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## Public procurement to address biodiversity loss: A first attempt at European mapping

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by

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***Abstract***

Mission-oriented research projects have become fashionable, and they are often suggested as an appropriate policy tool to foster scientific and technological activities. But how do they operate? And are they effective?

The purpose of this article is not to reintroduce a debate on the importance of demand-side versus supply-side policies. Rather, we simply consider the use of demand-side policies as an additional tool to promote innovative policies that can complement existing supply-side measures, with a particular focus on biodiversity issues.

To this aim, the use of a particular tool of demand-side policies, public procurement for innovation, is investigated at the European level.

Public procurement at the European level is a large component of GDP, estimated at 15%. But the percentage drops dramatically when identifying the innovation component and even more so when analysing the use of public procurement related to the purchase of R&D services and its use in biodiversity issues.

Preliminary findings suggest that this tool is still underutilised in Europe, especially in Italy, and the tenders analysed show a suboptimal use compared to their real potential. Rather than promoting the development of new technological solutions for addressing biodiversity issues, tenders are used by public agencies to procure consulting services as well as support for data acquisition and environmental monitoring.

Taking into account certain European experiences, some policy recommendations are proposed, especially for the Italian case, which mainly concern the need to improve the skills of public procurers and to introduce spending targets for innovative tenders.

***Key words:*** demand-side innovation policy, public procurement, biodiversity

## *1. Introduction: Biodiversity issue*

This study, funded by the National Biodiversity Future Centre, focuses on the role of public organisations in promoting pathways to address grand environmental challenges, particularly biodiversity loss, through mission-oriented approaches that are emerging as popular solutions to contemporary sustainability challenges (OECD, 2024).

The National Biodiversity Future Centre, set up by the National Recovery and Resilience Plan (PNRR), is one of five Italian national centres dedicated to cutting-edge research with the aim of helping to achieve the goals of the United Nations 2030 Agenda for Sustainable Development. The centre, to which Italian universities and research centres working in the field of biodiversity belong, can be supported by a network of more than 1,000 researchers. This network has been joined by about 350 new researchers specially hired on a fixed-term basis. The centre was created for studying biodiversity not only in terms of land management and conservation, but also for building a new socio-economic approach that will lead to a more resilient and sustainable future for everyone on the planet. Hence, there is interest in analysing how Science, Technology, and Innovation (STI) policies can support the preservation of biodiversity. For the realisation of the expected goals, the PNRR has funded the Centre with about 370 million euros in total.

Climate change and biodiversity loss are intimately related. It is predicted that climate change could overtake land-use change as the leading cause of biodiversity loss by 2070 (Newbold, 2018). Therefore, mitigating the worst effects of climate change will have significant benefits for biodiversity, and avoiding biodiversity loss will have a positive effect on climate change. From the time that human beings evolved, our dependency on biodiversity has remained.

Biodiversity is the variety of life in all its forms and takes many dimensions, including the diversity and abundance of living organisms, the genes they contain, and the ecosystems in which they live. Biodiversity is an enabling asset for the health of ecosystems that provide the basis for the regeneration of environmental resources. Biodiversity takes on its own economic value that arises from the productivity it confers on ecosystems. Biodiversity also takes on a certain economic value in relation to additional factors, including its direct contribution to human health, its value as an amenity, and its role in making the wide range of nature's goods and services on which we depend available (Dasgupta, 2021).

Therefore, there is a strong interest in economic studies in investigating issues related to biodiversity and biodiversity loss.

The loss of biodiversity-dependent ecosystem services is likely to accentuate inequality and marginalisation of the most vulnerable sectors of society by decreasing their access to basic materials for a healthy life and by reducing their freedom of choice and action. Economic development that does not consider effects

on these ecosystem services may decrease the quality of life of these vulnerable populations, even if other segments of society benefit (CBD, 2018).

Europe is running for cover by adopting the 2030 European Biodiversity Strategy, which aims to tackle biodiversity decline and safeguard the diversity of ecosystems, habitats, and species. The strategy, which aims to restore at least 30% of land and marine areas, plans to ensure a sustainable future for Europe by turning the ecological crisis into an opportunity to integrate biodiversity protection into all branches of the economy and promote sustainable management of natural living resources.

Current economic models, which do not consider humans beings as part of natural systems but outside of them, have not led to equitable social welfare, have generated deep inequalities between countries, and considerably damaged all of the planet's ecosystems with huge waste production (NBFC, 2024). If our global demand continues to increase for the next several decades, it is likely that the biosphere will suffer enough damage to make future economic prospects quite precarious (Dasgupta, 2021).

Practices that encourage the perspective of considering the human species outside the natural system have meant that in recent decades our global impact on the biosphere has exceeded the rate of regeneration of the biosphere itself, generating so-called impact inequality (Barrett et al., 2020).

To address this inequality, immediate action is required from companies and institutions. The reduction of the impact of the negative externalities on nature provided by human activities, not reflected in the price system, have been faced by market-based mechanisms (such as carbon pricing or carbon taxes) or neutral technology policies (such as tax breaks), both of which leave the market to determine the direction of change (Mazzucato, 2016).

Overall, the negative externalities are not the only market failure that have an impact on climate change and biodiversity loss. Key market failures that directly impact the issue of biodiversity include inefficiencies/inadequacies in R&D linked to the inability of enterprises to appropriate the full benefits of one’s actions and consequently to support the full costs of the innovative projects, free rider problems associated with public goods, the problems arising from the absence of markets, and the imperfections in risk and capital markets for promoting GHGs reduction. A mix of different policy measures must be adopted to overcome the abovementioned failures, including macroeconomic policies, education and research, regulation (e.g., pollution or health and safety), and competition policies (Stern and Stiglitz, 2023).

### *2. STI policy*

Carbon taxes, cap-and-trade, regulations, subsidies for green research, publicly funded research, and fostering of green development banks as well as of infrastructure to support the integration of new technologies represent some of the government policy measures that can make major progress in tackling the aforementioned failures even if they cannot entirely remove the underlying problem

(Stern and Stiglitz, 2023). It seems possible to reduce climate change and enhance growth by assembling a policy package to mitigate market failures and to address societal challenges. Regarding this policy mix (Flanagan et al., 2011), research and development directed towards specific goals are going to play key roles in addressing some of the market failures listed above. There are long-standing debates about the degree to which government intervention in the economy to support innovation is legitimate, and the economic rationale for such intervention is based primarily on market failures (Edler and Georghiou, 2007). Left to the market alone, the direction of innovation would result in socially suboptimal solutions, with the risk of devoting too little resources to research and innovation in environmental sustainability (Stern et al., 2022).

