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Article

The role of charitable funding in university research

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Abstract

There has been a diversification in the sources of university research funding in recent decades. While substantial research efforts have explored and discussed the implications of this diversification, with the exception of biomedical research the role of charities has typically been neglected, despite their importance in funding university research. This article explores the significance of charitable funding in academic research through the sponsorship of doctoral students. We demonstrate a sponsor classification strategy which classifies PhD theses by sponsor type with high accuracy and coverage. We find that: 1. charities play a significant role in funding doctoral students particularly within medical research, 2. charities are prominent in the wider network of research sponsors, and 3. they exhibit distinct preferences in terms of the subjects they fund. The dataset generated through this study provides an instrumental resource to initiate greater discussion on the role of this important source of research funding.

Key words: research funding; charities; PhD thesis

1. Introduction

Universities, through their research activities, have long been recognized as playing a central role in the process of knowledge creation. The latter half of the 20th century witnessed a changing role for university research as it became more mission-orientated and context-specific (Gibbons et al. 1994). In parallel, there has been a diversification in the sources of university research income as the proportion of funding received from governments has reduced while income from alternative sources has increased (Geuna 2001). In exploring these changes, the focus of the research community has typically been on the increasing involvement of industry in university research (Lee 1996; Bruneel et al. 2010; Perkmann et al. 2013; Ankrah and AL-Tabbaa 2015; Vedel and Irwin 2017).

Philanthropic foundations, trusts, and charities are also an important source of research funding. In the context of biomedical research, the significant role that charitable sources of income play (particularly in Western Europe) has been widely documented (Dawson et al. 1998; Wooding et al. 2005; Eckhouse et al. 2008; Sussex et al. 2016). In the UK, the proportion of biomedical research funding from both industry and charitable sources has gradually increased over several decades to the point where charitable funding is now on a par with government research funding (The Wellcome Trust 2001; Begum et al. 2018).

However, not much is known about the role of charities and foundations in other disciplines, despite the consensus that charities are an important source of university research funding (van Duinen 1998; Geuna 2001; Lambert 2003; Larédo 2003; Murciano-Goroff 2015). It is thought that charities could represent an untapped resource in the provision of research funding (European Commission 2006; Eckhouse et al. 2008). In the UK, charitable funding could play a key role in meeting the new government target of spending 2.4 per cent of GDP on R&D (Royal Society 2018). This article will investigate the research funding activities of charities, comparing them with other sources of research funding like government and businesses to provide insights about the role of charities in university research.

Many previous studies on the role of charities tend to focus on the activities of a few organizations (Hanney et al. 2004; Clay et al. 2006; Hanney et al. 2013; Jones and Wilsdon 2018). Some studies that offer a more generalized understanding of the charity sector have the limitation of being restricted to biomedical research (Dawson et al. 1998; Eckhouse et al. 2008). There is, therefore, a need for more systemic studies on the role of charities in research funding. From a methodological point of view, a number of studies have drawn valuable insights from the use of bibliometrics as a measure of research output, taking advantage of research funding information now routinely provided in the Web of Science (Lewison and Begum 2017; Begum et al. 2018). However, one important output not measured in bibliometric databases such as the Web of Science is PhD theses. A PhD thesis is a clearly identifiable output of university research, and obtaining a PhD is often essential to join the

university research workforce. Funding a doctoral candidate is therefore a critical part of advancing the knowledge creation capacity of universities.

In order to investigate the role which charities play in funding PhD theses, we extracted information on PhD theses from the British Library's electronic thesis online (EThOS) database, which maintains a record of all PhD theses produced at UK Universities (Gould 2016). We demonstrate a comprehensive search and annotation strategy for PhD research sponsors which allows a systemic and systematic exploration of the role charities in funding PhD theses in the UK.

Through the exploration of this dataset, we are able to investigate 1. the significance of the charity sector as funders of PhD research, 2. what collaborative arrangements exist between the charity sector and other sources of funding for PhD research, and 3. if charitable funding is associated with funding any specific subjects.

