Relationship between research funding and scientific output in two different biomedical disciplines

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Introduction

- Measuring the returns of research is of increasing importance for funding bodies, which have to demonstrate the benefits derived from their investment (ERC, 2016; NSF, 2004).
- Main efforts focus on studying the scientific output and socioeconomic effects (outcomes) arisen from the research with the aim of determining the success of financing initiatives.
- From a bibliometric perspective, it is possible to trace the scientific results of agencies' investments through the study of funding acknowledgments (FA) in publications.
- Since funding bodies increasingly require the inclusion of FA in publications (ERC 2012) and they are now covered by some bibliographic databases (since 2008 in WoS), studies on the topic are attracting increasing interest.

Background

- Studying the relationship between funding and research performance can increase our knowledge about the effectiveness of investments on research.
- A positive effect of funding on the productivity of scientists has been described (Campbell et al. 2010).
- Divergent results concerning the relationship between funding and research impact were reported: from “no relationship” (Cronin and Shaw, 1999; Sandstrom, 2009) to “greater impact” (Wang & Shapira, 2015; Yegros & Costas, 2013; Campbell et al., 2010).
- Indirect positive effects of research funding on output and impact by stimulating collaboration have been observed (Ebadi & Schiffauerova, 2015).
- Further research is needed, with special emphasis on potential inter-discipline differences, since research strategies and funding effects may vary by discipline.

Objectives

- To describe two biomedical disciplines in Spain regarding their scientific output and research funding profile through the analysis of funding acknowledgements data (FA) indexed in WoS.

- To characterize funded research through bibliometric indicators with particular attention to impact and collaborative features and to differences between disciplines.

METHODS

- Scientific articles (in English) of Spain-based researchers during 2010-2014 were selected from WoS in two biomedical disciplines: Cardiac and Cardiovascular Systems (CARD) and Virology (VIROL)
- Scientific output analysis
  - Number of articles
  - Collaboration indicators
    - mean number of authors
    - mean number of institutions
    - national & international collaboration rate
  - Impact indicators
    - citation rate relative to world average (RCR)
    - highly cited papers (10% most cited) (HCP)
    - percentage of papers in first quartile journals (Q1)
    - percentage of papers in first decile journals (D1)

