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Busy academics share less: The impact of professional and family roles on academic withholding behaviour

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Busy academics share less: The impact of professional and family roles on academic withholding behaviour

Although academics are increasingly expected to share their research data and materials with other academics, many appear reluctant to do so. While extant research emphasises commercial involvement and peer influence as determinants of withholding behaviour, we hypothesise that the volume of competing commitments plays an important role in preventing academics from sharing. Using rich, multi-source data on 876 academics at a large research university, we explore how withholding behaviour is related to the breadth of professional and family roles. We find that academics engaged in more activities, including research, teaching and commercialisation, and with more young children, are more likely than their colleagues to withhold research data and materials from their previously published research. We explore the implications of these findings for scientific production and exchange, and for academics' workloads.

Keywords: academic secrecy, data withholding, role theory, resource scarcity, parenthood, open science

Introduction

Academics are expected to disclose the results of their scientific research and provide access to their research data and materials (Anderson et al. 2010; Dasgupta and David 1994; Namer et al. 1975). This requirement emanates from the norm of communalism, which is rooted in the idea that research data and materials represent “a common heritage in which the equity of the individual producer is severely limited” (Merton 1973, 273). There is evidence that practicing communalism results in considerable collective benefits. The sharing of information and data – above and beyond the mere publication of articles – facilitates knowledge validation (Dewald, Thursby, and Anderson 1986), avoids the duplication of research effort and increases the speed of knowledge diffusion. As the benefits extend to society, adherence to communalism is seen as part of the ‘contract’ between society and public research institutions that justifies public support of academia (Brooks 1990). Path

breaking initiatives in science such as the Human Genome Project have demonstrated the benefit of openness for building effective scientific commons, prompting governments and research funding organisations to make science funding conditional upon various modes of open sharing (Perkmann and Schildt 2015).

However, it is clear from existing evidence that academics do not always adhere to the norm of communalism (Kowalczyk and Shankar 2011; Harman 2002; Fecher et al. 2015). Given the relevance of data sharing to society and the functioning of the academic system, it is important to understand why academics fail to share their data and materials. Previous literature has provided two main explanations. The first links withholding behaviour to the fact that academics often operate in contexts influenced by multiple logics. Involvement in commercial collaboration, for instance, influences academics' preparedness to share data and materials (Czarnitzki, Grimpe, and Toole 2015; Walsh and Huang 2014; Mello et al. 2013; Blumenthal et al. 1997). The second explanation centres on the fact that adhering to communalism may collide with academics' self-interest, for instance in protecting scientific lead, leading to ambiguity as to when and how the norm should be followed (Haas and Park 2010; Anderson, Martinson, and De Vries 2007).

Although these two explanations provide important insight for understanding data-withholding behaviour in academia, little attention is paid to the situational constraints that affect academics in their day-to-day working lives. This limitation is particularly salient as evidence indicates that constraints related to time and resources are an important factor informing academics' performance (Jacobs and Winslow 2004). Our starting point is prior research that suggests a positive link between the personal costs involved in data and material sharing, and withholding behaviour (Campbell et al. 2002; Haeussler and Colyvas 2011; Kim and Stanton 2016; Fecher, Friesike, and Hebing 2015; Tenopir et al. 2011). We propose that

both work-related and personal contexts in which academics operate shape the personal resources they can dedicate to sharing data and materials.

Performance expectations on academics regarding research and teaching have grown over time, leading to an increase in academic workload (Jacobs and Winslow 2004; Austin 2002). Moreover, academic careers are now partly shaped by their engagement in a variety of additional activities, some contractually formalised and others of a discretionary nature across different spheres, including commercialisation, outreach and administration (Kraimer et al. 2019; Bolden, Gosling, and O'Brien 2014; Macfarlane 2007; Jacobs and Winslow 2004). All these activities require scarce personal resources, such as time and attention. In addition to work roles, many academics also perform family roles such as parenting (Harris, Myers, and Ravenswood 2019), which are equally demanding in terms of time and attention (Greenhaus and Beutell 1985).

In this study, we explore the role that professional and personal commitments of academics play in shaping their data-withholding behaviour. Adopting a role theory perspective, we consider how prescribed and discretionary job demands, as well as parenthood, draw time, attention and resources away from the sharing of research data and materials.

Our study is based on rich multi-source data on a large sample of faculty working at a globally leading research university. We find that withholding behaviour increases with the volume of professional and personal commitments. The greater the breadth of commitments that make up an academic's professional life, including their research, teaching and commercial activities, the less they share data and materials from their published research upon request. Moreover, the higher the number of children under the age of seven an academic cares for, the more likely they are to withhold data and materials. Our study depicts the possible consequences of pressures emanating from both work and family spheres for the

sharing of scientific data and materials, which is arguably an important cornerstone for the functioning of public science.

Theoretical background

Extant work has emphasised conflicting logics and role ambiguity as sources of data withholding. The first explanation draws from literature on institutional complexity and regards non-conformity as a consequence of the complexity of the institutional context in which individuals operate. Specifically, when individuals operate across institutions that have different institutional logics, they may face contrasting norms (Shibayama 2015; Greenwood et al. 2011). Academics who collaborate with industry (or intend to commercialise the results of their research) are confronted with two incompatible prescriptions: the logic of science, prescribing open publication of research results, and the logic of commerce, which imposes secrecy to facilitate the commercial exploitation of research results (Dasgupta and David 1994; Perkmann, McKelvey, and Phillips 2019). In such situations, academics are more likely to withhold their research data and materials to uphold contractual obligations and protect commercial advantage (Czarnitzki, Grimpe, and Toole 2015; Walsh and Huang 2014; Mello et al. 2013; Blumenthal et al. 1997).

A different case of conflicting logic arises when scientists work with others located in countries where the legal framework and standard for data protection are inconsistent with the country of origin (Kaye et al. 2009). In this situation, the complexity of complying with different data standards might discourage academics from sharing data for fear of breaking the law (Saulnier et al. 2019; Laker 2006).

