3	4.59	
		(− 0.12)	(− 1.15)	(0.71)	(2.38)	(− 0.42)	(− 1.26)	(3.67)	(− 1.82)	
SDG 11 (Sustainable Cities)	1.73	3.28	4.23	4.76	5.51	3.7	4.13	4.8	4.13	
		(1.65)	(0.96)	(0.71)	(1.23)	(− 3.15)	(1.06)	(2.29)	(− 1.89)	
SDG 12 (Production and consumption)	13.82	9.1	7.65	6.08	5.75	4.87	4.25	5.38	7.34	
		(− 2.46)	(− 0.97)	(− 1.62)	(− 0.51)	(− 1.44)	(− 1.4)	(3.82)	(4.38)	
SDG 13 (Climate)	4.71	3.04	6.51	5.25	4.75	6.16	8.45	8.81	13.56	
		(− 1.5)	(3.28)	(− 1.42)	(− 0.82)	(2.32)	(4.36)	(0.93)	(8.4)	
SDG 14 (Life Water)	2.85	1.7	3.62	4.32	3.93	3.78	2.42	1.66	1.83	
		(− 1.27)	(2.32)	(0.96)	(− 0.69)	(− 0.28)	(− 3.46)	(− 3.83)	(0.74)	
SDG 15 (Life Land)	8.36	7.53	9.93	7.06	6.64	4.93	4.24	3.76	4.78	
		(− 0.5)	(1.65)	(− 2.76)	(− 0.61)	(− 2.74)	(− 1.58)	(− 1.83)	(2.86)	
SDG 16 (Peace, Justice , Institutions)	0.2	0.92	1.38	1.56	1.97	2.39	2.76	2.95	2.55	
		(1.55)	(0.85)	(0.42)	(1.14)	(1.11)	(1.11)	(0.81)	(− 1.37)	
SDG 17 (Partnerships)	1.29	3.79	3.93	4.38	3	4.69	3.38	2.86	2.09	
		(2.78)	(0.14)	(0.62)	(− 2.71)	(3.29)	(− 3.05)	(− 2.1)	(− 2.94)	

The relative prevalence is calculated as the proportion of projects that mention each SDG, relative to the total number of SDGs each project mentions. Here, we only focus on projects that mention at least one SDG. The final row shows the proportion of research projects related to multiple SDGs. We applied two-sided t-tests to ascertain significant variations in proportions across consecutive programmes, with changes significant at the 5% level of significance denoted in grey. The t-statistics are presented in parentheses. SDG 8 is put in bold

suggest that their linkages focus primarily on physical well-being rather than mental health.

SDG 7 was among the top contributors during the late-1980s to mid-1990s (FP2-FP4). Titles like "Climate Technology Strategy within Competitive Energy Markets: Towards New and Sustainable Growth" show that their relationship was already tied to climate change research. SDG 7 disappeared during FP5-FP6 but reemerged from FP7 onwards as one of the top contributors. Conversely, SDG 9 appears consistently from FP4 onwards. In the recent programs, the goal's linkage to SDG 8 is reflected by titles like "IDILAB: Implications of Digital Transformation for Migrant Labour" and "ODDEA: Overcoming Digital Divide in Europe and Southeast Asia". These titles point to a shifted focus on research about the anti-inclusive feature of digitalization, as mentioned in Occhipinti et al. (2024).

While SDG 10 only appears in FP5 with titles like "Population, Ageing and Labour Markets," SDG 12 exhibits a similar pattern to SDG 7. SDG 12 was the most important contributor to SDG 8 projects during FP3, with project titles like "Energy—Technology—Environment - Competitiveness: Analysis and Modelling of Policy Strategies" reflecting their relationship. From FP4 to FP6, it disappeared, only to reemerge as the third most important link from FP7 to HE. In these recent FPs, their connection was evident in titles such as "Systemic Large Scale Eco-Innovation to Advance Circular Economy and Mineral Recovery from Organic Waste in Europe," illustrating its recent relation to decent work and economic growth. Finally, SDG 13 has only recently become an essential contributor to SDG 8 research projects, with titles such as "Decoupling It? A Global Comparative Ethnography of the Role of IT in the Mitigation of the Climate Crisis" becoming more prevalent.