2. Literature review

2.1 Charity and university research

Charity, as a voluntary act of giving something to someone in need, is probably as old as human civilization but philanthropy, or charitable giving that is institutionalized in formal, arms-length organizations, is a modern concept (Gold 2012). A global and universal definition of charities remains elusive because the act of giving is affected by the institutional environment it operates in—charitable organizations in social democracies are integrated in the welfare state framework, supplementing the role of the state, while in liberal market economies philanthropic foundations and grant-making trusts form a parallel system of financing activities, providing an alternative to mainstream funding (Anheier 2018: 1599). For example, in Germany, charities typically play a subsidiary role in a larger, state-led welfare system, whereas the situation of charities in the USA resembles the liberal model (Anheier and Daly 2007). The charity sector in the UK is considered to defy such a classification due to the specific political history and deep inequalities present in the country compared with other Western democracies (Jung 2018). According to Jung, UK charities operate as autonomous funding sources which are mobilized by society for a wide range of purposes.

Salamon and Anheier (1992) provide a structural–operational definition of charitable organizations, characterizing them as private, asset-based, self-governing bodies that serve a public purpose and are self-aware of their philanthropic role in society. In the domain of higher education and research, the role of charities is understood as grant-making to fund universities and university research (Jung 2018; Mangold 2018).

Charitable giving has been playing a role in knowledge creation since the late 19th century (Fleck and Beister 2011; Acs 2013). Stanford University, recognized as one of the leading centers of innovation and research in the world, was a product of charitable giving, created by the industrialist Leland Stanford in 1885 to preserve the memory of his late 15-year-old son. Billionaire philanthropists of this period like Leland Stanford, Andrew Carnegie, and John D. Rockefeller devoted large sums of money during their lifetime toward the establishment of universities in the USA and stressed on research, innovation, and entrepreneurship.

The names of billionaire philanthropists may be easy to identify for their contribution to universities, but it is important to recognize that these persons are examples of a wider story that links charitable funding with university research. Acs (2013) calls this the story of capitalist culture—industrialization and entrepreneurship allowed wealth creation at unprecedented levels and putting this wealth toward education and research was meant to provide entrepreneurial skills to more people and improve the state of knowledge in the society to further expand total wealth (87–120).

Table 1. Share of UK university research income from different sources

Funding Source	2013–4 (%)	2014–5 (%)	2015–6 (%)
UK Government	65	66	64
UK business	4	4	4
UK charity	14	13	15
EU sources	11	11	11
Non-EU sources	5	5	5.58
Other sources	1	1	0.72

Source: Universities UK Higher Education Research in Facts and Figures, various years.

The UK has some of the wealthiest foundations in the world which engage in providing grants for research (Lambert 2003). A number of foundations in Germany are highly focused on investing in higher education, identifying their role in 'promoting talent', 'finding solutions to problems', and 'driving innovations' in institutes of higher education (Mangold 2018: 1700). Evidence of charitable funding for postgraduate studies can also be seen in developing countries like India where organizations like the Tata Trust, the Inlaks Foundation, and others provide several scholarships on an annual basis.

During the latter half of the 20th century, as a result of the diversification of university funding sources, charity funding of university research has acquired greater importance. Between 1983 and 1995, government funding for universities in the UK fell from 85 per cent to 67 per cent, a trend that was occurring in several other countries (Geuna 2001). However, this did not lead universities to shrink. Instead, other sources of income such as charities and industry became more significant. Table 1 shows the share of different sources of university research income in the UK in recent years.

2.2 Collaboration and coordination between research sponsors

As a wider variety of institutional actors take on roles in funding university research, there are avenues for diversification of research collaborations. Commercial collaborations are now actively promoted through tech-transfer offices and the establishment of jointly-funded research institutes. The Industrial Cooperative Awards in Science & Technology (CASE) scheme in the UK is an example of a collaborative funding arrangement where PhD students are sponsored by the UK research councils and a company from the industry that is relevant to the doctoral research being pursued.

A number of authors have discussed the implications of these new interactions and collaboration for university research. For example, Geuna (2001) warns that greater reliance on businesses for funding research would lead to a more short termist and application-based approach to knowledge creation, van Duinen (1998) notes that the comparatively larger 'direct funding for topical research' by businesses, governments, and charities causes traditional sources of research funding from research councils to lose their influence, and Larédo (2003) comments on the opening up of the university research environment, where the greater involvement of not-for-profit organizations plays an important role in relating research to wider society.