For many decades, the core aim of Science, Technology, and Innovation policies was to fix market failures concerning research and development private firms' underinvestment. From the 1990s onwards, a second generation of innovation policy has attempted to fix failures in national innovation systems and strengthen national innovation networks. Both policy approaches focused primarily on innovation for economic growth (Schot and Steinmueller, 2018). A new era of transformative innovation policies that legitimise government interventions aimed at providing direction for innovation systems has been designed to address grand societal problems (Steward, 2012; Gee and Uyarra, 2013; Boon and Edler, 2018; Kattel and Mazzucato, 2018; Wesseling and Edquist, 2018; Wanzenböck et al., 2019). Systems perspectives on innovation yield a much more fruitful perspective on the demand side, in terms of both theoretical and policy relevance (Edquist and Hommen, 1999).

Over longer time periods, public demand triggers greater innovation impulses in more areas than did R&D subsidies. Public demand creates clear incentives for manufacturers, reduces their market risk, and enables early economies of scale and learning. This critical mass also structures the manufacturing branches connected with the innovation in question. This effect is especially strong for young technologies, i.e., when industry is able to react to strong impulses on the part of the state. In contrast to R&D subsidies, the concrete state demand for innovation leads not only to technological capacities, but also to increased production capacities for innovation (Geroski, 1990). Hence, there is an interest in adding insights regarding the use of demand-side STI policies for addressing environmental challenges.

According to Edler and Georghiou (2007), demand-side innovation policies are defined as all public measures to induce innovation and/or speed up diffusion of innovations through increasing the demand for innovation, defining new functional requirements for products and services, or better articulating demand.

This means the aims of policy are not to put patches on existing trajectories provided by markets but to address innovation and societal challenges by transformative, catalytic, mission-oriented public investments (Foray et al., 2012) that create new technologies and sectors that did not previously exist.

One of the most relevant tools for public administration to promote mission-oriented policies is public procurement, and its use as a tool to promote innovation is considerable (Edler and Georghiou, 2007). When a public agency places an order for

a product or system that does not currently exist, what is called public procurement for innovation (PPI) occurs (Edquist and Zabala-Iturriagagoitia, 2012).

Needless to say, grand challenges can also be mitigated through other means and instruments, for example R&D funding, tax credits, environmentally motivated regulations and standards (e.g., mileage standards for automobiles), creation of markets for innovative ideas, support for education and training, or enhancing capacities for knowledge exchange (OECD, 2011).

The objective of this study is merely to map the use of PPI in European countries in the field of biodiversity as an additional tool to promote innovative policies, complementing existing supply-side measures. It is shown that the design of the policy mix matters, and its effectiveness improves when demand-side and supply-side instruments are jointly implemented (Caravella and Crespi, 2020).

The rest of the paper is structured as follows: Section 2 discusses the background literature concerning public procurement for innovation, like powerful demand-side innovation tools; Section 3 describes some of the barriers for the implementation of PPI in Europe and especially in Italy; Section 4 describes the methodology for analysing the PPI concerning biodiversity through European public institutions during the period 2019-2023 and shows preliminary findings; and Sections 6 and 7 discuss the results, providing concluding remarks and identifying future lines of research.

## *3. Public procurement for innovation*

Economies and societies need to transform for meeting grand challenges, such as climate change and biodiversity loss. Sustainable development, including biodiversity preservation, requires national and intergovernmental engagement as well as engagement by communities and civil societies throughout the world. It advocates for institutions that encourage information and directives to flow in every direction (Dasgupta, 2021).

Science, technology, and innovation can make essential contributions to these transformations. All aspects of STI policy and governance are affected, including research and innovation directionality, funding, human and physical resources, co-ordination mechanisms, and evaluation and measurement. Demand-side innovation policies focused on promoting the development and diffusion of innovations lie at the heart of the OECD Transformative Agenda, which provides high-level guidance for national STI policymakers in formulating and implementing reforms to support the acceleration and scale-up of positive economic and societal transformations in the face of global challenges. The urgency and scale of the transformations call for sustained levels of STI investment and greater directionality, agility, and co-ordination in funding portfolios. Direct measures, including R&D grants, and loans and credits, as well as public procurement, are crucial (OECD, 2024).

The implementation of this transformative agenda and mission-driven innovation policies gives policymakers great responsibility in setting or shaping the direction of technological change (Diercks et al., 2019; Schot and Steinmueller, 2018; Weber and

Rohracher, 2012; Foray, 2018; Hekkert et al., 2020; Mazzucato, 2016). Hence, there is an interest in learning more about the tools by which public policy could set the directionality of these changes.

There is a broad scientific understanding that public procurement for innovation is a relevant tool potentially suitable for setting or shaping the direction of socio-technical transitions. Over the past decade, the strategic use of public procurement has become a central topic of European innovation policy. In an economic phase characterised by scarcity of available resources, public demand for innovation could improve the delivery of public services by consuming fewer resources and steering the process of technological change towards socially shared goals (European Commission, 2005; Edler et al., 2016).

The main characteristic of public procurement for innovation is the focus on the outcome and performance to be achieved. This entails that a public organisation places an order for goods and services that do not yet exist and that fulfil certain functions that satisfy human needs or solve societal problems. This functional approach seems particularly suitable for meeting emerging needs and the consequent purchase of goods and services in markets characterised by great uncertainty (Edquist and Zabala-Iturriagagoitia, 2020).

A complementary tool of PPI is pre-commercial procurement, or PCP. The basic idea behind public pre-commercial procurement is that it targets innovative products and services for which further R&D needs to be done. Thus, the technological risk is shared between procurers and potential suppliers. By definition, this means that potential producers are still in the pre-commercial phase, and the products and services delivered are not ‘off the shelf’. In practical terms, the procurement is an R&D service contract (Spallone et al., 2019).

Public procurement for innovation can take different forms. When the focus concerns the public procurement of completely new-to-the-world products and/or systems, we see developmental procurement. It can be regarded as ‘creation oriented’ PPI and involves radical innovation. When the product or system procured is incremental and new only to the country (or region) of procurement, we see adaptive procurement, in which innovation is required to adapt the product to specific national or local conditions. In direct procurement, the procuring organisation is also the end-user of the product resulting from the procurement. This type meets the needs of the public agencies themselves. However, the resulting product can be useful not just for the performing agencies, but also for society. Catalytic procurement is when the procuring agency serves as a catalyst, co-ordinator, and technical resource for the benefit of end-users. The needs are located ‘outside’ the public agency acting as the ‘buyer’. Hence, the public agency acts to catalyse it for broader public use (Edquist and Zabala-Iturriagagoitia, 2012).

