

Indicators for internationalization of funding agencies¹

Peter van den Besselaar^{*}, Annamaria Inzelt^{**} and Emanuela Reale^{***}

^{*}*p.a.a.vanden.besselaar@vu.nl*

Network Institute & Department of Organization Sciences, VU University Amsterdam,
de Boelelaan 1081, 1081 HV Amsterdam (The Netherlands)

^{**}*annamaria.inzelt@uni-corvinus.hu*

IKU Financial research, Budapest, Hungary

^{***}*e.reale@ceris.cnr.it*

CERIS CNR, Rome (Italy)

Abstract

For science policy, internationalization is increasingly an important issue. However, the evidence base for internationalization policies is lacking. In an *ESF member forum* we are developing a set of indicators for internationalization for research funding organizations and research performing organizations. These indicators are mainly using data owned by the organizations. However, it is not easy to relate funding and internationalization of collaboration and output, only using that information. The WoS recently started to include a field with funding information, and in this paper we explore whether that information can be used to improve indicators for internationalization of funding agencies. The results are a useful deepening of the evidence base for internationalization policies.

Introduction

For science policy, internationalization is increasingly an important issue. However the evidence base for internationalization policies is lacking (Edler & Flanagan, 2011). Generally, the focus is on the internationalization of research in terms of international collaboration between researchers – often using the share of internationally coauthored papers as an indicator. This however is only one dimension of internationalization of the science system. For example, also international mobility of research staff, agenda setting and funding are increasingly debated.

Indicators of internationalization may have two functions. One is to understand the global patterns of internationalization; the other is to inform science organizations, such as research performing organizations and funding organizations about their international position. Within the context of the European Science Foundation, we conduct a project for developing indicators for internationalization, focusing among others on funding agencies (FAs). The rationale of the project is the increasing relevance of transnational and cross-border research activities those organizations.

¹ This paper is an outcome of the work in the *ESF Member Forum on Internationalization*. We thank the ESF for support, and the

We followed a participatory approach (Reale et. al., 2012) in order to select indicators that were considered useful and feasible by the participating organizations. This resulted into the following list of indicators (table 1) that (i) were considered relevant for their policies, and (ii) feasible in the sense that data are relatively easily available through the FAs will be so in the near future (ESF, forthcoming 2012). Indicators 7 and 8, however, are considered as *blue-sky* indicators: indicators that need more conceptual development and new data collection, and therefore remain possibilities for the future.

Table 1: Selected indicators for the internationalization of funding agencies

	Indicator	Examples of units
1	Budget for joint research programs	Budget & share of total budget
2	Budget for attracting researchers from abroad	Budget & share of total budget
3	Share of foreign evaluators and panelists	Share of total nr of evaluators
4	International coauthored papers	Share of total publication output
5	International co-patenting	Share of total patent output
6	International mobility	Budget & share of total budget
7	Openness of programs to foreigners*	Share of all programs
8	Budget spending abroad*	Budget & share of total budget

* Blue-sky indicators

As indicated, the project planned to use information available at the FAs. Although FAs may have data on international collaboration and publication activities in the context of funded research, this information may be incomplete and sometimes difficult to aggregate. As the Web of Science recently introduced a field with acknowledgements to FAs, we may use that information to improve the production of indicators 4, 7 and 8, but also build indicators for other important dimensions of the internationalization of research funding. In this paper we show the possibilities of this new data source, using several FAs as example. Through this project, we aim a contributing to a better understanding of how specific funding arrangements contribute to the internationalization and Europeanization of research.

Some relevant indicators for the internationalization of funding

What dimensions of internationalization of research funding can be distinguished, and how can we design an indicator for it? Funding can influence the internationalization in different ways. Firstly, national funding organizations may stimulate researchers that operate internationally more than researchers with a national orientation, and so stimulating international collaboration (the latter which may be measured in terms of international co-authoring). Secondly, national funding organizations may use co-funding, that is how often does an (international collaborative) research project gets money from different sources, and more specifically, from sources from different countries? Thirdly, national funding organizations may fund researchers in other countries who do not collaborate with someone from the home country. And fourthly, the opposite can be measured: how often do foreign FAs fund researchers in the home country?