Specifically, in the case of biomedical research, the significant role that charities play, almost matching government sources in some countries, has been suggested to be a contributing factor to the fragmented nature of the field (Eckhouse et al. 2008). The involvement of so many different actors with potentially conflicting agendas may undermine the efforts to coordinate research in the UK and achieve a more strategic approach to biomedical research (Cooksey 2006; Jones and Wilsdon 2018).

However, with the exception of biomedical research, the focus of the research community has typically been on collaboration between university research and industry when discussing the changing nature of university funding (Lee 1996; Bruneel et al. 2010; Perkmann et al. 2013; Ankrah and AL-Tabbaa 2015; Vedel and Irwin 2017). Given the significant role charitable research funding is known to play in university research (Table 1), it would be prudent to investigate the role charities play in these crucial collaboration networks.

2.3 The impact of charities on research

Far from being a passive source of money, charities and foundations have actively promoted their values and beliefs when supporting research. Fleck and Beister (2011) describe the emergence of empirical approaches in social science research in the 20th century, a methodological orientation that began in US research universities but soon spread to Europe, largely because philanthropic organizations favored such methods and sponsored the academic exchanges. Philanthropists and large charities as plutocrats may even undermine democracy through their preferences (Bishop and Green 2010; Rogers 2011; Barkan 2013). In a large study of 194 major foundations in the USA, Goss (2016) finds that with few key exceptions, donors tend to be liberal on politically-divisive issues (abortion rights, climate change, immigration, gun regulation) and their primary strategy for influence is through the funding of research and education. Mangold (2018: 1703) reveals interview responses from higher education-focused foundations who state that 'certain study courses would not be offered' without their financial support. Thus, charitable funding of research can have effects on the subjects and topics pursued.

In medical research, some see the role of private foundations and charities favorably since charities tend to fund high-risk early-stage scientific work and fill gaps in research funding for topics where public grants fall short and there is a lack of commercial interest (Moses et al. 2015; Murciano-Goroff 2015). Anheier (2018: 1597) describes this as the 'risk absorber' strength of foundations. However, potential negative consequences have been noted, like the funding by medical research charities for diseases being disproportionate to the disease burden (Luengo-Fernandez et al. 2012).

There may also be a Matthew effect of accumulated advantage at work if charity funding simply crowds-in on government funding (Lanahan et al. 2016). The political science literature that has grown around philanthropy keenly discusses the micro-managerial involvement of donors with beneficiaries (Farley et al. 2018). Anheier (2018: 1597) also points toward particularism or the expression of value preferences by foundations as a potential weakness of charitable giving. It is, therefore, important to note the involvement and effects of charities as sponsors in university research.

We present an exploratory study that looks at the significance, co-funding networks, and subject preferences of charitable funding in university research.

3. Methods

The research on understanding the role of charities has so far mostly reviewed the activities of a single organization (Kinnamon and Redington 2001; Clay et al. 2006; McCoy et al. 2009; Hanney et al. 2013). However, this does not allow a broad or general understanding of the charity sector. Therefore, we started our analysis by calculating a variable to denote university research and traced the involvement of charities toward it. Besides providing a coverage of the charity sector, this approach also has the benefit of noting the relative importance of charities vis-à-vis other sources of university research funding like the government and industry or businesses.

We measure university research as completed PhD theses. The PhD is an important component of university research, representing an output not just in terms of research work on a topic but more importantly in terms of human capital formation—after all, completing a PhD is often essential for joining the research workforce in universities. Pursuing a PhD is an expensive proposition, and funding plays a critical role in reducing attrition and completion time (Abedi and Benkin 1987; Gillingham et al. 1991; Ehrenberg and Mavros 1995). Therefore, we ask the following research questions:

1. what is the significance of the charity sector as funders for doctoral students?
2. what collaborative arrangements can be detected between the charity sector and other sources of funding in PhD theses? and
3. is the charity sector associated with funding specific subjects?

3.1 Data

The data for this study were sourced from the British Library's EThOS database (Russell 2006; Gould 2016). In all, 302,327 metadata records were harvested utilizing the open archives initiative protocol for metadata harvesting (Yi 2004). Each record corresponds to a PhD thesis. The records were processed and analyzed using the R programming language (R Core Team 2018). Of the records harvested, 11,186 were published between 2011 and 2017 (inclusive) and contained abstract, Dewey Decimal Classification (DDC), and sponsor information. This dataset formed the starting point for further analysis. A methodological workflow has been outlined in Supplementary data, Fig. S1.