The paper will provide a first look at the Europe-wide use of public procurement of research and development services on the topic of biodiversity, as a proxy of the extent to which European governments are using public procurement for innovation to address this challenge.

## 4. *How do European public institutions open up to the purchase of innovation? A hypothesis about the use of public procurement for innovation for addressing biodiversity issues.*

Before analysing the data collected at the European level on R&D services purchased by public administrations in the area of biodiversity, it is useful to understand the degree to which the European procurement system, and Italy specifically, is open to innovation.

Public procurement expenditure as a share of GDP increased significantly across the OECD over the last decade, from 11.8% of GDP in 2007 to 12.9% of GDP in 2021. Across OECD-EU countries, public procurement increased from 13.7% of GDP in 2019 to 14.8% in 2021. This increase is due mainly to the Recovery and Resilience Facility (RRF), the centrepiece of Europe's recovery plan to boost public investment. Public procurement expenditures as a share of GDP also increased in Japan (from 16.6% to 18.1%) and the United Kingdom (13.1% to 15.7%).[1] If only public procurement related to the purchase of research and development services is considered, the numbers drop dramatically: less than 1% of total public procurement spending at the European level is focused on this issue.[2]

The level of public demand for innovation, measured through the procurement of research and development services, still appears small. Some factors affect openness to purchasing innovations. The market engagement phase as well as the contract-awarding phase are two key levers to stimulate public procurement for innovation (Lenderink et al., 2019). Hence, their survey could be a good proxy for determining the degree of openness to innovation of a public body as well as the level of participation of small and medium enterprises (SMEs) to the public tenders for attracting innovators, most of whom may be start-ups in high-tech sectors and innovative SMEs (Spallone et al., 2019).

By comparing innovations with private operators to understand the maturity of the market and the functional characteristics of the works, services, goods, or possible subjects of procurement, public entities can receive support in identifying and choosing suitable solutions to meet the needs of their communities. Multiple specification and selection stages in the design of the developmental PPI makes it a powerful societal challenge tool. A fruitful balance may be struck by facilitating competition during the early design stages when technological variety is most

[1]Government at a Glance, 2023 – OECD - https://www.oecd-ilibrary.org/sites/ce2208f6-en/index.html?itemId=/content/component/ce2208f6-en (The size of general government procurement spending is estimated using data from the OECD National Accounts Statistics (database), based on the System of National Accounts (SNA). General government procurement is defined as the sum of intermediate consumption (goods and services purchased by governments for their own use, such as accounting or information technology services), gross fixed capital formation (acquisition of capital excluding sales of fixed assets, such as building new roads) and social transfers in kind via market producers (purchases by general government of goods and services produced by market producers and supplied to households).

[2]https://opentender.eu/all/dashboards/market-analysis. In order to identify research and development procurements, all tender notices with a CVP (Common Procurement Vocabulary) code referring to contracts involving research and development services were selected.

important and by facilitating cooperation during later stages when selected designs need to be further developed and implemented (Wesseling and Edquist, 2018).

This dialogue allows a comparison to take place that facilitates public administration learning from the market. This is essential in a context in which innovations are continuous. At the European level, just 0.1% of public procurement uses this procedure, and, in Italy, this procedure is barely used at all compared to in the UK, Germany, and France (Spallone et al., 2019).

Procurement selection criteria are fundamental in encouraging innovation procurement. Downward pricing, for example, does not give due consideration to the costs related to the entire product life cycle, corresponding to all subsequent and interdependent stages in the purchase of a good, job, or service. Taking into consideration only the price and quality of the (existing) product when the supplier is selected reduces the possibility to procure for innovative solutions (Edquist and Zabala-Iturriagagoitia, 2012). The empirical analysis proposed by Krieger and Zipperer (2020) shows that winning a public government contract that includes additional environmental quality criteria for awarding it increases the probability of firms introducing new environmentally friendly products compared to non-winning firms.

Award criteria concerning technical merits, quality, performance, aesthetics, and functionality also allow for the detection of innovative bidding. A Europe-wide average of the proportion of procedures awarded solely because the offer was the cheapest one available is about 80% with respect to the total number of procurements.[3] Thus, it seems that a high number of public contracts are still awarded based on price alone.

The participation of small and medium enterprises is crucial to understanding how a country is open to innovation. A significant gap between Italy and most of the EU member countries in the participation of SMEs in public procurement activities exists. The share of contractors involving SMEs in 2021 at the European level is 60%. Italy stands at the bottom of the ranking in terms of awarding contracts to SMEs (48%).[4] This low involvement of SMEs suggests the presence of significant barriers preventing small firms from participating in procurement procedures (e.g., red tape, calls for tenders that are biased against smaller firms, or low capacity among smaller firms to compete). This gap is particularly problematic since Italy is one of the countries in Europe with the largest share of SMEs.

The aims of the single market regulatory framework are to support investment and entrepreneurship by reducing unnecessary regulatory burdens and promoting good administrative practices. These aspects are important to create a favourable business environment for all economic actors and for small and medium enterprises. The administrative burden often deters SMEs and innovative start-ups from participating in public procurement procedures. The performance indicators of a survey[5] on the

[3] https://opentender.eu/all/dashboards/market-analysis
[4] https://opentender.eu/all/dashboards/market-analysis
[5] Question: "In your country, how easy is it for companies to comply with government regulations and administrative requirements (e.g., permits, reporting, legislation)?" (1 = Overly complex; 7 = Extremely easy). For this indicator, higher values indicate a better performance (i.e., less burdensome regulation) and vice versa.

burdens of government regulations in 2021 at the European level were between 3 and 4 on a scale of 1 to 7, with 1 being overly complex and 7 being extremely easy, highlighting the persistence of some regulatory constraints.[6]

The difficulty of setting spending targets for innovative procurement as a percentage of total government procurement spending is another critical aspect for promoting this type of procurement. The difficulty of targeting makes at least three criticalities evident: one ex-ante, related to the logic of setting a target without a prior measurement exercise quantifying the status quo of expenditure on innovation procurement; one in progress, related to the capacity of the public administration to demand goods and services that are innovative; and one ex-post, related to the difficulty of assessing the achievement of the target and measuring the impact of the legislation (Spallone et al., 2019).

