RISIS

RESEARCH INFRASTRUCTURE FOR SCIENCE AND INNOVATION POLICY STUDIES

DOCUMENTATION OF RISIS DATASETS

EFIL

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Outline

1 Basic Characteristics

Name: EFIL – European dataset of public R&D funding instruments

EFIL – European dataset of public R&D funding instruments is one of the new datasets included in RISIS2. It aims at enabling users to investigate public R&D funding in Europe at the level of project funding instruments and Research Funding Organizations (RFO), addressing questions related to policy design and policy implementation.

Main objectives of EFIL are:
- re-composing and characterizing the portfolios of funding instruments of RFOs from selected European countries;
- producing evidence of the structural, procedural, and allocational aspects of funding instruments, as well as organizational profiles.

Units of analysis are:
- Project funding instruments, deepening e.g., their orientation and mission, the selection procedures for beneficiaries, funding volumes.
- RFOs, deepening elements related to their organizational forms.

Data collection is based on publicly available official documentation accessible through web-exploration. EFIL enables the re-composition of data on funding instruments, which is scattered across multiple sources. EFIL provides a set of descriptors with an emphasis on a general characterization of the instrument (orientation, delegation mode of funding, composition of decision-making body, etc.); funding allocation criteria and eligible beneficiaries; and funding amounts allocated through each funding instrument for each year of the reference period (2018-backwards to 2010).

A peculiar feature of the dataset is the possibility to characterize the instruments through text analysis, key words, and vocabularies. Indeed, the database is complemented by a repository of official documents hosted on a cloud – composed of instrument calls, guidelines for participants, descriptions on official webpages, etc. – that is accessible to the database user. This official documentation allows further analyses on instruments mission and aim, as well as the elements related to proposal selections (e.g., evaluation criteria). In this regard, the database proposes descriptors based on SGC, KET and SDG classifications.

EFIL is integrated in the RISIS infrastructure, with the OrgREG facility through the ID of the RFOs managing the funding instruments; integration with NATPRO and SIPER, using the ID of the funding instruments, is under construction.

The operating organization is CNR-IRCrES – Research Institute on Sustainable Economic Growth of the National Research Council of Italy (http://www.ircres.cnr.it), Unit of Rome.

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2 Database content

2.1 Definition and description of observations

EFIL has two are units of observation:

- Research Funding Organizations (RFOs);
- R&D funding Instruments composing the RFO portfolios, represented at a meso-level of granularity (funding routes) and according to the availability of data at a basic level of granularity (instruments).

Research Funding Organizations (RFOs). RFOs are entities that distribute – through funding instruments – public project funds for research to R&D performers. Different types of RFOs have been categorized according to their positioning with respect to the State (Verohest et al., 2010), or according to the internal distribution of tasks (Christensen and Lægreid, 2011; Lepori, 2011), or according to the intermediary role between governors and research community they play (van den Meulen, 2003) and their role in the cognitive development of science (Braun, 1998). Another approach is to characterize RFOs by their organizational forms (Lepori and Reale, 2019), where the constitutive elements include 'cultural elements, social norms and templates on how to manage organizational structure and activities" (Lepori and Reale, 2019, 459). These elements are paired by other features that do not belong to the core identity of the RFOs and can be changed without modifying the legitimacy of the organization. This is the case of the funding portfolio of instruments that the funding agencies oversee.

Following Verhoest et al. (2010), RFOs included in EFIL have the following features:
- being public entities, meaning that they are based on a public law describing their structure and internal task distribution.
- having some capacity of autonomous decision-making with respect to the State.
- being under some forms of government control.
- having expectations of continuity in time.
- managing their own financial and human resources.

Since Ministries still retain important roles in the design and implementation of research funding instruments, EFIL also includes the Agencies controlled by the State, namely the Ministries in charge with research and sectoral ministries that are also managing research funding instruments in their domains.

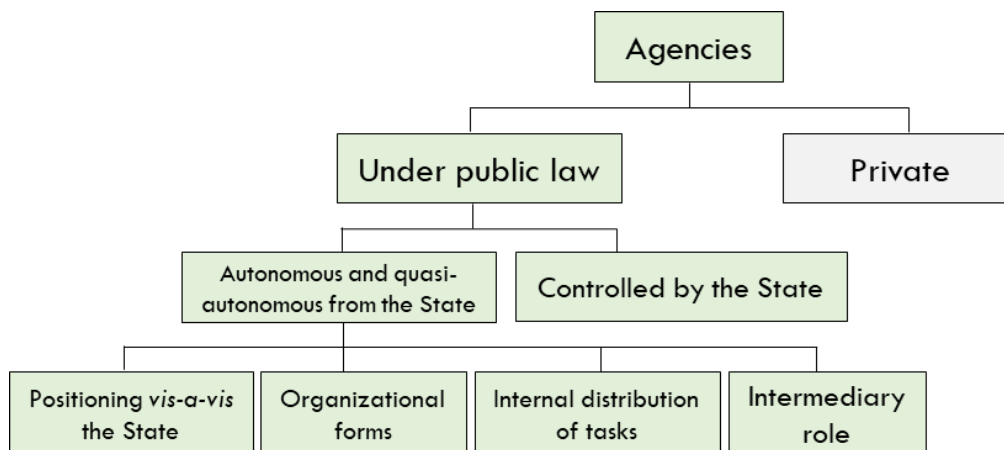Figure 1 summarizes the characteristics of the RFOs included in EFIL.

Figure 1. Perimeter of RFOs treated by EFIL dataset.

EFIL stores data on 52 European RFOs. RFOs are characterized by the following elements:

(i)   they manage and distribute public project funding.

(ii)   they manage organized research programmes with regular calls and evaluation procedures.

The list of national RFOs included in EFIL is extracted from OrgREG, the RISIS Register of Research Organization (see RISIS, 2017). Following the OrgREG criteria, the perimeter therefore excludes higher education funding agencies managing only institutional funds, but also governmental departments that award contracts for their policy needs on an ad hoc basis, without a general aim to support research.

R&D funding instruments. "R&D funding instruments" are funding schemes for R&D, within the total public R&D allocations, having proper characteristics in terms how they are managed, the beneficiaries, and how they are allocated. They are affirmative policy instruments, namely the monetary means providing new resources to the research beneficiaries (see the instrument configuration proposed by Vedung, 2007). EFIL considers the direct instruments providing new resources to pursue research linked to public purposes, instead of indirect means based on the interaction of third parties to deliver the funding (Salamon, 2002). The perimeter considers only funding instruments which earmark direct public funding for R&D to research performers and excludes indirect supports, such as R&D tax incentives.

Public research funding is generally divided between *institutional funding instruments* and *project funding instruments* (see Lepori et al., 2007; van Steen, 2012; Lepori, 2017). The former is primarily characterized by the fact that budget is transferred to research organizations for their running activities and, usually, for an unlimited period; the latter identifies funds attributed to a group or an individual to perform a research activity limited in scope, budget, and time. Normally, project funding is a) attributed based on the competitive submission of a project proposal describing the research activities to be done, b) attributed directly to research groups and not to a whole organization, c) limited in the scope of the research supported and its duration and d) assigned by a research funding organization outside the performing organization to which the beneficiary belongs. **EFIL data collection only considers project funding instruments managed by RFOs, and not institutional funding.**

Funding provided by RFOs to individuals in form of grants for their own career, mobility and development of human resources is included in the data collection. Likewise, funding supporting research infrastructures and science communication activities through projects is included. Project funding instruments are also included in the collection when they are designed as "joint R&D programmes'", i.e., when they have been established through a bilateral or multilateral agreement, and management is shared among more than one research funding organizations, also from different countries (Spinello, 2018). Internal funding schemes to research organizations (that are not open to outside the organization) are excluded from the collection.