3.2 Data processing and annotation

In order to investigate the role of charities, we annotated sponsors into three categories—UK Government, business, and charity—according to the following definitions:

- UK Government: UK Research Councils, government department/ministry, or nondepartmental public body;
- business: profit-making companies and organizations; and
- charity: sponsors with nonprofit objectives operating separately from government, i.e. not public; including charitable foundations, trade associations, and learned societies.

The advancement of education is defined by the Charity Commission for England and Wales as a charitable purpose and therefore, in the absence of alternative motive, a PhD sponsor can generally be considered a charitable source (Charity Commission 2013). Funding by a foreign government was not annotated. Funding from university was considered to be neither government, business or charity due to ambiguous nature of universities' funding activities, which could be perceived as commercial, charitable, or public sector depending on the particular context (Burston 2017).

In the EThOS database, sponsor information is provided but the names of sponsoring organizations are entered manually. Therefore, the data had to be first processed and cleaned to

Table 2. Search terms for annotating sponsors

Sponsor type	Search terms
UK Government	UK Research Councils; Government departments; nondepartmental public bodies
Charitable	Charity-related terms (trust, charity, charitable, society, foundation, etc.); members of the AMRC; UK's top 1,000 charities by donations
Business	Industry- and business-related terms (plc, ltd, limited, inc, corp, corporation); lists of large firms in various sectors; members of the S&P500 index

Table 3. Subject-mapping schema

DDC number	DDC classification	Our classification
0–100	Computer science, information and general works	Technology and management
100–200	Philosophy and psychology	Arts and humanities
200–300	Religion	Arts and humanities
300–400	Social sciences	Arts and humanities
400–500	Language	Arts and humanities
500–600	Science	Science
600–610 and 620–700	Technology (nonmedical)	Technology and management
610–620	Medical	Medical
700–800	Arts and recreation	Arts and humanities
800–900	Literature	Arts and humanities
900–1,000	History and geography	Arts and humanities

account for different naming conventions and spelling mistakes. This was accomplished by using text mining and fuzzy string-matching functions available in R (Feinerer et al. 2008; R Core Team 2018). Sponsor names were also merged according to common abbreviations. The records, or theses, were then annotated as to whether they had charitable, business, and/or UK Government sponsorship using the search terms summarized in Table 2. Theses where the sponsor was annotated as charity were further annotated with respect to membership of the Association of Medical Research Charities (AMRC).

3.3 Accuracy and coverage

In order to evaluate the quality of the funder annotation strategy, random subsampling followed by manual curation was undertaken to calculate two performance parameters for each of the three sponsor types:

- accuracy: A random subsample of 300 records was taken for each of the three sponsor types which was then manually checked for false positives and
- coverage: to check for false-negative results, a random subsample of 500 records was taken from the whole dataset (including unannotated records) and was manually annotated. This allowed us to calculate the percentage of true positives correctly annotated for each sponsor type.

3.4 Annotation of theses according to subjects

Theses were already classified into different subjects using the DDC. However, a bespoke mapping of the DDC was developed in order to group theses into fewer subject groups for ease of analysis and comprehension. The literature review on research funding by charities indicates significant involvement of the charity sector in medical research. Therefore, medical research was given its own distinct subject class. The mapping schema is outlined in Table 3.

3.5 Limitations

This study, while allowing a systemic perspective through the use of a large national database, also has a number of limitations:

- each sponsor mentioned does not necessarily reflect the magnitude of funding received;
- our work is constrained by the comprehensiveness of the data that were available—11,186 of 103,563 records published between 2011 and 2017 contained the necessary information for our analysis. This is largely because sponsor information is self-reported and not declared in the majority of records;
- our dataset showed biases in subjects covered, with a greater proportion of theses being in Science or Technology and Management and less in Arts and Humanities (Supplementary data, Fig. S2). An increased prevalence of self-funding in Arts and Humanities may be a possible explanation for this systematic bias (Xu et al. 2015).

3.6 Statistical and network analyses

To test our hypothesis that charitable funding might have different subject preferences compared to other sponsor types, we used Chi-squared tests. As a Chi-squared test only reveals the presence of a significant difference and not the direction, *post hoc* analysis of the residuals from the Chi-squared test was also used to indicate the subject areas where differences were present and whether there was a positive or negative difference.