5.4 SDG 8 Target Decomposition

Each SDG consists of related aspects, and our fifth research question examines to what extent SDG 8 tackles a heterogeneous set of targets. This section examines which SDG 8 targets are most prevalent in the FPs. Figure 2 shows our prevalence measure for SDG 8 as in Table 1, but decomposed into the different targets using normalisation. We have assigned descriptive names to these targets based on our interpretation of their official definitions, details of which are provided in our Supplementary Appendix.

Our results show that in FP1, SDG 8 research projects were mainly focused on target 8.2 on productivity, with target 8.8 on labour rights and safe working conditions ranked second but with a considerably lower prevalence. While negligible in FP1, the target 8.5 on full- and decent employment emerges as the dominant target in FP2. The prevalence of target 8.2 sees a substantial reduction, while target 8.8 maintains its attention. FP3 shows a resurgence of 8.2, alongside a notable shift towards target 8.1 on economic growth, which gains significant traction for the first time. Meanwhile, target 8.5 loses its previously gained prominence. Furthermore, target 8.8 maintains its presence, accompanied by an increased focus on target 8.4 on sustainable production and consumption.

Table 3 Top 5 SDGs that have the highest co-occurrence with other SDGs over the EU FPs

		Interlinked SDGs*				Disciplines**		Consortium size***
		Number	Top			Number	Top	
			First	Second	Third			
FP1	SDG1	1	SDG3	SDG7	SDG14	2.7	COMP	1.7
	SDG13	0.9	SDG7	SDG12	SDG15	1.8	EARTH	5.2
	SDG17	0.7	SDG14	SDG6	SDG7	1.8	CHEM	1.2
	SDG11	0.6	SDG2	SDG3	SDG7	1.5	CHEM	2.1
	SDG10	0.4	SDG9	SDG3	SDG7	1.9	CHEM	2
	All Projects	0.4	SDG7	SDG3	SDG12	1.7	CHEM	2.3
FP2	SDG1	1.2	SDG3	SDG9	SDG11	1.2	AGR	5.6
	SDG5	1	SDG10	SDG1	SDG2	3	AGR	3
	SDG13	0.7	SDG7	SDG2	SDG15	1.9	EARTH	6.5
	SDG8	**0.6**	**SDG17**	**SDG3**	**SDG7**	**1.7**	**ECO**	**5**
	SDG17	0.6	SDG9	SDG7	SDG8	1.7	COMP	5.4
	All projects	0.4	SDG3	SDG7	SDG9	1.7	CHEM	4.4
FP3	SDG1	1	SDG7	SDG13	SDG16	1.7	ENV	5.8
	SDG8	**1**	**SDG12**	**SDG7**	**SDG3**	**1.8**	**ECO**	**6.5**
	SDG11	0.8	SDG7	SDG9	SDG15	1.7	ENV	5.5
	SDG6	0.8	SDG15	SDG2	SDG9	2.3	EARTH	6.2
	SDG15	0.7	SDG2	SDG13	SDG6	2.1	AGR	6
	All projects	0.5	SDG3	SDG7	SDG15	1.8	BIO	5.9
FP4	SDG1	1.2	SDG8	SDG10	SDG3	1.7	SOC	6.1
	SDG6	1	SDG15	SDG9	SDG12	2	EARTH	5.7
	SDG8	**1**	**SDG1**	**SDG9**	**SDG7**	**1.8**	**ECO**	**5.4**
	SDG16	0.9	SDG3	SDG10	SDG15	1.8	COMP	4.5
	SDG17	0.9	SDG9	SDG8	SDG3	1.7	COMP	6.3
	All projects	0.5	SDG3	SDG9	SDG7	1.7	BIO	4.5
FP5	SDG1	1.1	SDG8	SDG10	SDG3	1.5	SOC	6.6
	SDG5	0.9	SDG10	SDG1	SDG3	1.3	SOC	6
	SDG16	0.8	SDG11	SDG9	SDG10	1.8	COMP	6.5
	SDG8	**0.8**	**SDG9**	**SDG10**	**SDG1**	**1.6**	**ECO**	**7.3**
	SDG17	0.7	SDG9	SDG8	SDG11	1.6	COMP	9.2
	All projects	0.5	SDG3	SDG9	SDG7	1.6	BIO	5.8
FP6	SDG1	1.2	SDG10	SDG3	SDG4	1.7	SOC	10.8
	SDG5	1	SDG10	SDG3	SDG9	1.5	SOC	7.4
	SDG6	1	SDG13	SDG15	SDG9	2.3	EARTH	8
	SDG8	**0.9**	**SDG9**	**SDG10**	**SDG17**	**1.9**	**ECO**	**9.4**
	SDG15	0.9	SDG13	SDG9	SDG14	2.1	BIO	8.2
	All projects	0.5	SDG3	SDG9	SDG7	1.8	BIO	6.1