The second explanation ascribes non-conformity to the norm to ambiguity created by contrasting role expectations (Haas and Park 2010; Anderson, Martinson, and De Vries 2007). While the norm of communalism encourages academics to be nominally altruistic and share their research results to accelerate the process of knowledge creation, academics are

incentivised to withhold information as they are in a winner takes-all publishing competition (Merton 1976). The rule of priority means that the first researcher to publish a new finding reaps the associated rewards, while the second will receive little recognition. Because priority in publication determines important career outcomes, including academic positions, tenure, grants or prizes, academics may avoid sharing data with others competing in the same field (Waaiker et al. 2018; Hong and Walsh 2009). Also, Tenopir et al. (2011) found that younger scholars are more likely than others to deny a data-sharing request, suggesting that career insecurity might drive such behaviour (Ortlieb and Weiss 2015). Overall, in a situation of ambiguity – whether to follow the norm of communalism or protect self-interest – Haas and Park (2010) suggest that scientists look to others in their professional groups for cues about appropriate behaviour.

The two explanations offered by previous work focus on the determinants of an individual's decision to share data and materials but pay less attention to the practicalities of sharing. Academics operate in a complex situational context, and the sharing of data and materials requires time and resources, in addition to mere willingness. To explore this aspect of sharing, we draw upon insights from organisational role theory (Katz and Kahn 1978). This theory explains individual behaviour and task performance while considering the normative, organisational and social structure in which individuals operate.

One of the key tenets of role theory is that human behaviour is shaped by the expectations associated with an individual's societal position (Allen and van de Vliert 1984). Each position identifies an individual role; each role includes a range of activities (or job demands) and tasks whereby roles differ in terms of their breadth (Biddle 1979). Accordingly, an individual who performs the role of an 'academic' is expected to inhabit this role in accordance with a set of associated behaviours – as stipulated by both formal rules and regulations, and informal norms and expectations (Kyvik 2013). Specifically, the sharing of

data and materials can be seen as part of research activity associated with the academic role (Stuart and Ding 2006).

Rewards structures or sanctions can enforce role expectations by imposing pressure on individuals to adhere (Biddle 1979). However, performing activities and tasks associated with a role requires resources (Katz and Kahn 1978; Kahn 1990; Navon and Gopher 1979; Marks 1977). For individuals, time and attention are particularly important resources for being able to perform roles, yet they are simultaneously naturally limited. Once time and attention constraints are allocated to one particular activity, they are removed from the performance of another (Sieber 1974).

Of course, roles do not only exist at work but extend to individuals' personal sphere (Greenhaus and Beutell 1985; Ten-Brummelhuis and Bakker 2012). Individuals routinely fulfil multiple roles, such as being a professional and a parent, and are therefore exposed to conflicting pressures. Assuming limited personal resources, therefore, the performance of a particular activity is interdependent with the demands and pressures related to other personal or work related activities (Goode 1960; Kahn 1990; Greenhaus and Powell 2003). Hence, sharing (and withholding) cannot be explained without considering the overall set of demands and pressures an academic faces from both work (Kraimer et al. 2019) and family (Jacobs and Winslow 2004; Ylijoki 2013). The amount of resources needed for performing other job demands and family roles influences the amount of resources available for performing data sharing.

Before discussing the demands and pressures arising from the job and family role and their effects on data sharing, in the next section we discuss the practicalities of sharing data and materials.

The performance of data sharing: expectations, rewards and costs

The expectation that academics will share their research data and materials derives from the norm of communality (Merton 1973). Such a norm represents one of the “central values and ideals of academic science” (Bok 1982, 142). While it is not a codified norm, it is part of the normative structure that defines how an academic ought to perform their research (Braxton 2010). Adhering to the norm is regarded as a scientist's moral obligation towards the scientific community and society at large (Merton 1973).

Besides facilitating the flow of knowledge, data sharing helps increase the reproducibility of existing research and enables others to ask new questions (Jasny et al. 2011; Borgman 2012). In doing so, data sharing implies a willingness to help other academics in the pursuit of knowledge advancement and therefore represents a form of altruism and pro-social behaviour within academia (Iorio, Labory, and Rentocchini 2017; Krebs 1970).

The sharing of research data and materials benefits its recipients but may also have a positive impact on those who share. Academics who share their data may be rewarded by acknowledgements and citations (Kim and Stanton 2016; Piwowar, Day, and Fridsma 2007), and may attract new collaborators (Enke et al. 2012). Those who share are also more likely to be given a reciprocal opportunity of access to others' data. Overall, sharing can have positive effects on reputations and research opportunities even though it may take time to reap such rewards.

Nevertheless, sharing data or research materials is rarely costless. First, there is often a need to codify and re-package research data and materials so that they are useable by others (Dasgupta and David 1994). This requires additional effort aimed at creating a set of explanatory manuals, workbooks or other documentation in addition to the research data and materials. Research grants rarely provide an allowance for preparing such documents or

archiving data. Few universities have resources to support data management or archiving, leaving this burden entirely with the individual scientist. Data sharing requests may also relate to older publications for which research materials are no longer close at hand. Indeed, junior researchers who have collected and manipulated data may have moved on to new employers, taking with them some of the knowledge required to codify the data and enable their use by others. Moreover, older research data and materials may not be fully digitised and accessible and may be held in paper-based records, outmoded file formats or on disused computers.