Project funding instruments managed by RFOs are usually identified within official documents such as annual reports or websites and produce calls for funding on a regular basis. The experience in the EC PREF experimental project data collection, which was based on the re-composition of national public research funding (see Lepori, 2017; Reale, 2017), revealed that:

i. when dealing with RFO portfolios, the degree of fragmentation/granularity o proposed by the European RFOs is so highly different that comparability issues are not avoidable without taking methodological countermeasures.

ii. project funding instruments offered by the different RFO can include many different sub-schemes, thus functioning as "umbrella-programmes", containing different calls of proposals covering multiple research topics, or presenting some peculiar rules for funding: as a result, ideally different sub-schemes under the same "umbrella programme" should be considered as different instruments in the data collection.

iii. the closer the collection gets to the level of individual sub-schemes, the less data on their characteristics is likely to be found (especially for Sectoral RFOs and Innovation Agencies), challenging the database's capability to represent portfolios in their entirety.

Thus, to establish a comparable level of granularity for the funding instruments, EFIL – as a first method of representation – proposes a **meso-level re-composition of RFO portfolios based on "funding routes"**.

In EFIL, there are two types of funding routes:
a) a *large project funding instrument* that cannot be disaggregated in sub-schemes.
b) an *aggregation of schemes having similar characteristics*, grouped according to the following criteria:
   I. the upper-level decomposition presented by RFOs in annual reports/websites/RFOs leaflet.
   II. the overlapping of missions and objectives, the continuity over time, the similarity of selection process.
   III. the thematic orientation of the instrument in terms of research field.

EFIL data collection presents **299 funding routes** from 52 European RFOs. The creation of funding routes is a methodological solution that allows not to compromise the completeness of the reconstruction of the RFO portfolios when official data on single instruments are not available. Founding routes and their characteristics are represented in a table called "Funding route table".

According to data availability, the **basic level of granularity (single instrument) is represented in EFIL** and stored in the "Funding Instrument table". The table is composed of the routes of *type a*; and the single sub-schemes which compose the routes of *type b*. Funding instruments and their characteristics are represented in a table called "Funding instrument table". At its first release, EFIL data collection detected **528 single funding instruments**.

In summary:
- a first level of representation of the RFO project funding portfolios in EFIL is made by funding routes defined by EFIL team and presented in a related table.
- single funding instruments (routes of *type a* representing large project funding instrument, and sub-scheme that compose a route of *type b*), clearly identified as a unit of financing in the RFO official sources, are represented in the database in a proper table.

2.2 Data acquisition and processing

EFIL data collection is based on **web-exploration of publicly available information dispersed into multiple resources**. The data acquisition and processing procedure for the creation of the relational database has been carried out according to the following steps.

1. *Identification of relevant RFOs.* EFIL data collection is RFO based, which means that the first step was to identify the relevant RFOs for selected countries as they are included in RISIS OrgREG. The list of RFOs is integrated with original RFO descriptors included in the EFIL design.

2. *Re-composition of portfolios.* For each selected RFO, data collection first foresaw a re-composition of the funding instrument portfolio it manages, according to the methodological approach described in par. 2.1 and represented in Fig. 2.
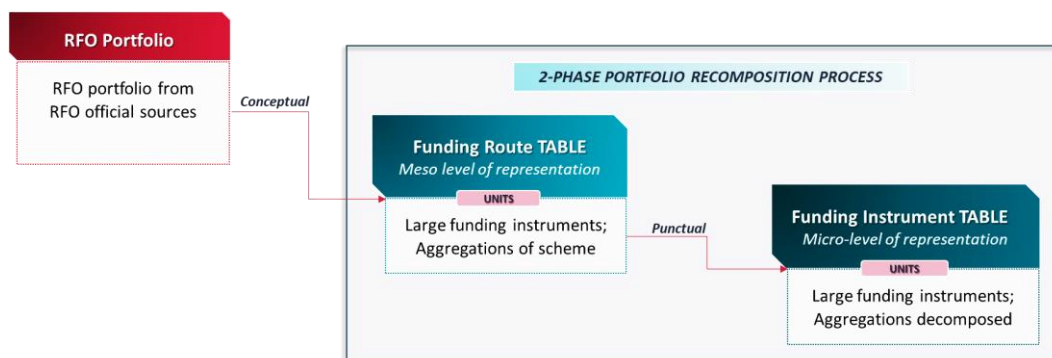

Figure 2. Re-composition of RFO instrument portfolios in EFIL database.

3. *Data retrieving on routes/instruments.* Qualitative and quantitative data according to the list EFIL descriptors (see Par. 2.3) are retrieved from official sources on the internet. Main data sources for the data collection were: i) RFO websites, annual reports, activity reports and evaluation reports; ii) funding schemes leaflets; iii) calls for proposal found on sources other than RFOs websites; iv) statistical databases on public research funding. More specifically,

information on qualitative characteristics of the instrument can be generally retrieved from official documentation uploaded on websites, data on funding are generally available in RFO annual reports or in publicly available statistical banks.

4. *Storing of textual documents and creation of descriptors based on SGCs, KETs and SDGs.* Official documents retrieved from RFO websites (e.g., instruments calls, reports, and guidelines for applicants) are saved and hosted in the cloud, available for user's access, to further analyse instrument mission and allocation procedures. This "side-collection" in the form of a repository of official textual documents pertaining to funding instruments allows for a deeper understanding of factors relating to policy implementation and R&D funding orientation. Based on the official documents, an automated text analysis process was used to generate SGC, KET, and SDG descriptors in the relational database. The ontology developed in the KNOWMAK project was used to create SGC and KET indicators (see Maynard et al., 2020). The keywords provided from the ontology have been used to associate the official documents of the Funding Instruments to the SGC or KET categories. The selection of the SDGs categories is based on keywords developed by United Nations Sustainable Development Solutions Network (SDSN) and Monash University (Kestin et al., 2017).

5. *Data cleaning.* Exploratory controls focused on the detection of non-sampling errors, whom correction required the recognition of systematic errors and random errors, have been carried out: - a harmonization of the codes of the units of analysis has been accomplished; - consistency checks between different descriptors have been undertaken in order to guarantee the coherency of data; - errors committed in the transcriptions of data have been corrected through format checks; - a check of referential integrity has been implemented as ultimate database safety check for inconsistent data. Treatment of IDs is already harmonized with OrgREG (in the case of RFO IDs) and will be harmonized with NATPRO and SIPER (in the case of instruments IDs).
   The following special codes apply in the relational database, partially following the standard notation from EUROSTAT:
   - code 'm' refers to the fact that the data is missing;
   - code 'z' refers to the fact that the variable is not applicable to the unit of observation;
   - code "i" is used when funding data on a single funding instrument includes amount from other funding instruments;
   - code "xr" is used when funding data on a funding instrument are included in other rows, which e.g. can occur when a scheme is part of another scheme.
   As for KET, SGC and SDG classifications, flag "(nd)" is applied when the classifications are not detectable by the text analyses applied to the programme documentation.