Table 3 (continued)

		Interlinked SDGs*				Disciplines**		Consortium size***
		Number	Top			Number	Top	
			First	Second	Third			
FP7	SDG1	1.1	SDG8	SDG10	SDG3	1.6	SOC	7.8
	SDG6	1.1	SDG13	SDG7	SDG12	2.1	ENV	7.5
	SDG15	0.9	SDG13	SDG14	SDG9	1.8	BIO	6
	SDG8	**0.9**	**SDG9**	**SDG7**	**SDG12**	**1.7**	**ECO**	**7.6**
	SDG12	0.9	SDG7	SDG9	SDG8	2	ENV	8.9
	All projects	0.5	SDG3	SDG9	SDG7	1.6	BIO	4.4
H2020	SDG6	1.3	SDG13	SDG9	SDG12	2.3	ENV	8.2
	SDG1	1.3	SDG3	SDG10	SDG11	1.9	SOC	8
	SDG15	1.1	SDG13	SDG2	SDG9	2.1	BIO	7.4
	SDG5	1.1	SDG10	SDG3	SDG16	1.6	SOC	4
	SDG8	**1.1**	**SDG9**	**SDG7**	**SDG12**	**2**	**ECO**	**9.6**
	All projects	0.6	SDG3	SDG9	SDG7	1.8	BIO	4.9
HE	SDG1	1.9	SDG13	SDG10	SDG11	2	SOC	8.6
	SDG11	1.3	SDG13	SDG9	SDG8	1.9	SOC	10.4
	SDG8	**1.3**	**SDG9**	**SDG13**	**SDG12**	**1.9**	**ECO**	**8.8**
	SDG17	1.3	SDG9	SDG13	SDG8	2	ECO	9.9
	SDG6	1.3	SDG13	SDG12	SDG7	2.4	ENV	6.6
	All projects	0.7	SDG13	SDG9	SDG7	1.8	BIO	5.3

*The column "Number" indicates the average number of other SDGs to which each primary SDG is connected, while the column "Top" lists the top three SDGs to which each primary SDG is most frequently linked. **The disciplines represent the NT1 category of the EuroSciVoc taxonomy. *AGR* Agriculture, forestry, and fisheries, *BIO* Biological sciences, *CHEM* Chemical sciences, *CLIN* Clinical medicine, *COMP* Computer and information sciences, *EARTH* Earth and related environmental sciences, *ECO* Economics and business, *ENV* Environmental engineering, and *SOC* Sociology. Here, the column "Number" indicates the average number of disciplines involved. SDG 8 is highlighted in bold. ***The consortium size refers to the average number of participants

Recovering from a substantial economic crisis in the United Kingdom caused by Black Wednesday, the landscape transforms again in FP4, where targets 8.1 and 8.5 become the most prevalent SDG 8 targets within the programme. As target 8.2 decreases to a lower rank of importance, target 8.3 on entrepreneurship and decent work climbs to the third rank, marking its first noticeable appearance in the FPs. This shift contributes to the peak in SDG 8 discussions in FP4, predominantly driven by the emphasis on targets 8.5 and 8.3. Moving on to FP5, there is a general decline in the prevalence of all targets except for target 8.2, which regains its position as the second most prevalent. This trend of rising prominence for target 8.2 and decreasing focus on target 8.5 continues into FP6 and FP7, with target 8.2 re-establishing itself as the leading SDG 8 target.

However, H2020 introduces a different set of trends. Despite a general increase in the prevalence of SDG 8, as discussed in Sect. 5.1, this surge is primarily driven by a significant increase in target 8.3. This surge in target 8.3 aligns with the EU's growing commitment to support small and medium-sized enterprises (SMEs) by allowing them to coordinate research projects in the FPs (Mina et al., 2021). This shift in the EU's SME priorities significantly impacts the prevalence of target 8.3, underscoring the robustness of our lexicon in detecting these important changes. Notable, however, is that we also observe rises in the prevalence of targets 8.1 and 8.2. Conversely, HE again presents a shift, as detailed in Sect. 5.1, with an overall significant decline in the prevalence of SDG 8. While targets 8.1 and 8.5 maintain their positions, this decrease can be mainly attributed to decreases in targets 8.2 and 8.3.