The second issue is that a request to access research data and materials may require a complex approval process (Mello et al. 2013; Savage and Vickers 2009). Such processes may be related to gaining approval from co-authors who may be unresponsive or concerned about negative implications from sharing. They might also require the approval of actors outside the immediate research team. Research data and materials may also be subject to external agreements that limit or impose burdens on sharing. Moreover, academics need to be mindful that they do not violate regulations and institutional rules on data sharing, especially in medicine and in the social sciences, which often involve data about individuals (Axelsson and Schroeder 2009). For example, in the UK, the Human Tissue Act makes it illegal to transport previously collected human tissue cells outside the national boundaries without prior consent (Laker 2006). Difficulties may also arise in projects that are funded by industrial partners. Frequently, industrial partners allow for the publication of research from data they provided to research teams, yet stipulate that any commercially sensitive information be removed prior to publication (Perkmann, McKelvey, and Phillips 2019). Navigating the approvals process and legal specifications can be time-intensive, and at different stages, a negative response from a stakeholder may hold up an attempt to share. As such, individuals may feel that the legal risk associated with data sharing too great to them personally.

Third, the transfer of research data and materials is rarely easy. Much of the knowledge developed in the research process is tacit, built up through direct, hands-on experience of the researcher(s) (Pavitt 1987; Rosenberg 1982). Therefore, a request may require additional time and effort on the part of the recipient in translating the material for the requester.

In sum, while the sharing of data and materials may generate positive social and personal benefits for academics, it is a discretionary activity that is not often directly rewarded by their employer. Therefore, academics weigh the benefits of sharing against the potentially substantial costs in terms of time and effort required to prepare and transmit research data and materials.

Role breadth and data withholding

Given the scarcity of personal resources, an academic's decision to share will not depend exclusively on associated expectations and rewards, but also on expedience of sharing compared to competing activities and related opportunity costs (Hockey 1997). This requires us to consider sharing in the context of all other activities that academics regularly perform.

Being an academic means facing a complex set of demands within the two core domains of research and teaching. Research does not merely consist of planning and conducting experiments, collecting data and authoring publications, rather - research teams need to be managed, funding must be secured and research results disseminated. Acquiring grants, for instance, requires significant effort, particularly as success rates of funding applications have fallen (Daniels 2015). Moreover, academics are called upon by governments and their research funders to ensure their research has an impact on the economy and society (Hicks 2012). For example, in the UK, the research of all academic departments is partially judged according to its 'impact', and scores inform the level of government research funding that departments receive in subsequent years (Power 2015;

RCUK 2015). Academic research is also increasingly subject to ethical review and compliance to ensure the conduct of researchers is in line with institutional and social expectations (Schrag 2010). In teaching, another core domain, there has been a major shift in expectations by students, leading to attempts to improve teaching quality by way of new procedures and evaluations of every academic's teaching efforts (Power 1997).

The academic role now involves expectations that go way beyond teaching and research (Austin 2002; Becher 1994; Kraimer et al. 2019). Academics are increasingly expected to be entrepreneurial and generate consultancy contracts and patents from their research (Wright et al. 2007; D'Este and Perkmann 2011). Academic institutions have created media departments to help direct public attention to the research of their staff, counting the number of press mentions of the university as a key indicator of their performance (Peters 2013).

According to role theory, when job demands increase over time, this generates a *resource conflict*, affecting one's ability to perform multiple demands (Michel et al. 2011; Hockey 1997). To resolve this conflict, individuals must compromise in allocating their limited resources (Sieber 1974). In this case, preference will be given to highly valued activities and those that are assessed or ranked (Marks 1977). In simple terms, activities subject to stronger pressures will attract more resources.

For academics, these core demands often revolve around publishing and the acquisition of research funds (Waaijer et al. 2018). Both hiring and promotion outcomes are often conditioned by an overriding focus on publications in highly-ranked journals (Alvesson and Spicer 2016, p. 32). Of equal importance is an academic's contribution to teaching on degree programmes, which represent the dominant funding basis and statutory objective for most institutions. Finally, universities are typically governed and managed by academics

themselves, meaning administrative demands will be made on academics and, particularly, on more senior ones (Alvesson and Spicer 2016; Kraimer et al. 2019).

The ambition to build a successful academic career comes, then, with the need to comply with a multitude of demands. With it comes the fear of failure of not meeting them, and of the sanctions associated with such a failure (Knights and Clarke 2014; Alvesson and Spicer 2016; Kraimer et al. 2019). Failed compliance with performance demands will result in career stagnation and barriers to pursuing a research-active career path (Henkel 2005, 1999) and even financial sanctions (Parker, 2014). Consistent failure to satisfy the core demands of the job will, in many cases, force an exit from the profession.

In this pressured context, academics are likely to focus their resources on activities that directly meet the core demands of research, teaching and administration. In turn, the more pronounced these demands become, the more discretionary and less observable tasks will fall by the wayside, such as reviewing, mentoring or public engagement where academics provide “service to students, colleagues, their institution, their discipline or profession, and the public” (Macfarlane 2007, 264). The sharing of research materials and data falls under these discretionary and less observable activities. Overall, as the volume of demands on academics increase, and hence their role breadth expands, we expect academics’ propensity to withhold their data and materials to increase.

Parenthood demands and withholding behaviour

Work and family are two interdependent spheres of an individual’s life because work roles can affect the performance of family ones and vice-versa (Edwards and Rothbard 2000). Our interest lies in the factors that affect data-sharing behaviour as part of a work-related role, and therefore our focus is on the family-to-work interface, that is, the degree to which family demands impact upon an individual’s work (Frone, Yardley, and Markel 1997).

The interference of family roles with work roles has, traditionally, been conceptualised as negative, with family pressures eroding or diverting resources from work roles and reducing job performance. The conflictual view sees family roles engendering a *time-based conflict* (Michel et al. 2011). As individuals are devoted to family responsibility, they have less time for performing work-related tasks (Greenhaus and Beutell 1985). Such reallocation of resources from work to family is conditioned by the importance that family roles play in defining an individual's identity. According to identity theory, if a role is central in defining one's self-identity as an individual (Ashforth and Mael 1989), they will devote more resources to it (Brown 1996). Yet, even independent from identity considerations, being an active parent invariably obliges individuals to shift time commitments away from their professional roles to attend to the needs of their children, particularly in cases of a young family (Misra, Lundquist, and Templer 2012). Indeed, academic careers and parenthood have been described as two 'greedy institutions', imposing a range of conflicting pressures (Jacobs and Gerson 2004).