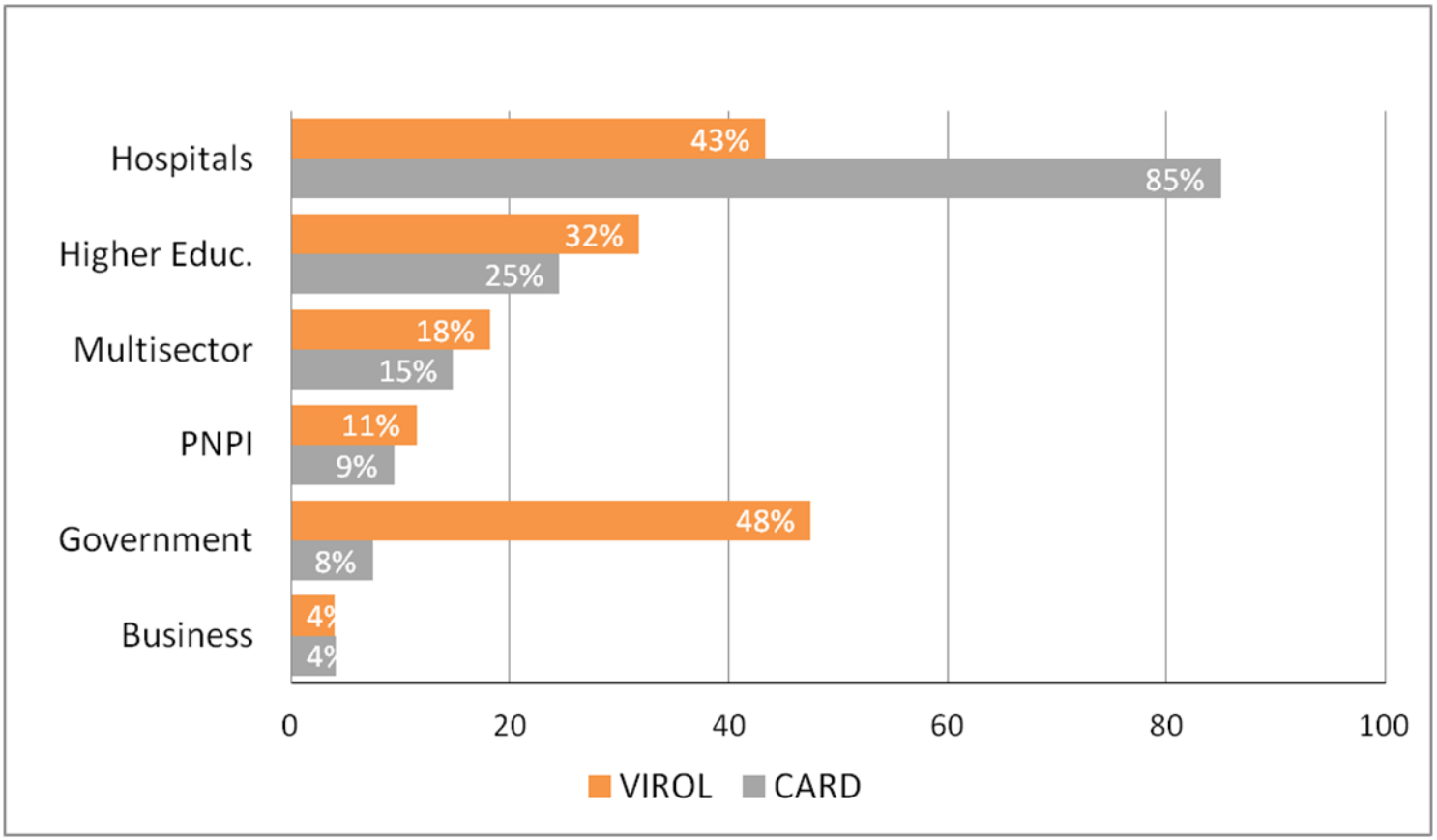
Methods
Funding data

- Data included in the funding agency field was normalized and classified using a web application created for this purpose.
- A master file of agencies was built, including normalized name, acronym, institutional sector, type of funding (public or private) and country.
- A comparative analysis of the two disciplines was conducted regarding the following aspects:
  - Funding rate: percentage of papers which include FA
  - Average number of funding agencies per article
  - Percentage distribution of papers by type of funding: public/private, national/foreign and by institutional origin
  - Main funding agencies from Spain and abroad
- A logistic regression analysis was conducted to identify which aspects of research contribute to explain the presence of FA.