Despite these challenges, governments in various parts of the world have set targets in order to allocate a certain percentage of their procurement budgets to research, development, and innovation. For example, the United States aims to spend at least 2.5% of its GDP on research and development procurement, while South Korea aims to spend 5% of its procurement resources on development and 20% on the deployment of innovative solutions (EC, 2021). In Europe, the central government of the Netherlands, through a Communication from the Minister of Economy and Finance to the Representatives of the Chambers (2011),[7] set a target for spending on innovation procurement at 2.5% of total spending on public procurement of goods and services.

There are still some factors that influence openness to innovation procurement within European countries and affect the level of public demand for innovation that seem to be too low. The demand for innovative investment requires a sound diagnosis of the challenges to be addressed, as well as the ability to engage the market during the procurement process and introduce procurement selection criteria that can promote innovation. The enhancement of the buyer's level of competence as well as the introduction of spending targets appear to be key issues for increasing the use of innovative procurement. A cultural shift aimed at providing innovative solutions through the use of public procurement is needed (de Freitas Chagas Júnior and Francelino, 2023).

Considering the low degree to which the European procurement system, and Italy specifically, is open to innovation, we expect that public procurement for innovation, as far as the biodiversity sector is concerned, is not only underutilised but also sub-optimally utilised in terms of the effectiveness of the tool in promoting innovative technological pathways.

To what extent are governments using this tool to address biodiversity issues, what challenges do they intend to address, and what are governments procuring from the market are the questions the following data analysis seeks to answer.

[6] https://single-market-scoreboard.ec.europa.eu/business-framework-conditions/administration_rules_en
[7] https://zoek.officielebekendmakingen.nl/kst-32637-15.html

## *5. Methodology and results*

In this framework, an analysis of the projects promoted by European countries using public procurement for the purchase of research and development services to address biodiversity issues as a proxy for the extent of PPI use in this area is provided. The information has been collected from the EU Tender Electronic Daily (TED), which contains all tenders related to public procurement for the European Economic Area, reporting the most important fields of the tender notice and standard forms of the award notice, such as who purchased from whom, for how much and for what procedure, and what award criteria were used. A subset of the data contained in TED was selected to verify through quantitative and qualitative analysis the extent to which public demand for innovation is being used to foster actions to tackle biodiversity loss and how this tool is useful to face this challenge.

The data collection activities have been done through the 'advanced search' tool provided by TED, selecting 'all notices', entering keywords like 'biodiversity', 'biodiversità', 'biodiversitat', 'biodiversidad', and 'biodiversiteit' in the 'text' field and delimiting the tenders to the last five years by using 'the time interval' field.

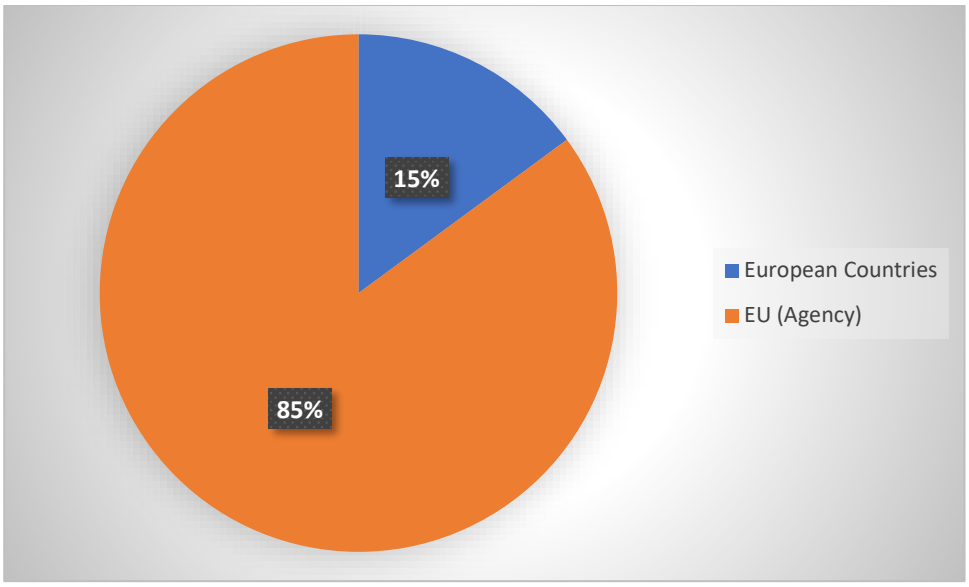
The 'contract subject' field has been used for selecting only the tenders concerning innovative issues in choosing the procurements sorted with the code CVP (Common Procurement Vocabulary): 'research and development'. The Common Procurement Vocabulary is the procurement classification system aimed at standardising the description of the subject matter of the contract by the public administrations issuing the calls.

The data collected are not without limitations that prevent an exact quantification of the number and value of the procurements. First, the classification system adopted does not allow for the selection of direct information regarding procurement for innovation. Hence, the choice was made to use the CVP concerning 'research and development' as a proxy for the procurements for innovation. At the same time, not all countries have the same rate of publication in the TED platform, either because of domestic regulatory provisions that favour procurement procedures that are not subject to EU legislation or because of national strategies. The information reported on the TED may contain errors due to incorrect compilation by contracting authorities. Despite these limitations, the extracted data are used below to make comparisons on the use of public procurement (Spallone et al., 2019).

We obtained about 120 tenders from all over Europe with the above-mentioned characteristics, representing just 0.6% of total public procurement concerning research and development services published during the same period. The total value of tenders collected concerning biodiversity issues amounted to about €920 million. These numbers referring to explicit innovation procurement may be underestimated, as the innovation component embedded in ordinary procurement (Lenderink et al., 2019) is difficult to bring out. More than 85% of these resources were managed directly by the various EU decentralised agencies in charge of running specific technical and scientific tasks in the environmental field (i.e., European Climate, Infrastructure and Environment Executive Agency, Executive Agency for Small and Medium-Sized Enterprises, European Centre for Medium-Range Weather Forecasts,

etc.). The remaining were handled by public institutions of the different EU countries (Fig. 1). Procurement management appears to be assigned mainly to European institutions rather than national authorities, highlighting a potentially different level of expertise within the public administration to handle this type of tender. It seems to confirm that not all administrations, as well as officials in charge of procurement processes, have the same experience or skills to know what is the best way to meet community needs (Edquist and Zabala- Iturriagagoitia, 2020).