These questions can be answered at the national level, aggregating all project funders from a country to one 'virtual' funder. By doing so, one may compare the internationalization of project based funding with e.g., the level of internationalization of university-funded research. Alternatively, one may do the analysis for a single FA, leading to FA-specific positioning indicators (Laredo, Mustar 2000, Lepori et. al., 2008; Merckx, van den Besselaar 2008) that show where an FA stands in terms of internationalization, in comparison with other (foreign) FAs.

In this paper we focus on *positioning indicators* at the level of the *individual FA*. Based on key questions in the relevant literature, four indicators will be developed for measuring internationalization of FAs. They are all based on co-author relations.

- (a) Does a research council stimulate the *internationalization of research*? Is the agency stronger supporting internationally or nationally oriented researchers and research fields? This is an alternative way of operationalizing indicator 4 (table 1).
 - This indicator will be measured by the share of international coauthored papers among all papers that acknowledge funding of the council, compared to the share of international coauthored papers in the total national output. If the FA scores above (below) the national share, it over proportionally (under proportionally) supports internationalization.
 - Of course, we control for the differences between the councils' disciplinary portfolio and the national disciplinary portfolio, as levels of international collaboration may differ between fields.
- (b) How much research abroad is funded by a funding agency? What is the level of *outgoing funding* of the FA? This can be used as a first version of indicators 7 and 8 (table 1)
 - This can be measured by estimating the share of papers that acknowledge funding of the FA, but do not have authors from the home country.
- (c) Of course, one may also look for the opposite direction; that is how much 'foreign' research money comes in. *Incoming funding* is not an internationalization indicator for the specific FA under study, but an indicator at the level of the national science system.
 - This can be measured by estimating the number of papers of national researchers that are funded by foreign FAs, without participation of foreign co-authors.
 - Here, of course, we have to be careful in deciding what counts of foreign funding. We suggest that EU funding does not count as 'foreign', and for the time being we do not take industrial funding into account here, as it are often multinational corporations that fund. These are not easily to localize geographically: is it a national or a foreign part of the company?
- (d) Finally, the issue of *international pooling of resources* is an important indicator for internationalization. This can be done in terms of top down joint programs (see indicator 1 in table 1), but also in terms of a bottom up pooling of resources through international collaborating researchers.
 - The level of bottom up pooling of resources will be estimated by the share of publications supported by an FA that are internationally co-funded by FAs from other countries.¹

Method and data

As the uptake of acknowledgements to funding agencies in the WoS database is recent, we restrict the analysis to 2011 only. Therefore we cannot analyze change at this moment, something that will become possible in the future. We restrict the analysis to four research councils in Switzerland, Norway, the Netherlands and Germany: two small countries, one medium sized and one big country. Three of the councils are participating in the ESF project. In this paper we describe the method using the *Swiss Science Foundation* (SNF), the Swiss national research council as example. Other cases are analyzed similarly.

We selected all citable WoS publications in 2011 (articles, reviews, letters, notes, proceedings papers and book chapters) for each country: 23.298 documents. Of these, two third (15.773) do mention one or more funders. This is a high share, as the practice of acknowledging funders was supposed to be less normal in the EU than it is in the US. This resulted in a huge list of more than

18.000 funder *names*, indicating that FAs are present in the database with a large variety of name variants. Furthermore, it is not always clear whether a specific funding instrument belongs to the FA or not, as the reference is regularly mentioning the instrument only and not the responsible FA. As not much other information is available, automated disambiguation is hardly possible. A second problem is the difficulty to classify funders in terms of nationality and type (council, university, foundation/charity, company, etc.) In case of the Swiss SNF, selected manually all name variants of the SNF, about 154. In case of uncertainty (e.g., the Flemish council sometimes uses the same abbreviation as one used for SNF), we checked it in the documents and on the web.

We use the online version of WoS for our analysis, deploying the ‘further analysis’ function. Where possible, all 2011 papers were used. However for answering the questions about incoming funding and international co-funding, we use only the 100 most frequent funder names – a unavoidable restriction when using the online version. A full analysis would require disambiguation of all 18.400 funder names used in the 2011 papers with a Swiss address, which would be a huge effort. By restricting the analysis as indicated, we of course *underestimate* incoming funding and international co-funding. More specifically, these two parts of the analysis cover about 58.5% of the papers acknowledging the funding agency.²

Are national research agencies stimulating international cooperation?

We firstly determined which of the papers are internationally co-authored and which are not. We then calculated the papers that were funded through the SNF, through other funders, and the papers that do not acknowledge funding. We present the basic data for SNF in table 1.