2.3 Information on all variables/indicators

As anticipated in Section 1, the units of analysis in EFIL are RFOs and Project funding instruments. This paragraph will present the sets of descriptors which allow to characterize them.

The RFOs in the EFIL dataset have the same ID and acronym as those in the OrgREG dataset. In addition, EFIL presents a set of original descriptors useful to characterize RFOs in terms of domain of activity, mission, and organizational features (see Table 1).

Descriptor	Characterization
RFO_ID *(rfo_id)* *Same ID as in OrgReg*	It is an identifier meant to uniquely identify organizations included in OrgREG and other RISIS datasets across time. The identifier for the RFO has the following format: ISO code 3166-1 alpha-2 + 4 digits numeric (e.g., AT0001).
RFO acronym *(rfo_acronym)*	The official acronym of the RFO, taken from OrgREG.
RFO position *vis a vis* the State and domain *(rfo_domain)*	The descriptor presents the RFO position with respect to the State and the domain of activity. o *National research ministry.* o *National sector ministry* (e.g., economic development, energy, etc.). o *Innovation agency*, whose mission and funding are oriented towards innovation and creation of economic value. o *Research Council*, whose funding is mainly oriented towards curiosity-driven research and having strong connection to the academic community. o *Sectoral RFO* – related to specific topic (energy, environment, etc.), e.g., sectoral regulatory agencies or sectoral funding agencies.
Performer role *(rfo_performer_role)*	This descriptor informs whether the RFO has also a performer role directly managing research laboratories and research facilities. A binary variable is provided.
RFO mission *(rfo_mission)*	A short description of the RFO mission, extracted from the RFO website, including the type of research and eventual collaborations.
RFO organizational structure *(rfo_organizational structure)*	A short description of the organisational structure of the RFO, including information on the composition of the executive Board and of scientific/advisory committees.
Remarks *(rfo_remarks)*	A textual field for more information on the general characterization of the RFO.

Table 1. RFOs descriptors.

The selection of descriptors used for funding routes and single funding instruments is based on the experience of three experimental studies – PREF (on the evolution and characterization of public R&D funding for the period 2000-2014: see Reale, 2017 and Lepori, 2017), JoREP (on the monitoring of investments in joint R&D programmes in the European countries, see Spinello, 2018), and KNOWMAK (on knowledge co-creation in the European Research Area: see Scherngell and Zahradnik, 2019).

Funding routes and single funding instruments share most of the descriptors, with the first presenting synthesis data in the case of aggregations of sub-schemes (see Par. 2.1), and the latter presenting data referred to lower level of portfolio granularity.

Table 2 lists the names and the respective characterization of the descriptors of funding routes and funding instruments, specifying when the descriptors apply only to one of the two categories.

Descriptor	Characterization
Route ID (*route_ID*)	A unique code created to identify the funding route as follows: "PF" + RFO ACRONYM + "-XXX', where PF stands for 'project funding'. Since each RFO can manage more than one funding route, IDs are distinguished by -001, -002 etc. (e.g., PF-DFG-001, PF-DFG-002).
Instrument ID (*instrument_ID*)	A unique code created to identify the single funding instruments. Instrument IDs depends on the type of Funding Route in which they are included: (i) if the route is a large project funding instrument that cannot be disaggregated in sub-schemes, the same ID of the route is applied also for the instrument; (ii) if the route is an aggregation of schemes (type b), the respective single instruments have an ID composed of the Route ID+ a letter (PF-DFG-001a; PF-DFG-001b, etc.).
Country (*country*)	The ISO country code of the national RFO which manages the Funding route/instrument.
Start year (*start_year*)	Start year of the route/instrument. There might be cases where this information is not available with precision, especially for the older instruments.
RFO ID (*rfo_id*)	The ID code associated to the managing RFO. The code is shared with the OrgREG facility.
Route/Instrument name in the original language (*name_original_lang*)	The name of the funding route/instrument in official language, as it is officially labelled in the data source.

Route/Instrument name in English *(name_in_English)*	The name of the funding route/instrument in English, as it is officially labelled in the data sources. Whether the English name is not available a literal translation might be entered.
Route/Instrument website *(website)*	The URL of the website or the webpage where the funding route/instrument is presented and described.
Status *(status)*	This descriptor states whether the instrument is still active or inactive as of the reference years of the collection (2017, 2018).
Route type *(route_type)* *only referred to Funding Routes*	A funding route in EFIL is of two types: o Type a) a large project funding instrument that cannot be disaggregated in sub-schemes. o Type b) an aggregation of schemes having similar characteristics.
General remarks *(general_remarks)*	A textual field with notes on the general characterization of the instrument.
Umbrella programme *(umbrella_programme)* *only referred to Funding Routes*	The descriptor informs about the belonging of the funding route to a larger programme.
Name of the umbrella programme *(name_umbrella_programme)* *only referred to Funding Routes*	The field reports the name of the umbrella programme.
Joint programme *(joint_programme)*	The descriptor informs about the presence of two or more agencies managing the same funding route/instrument.
Remarks on joint programme *(remarks_joint_programme)*	A textual field for more detailed information on the joint programmes.
Instrument aim *(instrument_aim)* *only referred to Funding Instruments*	The general aim of the funding instrument, according to the following categories: o *Dissemination, communication*, i.e., funding of research dissemination activities, communicating science. o *Career development*, i.e., funding for researchers with a view to improve career perspectives; funding for researcher mobility and exchange programmes; awards for researchers and early career prizes.

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	o *Excellent research*, i.e., funding for strengthening research excellence and international visibility through cutting-edge initiatives. o *General advancement of knowledge*, i.e., the standard funding for research projects without a specific goal. o *Infrastructure*, i.e., funding of equipment or research infrastructures. o *Innovation*, i.e., funding for innovation programmes. o *International collaboration*, i.e., funding for improving research cooperation between countries. o *National priority-setting*, i.e., funding for programmes based on strategic policy priorities.
Route/Instrument goal *(goal)*	The general objective of the instrument based on a categorization of the goals of the instrument, as stated in official documents or sources (not referring to the effective use of funds). o *Curiosity-driven* devoted to the general advancement of knowledge, without an explicit topic to be included in one of the NABS classification (code: *Curiosity-driven*). o *Route/Instruments having a specific policy goal*, such as environment or energy (most instrument might cover multiple domains), (code: *Policy*). o *Route/Instruments oriented towards economic innovation*, i.e., instruments which have goals that can be included in NABS06 category (industrial production), (code: *Economic Innovation*).
Instrument SGC *(instrument_SGC)* *only referred to Funding Instruments*	(Sub)categories of Societal Grand Challenges (SGCs) are provided and associated to each funding instrument (classification is listed in Par. 2.4). To link instruments and SGCs, text analysis of calls (or other official documents) collected and stored in the EFIL repository was used, which was based on ontology developed in the KNOWMAK project (see Maynard et al., 2020).
Instrument KET *(instrument_KET)* *only referred to Funding Instruments*	(Sub)categories of Key Enabling Technologies (KETs) are provided and associated to each funding instrument, (classification is listed in Par. 2.4). To link instruments and KETs, text analysis of calls (or other official documents) collected and stored in the EFIL repository was used, which was based on ontology developed in the KNOWMAK project (see Maynard et al., 2020).
Instrument SDG *(instrument_SDG)* *only referred to Funding Instruments*	The 17 Sustainable Development Goals (SDGs) are linked to the funding instruments (classification is listed in Par. 2.4). Text analysis of calls (or other official documents) collected and stored in the EFIL repository was used to link instruments and SDGs. The selection of the SDGs categories is based on