To assess the role that charities play within the network of research funders, we analyzed cosponsorship arrangements. A network of UK Government, industry and charity sponsors which funded more than one thesis was generated. Each sponsor became a node and the edges depict the sponsorship of at least one thesis with another sponsor. This results in an undirected, weighted adjacency matrix. A subnetwork of major interactions in the network map was generated by extracting only edges with the weight of at least five. Louvain Modularity for community detection was used to assign

Table 4. Annotation strategy accuracy and coverage

Sponsor type	Annotation accuracy (%)	Annotation coverage (%)
UK Government	>99	97
Business	98	73
Charitable	91	80

Table 5. Measured and predicted theses funded by each sponsor types

Funding Source	Measured	Predicted[a]
	N (%)[b]	*N* (%)[b]
UK Government funded	5,072 (45.3)	5,251 (46.3)
Business funded	944 (8.4)	1,279 (11.4)
Charity funded	1,628 (14.6)	1,810 (16.2)

[a]Predicted according to measured accuracy and coverage figures outlined in Table 4

[b]Percentage of total theses in the dataset (n = 1,186).

communities of major sponsors according to their co-sponsorship relationships (Blondel et al. 2008).

4. Results

4.1 Charitable funding of doctoral theses

Based on the annotation strategy developed in the previous section, 6,882 theses were annotated to at least one of the three sponsor types. A total of 5,072 had UK Government funding, 1,628 were funded by charities, and 944 received funding from businesses or industry. From the figures determined for the accuracy and coverage of the annotation strategy (Table 4), it is possible to predict the total number of each sponsor type for the entire dataset (Table 5). This study finds charitable funding to be second only to the UK Government in funding university research, funding substantially more theses than businesses.

4.2 Co-funding relationships

Co-funding is found to be substantially more common between the UK Government and businesses or UK Government and charities, than between businesses and charities. (Fig. 1A and Table 6). However, co-funding with UK Government is far more common for business-funded theses (46.4 per cent) than for charity-funded theses (18.6 per cent). Interestingly, theses funded by charities had, on average, a greater number of sponsors and charity funded theses are substantially more likely to be co-sponsored with other charities. In all, 13.2 per cent of charity-funded theses involve funding from multiple charities (Table 6).

Breaking down by subject (Table 7), government business co-funding is particularly common in Technology & Management where 6.5 per cent of theses in this subject are co-funded between the UK government and businesses. In the medical field, there is a substantial amount of co-funding between the UK government and both businesses (3.3 per cent of theses) and charities (5.3 per cent of theses).

A network of major co-funding relationships is shown in Fig. 1B and shows the UK research councils playing central coordinating roles. Communities derived through Louvain modularity divide this network into four communities (Fig. 1C). Each community has at least one Research Council at its center. One community clusters around the Engineering and Physical Sciences Research Council and consists predominantly of engineering and manufacturing companies, with the notable addition of the Royal Society. While one community forms around the Biotechnology and Biological Sciences Research Council involving the major pharmaceutical and biotechnology companies, a distinct community is also found with the Medical Research Council (MRC) at its center involving three major medical research charities (The Wellcome Trust, Cancer Research UK, and the British Heart Foundation). This further demonstrates the trend of businesses and charities co-funding with the UK Government but not with each other.

4.3 Subject preferences

It is clear from Fig. 2 that the three sponsor types fund different distributions of subjects. While the UK Government funds a good spread of subjects, businesses, and charities are both highly biased in the subjects they fund ($P < 0.001$). Analysis of residuals from Chi-squared tests shows that businesses disproportionately fund technology and management subjects while charities disproportionately fund medical research (Supplementary data, Fig. S3).

The significance of charity funding in the medical field can be seen in Table 8 where the number of charity funded- theses is 80 per cent (=742/924) of the number funded by the UK Government, a feat not seen in any other field. The charity sector can, therefore, have a substantial impact on the medical research sector which businesses cannot in the subject they favor the most—technology and management, where sponsorship by businesses corresponds to funding only 35 per cent (=468/1,350) of the number funded by the UK Government.