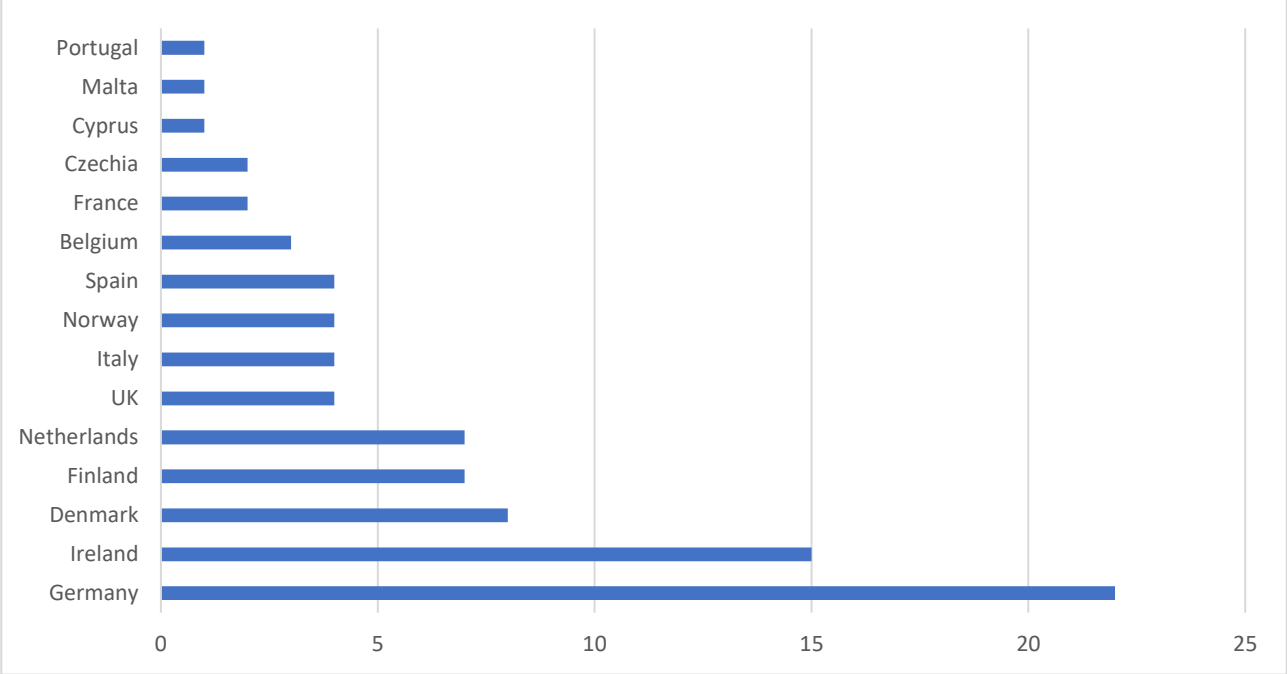
**Figure 1** – Share (%) of the resources managed at the European level for procurement concerning research and development on biodiversity issues.




Source: TED, own elaboration

Figure 2 shows the number of tenders published in the last five years by different European countries. The data show how this tool is particularly used in the northern European countries, confirming how the policies accompanying the introduction of these instruments (development of national strategies, introduction of spending caps, competence centres, etc.) have created favourable conditions and appropriate skills for its use (EU Report, 2021).

**Figure 2** – Total number of procurements concerning research and development on biodiversity issues by European country (2019-2023).

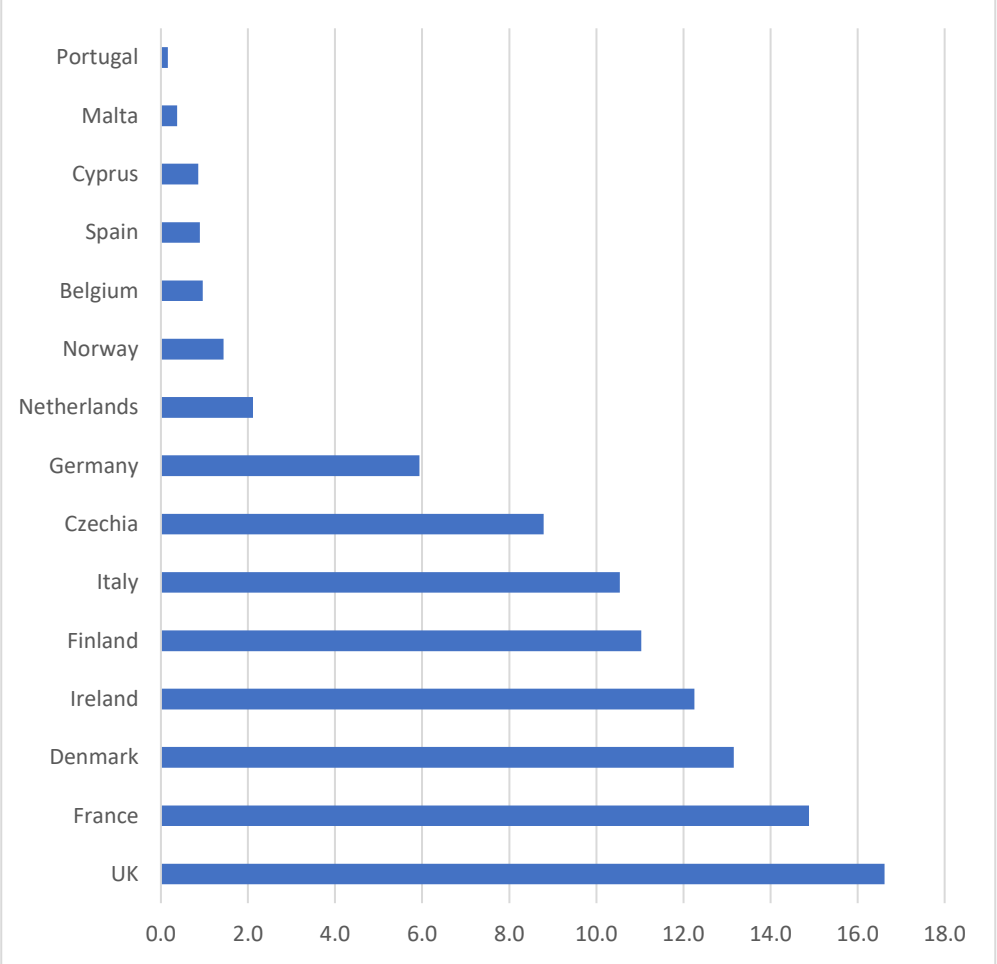



Source: TED, own elaboration

In Italy, the number of tenders is especially low, confirming the limited use of this tool in facing biodiversity loss.