However, family roles can also have a positive impact on work roles. In particular, Greenhaus and Powell's (2006) theory of enrichment proposes that family roles such as marital and parenthood responsibilities generate resources, such as new skills and knowledge, that can have a positive effect on work roles (Rothbard 2001; Ten-Brummelhuis and Bakker 2012) and improve performance (Dumas and Stanko 2017). The evidence suggests that family roles, and parenthood in particular, might lead to positive effects by forcing individuals to better manage their time, for instance, by effectively prioritising and increasing focus on more salient activities (Ruderman et al. 2002; Graves, Ohlott, and Ruderman 2007).

Evidence from the academic context suggests that the enrichment (positive) effect of family roles might exclude some discretionary activities. The presence of children in the household increases the overall level of domestic labour and, partly as a result, academic

parents – both men and women – work 3.8 hours fewer per week than other faculty members (Misra, Lundquist, and Templer 2012). Academic parents are also less likely to engage in extra activities at work (Kaufman and Uhlenberg 2000). Because the sharing of research materials and data are often hardly observable and generate limited credit, they are likely to receive less attention compared to other tasks demanded of an academic that appear more pressing or are even mandatory. Thus, we expect that academics with heavy domestic responsibilities, and specifically caring for young children, are less likely to share research data and materials compared to colleagues without such responsibilities.

Research setting and data

We draw on a dataset containing information about academics employed by Minerva (pseudonym), a large research university specialising in the natural sciences, engineering, medicine and business. The university is a leading recipient of government and industry research funding among competing universities in its home country.

We collated data from several sources, including a survey, the university's live administrative databases and third-party databases. Following a pre-test with 18 individuals, we circulated an online survey in October 2013 to all 3,725 academics employed by Minerva. The response rate was 51%, resulting in 1,909 usable responses.

In this paper we focus exclusively on withholding behaviour by faculty and exclude 1,033 junior researchers (post-docs) from our sample, leaving us with 876 faculty as our focal sample. Junior researchers are unlikely to command the level of autonomy to be able to independently decide on whether to share data and materials. Respondents in our sample are drawn from all discipline domains present at the university, e.g. medicine (35%), engineering (33%), ('hard') natural sciences (12%), life sciences (9%), business (6%), and mathematics (5%). To identify response bias, we examined whether key characteristics, including individuals' gender, faculty affiliation and job position (drawn from the university's human

resources system), differed between respondents and non-respondents. Accordingly, medical academics and junior faculty are underrepresented, while engineering and natural science academics as well as senior faculty are overrepresented.

The survey questionnaire covered various themes, ranging from individuals' engagement with industry, their identification with the university, their values and behaviours, their personal and family circumstances. Of particular relevance for this article, the questionnaire requested information on withholding behaviour, hours worked, career motivation as well as the number and age of respondents' children.

We linked the survey records with administrative information on each individual from seven Minerva databases. Scientific publication records were drawn from Minerva's publication management system, which automatically harvests publications from a set of bibliographic databases, including Thomson Reuters' Web of Knowledge and PubMed. The system requires each academic to approve and, if required, edit each of their publication records before listing on their public webpages. Unlike automatically compiled publication data that tends to suffer from name disambiguation irregularities, our publication data is quality controlled and manually approved by each author. We also extracted information from Minerva's grant application system and grant management system, its intellectual property management system, consulting contracts registry, course management system, and human resources system. Further, we extracted information on individuals' record of acting as company directors from Bureau van Dijk's Fame and Amadeus databases and patenting data from the European Patent Office. The use of multiple data sources independently compiled by different administrative units at Minerva and by external providers ensures that our data is robust against common method and self-reporting bias, and aligns with recent efforts to use rich, linked datasets in the study of science (Lane et al. 2015).

Dependent and independent variables

Our dependent variable is *withholding*. To measure it, we use the responses to two survey questions: (a) ‘In the last three years, how many times have you received requests from other academics for research results, data, or materials relating to your published research? (not including requests for papers)’; (b) ‘In the last three years, how many times have you denied requests from other academics for research results, data, or materials related to your published research?’ We express the variable as the fraction of total requests (a) that were denied (b). This measure is similar to that used by Haas and Park (2010) and Campbell et al. (2002).

We define two independent variables, *role breadth* and *parenthood*. We define as *role breadth* the number of activities in which an academic engaged as part of their professional role. An academic career involves activities related to research and research management, teaching, administration, commercialisation, citizenship and engagement (Kyvik 2013; Jacobs and Winslow 2004; Kraimer et al. 2019), and our measure seeks to capture the volume of those activities for each academic. To construct the measure, we consider activities under each of the following categories for the time period 2010–2013. First, we measure the volume of research activity, using as a proxy the number of all publications a scientist (co)authored, as recorded in the publications management system described above. Second, to account for research management, we add the number of grants each individual had acquired, as reported in the Minerva grants management system. Third, to capture fund raising, we add the number of grant applications submitted by each scientist, as drawn from Minerva’s grant application

management system.¹ Fourth, to account for commercialisation, we include the number of inventions that the scientist in question had reported to the university, according to Minerva's intellectual property management system. Fifth, we depict teaching by including the number of courses taught, as listed in Minerva's course management system. Sixth, we add the number of consulting engagements, as drawn from records held by Minerva's consulting arm. Seventh, we add the number of board directorships held by an academic according to the Fame and Amadeus databases. Last, we add the number of advisory board memberships held by each academic, as captured by our survey.

The *role breadth* variable computes the sum of all single instances of activity in any of the above categories. The variable has an average value of 32, with a standard deviation of 36 and a maximum value of 297 activities. There is variation between respondents in terms of the weight of each component of the sum; for instance, some academics' activities were concentrated around publication, while teaching was more prevalent for others.