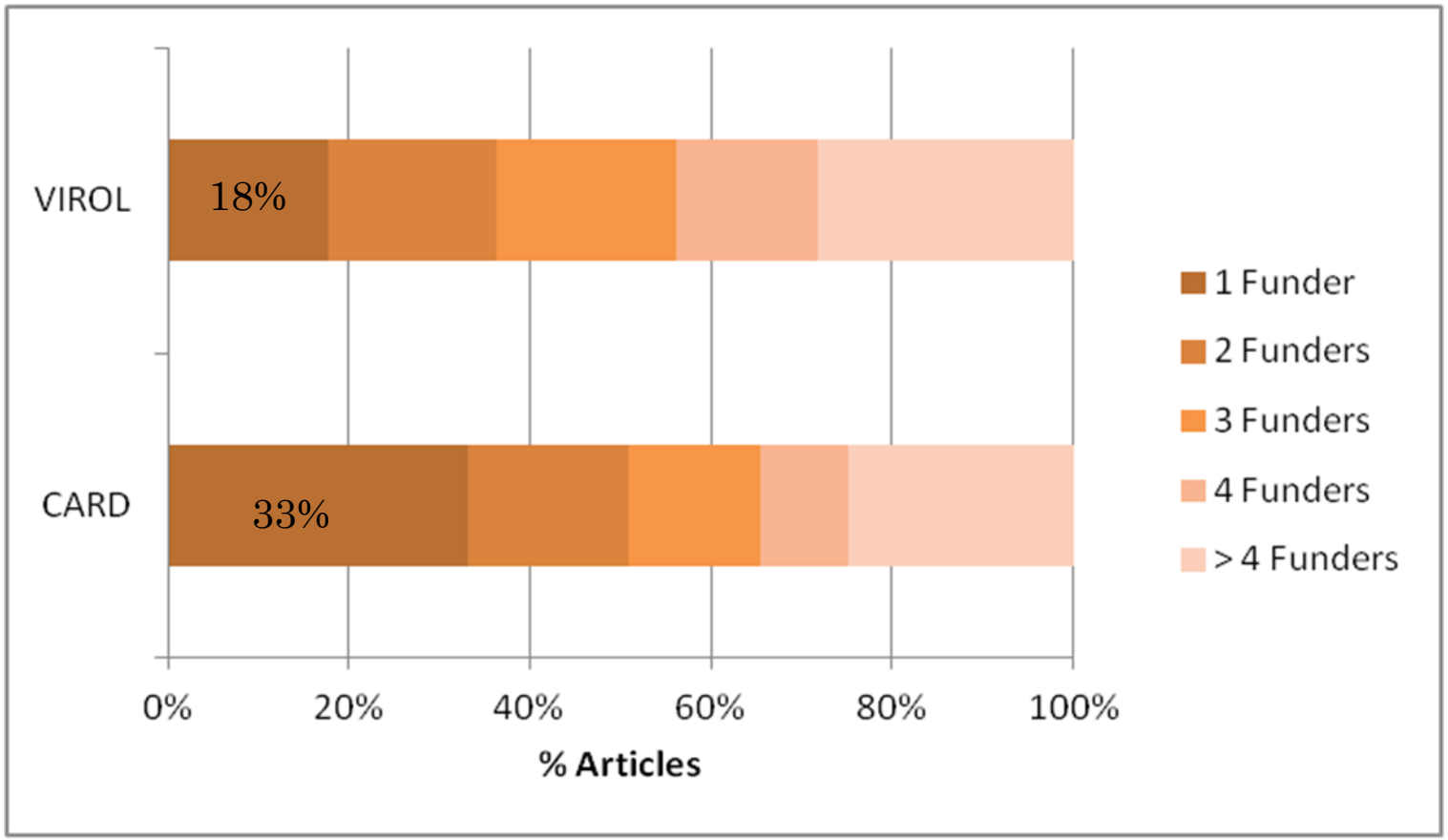
Results. Indicators of activity, collaboration and impact

	CARD	VIROL
No. Articles	2,523	1,143
% Articles with FA	57.2	**91.9**
Research level	1.8	**3.2**
Collaboration		
No.Authors/paper	9.8	8.8
No.Institutions/paper	5.8	5.0
% collaboration (>1 centre)	85.6	87.9
% national collaboration	57.1	59.3
% international collaboration	47.3	49.4
Publication journals		
% Articles in Q1	41.3	41.4
% Articles in D1	**20.7**	13.9
Citations		
RCR	1.4	1.1
% HCP	**17.2**	11.0