Table 1: Funding by international orientation (international co-authored publications)*

	Total	SNF [#]	Other ^{##}	No funding
All papers	23298	5608	8996	8692
International co-authors	67.7	59.7	83.4	55.8
Swiss (co-)authors**	32.0	39.7	16.6	44.2

* Switzerland 2011

** We only use publications from WoS and miss more national than international authored papers. The latter may therefore be overestimated. This does not influence the findings.

[#] No SNF funding, but at least one other funder.

^{##} Possibly also other funders.

Of all papers in 2011 with a Swiss address, two third are internationally co-authored. If we focus on the papers that received SNF funding, this is about 60%. Please note that these papers may have also funding of another source – we will discuss this below. The papers that acknowledge other funders show a considerable higher level (above 80%) of international co-authors. By the way, these ‘other funders’ can be from Switzerland, from abroad, or from international organizations (EC, CERN), and they can be public, private foundations and charities, or companies. Finally, the papers that do not mention funders have the lowest share of internationally co-authors: about 55%. Clearly, as table 1 shows, the SNF does support more international than national (co-)authored papers. But the international orientation of the total SNF funded output is lower than average, so one may conclude that SNF focuses only weakly on internationalization.

We introduce now the indicator *International Orientation* (IO) which can be defined as:

$$IO = \frac{\text{(share of FA funded papers with international coauthors)}}{\text{(share papers with international authors in national output)}}$$

In the current case, this is: $IO = (59.7\% / 67.7\%) = 0.88$. What does this mean? Does the council fund researchers with a stronger national orientation more than the predominantly internationally operating researchers? Or is this due to the portfolio: an agency may also fund fields that are mainly characterized by single or nationally co-authored papers, such as in the humanities and large parts of the social sciences, as often claimed. And if these fields receive relatively large agency support (implying a different thematic and disciplinary focus of the agency, compared to the national portfolio) this effect may even be stronger. We therefore test whether that is the case.

To do this, we analyze the data in a slightly different way (table 2). Of all papers, about a quarter (24.1%) gets SNF funding, and the rest is equally divided between other funding (38.6%) and no funding (37.3%). Please note that this international funding often comes through the international coauthors. If we divide between international co-authored papers and national (co-)authored papers, the first group is less often SNF funded and one often ‘other funded’ than the second. Interestingly, much more internationally co-authored papers were funded (almost 70%) than the national authored papers are (less than 50%).

Table 2: Internationalization by funder*

	All	With intern co-authors	Only Swiss author(s)
Total	23298	15774	7445
SNF	24.1	21.2	29.9
Other FOs	38.6	47.6	20.0
No funding reported	37.3	30.7	51.6

* Switzerland 2011

Different fields have indeed different percentages of internationally co-authored papers. Overall, the national authors have a 1.4 higher chance to be funded ($29.9\% / 21.2\% = 1.4$ table 2). We calculated the same index for each of the 111 WoS Subject Areas. Physics is a good example. Of all internationally coauthored physics papers, 34.4% acknowledges funding of the SNF, whereas this is true for 47.5 of all nationally authored physics papers. The ‘national orientation index’ for physics is 1.38, equal to the national average. For chemistry, the index is 1.78 and for molecular biology 1.61. Generally one may say that at field level, the same pattern emerges as for the country as a whole. Notably exceptions are general internal medicine, psychology, agriculture, anesthesiology, dermatology, and a few tiny fields (in terms of the number of granted SNF proposals).

Our conclusion remains valid: although more funding goes to internationally co-authored papers (the majority of papers), relatively more nationally (co)authored papers are SNF supported than the internationally co-authored papers are – and that holds for almost all fields.

Money going abroad?

Are foreign researchers funded by a council, and to what extent? We retrieved all papers with acknowledgment to SNF in the database, published in 2011.³ In contrast to the previous section, this set also includes papers that do not have a Swiss address, and it does not include (of course) papers that do not acknowledge SNF.

In total we found 6252 articles, reviews, notes, letters, and proceedings papers, and of these some 644 have no Swiss address.⁴ This may suggest that about 10.3% of the output produced with SNF funds, is produced by foreigners and/or by Swiss researchers abroad. One should bear in mind that this may also due to mobility of researchers, although if the grant was used in a Swiss university or research institution before moving, one would expect this organization in the address. If we can disambiguate the funding agencies field adequately, we can produce this indicator of internationalization.⁵ The meaning of this indicator needs further research, as the reason for funding researchers abroad needs to be clarified. Or do we measure here money leaking away and fruits of research going abroad?