	keywords developed by United Nations Sustainable Development Solutions Network (SDSN) and Monash University (Kestin et al., 2017).
Instrument goals – documentation for analysis of mission *(instrument_link_analysis_mission)* *only referred to Funding Instruments*	An URL is provided linking to a webpage in which the objectives of the instrument are detailed to perform further analyses of the instrument's mission. **The linked documentation is downloaded and stored in the EFIL repository in a folder having the same code of the respective instrument.**
Type of transfer *(type_of_transfer)*	The type of transfer is distinguished between the following three categories: o *Project*, funding for a specific research activity limited in time and scope. o *Grant*, funding provided to individuals for their own career and development of human resources. o *Network*, funding for cooperative research between different organizations composing a network or a consortium, where the internal decision-making process determinates the allocation among partners (see Braun, 2003).
Academic-private cooperation *(academic_private_cooperation)*	This descriptor informs whether the route/instrument is specifically devoted to public-private cooperation. The definition should be handled in a restrictive way to identify the instruments whose main goal is to foster cooperation, which is enforced through specific rules (like having an academic and industrial partner).
Composition of the decision-making body for selecting the projects *(composition_dmb)*	This descriptor informs on the composition of the decision-making body for selecting the projects in terms of the presence of individuals from the following categories: o *Academic,* university professors and/or other public-sector researchers. o *Experts*, from policy, society and economy. o *Policy and administration*, policymakers and civil servants.
Funding allocation – 1st level: Assessment criteria *(assess_criteria)*	Criteria for funding allocation deals with the items assessed for the evaluation of projects (one dummy variable by each category): o *Scientific quality* (novelty, originality, and innovativeness of the project). o *Commercial exploitation.* o *Social impact.* o *Internationalization*.

Funding allocation – 2nd level: Assessment methods *(assess_method)*	Methods for funding allocation deals with the assessment methods, distinguishing among: o *Peer review assessment (including informed peer review).* o *Bibliometric indicators* (use of metrics from Scopus, Web of Science, Google Scholar, Altmetrics). o *Other methods* (textual field).
Funding allocation – Documentation *(instrument_link_analysis_eval_proc)* *only referred to Funding Instruments*	An URL is provided linking to a webpage in which the evaluation procedures and criteria are detailed (typically the guidelines for applicants). **The linked documentation is downloaded and stored in the EFIL repository in a folder having the same code of the respective instrument.**
Openness *(openness)*	The descriptor informs whether the roue/instrument foresees the funding of research performed by abroad individuals/research groups. Categories are yes (in general), with limitations, no.
Eligible sectors *(eligible_sector)*	The descriptor identifies the Frascati Manual sectors which are in principle eligible to receive funding from the instrument. The considered Frascati manual sectors are: o *Higher Education* (HE). o *Government* (GOV). o *Business Enterprise* (BE) and *Private Not Profit* (PNP). One dummy variable is reported for each sector.
Availability of the call in English language *(availability_call_in_english)*	The descriptor informs whether the instrument call for proposal is available in English language.
Remarks about structural, procedural and allocational features *(remarks_on_instrument_features)*	A field for more detailed information about structural, procedural and allocational features.

Table 2. Funding route/instruments descriptors.

Budgetary information is provided for the basic level of granularity in EFIL: (i) single instrument obtained because of decomposition of the funding route; (ii) large project funding instrument that cannot be disaggregated in sub-schemes (funding routes of *type a*).

The list in Table 3 presents the descriptors related to the budgetary information:

Availability of budgetary information (Flag) *(budget_availability)*	The field informs on the availability of budgetary information for the reference year: o code 'm' refers to the fact that the data is missing. o code 'i' is used when funding data on a single funding instrument includes amount from other funding instruments. o code "xr" is used when funding data on a funding instrument are included in other rows, which can occur when a scheme is part of another scheme.
Reference Year *(reference_year)*	The reference year to which the budgetary information refers.
Total budget in the year *(total_budget_in_the_year)*	The amount of funding awarded through the instrument in thousands currency units (rounded to the unit). As a preference, the amount should correspond to the effective transfer to performers, as for example recorded in accounts of RFOs. Funding decisions are however acceptable when other data are not available.
Currency *(currency)*	The currency used for the amount in reference year.
Type of funding *(type_of_funding)*	The descriptor specifies whether the total budget reported for the reference year is the *approved* budget (awarded budget) or the *earmarked* budged (planned budget).
Specific remarks for budgetary information (remarks_budgetary_information)	A textual field for more detailed information on budgetary information.
Data source and date of retrieval *(source_and_date_of_retrieval)*	The source from which the data were retrieved and the date of retrieval.

Table 3. Budgetary descriptors.

2.4 Geographical, temporal, and sectoral coverage

As for the geographical perimeter, at its first release the collection has covered data on project funding portfolios from 52 relevant RFOs from 9 countries: AT, CH, CZ, DE, DK, EE, IT, NO, UK.

Countries are classified according to the International Standard for country codes (ISO 3166-1 alpha 2). Currency indication follows the ISO code 4217 – three digits.

The temporal coverage assumes 2017 and 2018 as reference years for the re-composition of portfolios. When available, data on routes/instruments present in RFO portfolios prior to 2017-2018 and not yet active have been collected, with the indication of route/instrument status: "inactive". The route/instrument dynamic is followed though budget data, while qualitative descriptors are static. Financial data refer to the calendar year of each year and refers to the period 2010-2018.

The performing sectors that are legally entitled to get funding from the instruments have been classified using sectorial classification of the Frascati Manual (OECD, 2002), contained in tab. 4.

GOV	Government sector: Research institutes/governmental institutions with R&D which are mainly financed and controlled by the government.
HEI	Higher education institutions
BE+PNP	Business enterprise sector: firms/organisations/institutions whose primary activity is the market production of goods or services, including the private non-profit institutions mainly serving the business enterprise sector.

Table 4. Sectoral classification of research performers from Frascati Manual.

Funding Instruments are linked to the SGC, KET and SDG standard classifications through analytical text mining procedures (see Par 2.2). Table 5 shows the main categories associated to the three classifications. While SDG classification is introduced in EFIL using the categories listed in Tab. 5; SGCs and KETs are presented using a sub-level for each main category as presented in Table 6 and Table 7, respectively.