Results. Distribution of articles by affiliation of authors

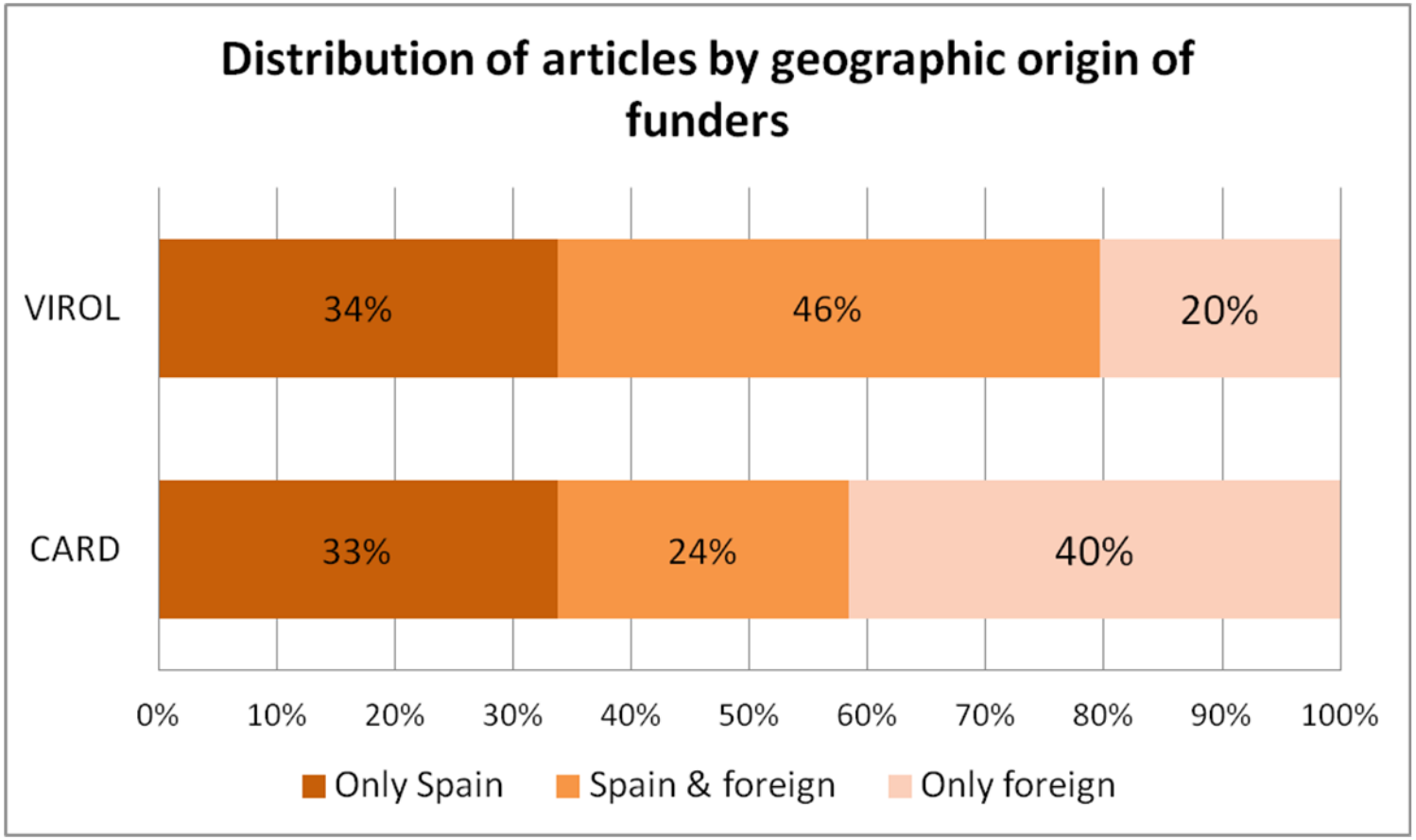


Results. Number of funders/article