Table 3: Funding research abroad*

	#	%
All papers with SNF funding in 2011	6252	100 %
All papers with SNF funding in 2011, at least one Swiss author	5808	89.7%
All papers with SNF funding in 2011, no Swiss author	644	10.3%

* Switzerland 2011

Incoming funds

Do Swiss researchers get non-Swiss money? We analyzed in more detail the other types of funders present in the dataset, and we distinguish those into seven categories. Table 4 shows how funding is distributed over these categories. Non-Swiss funding bodies are in the categories 3, 4, 5, 6, 7, and partly 2. Within the latter category is difficult to distinguish between national and international funders, as many of these companies are international and have Swiss and non-Swiss divisions.

It is important to note that the data in this section differ from the data in the previous sections, as due to restricted data access, we are only able to include *the 100 largest funders*. As a consequence, only 8.445 of all papers are included, and that is about 58.5% of the 14.606 papers with funding acknowledgements.

Table 4: Categories of funders, Switzerland 2011*

Funder	# papers
1. Other Swiss (government, agencies, foundations, universities)	967
2. Companies*	691
3. Elsewhere in the EU (government, agencies, foundations, universities)	1695
4. EC (FW programs, ERC)	2061
5. International organizations (CERN)	120
6. US (government, agencies, foundations, universities)	1234
7. Elsewhere world (government, agencies, foundations, universities)	456
Total international funded excluding 1 and 2.	4452

* Excluding SNF

For the time being, we take categories 3-7 as international funding, in total 4452 papers. Quite some of these papers have international coauthors, who may have brought the international funding into the paper. Therefore we consider as real incoming funding (to Switzerland) those international funders mentioned in papers with *only* national (Swiss) authors: 466 papers. Of the 1491 papers without international coauthors a substantial percentage of 31.3% gets international funding. However, further inspection shows that the large majority of this is EC funding, through

Framework Programs and through the ERC. If we exclude this part of international funding, 73 papers remain. As a conclusion, a few percent of papers with only Swiss authors acknowledge international (non EC) funding.

Table 5: Incoming funding*

	Only international funding	Only EC funding	Other intern. funding
All papers	4452	2061	2906
National authored papers	466	393	73
	10.5%	19.1%	2.5%

* Switzerland 2011

International co-funded research

Again for Switzerland 2011, we analyze internationally co-funding: How often does the Swiss Research Council (SNF) co-fund together with another foreign public funding agency? And how often are they the only funder? We use the top 100 funding agencies only (through the Web interface of WoS) – similar to the section on “money going abroad”. We use the same categories of the previous section, and now calculated for each category the papers that were also funded by SNF. Table 6 shows the results.

Table 6: International co-funded research*

Funder	# papers	% of category	% of SNF
0. SNF	3348		
1. SNF + other Swiss (government, agencies, foundations, universities)	495	51.2	8.8
2. SNF + Companies	177	25.6	3.2
3. SNF + elsewhere in the EU (government, agencies, foundations, universities)	453	26.7	8.1
4. SNF + EC (FW programs, ERC)	650	31.5	11.6
5. SNF + international organizations (CERN)	19	15.8	0.3
6. SNF + USA (government, agencies, foundations, universities)	365	29.6	6.5
7. SNF + elsewhere in the world (government, agencies, foundations, universities)	138	30.3	2.5
SNF + all international excluding 1. and 2.)	1249	28.1	22.3

* Switzerland 2011

Of the 15.772 internationally coauthored papers, some 3348 got SFW funding and 4452 got public funding from a non-Swiss funding agency. These two sets have overlap: some 1249 were co-funded by SFW and one or more of the foreign public funders. The appropriate indicator *internationally co-funded research (ICR)* is

$$\text{ICR} = (\text{internationally co-funded papers} / \text{all funded papers})$$

This indicator lies between 0% and 100%. Applying this on the Swiss data for 2011, we find the following ICR: $\text{ICR} = 1249 / 5608 = 22.3\%$

Table 7: International co-funding*

	SNF funded	International funding	co-funded (overlap)	International without EC
Nat authors only	3348	466	-	73
All	5608	4452	1249	2906

* Switzerland 2011

Overview

We have calculated the above-developed indicators for the main FAs in a few countries: apart from Switzerland we selected the main FA in two other countries participating in the ESF project (DFG in Germany, and NRC in Norway) and NWO in the Netherlands. Table 8 gives the results for the four indicators.