The distribution across countries of the related resources directed to procurement confirms the strong commitment of Northern European countries to addressing biodiversity issues (Fig. 3). The United Kingdom runs more than 16% of the total resources allocated by different European countries on these topics. This result can be related to the measures, introduced in the 2000s, aimed at increasing the impact of research and innovation on public procurement (e.g., Government Innovation Report 2003) and some consequent actions to make innovation procurement a relevant issue at the operational level as well (Edler and Georghiou, 2007).

**Figure 3** – Share (%) of the total resources for procurement concerning research and development on biodiversity issues by European country (2019-2023).




Source: TED, own elaboration

For each of the collected tenders, we extracted the description of the subject matter of the tender and analysed it through text analysis to highlight key topics.

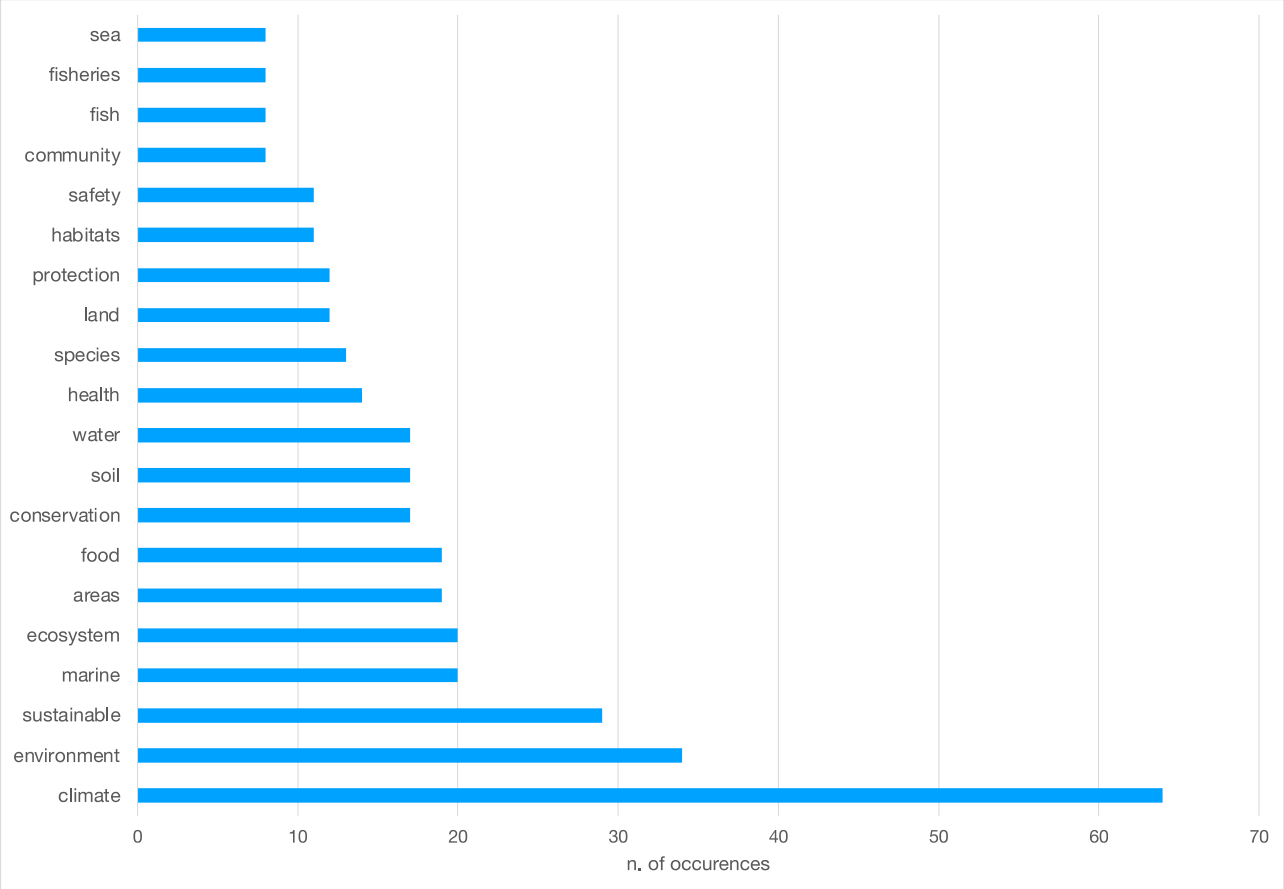
A word cloud analysis was applied to help emphasize the most significant topics among the investigated data as indicated by their frequency[8]. The word cloud analysis is based on n-grams, which are sub-sequences of n elements of a given sequence, which in this case are the texts related to the description from the procurements. The objective is to summarise and schematise in a static way through a graphic representation of the main issues included in the textual data.

Some words were eliminated from the list: all numerical values, articles and verbs, normative references, and some generic words not relevant to the purposes (e.g., law, region, project, measure, fund, financing, etc.) or predictable words (e.g., biodiversity), and the unigrams, to make the most relevant themes even more evident. The words are classified into two main groups. The first refers to the thematic scope of the procurement, i.e., which aspects concerning biodiversity are

[8] Using https://www.wordclouds.com/

taken into consideration by the tenders. Figure 4 shows the top 20 most recurring words concerning the themes of the procurements.