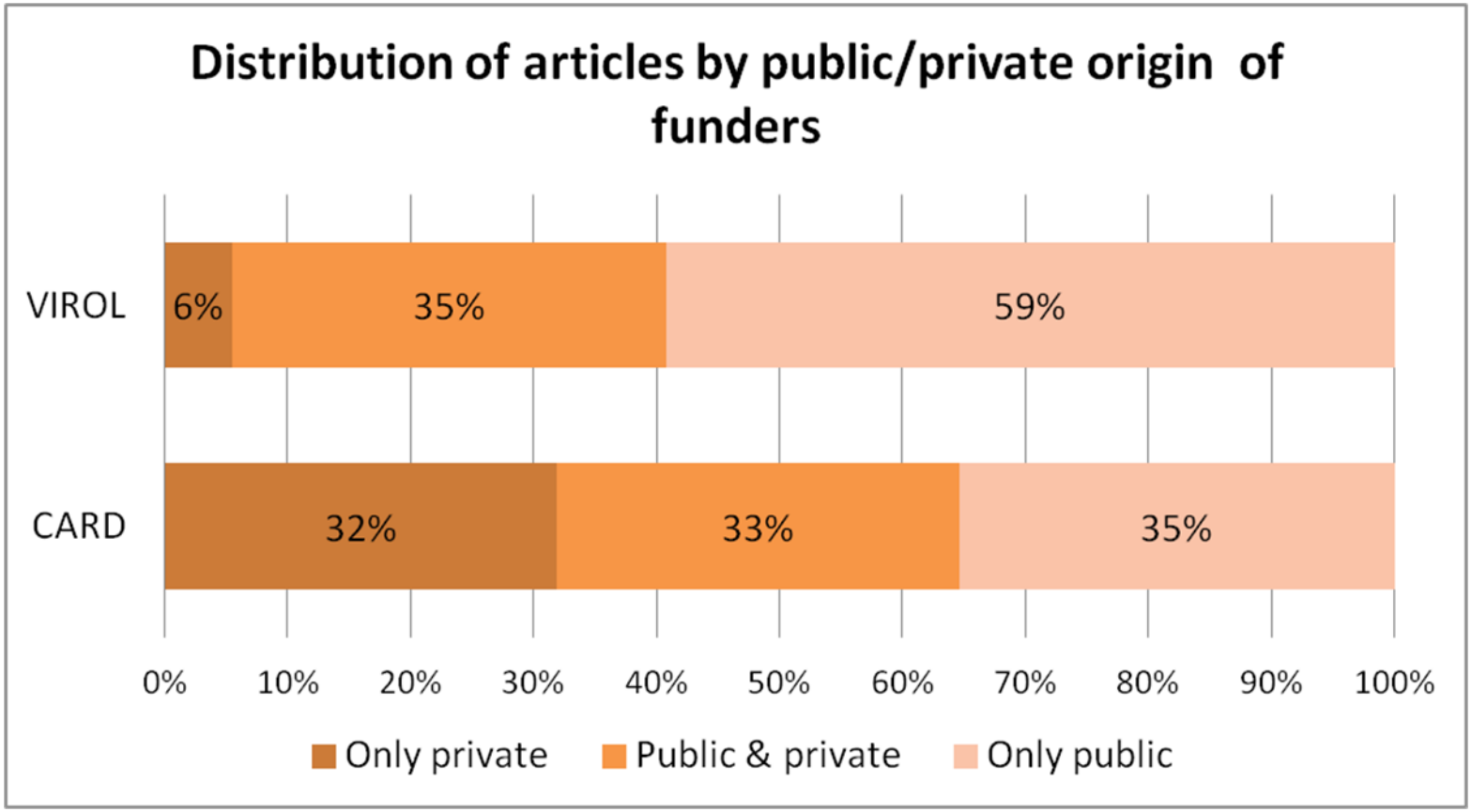


A higher average number of funders/article is observed in VIROL (3.8 vs 3.6)