SGC (7 categories and 70 subcategories)	▪ Health, demographic change and wellbeing [HEALTH] ▪ Food security, sustainable agriculture and forestry, marine and maritime and inland water research and the bioeconomy [BIOECONOMY] ▪ Secure, clean and efficient energy [ENERGY] ▪ Smart, green and integrated transport [TRANSPORT] ▪ Climate action, environment, resource efficiency and raw materials [CLIMATE] ▪ Europe in a changing world - inclusive, innovative and reflective societies [SOCIETY] ▪ Secure societies - protecting freedom and security of Europe and its citizens [SECURITY]
KET (6 categories and 66 subcategories)	▪ Advanced manufacturing technologies. ▪ Advanced materials. ▪ Industrial biotechnology. ▪ Micro and nanoelectronics. ▪ Nanotechnology. ▪ Photonics.
SDG (17 categories)	▪ GOAL 1: No Poverty. ▪ GOAL 2: Zero Hunger. ▪ GOAL 3: Good Health and Well-being. ▪ GOAL 4: Quality Education. ▪ GOAL 5: Gender Equality. ▪ GOAL 6: Clean Water and Sanitation. ▪ GOAL 7: Affordable and Clean Energy. ▪ GOAL 8: Decent Work and Economic Growth. ▪ GOAL 9: Industry, Innovation and Infrastructure. ▪ GOAL 10: Reduced Inequality. ▪ GOAL 11: Sustainable Cities and Communities. ▪ GOAL 12: Responsible Consumption and Production. ▪ GOAL 13: Climate Action.

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	▪ GOAL 14: Life Below Water.
	▪ GOAL 15: Life on Land.
	▪ GOAL 16: Peace and Justice Strong Institutions.
	▪ GOAL 17: Partnerships to achieve the Goal.

Table 5. SGC, KET and SDG categories linked to the funding instruments.

level_1	level_2
bioeconomy	agriculture_and_forestry
	biomass
	food_consumption
	food_production
	land_use
	marine_resources
	marine_technology
	Bioeconomy
climate	air_quality_management
	carbon_footprint
	noise
	packaging
	soil_quality
	waste_management_and_recycling
	water_resources
	water_systems
	climate change and the environment
energy	alternative_fuels
	biofuels
	carbon_capture_and_storage
	energy_efficiency
	energy_storage
	energy_supply
	geothermal_energy
	hydro_power
	low_carbon_technology
	nuclear_energy
	ocean_energy
	photovoltaics
	renewable_heating_and_cooling
	smart_cities_and_communities
	wind_energy
health	active_ageing_and_self_management_of_health
	preventing_disease
	treating_and_managing_disease

level_1	level_2
	e_health
	health_biotechnology
	health_care_provision_and_integrated_care
	health_data
	personalized_medicine
	pharmaceuticals
	social_care
security	border_security
	catastrophe_fighting
	crime_and_terrorism
	digital_security
	public_safety_communication
	security_monitoring
society	co_creation
	cultural_heritage
	democracy
	education
	employment
	entrepreneurship
	global_engagement
	housing
	knowledge_transfer
	local_engagement
	migration
	poverty
	social_inequality
transport	aeronautics
	automobiles
	freight
	intelligent_transport
	maritime_transport
	rail_transport
	sustainable_transport
	transport_infrastructure
	urban_mobility

Table 6. Levels for SGC classification.

level_1	level_2
advanced_manufacturing_technology	mne_in_manufacturing
	advanced_materials_for_manufacturing
	biotechnology_for_manufacturing

	nanotechnologies_for_manufacturing
	photonics_for_manufacturing
	software_for_manufacturing
advanced_materials	advanced_biomaterials
	advanced_ceramics
	advanced_metals
	advanced_polymers
	advanced_superconductors
	novel_composites
industrial_biotechnology	sequencing
	animal_biotechnology
	applied_immunology
	assay_systems
	biologics
	biomaterials
	biomimetics
	cell_delivery
	environmental_biotechnology
	expression_systems
	gene_delivery
	genomics
	industrial_microbiology
	metabolomics
	molecular_engineering
	nanobiotechnology
	nucleic_acid_therapeutics
	oligo_delivery
	protein_and_peptide_delivery
	proteomics
	regenerative_medicine
	stem_cell_biotechnology
	tissue_engineering
micro_and_nanoelectronics	mems_and_nems
	actuator_technologies
	computer_memory_technologies
	hardware_architectures
	microcomputing_technologies
	nanoelectronics
	passive_electronic_materials
	photonics_based_communication_technologies
	power_electronics
	rf_technologies

	semiconductor_materials_technologies
	sensor_technologies
nanotechnology	dna_nanotechnology
	computational_nanotechnology
	food_nanotechnology
	graphene
	nanobiotechnology
	nanoscale_devices
	nanoscale_materials
	nanoscience_techniques_and_instrumentation
	nanotoxicology
photonics	applied_optics
	biophotonics
	green_photonics
	lasers_leds_and_light_sources
	optical_materials_and_structures
	optical_metrology
	optical_physics
	optical_techniques
	optofluidics
	photoacoustics

Table 7. Levels for KET classification.

2.5   Quality and accuracy of data

EFIL adheres to the FAIR principles[1]. EFIL is "findable" and "accessible": metadata and the facility itself are open and included in a discoverable infrastructure. EFIL data are "interoperable", because of the integration in RISIS infrastructure with OrgREG and NATPRO and SIPER (underway). Data are "reusable" since are structured in such a way as to be reusable by many users.

The methodological approach for the EFIL data collection is largely based on the positive experience of PREF experimental study on the evolution of public R&D funding for the period 2000-2014 (Scherngell et al., 2016; Reale, 2017). The PREF collection has been established around the notion of 'decomposition' of public research funding into distinct lines of funding (or 'streams') - from the central state to the RFOs -, which in turn have been disaggregated into funding instruments addressed to research performers (Lepori, 2017). Such a decomposition into funding instruments has been allowed for a more fine-grained analysis of public R&D funding, profiling also the instruments' portfolio of several countries and identifying evolving patterns of institutional and

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[1] The acronym FAIR refers to a list of principles that have been defined to ensure optimal use of research data (quality of research, reuse, improved services, long-term preservation). The FAIR Principles aim to make digital data management methods homogeneous and open access.

project funding modes (see Reale, 2017; Lepori et al., 2018; Zacharewicz et al., 2018). While the PREF study has collected data on three components of public research funding – funding lines of funding, funding instruments and managing organizations –, EFIL is only focused to the last two.

General data quality is good, considering the characteristics of data acquisition with no automated retrieving systems (see 2.2). EFIL data collection is RFO-based and relies on publicly available official documentation accessible through web-exploration. This collides with the dispersion of the contents into multiple locations and sources or, in the worst cases, with the elimination of the contents from the websites. A very good coverage on financial data (due to the notable availability of RFO annual reports) and a quite good coverage on descriptors have been found, noting however the need of complement information not retrievable from the Internet sources through a direct contact with RFOs. Percentages of missing values are around 15% for Route and Instrument qualitative data and 10% on budgetary data. Main issues have been related to the very different availability of documentation (e.g., specific calls or guidelines for applicants) among the different RFOs and a recurrent unavailability of some information, e.g., decision-making body composition, detailed information on the evaluation procedures. As for budgetary data, in the case of UK RFOs, it was not always possible to assign yearly amounts to the respective instruments due to official data being aggregated: in this case, amounts are included on a larger instrument presenting the flag "i" (see Par. 2.2).

Descriptors referred to SGC, KET, and SDG classifications, based on the ontologies developed by KNOWMAK project, United Nations Sustainable Development Solutions Network and Monash University (see Par. 2.2), are provided when official documentation on instruments has been retrieved and stored in the EFIL repository. They could present categorization issues (e.g., classifying a funding instrument into a category that it does not belong to), due to automated processes that could generate so-called "false positives" when identifying terms associated with the SGC, KET, and SDG sub-categories. In the first release of EFIL, the number of false positives was limited in order to improve funding instrument assignment accuracy to the three indicators.