The AMRC consists of the major medical research charities active in the UK. Extracting these charities from the wider sample of charitable research funders identifies these charities as highly specialized funders of medical research (Fig. 2D and Supplementary data, Fig. S4). Meanwhile, the theses funded by charities which are not members of the AMRC show a very different distribution of subjects funded (Fig. 2E), funding a more even spread of subjects. Quite distinct from other sponsor types, these charities are most likely to fund theses in the arts and humanities (Supplementary data, Fig. S4).

5. Discussion and conclusion

Lambert (2003) had noted charities as the third most important source of funding for university research. However, our study finds charity funding to be second in importance to the government in supporting PhD theses. Furthermore, our figures for the output measure of university research (published theses) is consistent with the data on input measures, like the relative contributions of different sectors to university research income (Table 1). Charitable funding is therefore of great importance in supporting and potentially directing research in universities in the UK. While previous research has focused on the growing role of businesses and industrial actors in funding and collaborating to produce university research (Lee 1996; Bruneel et al. 2010; Perkmann et al. 2013; Ankrah and AL-Tabbaa 2015; Vedel and Irwin 2017), this study demonstrates the need to consider the role of charities in university research. Ignoring the role of charities will give us a substantively incomplete picture of university research funding and research collaborations, a warning also echoed by Geuna (2001) and Larédo (2003).

Table 6. Co-funding relationships

Sponsor type	Average number of sponsors	Co-funding (%)[a]		
	n	UK Government funded	Charity funded	Business funded
UK Government funded	1.5	4.2	6.0	8.6
Charity funded	2.0	18.6	13.2	2.3
Business funded	1.9	46.4	3.9	3.3

[a]Diagonal shows co-sponsorship between sponsors of the same type.

Table 7. Co-funding relationships by subject

Co-funding type	Arts and humanities (%)	Medical (%)	Science (%)	Technology and management (%)
UK Government and charity	2.4	5.3	2.7	1.2
UK Government and business	0.6	3.3	4.6	6.5
Charity and business	0.1	0.5	0.3	0.4