While we cannot control for unreported activities, such as reviewing or mentoring, we expect these activities to correlate with the measured activities (e.g. those who publish more are likely to review more as well). Therefore, given that we omitted some unreported activities, we expect that the estimates we present in the results section may represent the lower bound of the true effect of role breadth on withholding behaviour.

To operationalise parental responsibilities (*parenthood*), we count the focal scientist's number of children below the age of seven. We focus on young children as this is the age at which we expect parenthood to impose the highest time pressure. This information was

¹ We separate awarded grants and bids between those where the focal scientist is the Principal Investigator (PI) and those where they are a co-PI.

obtained from the survey, which asked respondents to indicate the birth year of each of their children.

Control variables

To control for competing explanations of our findings, we include a number of control variables. These variables describe: a) work-related characteristics; b) individual characteristics; and, c) the nature of the academic's research.

Although our role breadth measure captures the scale of job demands for each individual, it is also possible that individuals overcome resource constraints in meeting such demands by working extra hours (Jacobs and Winslow 2004). To control for differences in time allocation, we include a variable that measures the number of hours a given academic reported in the survey as having worked in an average working week (*no. of hours worked per week*).

Because industry funding can influence the intensity of sharing research material (Czarnitzki, Grimpe, and Toole 2015), we control for whether an individual collaborated with industry. Our measure for the *industry funding* variable is the inflation-adjusted sum of research funds from industry sources obtained by the academic PI over time, up to three years before the survey was conducted, as more recent research may not yet be published.

Prompted by the findings of Haas and Park (2010), who show that more experienced colleagues exert strong influence on their peers, a peer-effects variable (*senior colleagues*) measures the number of senior faculty (readers, associate professors, full professors) in the focal scientist's division who had denied at least one sharing request in the three years preceding the survey. Junior faculty (lecturers, senior lecturers, assistant professors) may decline sharing requests for reasons different to senior faculty; for instance, concerns about employment security may deter them from engaging in discretionary activity. Accordingly, we include a variable (*junior faculty*) that takes the value of 1 for junior faculty, and 0

otherwise, drawn from Minerva's HR records. Furthermore, academics who perceive strong competitive pressure may be reluctant to share material (Walsh and Huang 2014). To account for this, we include a variable (*perceived competition*) that reports survey responses to the binary question, 'In the last 3 years did you delay publication by more than six months in order to protect a scientific lead?' To control for potential differences in withholding behaviour among men and women as a result of differences in family responsibilities, we include a dummy variable (*gender*) that takes the value of 1 when the respondent is male, and 0 otherwise. We include the academic's age as a control variable (*age*) because older academics may have a stronger professional identification and feel a stronger obligation to conform to the norms of open science than their younger counterparts. Both gender and age were drawn from Minerva HR data.

Academic status may also influence withholding insofar as high-status individuals may feel less threatened by competition and hence more likely to share with other academics. They are also likely to receive more requests to share. To proxy for academic status, we include a variable (*academic status*) that represents the sum of articles published, weighted by the impact factor of the journals in which they appeared (Fini et al. 2018). This data was drawn from our publication records and we used time-variant Web of Science impact factor scores according to the year of publication.

To account for the effect of motivation on role performance, we use measures based on a survey question used by Sauermann and Cohen (2010). We define the variable *extrinsic career motivation* as an index that increases with the extent to which a respondent reports benefits (pensions, holidays etc.), security, opportunities for career advancement and salary as important factors when thinking of their job as an academic. The *intrinsic career motivation* variable, also included in the analysis, is an index that increases with the extent to which respondents report contributions to society, their degree of independence, intellectual

challenge and level of responsibility as important factors when thinking of their job as an academic. Both variables are created using principal component analysis.

We also expect the nature of an academic's research to affect their withholding behaviour. More specifically, we expect academics working with more co-authors to face higher coordination costs when handling sharing requests. Accordingly, we include a variable (*no. of co-authors*) that measures the average number of co-authors in articles published by the focal academic in the three years preceding the survey. Further, academics conducting interdisciplinary research may be more open to requests to acquire legitimacy from more established fields. We construct a variable (*research interdisciplinarity*) that measures the average number of science classification codes, as defined by SCOPUS, for journals in which the focal academic published during the previous three years. In addition, the orientation of the academics' research may influence withholding behaviour, as those conducting more applied research may be less likely to share than those conducting basic research because of potential commercial protection concerns. Thus, we include a regressor as a control variable (*research basic orientation*) that measures the average research-level score for journals in which the respondent published in the last three years (larger values corresponding to more basic research). For this variable, we employ the journal classification level provided by the Patent Board/NSF.² Each journal in the Thomson Reuters' Science Citation Index (SCI) is assigned a research level from 1 to 4, with level 1 representing highly applied, targeted research, and level 4, very basic, untargeted research.

We also include a variable (*research budget*) that indicates the sum of inflation-adjusted research budgets from government sources obtained by academic principal investigators (PI) for the previous three years, because those with larger budgets may shift the

² The Patent Board was formerly ipIQ and CHI.

costs of sharing onto junior members of their team. Furthermore, government funders may also require that investigators share data openly (Piwowar 2011). Information for this variable was drawn from records of Minerva’s grant management system. To account for differences between scientific disciplines, we include a set of dummy variables corresponding to the field with which individuals’ divisions are associated (i.e. business, life sciences, mathematics, medicine, natural sciences).

Results

Table 1 presents descriptive statistics for our sample.³ On average, 7.2 per cent of academics denied requests for sharing. The standard deviation is nearly three times greater than the mean, indicating a wide distribution of values. On average, from 2010 to 2013, respondents received 5.6 requests from other academics to share material. Approximately one in five respondents received more than ten requests, while a similar number received just one or two. Most respondents do not have any children under seven years of age. On average, one senior colleague in the same division denied at least one sharing request during the period in question. For most academics, the number of publications in the last three years is the largest item in the role breadth index, but for more than 30 per cent, the largest items are a combination of grant applications, either as principal investigator (PI) or co-PI, and consultancy projects. On average, teaching accounts for low values in the index because most Minerva academics teach a limited number of units. However, for a handful of academics, teaching is the main component of their job duties.