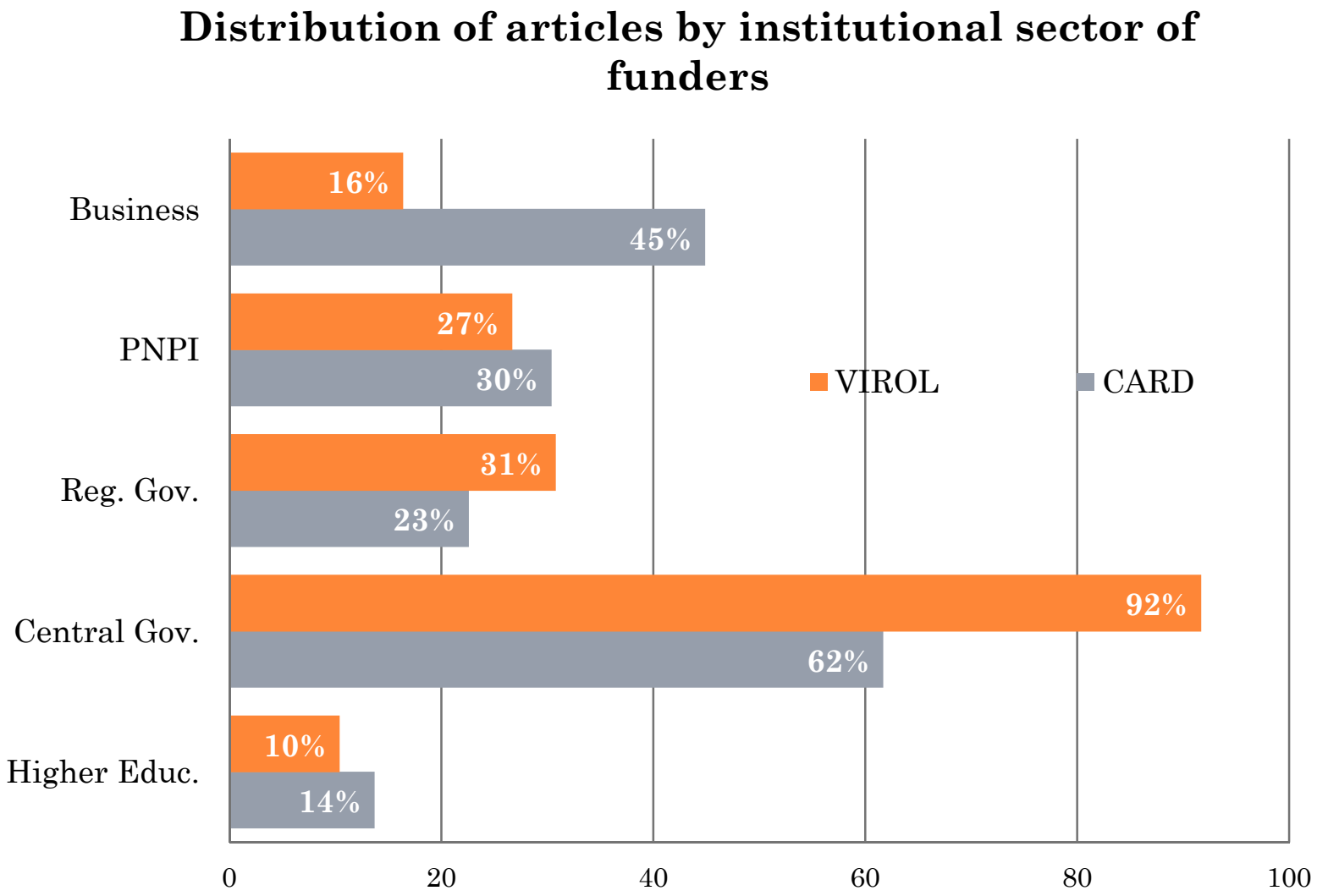
Results. Type of funding



Results. Type of funding



Results. Type of funding

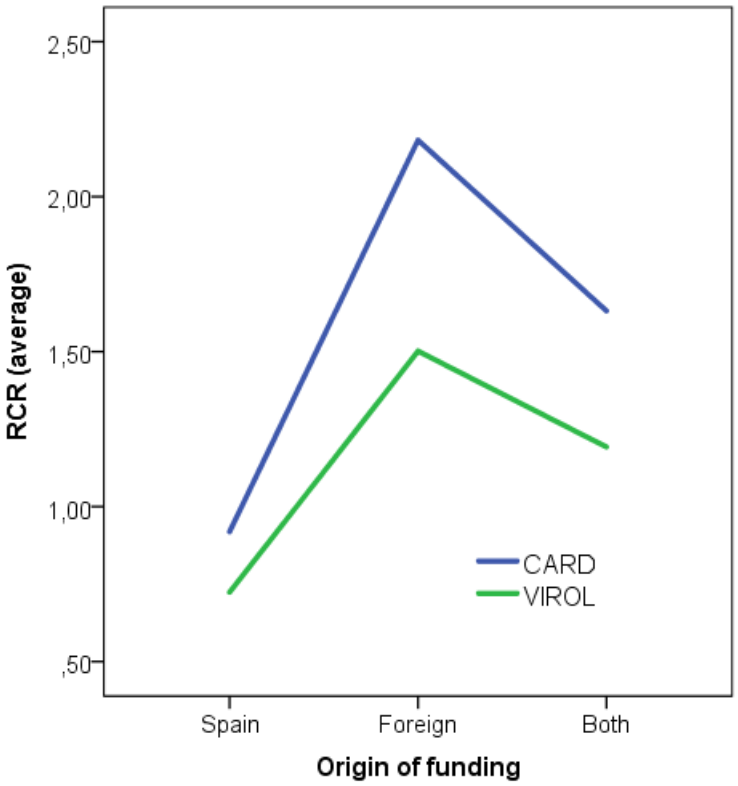


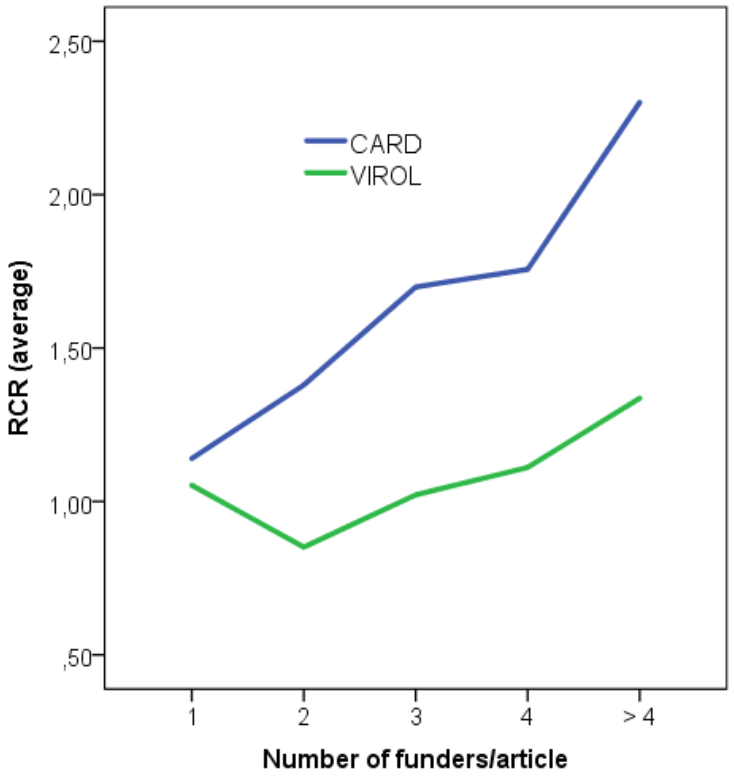
Results. Comparison between funded and non-funded research

- Funded research was more likely to appear in high impact factor journals (higher Q1) and to receive citations (higher RCR and HCP) than non-funded publications in both disciplines.
- Funded research was conducted in teams of greater size in CARD and showed international collaboration more often.

	CARD		VIROL	
	With FA	Without FA	With FA	Without FA
Publication journals				
% Articles in Q1	**52.9**	24.9	**43.8**	14.1
Citations				
Citations/article	23.1	14.6	15.8	11.7
RCR	**1.6**	1.0	**1.1**	0.7
HCP10	**22.1**	10.7	**11.5**	5.4
Collaboration				
No. Authors/art.	**11.2**	8.1	8.9	8.1
No. Institutions/art.	**6.9**	4.4	5.0	4.7
% Collaboration	93.3	75.3	87.0	97.8
% National collab.	35.4	42.2	36.5	61.3
% Int.collab	**57.9**	33.1	**50.6**	36.6

RCR BY TYPE OF FUNDING





- Articles with foreign funding show a significantly higher RCR ($p<0.001$)