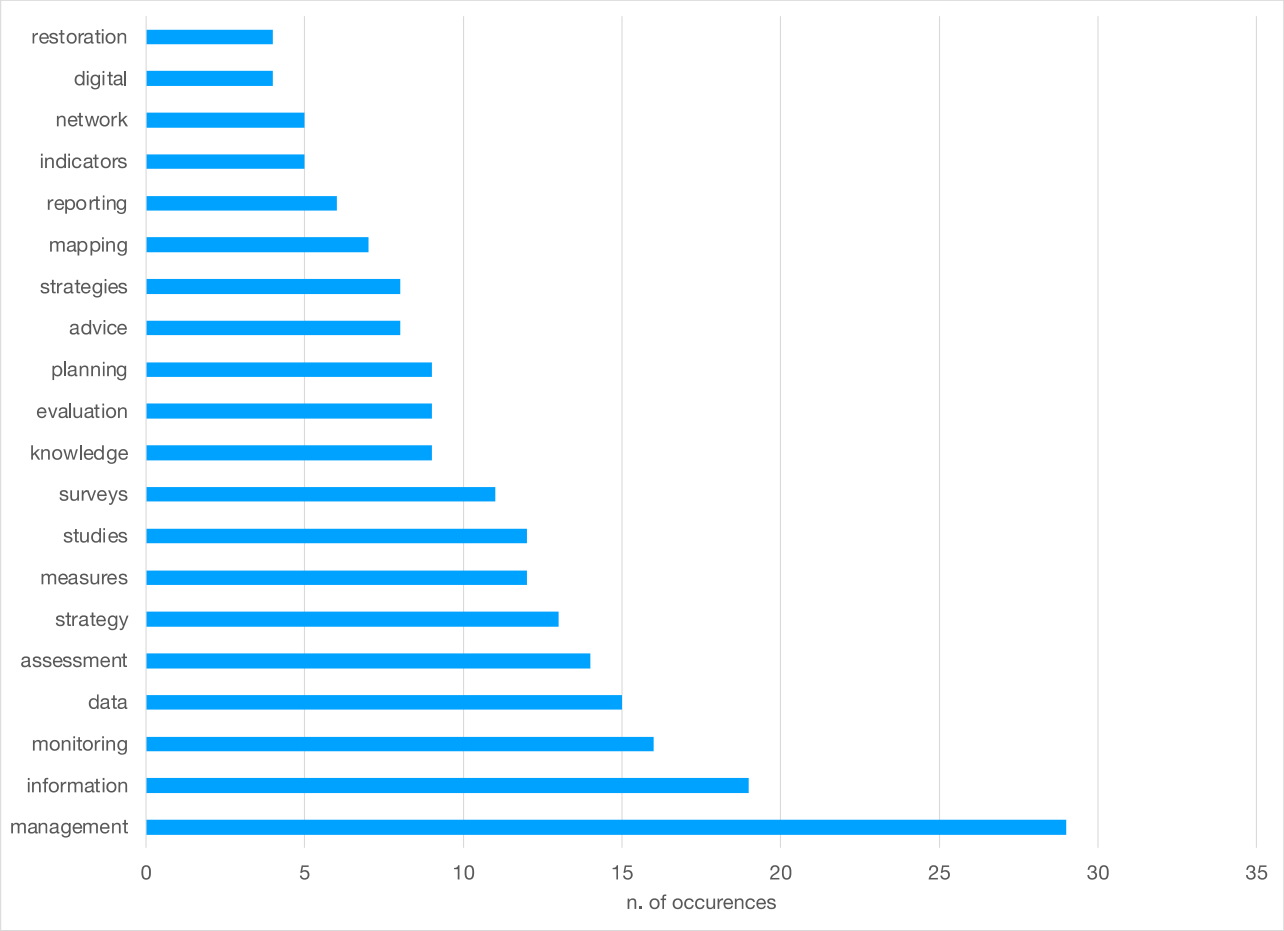
**Figure 4** – Top 20 words concerning the themes of the procurements concerning research and development on biodiversity issues.




Source: TED, own elaboration

The latter group refers to the type of activity to be procured. Figure 5 shows the top 20 most recurring words regarding the activities required for the procurement.

**Figure 5** – Top 20 words regarding the activities required for procurement concerning research and development on biodiversity issues.




Source: TED, own elaboration

The survey shows that the procurements on biodiversity issues seem to be strongly oriented towards reducing the information gap and defining tools for managing information to ensure adequate decision-making processes in the field of biodiversity.

The next step was to group the activities covered by the procurements into the following four areas consistent with the key topics identified:

-Consulting and strategic support: Consulting was purchased to help public institutions in terms of technical, legal, and legislative support, as well as to ensure monitoring and evaluation of ongoing biodiversity programmes. This area includes the provision of reporting relevant climate information to specific stakeholders.

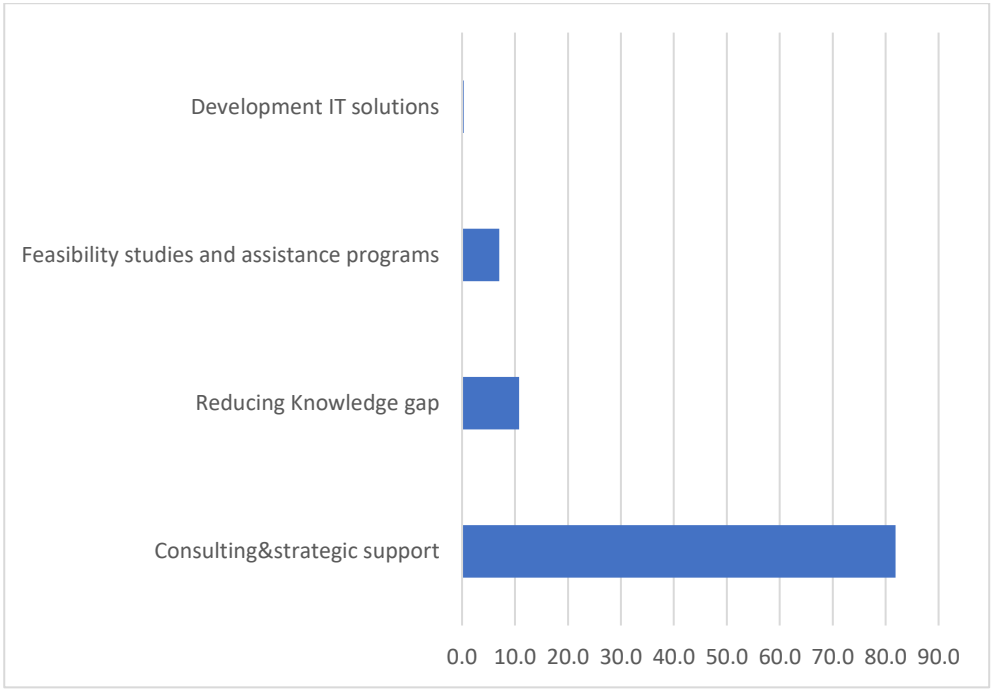
-Reducing the knowledge gap: This includes the procurements focused on collecting data on specific natural lands to reduce the knowledge gap on biodiversity as well as the development of research activities on biodiversity topics.

-Feasibility studies and assistance programmes: These include strategy development activities for economic and technological feasibility of projects related to green transitioning and strategic planning for biodiversity conservation, as well as assistance in planning sustainable economic activities for biodiversity conservation.