Insert Table 1

³ We also performed a correlation analysis. The correlation table (available on request), shows that in general correlation coefficients take low values, except for the correlation coefficient between *academic status* and *role breadth* variables, which takes the value of 0.66. In the robustness checks discussed in the next section, we do not find this correlation to have influenced our estimates in any meaningful way.

We present the results of the empirical analysis in Table 2. Because, as a percentage, the dependent variable takes values between 0 and 1, we follow Papke and Wooldridge (1996) in estimating our specifications with a generalised linear model using the logit link and specifying the binomial family. In this way, we ensure that predicted values fall between 0 and 1.

Insert Table 2 near here

The estimates in Table 2 show that *role breadth* and *parenthood* variables are positive and statistically significant. Importantly, the magnitude of the coefficients is also meaningful. Evaluated at the mean values for all variables, one additional young child increases the denial of requests by 2.2 percentage points when the average value of the dependent variable (see summary statistics) is 7.5 per cent. Therefore, on average, an additional young child increases the percentage of request denials by almost 30 per cent. The marginal effects for a unit increase in the *role breadth* variable correspond to a 0.037 per cent increase in denied requests. When evaluated at the mean value of the *role breadth* variable (31.84), this 0.037 per cent translates to a 1.2 per cent increase in request denials. Accordingly, at one and two standard deviations about the mean for *role breadth*, the percentage of denied requests increases by almost 19 per cent and 38 per cent, respectively. Overall, there is strong support to suggest that *role breadth* and *parenthood* of young children, do indeed hinder sharing behaviour

With regards to the control variables, we observe that greater numbers of co-authors are associated with increased percentages of sharing request denials. As such, it appears that academics with a larger network deny requests at a higher rate, which may be due to the

coordination costs associated with sharing. However, the effect we reveal is rather small in magnitude, with the marginal effect of an additional co-author being 0.006 per cent.

Depending on the specification, we also reveal that academics who work more hours tend to deny more requests than others. With regards to age, gender, academic eminence and remaining controls, we do not find an effect on withholding behaviour.

Robustness checks

To test the robustness of the estimates, we performed a number of exercises that we document in Tables 3a and 3b. We start by exploring the sensitivity of our composite measure of *role breadth*. In robustness checks 1 to 5, we sequentially omit all items used to measure activities in relation to commercialisation, publication, grant acquisition, grant bidding and teaching, respectively, from the *role breadth* index. The estimates from each of the resulting models are qualitatively similar to the estimates we present in Table 2. As such, they demonstrate that *role breadth* results are not driven by the presence of any single element within the index. This is particularly relevant given that the relative proportions of the elements making up the composite measure differ greatly between individuals; the evidence from these tests suggests that our results hold across different types of job demands. In addition, in unreported tests available upon request, we weighted each item in the *role breadth* index with a random weight to account for the fact that some academics may face more pressure than others when performing certain types of job demands, and again the results are consistent with our estimates.

Next, we incorporated into the analysis a variable that measures the number of children aged between 7 and 18 (see Table 3b). In support of our expectation that younger children (i.e. those below 7) impose the highest demands on parents, the variable for children aged between 7 and 18 is statistically insignificant. In additional specifications, we ran the analysis using a Tobit estimator, used alternative measures to describe scientific status that had a low

correlation with *role breadth*, and omitted social scientists from the analysis. In all of these tests, which are available upon request, our findings remained qualitatively intact.

Insert Tables 3a and 3b near here

Discussion

This paper provides a new perspective on why academics withhold their research data and materials from other scientists. Using role theory as a theoretical lens, we find that the breadth of academics' work-related activities as well as their parenthood responsibilities have a positive effect on withholding behaviour. Our suggestion that job demands and parental roles conflict with the Mertonian norm of communalism raises important questions about how academics navigate between competing professional and personal roles. In simple terms, our results indicate that academics who carry heavy burdens in their professional and personal lives may be more likely to violate professional norms or expectations. Busy academics share less.

One direct implication of this finding is that increasing pressure on academics' workloads may lead to a decline in the more pro-social aspects of their work. In this respect, our results support the claim that increasing demands may lead to "counter-productive" effects (Kenny and Fluck 2014, 596-7) to a degree that pursuing an academic career might "displace all other values, goals and relationships" (Grey 1994, 482). Specifically, the production of a collective good – shared data and materials – may be hampered to an extent whereby academics are prevented from practicing communalism when confronted with pressures related to career progression and research performance evaluations.

Our study has several implications for our understanding of data and material sharing and withholding behaviour in academia. First, our study proposes the idea that sharing in

academia is conditioned by its perceived and actual cost in a context where a variety of demands compete for an academic's time and attention. This insight is particularly pertinent as policymakers and research funders are seeking to foster openness and sharing in science. While this intent may seem compatible with the norm of communalism, at the same time, it imposes costs limiting academics' ability to comply. To enable data sharing, academics will require significant administrative help and support from their universities. Without this support, such requirements might be seen as an imposed additional burden from their own universities or external agencies. Proactive efforts to embed data sharing protocols into the early stages of research projects might help lower the downstream burden of sharing on individual academics. In addition, administrative support for data curation and the handling of requests for access to data could also lower the perceived costs of such efforts.

Second, as observers of higher education and public science have noted, there is increasing pressure on academics to perform activities across multiple domains. Academics are expected to publish in top-ranking journals, secure research grants, be good teachers, demonstrate social impact and support the organisation in a range of administrative roles (Kraimer et al. 2019). These pressures are reflected in a reward system that sees career entry and advancement as linked to an evaluation of performance across these various domains. Our results suggest that the extent of these pressures might also play a role in explaining why academics refrain from data sharing. A reward system based on performance across observable dimensions might encourage an academic to focus on activities that are visible and explicitly rewarded at the expense of those that might be valuable, but not rewarded (Clarke and Knights 2015).