- RCR tends to increase with number of funders

Logistic regression

		B	St.Error	Exp(B)
Affiliation of authors	University_add	0.843***	0.114	2.32
	Government_add	0.795***	0.172	2.21
	Business_add	0.288	0.234	1.33
	Hospital_add	-0.599***	0.153	0.55
	PNPI_add	0.359*	0.166	1.43
	Multisector_add	1.069***	0.150	2.91
Impact	First quartile journal	0.555***	0.099	1.74
	RCR_world			
	RCR_world (above average)	0.329**	0.116	1.39
	RCR_world (HCP)	0.289*	0.137	1.33
	(reference= below average)			
Collab.	Numinst			
	Numinst (2-4 inst)	0.372**	0.153	1.45
	Numinst (>4 inst)	0.992***	0.175	2.70
	(reference= 1 inst)			
	Int_collab	0.472***	0.112	1.60
	Virology	4.136***	0.734	62.54
	Virology by first quartile journal	0.800***	0.298	2.23
	Virology * Numinst			
	Virology by numinst (2-4 inst)	-2.697***	0.747	0.07
	Virology by numinst (>4 inst)	-3.153***	0.760	0.04
	Constant	-0.717***	0.191	0.49

***p<0.001; **p<0.01; *p<0.05

Dependent variable: funding (yes/no)

The model explains 38.6% (Nagelkerke R^2) of the variance and correctly classified 78.6% of the cases.