-Development of IT solutions: The development of new technologies for carrying out biodiversity-related processes is another issue addressed by the procurements. A preference towards the use of IT to create platforms that can manage the various environmental data and support decision-making has emerged. In developing these processes, strong data monitoring and the development of digital technologies capable of collecting, sharing, and analysing data that can be exploited for the implementation of agile and experimental policies is essential. This area represents procurement focused on shaping new markets in the IT sector.

Figure 6 shows the share (%) of the total resources allocated to procurements in the field of biodiversity at the European level for each of the four procured activity areas identified.

**Figure 6** – Share (%) of the resources allocated for procurement concerning research and development on biodiversity by activity procured.




Source: TED, own elaboration

The preliminary findings seem to show that tenders are mainly concerned with the fulfilment of functions aimed at reducing the knowledge gap in biodiversity issues through the acquisition of data and information as well as supporting governments

in strategic planning, rather than with developing or improving materials, products, and production processes. The procured activities that are closest to these latter goals concern the development of new IT solutions, but these account for less than 1% of the total budget for all biodiversity-related procurements.

***Discussion***

While identifying key societal challenges is straightforward—climate change, ageing, resource security, housing, urbanisation, etc.—translating challenges into concrete mission oriented innovative investments will require the involvement of an array of stakeholders concerned with sectors and socio-technical fields affected by the challenge itself. Therefore, defining the direction of investments should be based on sound diagnosis of each challenge by the state together with other stakeholders (Mazzucato, 2016).

The suboptimal use of the public demand for research and development services respects the fact that purchasing existing goods and services by public procurement could be affected by the difficulty of the public organisation in involving the several actors needed in the process. Identification and definition of the direction of innovative investment is challenging, as evidenced by the limited use of market involvement in the tender preparation stages as well as the procurement selection that still tends to be too price-based. The most encouraging results are achieved in those countries where public procurement for innovation is included in a national strategic framework, as in the case of the United Kingdom. The low involvement of SMEs, especially in Italy, suggests the presence of significant barriers preventing small firms from participating in procurement procedures. This gap is particularly problematic since Italy is one of the countries in Europe with the largest share of SMEs.

The effect of the procurer's skill level in the different levels of public administration seems a remarkable aspect.The complex nature of innovative procurement requires expertise and room for experimentation that is often lacking. The experience or skills to meet community needs is crucial.

The public procurement of R&D services concerning biodiversity issues, accounting for less than 1% of the total of innovative procurements, focuses on purchasing technical, legal, and legislative support to help public institutions as well as to overcome the knowledge gap and provide land managers with useful information to address biodiversity preservation programmes. Such investments co-ordinated by public initiatives have built new networks and driven the process of gathering data and managing information, but they do not seem focused on the development and improvement of materials, products, and production processes.

The data show a lower share of expenditure for the procurement of R&D services in the biodiversity sector for Italy, compared to Northern European countries where these tools are used to a greater extent. This confirms that Italy is still disinclined to support procurement for innovation, both in general and more markedly in the biodiversity sector. Several indicators that measure the openness of a procurement system to innovation confirm that. Specifically, the participation of SMEs is low,

and the share of tenders awarded on the basis of the simple criterion of price is too high, and the administrative burdens limit the level of openness to innovation.

***Conclusions***

The aim of this article was not to re-start the old discussion on the relative importance of demand versus supply-side factors for innovation. Rather, we simply argue the need to take demand, more concretely public demand, more into the focus of innovation policy making and use it to complement existing and new supply-side measures.

There is a scientific consensus that public procurement is a key tool for providing directionality for public policies to support the acceleration and scale-up of positive economic and societal transformations in the face of global challenges (Edquist and Zabala-Iturriagagoitia, 2020).

This paper presents Europe-wide data on the use of public procurement for R&D services as an indicator of the degree to which public procurement for innovation is being used to address biodiversity problems. The preliminary findings show that this tool in Europe and in Italy specifically is still underused, and the tenders analysed especially show that procurements are used sub-optimally compared to their potential power, as a result of some evident obstacles which need to be addressed.

A major effort must be directed toward the strengthening of the skills of public administration.

Governments should put more emphasis on defining a strategic agenda that considers procurement for innovation as an additional tool to promote innovation policies that can be used to complement existing supply-side measures of innovation as in the case of the UK, as well as defining policies that impose spending limits compatible with the volumes of public administration acquisitions to which they should strive, as is the case in the US and South Korea.

Setting spending targets could provide an effective way to improve the use of innovative public procurement. This means shifting a share of total procurement spending to innovative procurement. A regulatory intervention that provides a spending target for general government, not in terms of purchases, but in terms of expressing innovation needs seems to be a necessary step to direct general government to allocate an annual share of total spending to the purchase of supplies and services for set internal and external needs expressed in terms of results to be achieved and challenges to be faced.

The attempts by governments to increase and foster R&D expenditure and innovation within the business sector are always welcomed because of the externalities generated. However, there are enormous differences across national systems in the way in which governments promote R&D and innovation in the business sector. The UK case is interesting because the government seems less inclined to do in-door activities, and it is more inclined to buy as much as possible

from the market, as in the case of biodiversity. This guarantees more flexibility in government actions.

However, when governments decide to buy products, processes, and services from the business sector, they can decide to include embodied and disembodied components. Issuing contracts requires a public administration which knows where technology opportunities reside, and in the majority of cases these technological opportunities are much better known by the corporations than by public servants. Therefore, to effectively use a PPI, a country needs to build a smart public administration made of public servants with technical expertise. A few countries, but certainly not Italy, have them.

The complex nature of pre-commercial and innovation procurement requires skills and space for experimentation that are often lacking. Hence, there is a need to design and invest in a facilitation, support, training, and co-ordination initiative that affects the innovation procurement processes of public administration, especially in Italy, by drawing on the resources provided by the programmes co-financed by the European Structural and Investment Funds.

Additional aspects need to be further investigated and mapped to assess whether public procurement for innovation is an effective tool for mission-oriented policies. In order to validate the hypothesis of the under-utilisation of this tool at the European level for facing biodiversity challenges, a specific quantitative analysis correlating the public procurements and the production of patents in this area could draw a representative picture of the effectiveness of this tool and provide more useful recommendations. At the same time, further investigation could involve analysing the innovation pathways of firms participating in procurement for innovation to see whether tenders act as a reinforcing effect of public support on private innovation and whether procurement is a useful tool for encouraging innovative behaviour in firms engaged in biodiversity issues.

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