Third, the finding that academics' family lives shape withholding behaviour opens up an alternative perspective on this topic. Specifically, we found evidence – possibly for the first time – that parents of young children are significantly more likely to decline requests

from other researchers. This finding suggests that professional behaviour is not immune to non-professional pressures, indicating that attempts to explain withholding that take little or no account of domestic responsibilities may ignore an important explanatory factor. Indeed, our results suggest that the parenting of young children has a higher marginal effect on withholding than *role breadth* and other previously identified factors reported in the existing literature. Of course, this claim needs to be tempered by the fact that our study focuses on a particular subset of academics. Nevertheless, it suggests that family responsibilities can play an important role in explaining a range of professional behaviours, a finding that is consistent with work on the effects of parenthood on labour mobility among academics (Azoulay, Ganguli, and Graff Zivin 2017).

Limitations and future research

Although we have access to rich, multi-source data on individuals and their scientific behaviour, there are some significant limitations arising from this research, which in turn beget new research questions. First, in order to construct a detailed picture of the professional and personal lives of academics, we focus on a single university, therefore our results may reflect patterns of behaviour that are specific to this institution, limiting wider generalisability. For instance, since we studied a leading institution in a large urban area, respondents may be less concerned about job security compared to those at universities with lower profiles and in more geographically isolated settings. Future research should explore the effect of job security and career prospects on data sharing behaviours and validate our results across diverse locations.

Second, our study does not address how the characteristics of the person requesting the research materials or data, or the nature of the request itself, shapes the willingness of the academic to respond (Haeussler et al. 2014). This may be a rewarding question for future

research because individuals are generally more likely to engage in a task when they perceive it as being rewarding (Kahn 1990) or resulting in reciprocal benefits.

Third, our measures of professional role breadth and personal responsibilities are not complete. Although our measure of *role breadth* covers a wide range of activities, we lack information on the entire nature of an individual's work context, which might also include administrative roles, external commitments, and so on. In addition, our aggregate measure of role breadth does not account for differences in specialisation in specific activities, such as writing a paper, teaching a course and/or starting a business. In our defence, it is difficult to assign a time or attentional cost to each of these activities and our attempt to remove any single element from the measure and to use random weights produced consistent results. Further, our measure of *parenthood* does not fully account for an individual's domestic arrangements, such as childcare, support of local family members, and career breaks. Future research should consider the specific challenges that mothers face in their careers and how this shapes withholding, as it is likely that their domestic demands in the context of parenthood are particularly acute (Ceci and Williams 2011).

Finally, our research captures data withholding behaviour over a defined period, and as such, it does not provide evidence of how the broadening of the work and family role affects data withholding. Therefore, we are not able to address the intrapersonal trajectories that lead academics to compromise on the norm of communality. Some researchers have pointed out that role expansions may impinge on individuals' identities as they must mould their identities to encompass additional activities (McAlpine 2012). For instance, engaging in commercialisation requires individuals to reshape their identities in ways that can accommodate new demands that may conflict with their original identity (Jain, George, and Maltarich 2009). Similar identity reconfigurations are required when teaching-focused academics expand into research (van Winkel et al. 2018). Finally, identity work is involved

when academics negotiate the boundaries between work and family (Kreiner, Hollensbe, and Sheep 2006a, 2006b). Future research may explore such identity reconfigurations longitudinally within individuals to determine their impact on core professional behaviours, such as withholding.

Policy implications

Our findings have implications for policy, particularly as policymakers are intent on rendering the scientific system more open and collaborative. First, the research implies that interventions aimed at the busiest academics will yield the greatest effect, particularly as there is a positive correlation between capabilities and busyness, and the most capable academics will have the most to share within the academic system. Second, interventions will have to be aimed at reducing the costs of sharing, either by making the process of data sharing more efficient on a system-wide basis or by providing academics with dedicated resources to support their sharing activities. Third, although it is increasingly common for governments and journals to mandate or regulate openness by academics, and such measures might have the benefit of promoting open science, it is important to ensure that individuals are allowed sufficient time and resources by their universities to help them meet these external requirements. A possible intervention may include assuming staff with a mandate to manage the sharing process on behalf of academics who intend to share data or materials openly or upon request. Data sharing officers will be most effective if university-wide data inventory protocols are created in order to provide a standardised means for researchers to register their data and have them prepared for sharing as a natural part of the research process. In medical and social sciences, these efforts will be complementary with institutions' efforts to fulfil legal data management requirements, such as, for instance, GDPR in the EU.

Conclusion

Our study offers new insights into how pressures from expanded academic role responsibilities and family pressures influence adherence to core academic norms. We hope it contributes to the important discussion on how academics' roles are changing in response to pressure from both internal and external stakeholders, and the implications of these changes for both the conduct and impact of public science.

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Tables

Table 1. Descriptive statistics for the 876 academics included in the sample.