As for the re-composition of RFO portfolios, the disaggregation of routes into single instruments (see 2.1 and 2.2) has been always possible in the case of Research Councils and in the case of the Austrian Innovation Agency FFG. In the case of Sectoral RFOs and other Innovation Agency the route level is maintained as the primary one and treated also at the instrument level.

3 Technical Specifications

3.1 Information on the data base system

Qualitative and quantitative data are implemented in MS Access, considering the potential of the software in handling several sets of information from different archives logically related to each other and in creating custom views of data.

Currently, no future technical changes about the database system are planned. Nevertheless, the possibility to export new releases of the database to another software for a better fruition is not excluded.

Calls for proposals and other official documents linked to funding instruments, acquired during the EFIL data collection, are kept in a repository, hosted on a cloud accessible the dataset user. The PDF files in the repository mainly provide information about the instrument's missions and funding allocation procedures. Each PDF file is labelled with the name of the instrument to which it refers (Instrument ID). The repository objective is to enable to users to process and extract information that could be useful in the context of text/mining analysis for providing insights into the specific research scenarios.

3.2   Technical variable definition

Table 8 summarizes labels and data-type of the sets of variables in EFIL:

Variables	Data type
RFO table	
rfo_id	Short text (Code)
rfo_acronym	Short text
rfo_domain	Short text
rfo_performer_role	Short text - binary (yes/no)
rfo_mission	Long text
rfo_organizational structure	Long text
rfo_remarks	Short text
Funding route table	
route_ID	Short text (Code)
country	ISO code
rfo_id	Short text (Code)
route_name_in_english	Short text
route_name_original_lang	Short text
route_start_year	Short text (year or indication of a period)
route_website	URL
route_status	Short text
route_type	Short text
route_general_remarks	Long text
umbrella_programme	Short text
name_umbrella_programme	Short text
joint_programme	Short text
remarks_joint_programme	Short text
route_goal	Short text
route_type_of_transfer	Short text
route_academic_private_cooperation	Short text - binary (yes/no)

route_composition_dmb_academics	Short text - binary (yes/no)
route_composition_dmb_experts	Short text - binary (yes/no)
route_composition_dmb_policy	Short text - binary (yes/no)
route_assess_criteria_scientific_quality	Short text - binary (yes/no)
route_assess_criteria_commercial_exploitation	Short text - binary (yes/no)
route_assess_criteria_social_impact	Short text - binary (yes/no)
route_assess_criteria_internationalization	Short text - binary (yes/no)
route_assess_method_biblio	Short text - binary (yes/no)
route_assesst_method_peer	Short text - binary (yes/no)
route_assess_method_patent	Short text - binary (yes/no)
route_assess_method_other	Short text - binary (yes/no)
route_openness	Short text
route_eligible_sector_HE	Short text - binary (yes/no)
route_eligible_sector_GOV	Short text - binary (yes/no)
route_eligible_sector_BE_PNP	Short text - binary (yes/no)
route_ availability_call_in_english	Short text - binary (yes/no)
route_remarks_on_route_features	Long text
Funding Instrument table	
instrument_ID	Short text (Code)
route_ID	Short text (Code)
country	ISO code
rfo_id	Short text (Code)
instrument_name_in_english	Short text
instrument_name_original_lang	Short text
instrument_start_year	Short text
instrument_website	URL
instrument_status	Short text
instrument_general_remarks	Long text
instrument_aim	Short text
instrument_goal	Short text
instrument_SGC	Short text - multivalue field
instrument_KET	Short text - multivalue field
instrument_SDG	Short text - multivalue field
instrument_link_analysis_mission	URL
instrument_type_of_transfer	Short text
instrument_academic_private_cooperation	Short text
instrument_composition_dmb_academics	Short text - binary (yes/no)
instrument_composition_dmb_experts	Short text - binary (yes/no)
instrument_composition_dmb_policy	Short text - binary (yes/no)
instrument_assess_criteria_scientific_quality	Short text - binary (yes/no)
instrument_assess_criteria_commercial_exploitation	Short text - binary (yes/no)
instrument_assess_criteria_social_impact	Short text - binary (yes/no)
instrument_assess_criteria_internationalization	Short text - binary (yes/no)

instrument_assess_method_biblio	Short text - binary (yes/no)
instrument_assess_method_peer	Short text - binary (yes/no)
instrument_assess_method_patent	Short text - binary (yes/no)
instrument_assess_method_other	Short text - binary (yes/no)
instrument_link_analysis_eval_proc	Short text - binary (yes/no)
instrument_openness	Short text
instrument_eligible_sector_HE	Short text - binary (yes/no)
instrument_eligible_sector_GOV	Short text - binary (yes/no)
instrument_eligible_sector_BE_PNP	Short text - binary (yes/no)
instrument_ availability_call_in_english	Short text - binary (yes/no)
route_remarks_on_instrument_features	Short text
Budget table	
instrument_ID	Short text (Code)
route_ID	Short text (Code)
reference_year	Date
budget_availability	Short text (flag)
total_budget_in_the_year	Numeric
currency	Short text
type_of_funding	Short text
remarks_budgetary_information	Long text
source_and_date_of_retrieval	Long text
Demographic events table	
demo_event_id	Short text (Code)
parent_instrument_id	Short text (Code)
child_instrument_id	Short text (Code)
year_of_demo_event	Date
demo_event_type	Short text
remarks_demo_event	Short text

Table 8. Labels and datatype of EFIL variables.

3.3   Description of the Entity Relationship Model

The design the relational database is mainly based on two characteristics:
o   double representation of the RFO portfolios by funding routes defined by EFIL team and single instruments (smaller level of decomposition presented of the RFOs portfolios), see Par 2.1.
o   RFO and routes/instruments characteristics are represented statically, while budgetary data are followed over time (2018-back to 2010).

EFIL database rests on a structure of tables linked by one-to-many relationships (1:M), to create links between parent and child tables – through unique identifiers – synching up data. Four main tables were created, linked according to a chain model, so that each RFO has its portfolio

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decomposed into routes, which are decomposed into instruments, which are associated to a budget (see Fig. 3).
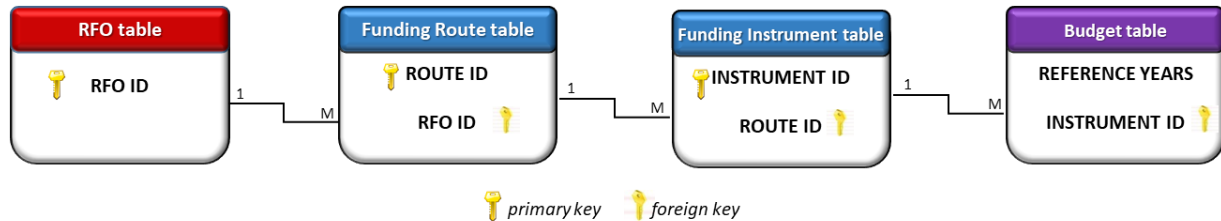

Figure 3. 1:M relationships linking tables in EFIL database.