Regarding prioritization of targets within SDG 8, targets 8.1, 8.2, 8.3, and 8.5 have been the dominant targets of varying importance. Targets 8.8 and 8.4 only saw some prominence in specific FPs. In contrast, the other targets, including 8.6 on youth employment, 8.7 on forced labour, 8.9 on sustainable tourism, and 8.10 on financial inclusion, were left entirely out of the SDG 8 discourse. This target prioritization was also evident for all EU policy documents from 2021 and 2022 by Borchardt et al. (2022). These authors, however, found that the discourse was dominated entirely by targets 8.1, 8.3, and 8.5 and, to a lesser degree, 8.2 and 8.8. Furthermore, they found that the other targets were nearly neglected, highlighting the need for a more comprehensive approach to SDG 8.

5.5 Economic Drivers of SDG 8 Prevalence

To conclude, we analyse the economic drivers of SDG 8 research funding, as explained in Sect. 2. We look at the intertemporal relationship between official macroeconomic indicators monitoring progress towards decent work and its specific targets. Our analysis mainly focuses on targets 8.1 (Economic Growth), 8.2 (Productivity), and 8.5 (Full and Decent Employment) alongside their respective official indicators: real GDP per capita growth, real GDP per employed person growth, and the unemployment rate for the EU-27 aggregate. Despite target 8.3 (Entrepreneurship and Decent Work) being a substantial proportion of SDG 8's prevalence, it was excluded from our analysis due to the lack of available data for its official indicator, informal employment.

Table 4 presents the estimated regression coefficient ($\widehat{\beta}$) and predictive power (R^2) derived from ordinary least squares regressions. We regress the outcomes for targets 8.1, 8.2, and 8.5, depicted in Figure 2, for each FP against the two-year average of the official indicators preceding those FP. We emphasise the limited sample size used in our analysis. Each variable aggregates thousands of observations (projects, economic decisions) and represents macroeconomic conditions. Our results should be interpreted as descriptive and not causal.

We expect negative coefficients to be observed on the diagonal for targets 8.1 and 8.2, suggesting that periods of low economic growth and productivity before an FP would correlate with a higher emphasis on these targets within the subsequent FP. Conversely, for target 8.5, a positive relationship with the unemployment rate was anticipated, indicating that higher unemployment levels would lead to a greater focus on this target in the next FP. Our findings support these hypotheses, particularly the relationship between target 8.1 and real GDP per capita growth, which shows significance at the 10% level. Notably, the most substantial detected relationship was between target 8.1 and the real GDP per employed person growth, the official indicator for target 8.2. Despite some relationships not reaching statistical significance, the small sample size may limit the statistical power to make these conclusions, which is why the R2 values were considered to evaluate the predictive accuracy of each macroeconomic variable.

The R2 values reveal intriguing insights. Once again, the predictive strength of the official indicators in forecasting target prevalence in the subsequent FP is highlighted. The real GDP per employed person growth rate, in particular, demonstrates the highest predictive power with an R2 of 0.777 concerning target 8.1. Notably, the two-year unemployment rate average only shows predictive value for target 8.5, underscoring the distinct dynamics between GDP growth rates and unemployment rates. Overall, the findings suggest that researchers and policymakers tend to respond to adverse shifts in SDG 8 indicators, with poor performance in these indicators before an FP usually leading to increased attention to the corresponding targets within that FP.

6 Conclusion

Since 1983, the EU has extensively funded research and innovation through its framework programmes. Its initial focus was on six thematic objectives: agriculture, development aid, energy, living conditions, industrial competitiveness, and raw materials (Council of European Communities, 1983). The thematic coverage has since then expanded, with the concept of ‘sustainable development’ appearing for the first time in the fourth framework programme (1994–1998) description (Kastrinos & Weber, 2020). The ILO defined the concept of ‘decent work’ in 1999 (ILO, 1999), which then became central in the definition of SDG 8 by the United Nations (UN, 2015) and has become widespread in policy analysis. These evolutions since 1983 motivate us to propose a large-scale textual analysis to track and trace SDGs’ current and past trajectories in EU-funded research. Our analysis studies the intended ex-ante research efforts in funded research projects, providing a complementary view of research activity to a standard systematic literature review. The tracing allows us to identify past trends and understand the historical drivers of SDG prevalence in EU-funded research. The tracking is insightful about actions to steer future SDG prevalence in EU-funded research in alignment with policy targets.