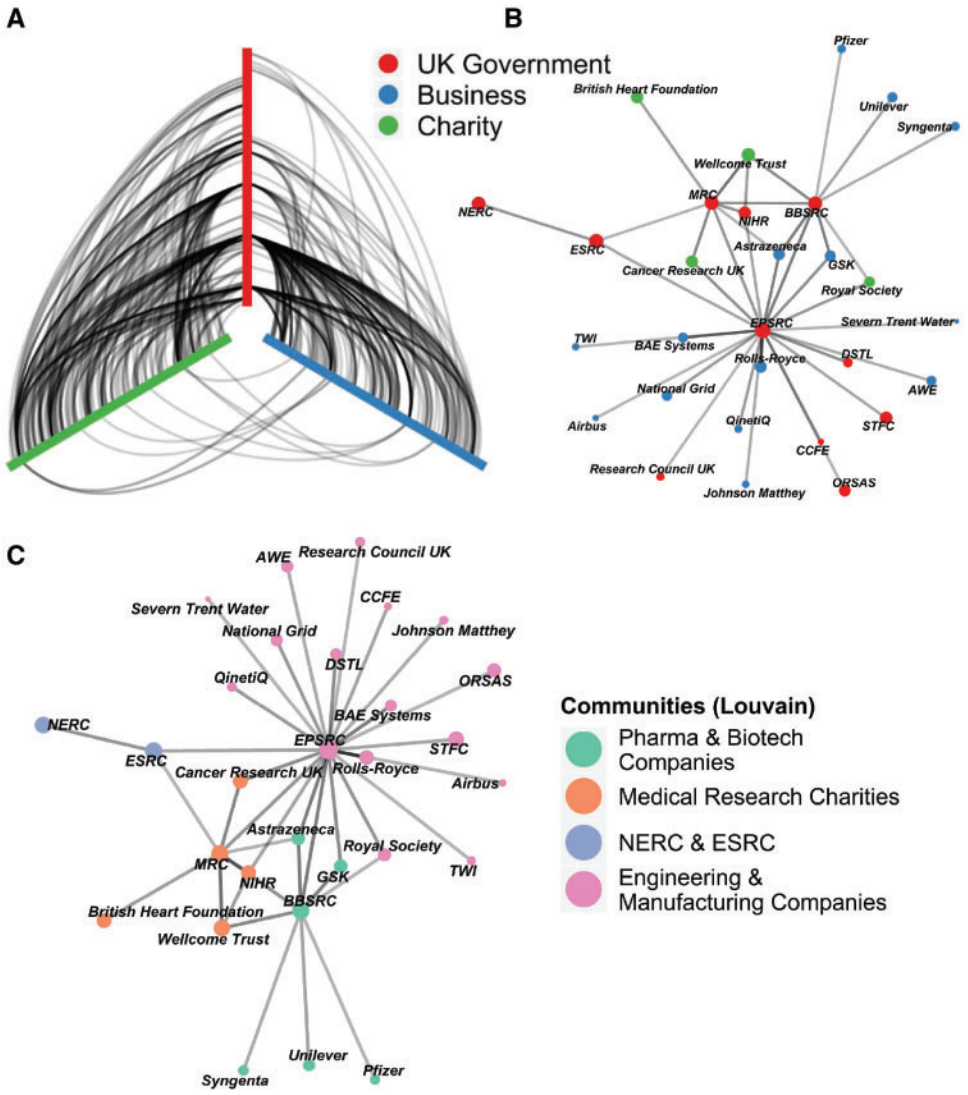

Figure 1. Network plots showing co-funding arrangements. The darkness of edges indicates the frequency of the co-funding occurrence. (**A**) A hive plot showing the co-funding links between the three sponsor types. (**B**) A subnetwork showing only connections of at least $n = 5$. (**C**) The same sub-network as (**B**) but with nodes coloured by communities detected through Louvain modularity

In terms of co-funding arrangements, charities, like businesses, appear to co-fund frequently with the UK Government. However, charities are less likely than businesses to co-fund a thesis with the government. This could be simply due to the lack of institutionalized co-funding arrangements like CASE awards. The fact that charities and businesses rarely co-fund a thesis might reflect their presumably distinct aims in funding research—businesses operating for profit, and charities for public benefit (Charity Commission 2013). A curious observation about big philanthropy is the tendency of philanthropists not to engage with the field which helped them generate their wealth in the first place. Thus, although many charities might be born out of the endowments of industrialists and businessmen, the ties are rarely maintained between the organizations in two sectors (business and charity). Meanwhile, the relatively high proportion of inter-charity co-funding (Table 6) may indicate the existence of internal networks of charitable funding. Additionally, charitable grants can often be smaller than grants from the UK Government and students therefore might be mobilizing their funds from multiple charities, therefore leading to a high density of co-sponsorship within the charity sector.

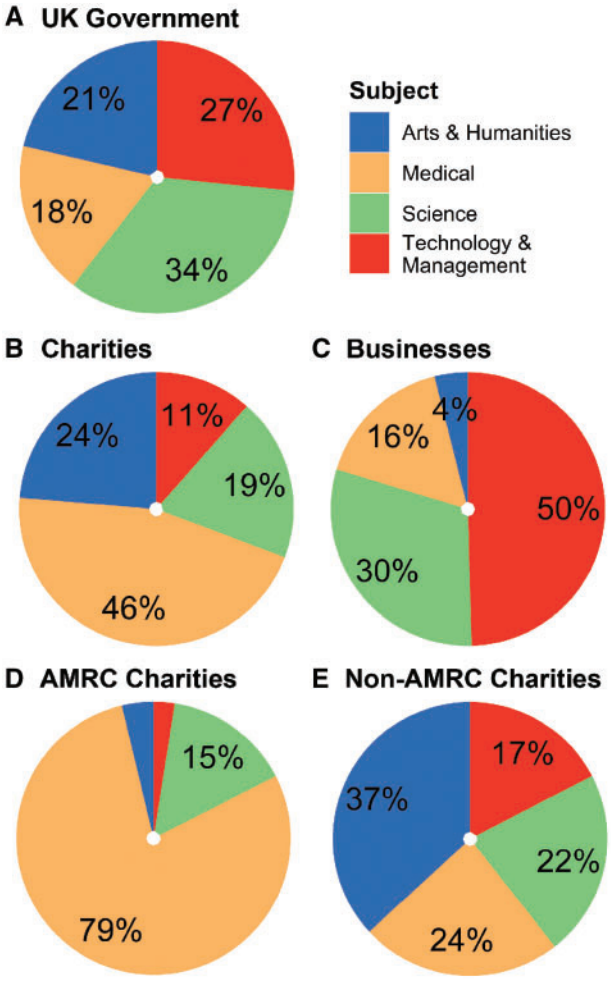

Figure 2. Pie charts showing differences in subjects funded between (**A**) UK Government, (**B**) Charities, (**C**) Businesses, (**D**) AMRC charities, and (**E**) Non-AMRC charities