Conclusions (1)

- Differences between disciplines in their funding rate, public/private origin of funds and their national/foreign nature do exist and constitute interesting information for research managers and funding bodies

  - Funding rate in VIROL is much higher (92%) than in CARD (57%). Obtaining research funding is an imperative for teams in very basic disciplines (i.e. VIROL), while some "unfunded" research can be derived from clinical practice in the case of CARD.
  - Public sector plays an important role in financing research in both disciplines, but in particular in the most basic field, where the contribution of private funding (mainly pharmaceutical industry) is lower
  - Support from foreign sources is acknowledged in almost 60% of the articles and yields the highest values of RCR

Conclusions (2)

- Funded research tends to be published in high impact factor journals and receive greater citation rates than non-funded research in the two disciplines, which sustains the ability of agencies to identify/support/foster high quality research (direct effect on impact)

- Funded research is more likely to include international collaboration (in both disciplines) and multi-institutional co-authored papers (in CARD), which also might contribute to increase impact (indirect effect on impact)

- Inter-institutional collaboration is a key factor enhancing access to funding in CARD -probably linked to clinical trials- but not in VIROL → differences between basic and clinical research should be taken into account in the analysis of disciplines

LIMITATIONS

- Methodological issues such as
  - Funding sources are not always acknowledged by authors
  - WoS´s errors in the identification and collection of funding bodies in the FA field
  - Our own problems in the identification of funding agencies
- The results cannot be generalized to other fields and countries

FUTURE RESEARCH

- In the short term
  - Including data on type of funding (projects, infrastructures, mobility…)
  - Exploring differences between specific funders
  - Extending the study to further disciplines
- In the long term
  - Development of more comprehensive and precise analyses focusing on the micro (scientists) and institutional levels

Thank you for your attention

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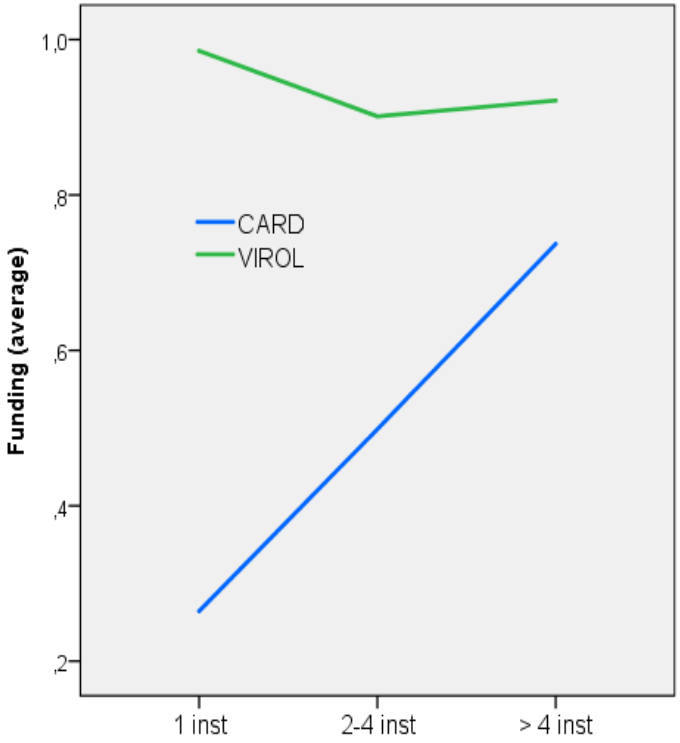
Why is the number of institutions more influential in Cardiology?



Differences in the funding rate of basic and clinical research can be a key factor →

- Clinical research is less often funded
- Clinical research predominate in 1-center papers