Table 8: Comparison between countries*

Indicator Unit Values	IO: International orientation Ratio 1 = neutral	OF: Outgoing funding % Publications 0-100	IF: Incoming funding % Publications 0-100	ICR: International co-funded research % Publications 0-100
Germany	To be completed	To be completed	To be completed	To be completed
Netherlands	To be completed	To be completed	To be completed	To be completed
Norway	To be completed	To be completed	To be completed	To be completed
Switzerland	.88	10.3	2.6	22.2

* Data for 2011

Conclusions and lessons

Acknowledgements to funders of research increasingly are becoming standard, and therefore the information provided by the field ‘funding agency’ in the Web of Knowledge can be used to study the role of funding and funders in the science system. About two-third of all recent papers in the WoS include information about funders – at least in the countries we studies here. In the future, when data are available over a longer period, it will be available to study changes in research funding patterns over time. But in order to use these data, they need extensive cleaning because of the huge variability in the names of the FAs.

We did so for a few countries, and this enabled us to measure several dimensions of internationalization of research. In this paper we use the data more specifically for studying the internationalization of research funding agencies. FAs can use these data for self-evaluation and international comparison.

More specifically we developed four useful indicators.

- (1) The level of *international orientation* of FAs can be measured easily in terms of international coauthored papers funded by the council. The indicator suggests that the FAs under study emphasize international research less than national research – compared to the national average.
- (2) The data enable investigating the important issue of international ‘bottom up’ *co-funding of research*. The indicator suggests that a rather large share of publications (more than 20%) mentions funding by sources from different countries. Clearly, by collaborating and coauthoring, researchers combine funding from different countries.
- (3) We also estimated the openness of programs of FAs for researchers from abroad, and this seems rather large. Further work is needed to find the details of the use of these *outgoing funds*.
- (4) Finally, foreign funded nationally authored papers can be interpreted as an indicator for *incoming funding*. Quite some papers refer to international funding, but this is to a large extent funding obtained from EC programs. If we do not include this EC funding, only a small number of nationally authored papers with foreign funding could be identified.

The developed indicators do lead to new observations and related research questions. We discuss here one. Overall, the results of the current analysis suggest that the agencies in developed countries fund research that leading to internationally co-authored papers much more than research leading to nationally authored papers. However, the share of internationally coauthored papers that receive FA support is lower than the share of nationally authored papers that receive FA support, suggesting that the FA is less internationally oriented than the national science system as a whole. We checked that this is not a *compositional effect* of the FAs research portfolio in comparison to the national portfolio. What then may explain this observation? Do internationally co-authoring authors less frequently report the funding agency? This is unlikely – one would expect the other way around. Do projects funded by the FA more often focus on topics in which international colleagues are not interested? If so, that would explain that the FA funded papers are more than average nationally authored. In that case, FAs indeed select more than average projects of merely local interest. Do FAs focus at national authored papers from the point of view of competition – to gain academic leadership in a field? Or are FAs dominated by the national elites, more than by the internationally operating scholars? Here is clearly interesting research to be done.

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¹ This can also be done for national co-funding: how much national funding agencies are jointly funding publications?

² In the next version a table will be added with the characteristics of the data of the four countries

³ We used the following query: FNS OR "fond* natio* Suisse*" OR "National center for competence in research*" OR NCCR OR "Schweiz* national*" OR SNF* OR SNSF* OR "Swiss FNRS*" OR "Swiss fond* national*" OR "Swiss funding Agenc*" OR "Swiss National center for Competence in research*" OR "Swiss National Fo*" OR "Swiss National Fund*" OR "Swiss National Research*" OR "Swiss National scien*" OR "Swiss Nationalfonds*" OR "SWISS NF*" OR "SWISS NSF*" OR "Swiss Research foundation*" OR "Swiss Research National Foundation*" OR "Swiss Science Foundation*" OR "Swiss Science National Foundation*" OR "Swiss Science National Foundation*"

⁴ We checked whether these 644 papers did have an address at all. That is the case for 642 of the papers. In other words, the analysis is not influenced by 'missing values'.

⁵ The remaining 6252-644 = 5608 papers are included in the other sections.