The proposed SDG tracking and tracing method follows a bottom-up approach. The first step identifies SDG keywords in the title and the abstract of each funded

Table 4 Macroeconomic performance as a leading indicator for SDG 8 prevalence in EU-funded research

$\overline{X}_{t-1,t-2}$	y_t	Target 8.1: Economic Growth	Target 8.2: Productivity	Target 8.5: Full -and Decent Employment
Real GDP per capita growth	$\widehat{\beta}$	−0.13*	− 0.06	− 0.03
	R^2	0.391	0.158	0.032
Real GDP per employed person growth	$\widehat{\beta}$	0.1**	− 0.12	0.08
	R^2	0.777	0.428	0.21
Unemployment rate	$\widehat{\beta}$	0.01	− 0.01	0.09
	R^2	0.006	0.009	0.326

This table evaluates the predictive power of key macroeconomic indicators (rows) related to SDG 8 targets within subsequent EU FPs (columns). We estimate ordinary least squares regressions $y_t = \alpha + \beta \overline{X}_{t-1,t-2} + \epsilon_t$, where $\overline{X}_{t-1,t-2}$ is the average value of the official indicator two years preceding the FP. The table depicts the R^2 and the estimated regression coefficient, $\widehat{\beta}$, resulting from this equation. Source: International Monetary Fund, World Economic Outlook October 2023.

'*', '**', and '***' depict the 10%, 5%, and 1% levels of significance respectively.

research project, as published in the CORDIS database. For this, we recommend using the SDG lexicon of Borchart et al. (2022). The second step aggregates the observed SDG prevalence to a time series at different levels of granularity. Subsetting the data based on period allows the identification of trends, while conditioning on fund characteristics reveals insights on differences in research approaches across SDGs.

Our findings reveal that the prevalence of SDG 8 in EU FP funding ranks as the median over the complete period, with varying degrees of importance over time. In the earlier programmes, SDG 8 ranked relatively low as the 10th to 12th most prevalent SDG. However, from FP4 to H2020, it consistently ranked as the fifth or sixth most prevalent SDG. These SDG 8 research projects are dominated by four targets: 8.1 (Economic Growth), 8.2 (Productivity), 8.3 (Entrepreneurship and Decent Work), and 8.5 (Full and Decent Employment), in varying order of importance over time. Additionally, SDG 8 projects tend to have larger consortium sizes than other EU-funded projects. Over the period from 1984 to 2023, the typical SDG 8 consortium size has nearly doubled and is consistently more extensive than the average consortium size.

SDG 8 also ranks systematically among the most interconnected SDGs across all FPs. SDGs 1, 3, 7, 9, 10, 12, 13, and 17 are most frequently linked to SDG 8 research projects, with solid connections to SDGs 7, 9, and 12. Finally, we find empirical evidence supporting the conjecture that EU economic performance is a leading indicator of SDG 8 in the research projects funded by the program. Specifically, the real GDP per employed person growth rate is highly predictive of research attention to target 8.1.

Overall, we uncover substantial differences in received funding across SDGs and targets within SDGs. Even if strategic policy choices primarily drive these inequalities, we expect that there are still unintentional gaps between effective and

desired SDG prevalence in funded research due to the lack of coordination between researchers, project evaluators and policymakers. To improve this coordination, we have released the SDG dashboard that allows researchers to find the most relevant funded research per SDG and policymakers to track and trace the prevalence of each SDG in EU-funded research. We refer the reader to the supplementary appendix for more details on the SDG dashboard.

There are several limitations which will inspire further research. First, while the obtained SDG allocation data relate to all SDGs, this paper focuses on SDG 8. It would be of interest to include the other SDGs. Second, the proposed framework does not embed a causal analysis. Uncovering the causes and consequences of the SDG funding variability in EU funding is beyond the scope of this research, but would offer policy relevant insights. An interesting direction for future research is to combine research project proposals in the eCorda database with funded research projects in Cordis, as in Ghirelli et al. (2023). Such a joint analysis could reveal important insights into the funding success of SDG 8 project proposals compared to other SDGs.

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Declarations

Conflict of interest The authors declare that they further have no competing interests relevant to this article's content.

Ethical Approval For our type of research, there was no legal or institutional requirement to apply for approval from the ethics committee.

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