- **RFO table**
  It contains the list of the selected organizations, that manage portfolios of funding instruments. Each RFO is identifiable by a code which is taken from RISIS OrgREG. EFIL collects a set of descriptors of the agencies (see 2.3).

- **Funding Routes table**
  The table contains a primary key that uniquely identify each Funding route as a single object. It provides descriptors (see Par 2.3) on routes of *type a* and *type b* (see Par 2.1). In the case of *type b*, the descriptors reproduce summary information on the set of single instruments included in the route.

- **Funding Instruments table**
  The table contains a primary key that uniquely identify each Funding instrument as a single object. Instrument IDs depends on the type of Funding Route in which they are included: (i) if the route is a large project funding instrument that cannot be disaggregated in sub-schemes, the same ID of the route is maintained also for the instrument; (ii) if the route is an aggregation of schemes (*type b*), the single instruments have an ID composed of the Route ID+ a letter (e.g. a,b,c,d.). An example is shown for the case of the Austrian RFO "FWF" in Fig. 4.
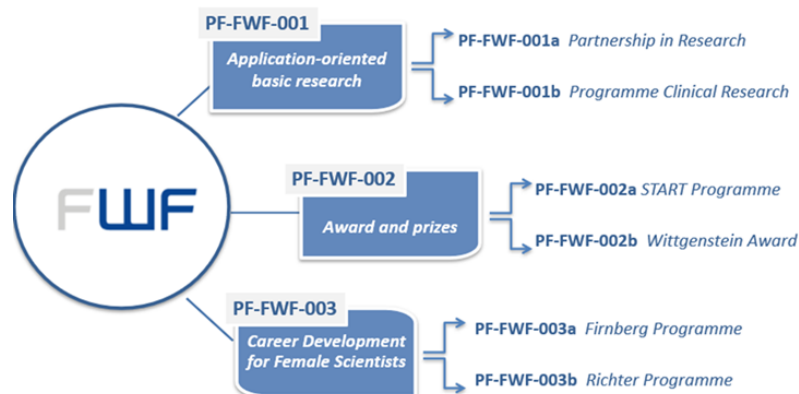

Figure 4. Example of treatment of IDs of route/instruments in EFIL.

Descriptors (see Par. 2.3) are intended to describe instruments at the lower level of data of granularity available.

- **Budget table**
  It is a time-variant table and stores the budgetary data related to the instruments from 2018-back to 2010.

A supplementary table called **"Demographic events"** is included to record future demographic transformation related to funding instruments in preparation of the next rounds of data collection. Fields are: Demographic event ID; Parent Instrument ID; Child Instrument ID; Year of demographic event; Type of demographic event; Remarks.

A first example of treatment provided in the first release of EFIL concerns instruments from Danish RFOs which merged into one (IFD) in 2014.

Type of events and related treatment of the field are listed in Table 9.

EVENT	FIELD	INFORMATION CONTENT
Closure/ creation	Parent Instrument ID	- Indication of the single instrument closed e.g. due to events involving RFOs (creation of merging of RFO) appears in the Parent Instrument ID field.
	Child Instrument ID	- Indication of the single instrument born e.g. due to events involving RFOs (creation of merging of RFO) appears in the child Instrument ID field.
Merger	Parent Instrument ID	- Indication of the single instrument merged appears in the *Parent Instrument ID* field related to the programme born from the merging;
	Child Instrument ID	- Indication of the programme born from the merging appears in the *Child Instrument ID* fields related with the merged instruments.
Split	Child Instrument ID	- Indication of the new instruments born after the split appears in the *Child Instrument ID* field related to instrument subject to split;
	Parent Instrument ID	- Indication of the instruments subject to split appear in the *Parent Instrument* fields related with the new instruments
Take-over	Child Instrument ID	- Indication of the instruments taking over in the *Child Instrument ID* field of the instrument taken-over.
	Demographic transformation	- Indication of the process of take-over (in *demographic transformations* field) associated to the instrument takin-over
Spin-out	Parent Instrument ID	- Indication of the original instrument in the Parent Instrument ID field of the spun-out programme.
	Demographic transformation	- Indication of the process of spin-out (in demographic transformations field) associated to the programme subject to the spin-out process

Table 9. Treatment of demographic events in EFIL.

Figure 5 shows the structure of the relational database in MS Access.
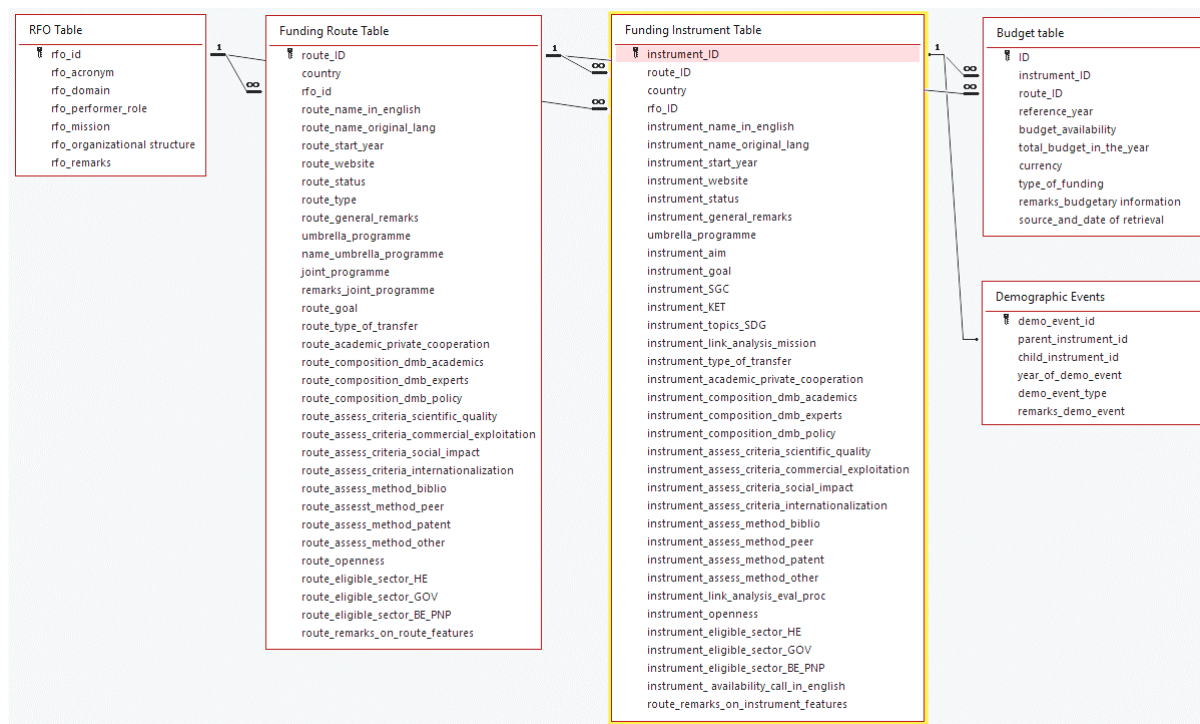
Figure 5. Relational scheme of EFIL in MS Access.