The importance of charitable funding in the medical field has been widely documented (Dawson et al. 1998; Wooding et al. 2005; Eckhouse et al. 2008; Sussex et al. 2016). Our study shows the relative magnitude of this funding to be at the same level as government funding of medical research, which corroborates similar findings from bibliometric studies (The Wellcome Trust 2001; Begum et al. 2018). By probing our dataset, we find that charities have an unprecedented level of control over medical research through their support of PhD theses in the field. UK Research and Innovation was recently established to develop a more coordinated approach to research funding by the research councils and multiple reports have specifically highlighted the need for a more coordinated approach to medical research funding (Cooksey 2006; Jones and Wilsdon 2018). However, any effort to change, redirect or coordinate research efforts in this field will clearly need to consider medical research charities, almost as equal players to the UK research councils. Promisingly, the network of medical research charities co-funding with the MRC demonstrates that interaction, if not coordination, may already occur.

Non-AMRC charities sponsor a broad range of subjects, especially improving the funding prospects for doctoral studies in arts and humanities. These charities are often supported by large endowments rather than regular public donations, granting them flexibility in making choices about subjects and topics that may not be available to other charitable research sponsors because of their reliance on the general public and popular support. Many researchers studying philanthropy have pointed out the potential for charitable funding to support causes that enjoy personal favor rather than popular backing (Bishop and Green 2010; Rogers 2011; Barkan 2013; Goss 2016; Anheier 2018; Mangold 2018). These researchers express concern (implicitly or explicitly) about the potential for caprice on the part of philanthropists and charities. Langford (2016) asks whether private donors can 'pick up the tab' in funding arts and our study responds with a 'yes', but there is a need to investigate the phenomenon of sponsorship of arts by charities in greater depth.

Table 8. Numbers and percentages of subjects funded by different sponsor types

Sponsor type	Total *N* (%)	Arts and humanities *N* (%)	Medical *N* (%)	Science *N* (%)	Technology and management *N* (%)
All theses	11,186 (100)	2,720 (100)	2307 (100)	2978 (100)	3,181 (100)
UK Government	5,072 (45.3)	1,083 (39.8)	924 (40.1)	1715 (57.6)	1,350 (42.4)
Business	944 (8.4)	37 (1.4)	155 (6.7)	284 (9.5)	468 (14.7)
Charity	1,628 (14.6)	386 (14.2)	742 (32.2)	313 (10.5)	187 (5.9)
AMRC	646 (5.8)	24 (0.9)	509 (22.1)	97 (3.3)	16 (0.5)
Non-AMRC charities	982 (8.8)	362 (13.3)	233 (10.1)	216 (7.3)	171 (5.4)

Our data show that in the UK, charities, foundations, and trusts sponsor a portfolio of subjects that significantly differ from the portfolio of government or businesses. This reveals differences in preferences. As well as investigating the nature and causes of these preferences, the potential UK specificity also warrants further research, given that the operation of charities and foundations is known to vary between national systems (Anheier 2018; Eckhouse et al. 2008).

The accurate and comprehensive annotation strategy for research sponsors developed in this study allows the generation of a powerful and flexible database for investigating the funding of doctoral research. This resource has allowed us to investigate the important role that charities play in funding university research in the UK. It can be utilized for a number of applications, like informing the selection of significant sponsors as case studies for analysis or for analyzing sponsor preferences alongside additional thesis information such as author demographics. The approach could also be extended to analyze other sponsor types such as foreign governments and universities. Thus, this study opens up several possible directions for further research.

Supplementary data

Supplementary data is available at *Science and Public Policy Journal* online. Additional research data (code, plots and raw data) supporting this publication are available from the Zenodo open-access repository at https://doi.org/10.5281/zenodo.2583191.

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Conflict of interest statement

None declared.

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