Connected to the Access database, EFIL provides a repository of official textual documents pertaining to funding instruments, allowing for a deeper understanding of aspects connected to policy execution and R&D mission. Within the repository (hosted on a cloud), the retrieving of the documents pertaining to the funding instruments is guided by the Instrument IDs (Fig. 6).
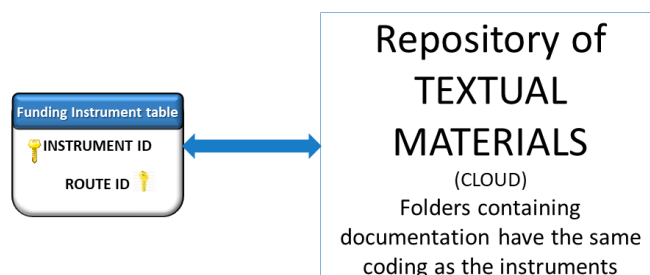

Figure 6. Connection between the Funding Instrument table and the repository of textual materials.

3.4 Interfaces for access and to other infrastructures

Requests for accessing EFIL can be made through the RISIS Core Facility (RCF). After a positive assessment of the request, the proponent will be put in contact with the team at CNR-IRCrES to agree on the access mode (virtual or physical mode, choice descriptors of interest, etc.)

EFIL is integrated in the RISIS infrastructure with the OrgREG facility, using the ID of the RFOs managing the funding instrument, and designed to be linked with other RISIS facilities, such as

NATPRO and SIPER though the ID of the single funding instruments. The creation of linkages between Instrument IDs is ongoing. The design of the integration of EFIL within the RISIS infrastructure is showed in Fig. 7.
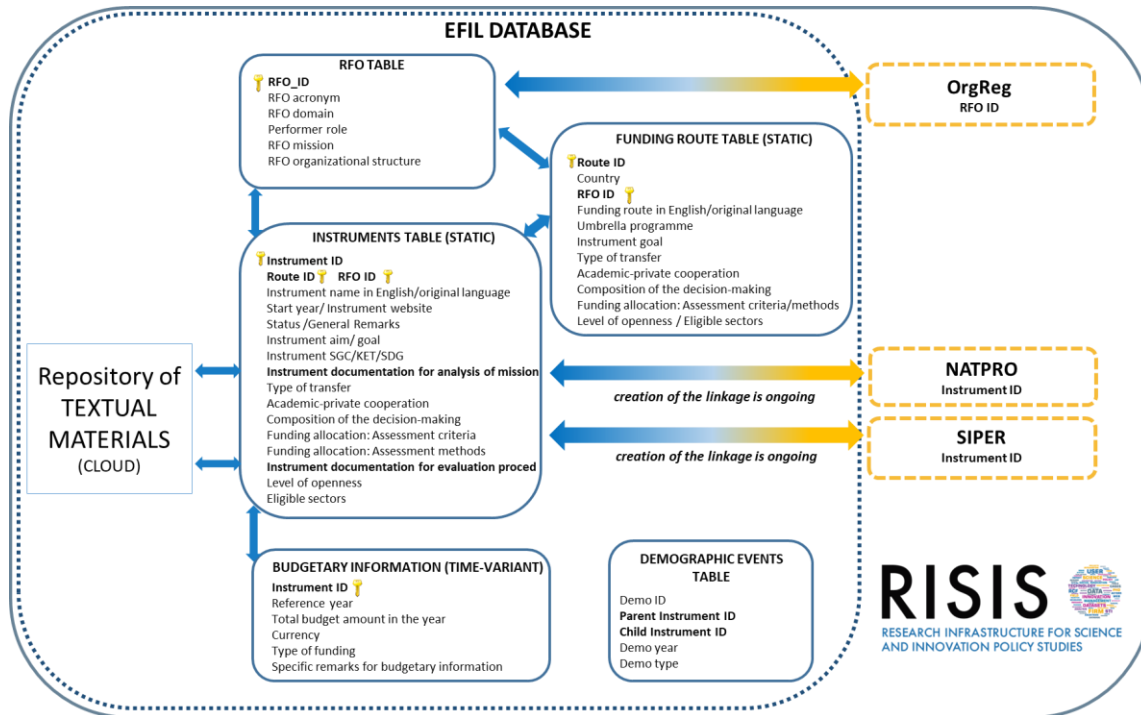

Figure 7. Integration of EFIL in the RISIS infrastructure.

4 Scientific use cases and main references

4.1 Scientific relevance of the dataset

The importance R&D funding policy instruments, as means used by policy makers to realize objectives related to a specific agenda, grew up in research policy literature and it is a major concern for policymakers whose aim is to improve efficiency and effectiveness of public investment (Hood, 1983; Howlett, 1991). Literature shows different approaches for studying policy instruments within the policy process (Salamon 2002; Lascoumes and Le Galès, 2007), either looking at the characteristics of the instruments, or looking at the context of application, or considering instruments as institutions following peculiar paths of development interacting with how actors use them.

Instruments show the characteristics of the actual policy design and its evolution, so that they are useful to describe empirically policy changes, revealing the real choices of public policies and their characteristics (Reale and Seeber, 2013). Furthermore, they are the basic units of any governance mode (Capano et al., 2019), and widely used both in research policy studies and innovation studies to deepen the characteristics of policy mixes (Flanagan et al., 2011; Kern et al., 2019), and to understand the mission orientation of public funding.

As to the relevance of public funding instruments for understanding R&D policy, it is worth to remember that funding allocation is at the core of the state steering, which wants to achieve certain goals incentivizing the beneficiaries to act toward reaching certain results and producing social impact (Wildavsky and Caiden, 2004; Larrue et al., 2018; OECD, 2020).

Research funding organizations (RFOs) are the agents which design and manage the R&D funding instruments – they reproduce motivations and objectives of the public action. They retain control over the process of selection of beneficiaries of the R&D funding and are in charge of transferring resources for research activities. Understanding the role, the mission and the structure of these organizational entities is essential to characterize the peculiarities of the national R&D funding systems and to analyse the way in which the research policy goals are shaped.

Because of the importance of policy instruments to understand new trends in public research funding, research and data collection on the evolution of modes of public funding allocation and its effects raised in recent years. One example is the launch by the EC of one project on public R&D funding – PREF –, to collect data about competitive and non-competitive funding allocation of public resources and the managing agencies, which produced both methodological and analytical results (Lepori, 2017; Reale, 2017; Lepori et al., 2018; Reale et al., 2018).

Based on the experience gained in the EC PREF experimental project, the framework for a dataset on R&D funding instruments has been designed, including decisions on the time span, indicators and descriptors, classifications, and the technical support of the dataset. The objective of this new RISIS dataset – EFIL, European Public Funding of R&D –, is to characterize the portfolios of instruments of research funding organizations (RFO) in Europe, developing evidence on the characteristics of the instruments, on the organizations' profiles at different levels of policymaking (national for the time being).

EFIL shall enable users to investigate public R&D funding in Europe at the level of RFOs and funding instruments in terms of a completely new information basis on the specific characteristics of these RFOs and schemes. Data are supposed to support research aimed at responding relevant policy questions, such as:

- What public R&D funding tells us about governance, autonomy, policy goals and means of different European R&D funding systems?
- How instruments combine different logics of governance generating hybridity of public action?
- How RFOs can be characterized within the research system?

Analyses of policy design and mixes can be performed:
- combining indicators of SGC/KET/SDG with instruments' goal.
- combining criteria and practices to select projects with missions.
- performing analysis of instruments portfolios of different actors by RFOs missions, topics, and goals to create typology of policy mixes in public R&D funding.

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