	Mean	Standard deviation	Minimum	Maximum
Percentage of denied requests	0.07	0.20	0.00	1.00
<i>Role breadth</i>	31.84	37.58	0.00	297.00
<i>Parenthood</i>	0.37	0.69	0.00	3.00
Senior colleagues	1.20	1.26	0.00	5.00
Industry funding	0.15	0.92	0.00	24.68
No. of hours worked per week	52.14	13.48	0.00	90.00
Junior faculty	0.21	0.41	0.00	1.00
Perceived competition	0.10	0.30	0.00	1.00
Gender	0.71	0.46	0.00	1.00
Age	41.38	11.08	20.00	65.00
Academic status	191.21	367.72	0.00	4797.40
Number of co-authors	19.13	154.22	0.00	2174.95
Research interdisciplinarity	2.19	1.04	0.00	7.00
Research basic orientation	2.30	1.31	0.00	4.00
Intrinsic career motivation	0.04	1.21	-5.77	2.83
Extrinsic career motivation	-0.03	1.70	-8.55	3.60
Research budget	0.81	2.58	0.00	30.61
Business	0.06	0.23	0.00	1.00
Life Sciences	0.09	0.29	0.00	1.00
Mathematics	0.05	0.21	0.00	1.00
Medicine	0.35	0.48	0.00	1.00
Natural Sciences	0.12	0.32	0.00	1.00

Table 2. Estimation results

	Coefficient	Standard error	P-value	
Intercept	-3.889	0.638	0.000	***
<i>Role breadth</i>	0.007	0.003	0.028	**
<i>Parenthood</i>	0.397	0.137	0.004	***
Senior colleagues	0.362	0.084	0.000	***
Industry funding	0.114	0.024	0.000	***
No. of hours worked per week	0.012	0.007	0.095	
Junior faculty	0.017	0.213	0.935	
Perceived competition	0.131	0.361	0.716	
Gender	-0.208	0.258	0.421	
Age	0.001	0.008	0.901	
Academic status	0.000	0.000	0.946	
Number of co-authors	0.001	0.000	0.000	***
Research interdisciplinarity	0.106	0.090	0.239	
Research basic orientation	-0.122	0.078	0.120	
Intrinsic career motivation	-0.081	0.119	0.495	
Extrinsic career motivation	-0.043	0.073	0.558	
Research budget	0.010	0.020	0.631	
Dummies of scientific discipline included		YES		
Number of observations		876		
Deviance		282.274		
Multicollinearity index		22.822		

** Significant at 5%; *** Significant at 1%.

Robust standard errors clustered at the academic unit level.

Table 3a. Robustness checks of baseline estimates; the dependent variable is the percentage of material-sharing requests that were denied.

	Robustness check 1. Omit <i>commercialization</i> activities from role breadth measure				Robustness check 2. Omit <i>publication</i> activities from role breadth measure				Robustness check 3. Omit <i>grant acquisition</i> activities from role breadth measure			
	Coefficient	Standard error	P-value		Coefficient	Standard error	P-value		Coefficient	Standard error	P-value	
Intercept	-3.903	0.631	0.000	***	-3.905	0.65	0.00	***	-3.89	0.64	0.00	***
<i>Role breadth</i>	0.008	0.004	0.030	**	0.007	0.00	0.05	**	0.01	0.00	0.03	**
<i>Parenthood</i>	0.411	0.135	0.002	***	0.400	0.14	0.00	***	0.40	0.14	0.00	***
Senior colleagues	0.355	0.086	0.000	***	0.373	0.08	0.00	***	0.36	0.08	0.00	***
Industry funding	0.120	0.024	0.000	***	0.110	0.02	0.00	***	0.11	0.02	0.00	***
No. of hours worked per week	0.013	0.007	0.083	*	0.012	0.01	0.10	*	0.01	0.01	0.09	*
Junior faculty	-0.001	0.215	0.997		0.022	0.21	0.92		0.02	0.21	0.93	
Perceived competition	0.148	0.359	0.680		0.125	0.37	0.73		0.13	0.36	0.72	
Gender	-0.203	0.259	0.433		-0.194	0.26	0.45		-0.21	0.26	0.42	
Age	0.001	0.008	0.863		0.001	0.01	0.86		0.00	0.01	0.92	
Academic status	0.000	0.000	0.939		0.000	0.00	0.31		0.00	0.00	0.98	
Number of co-authors	0.001	0.000	0.000	***	0.001	0.00	0.00	***	0.00	0.00	0.00	***
Research interdisciplinarity	0.107	0.090	0.232		0.106	0.09	0.24		0.11	0.09	0.24	
Research basic orientation	-0.120	0.078	0.125		-0.120	0.08	0.13		-0.12	0.08	0.12	
Intrinsic career motivation	-0.080	0.119	0.503		-0.077	0.12	0.52		-0.08	0.12	0.49	
Extrinsic career motivation	-0.043	0.072	0.553		-0.040	0.07	0.58		-0.04	0.07	0.55	
Research budget	0.009	0.021	0.678		0.012	0.02	0.55		0.01	0.02	0.63	
Dummies of scientific discipline included		YES				YES				YES		
Number of observations		876				876				876		
Deviance		282.09				282.97				282.14		
Multicollinearity index		22.68				23.01				22.80		

*Significant at 10%; ** Significant at 5%; *** Significant at 1%. Robust standard errors clustered at the academic unit level.

Table 3b. Robustness checks of baseline estimates; the dependent variable is the percentage of material-sharing requests that were denied.

	Robustness check 4. Omit <i>grant bidding</i> activities from role breadth measure				Robustness check 5. Omit <i>teaching</i> activities from role breadth measure				Robustness check 6. Include in the analysis a variable that measures the number of children aged 7–18			
	Coefficient	Standard error	P-value		Coefficient	Standard error	P-value		Coefficient	Standard error	P-value	
Intercept	-4.013	0.612	0.000	***	-3.912	0.64	0.00	***	-3.91	0.63	0.00	***
<i>Role breadth</i>	0.010	0.005	0.050	**	0.007	0.00	0.03	**	0.01	0.00	0.03	**
<i>Parenthood</i>	0.391	0.136	0.004	***	0.397	0.14	0.00	***	0.39	0.14	0.01	***
<i>Parenthood: Children between 7 and 18</i>									-0.14	0.14	0.31	
Senior colleagues	0.366	0.083	0.000	***	0.360	0.08	0.00	***	0.36	0.08	0.00	***
Industry funding	0.120	0.027	0.000	***	0.115	0.02	0.00	***	0.11	0.02	0.00	***
No of hours worked per week	0.014	0.007	0.056	*	0.013	0.01	0.09	*	0.01	0.01	0.09	*
Junior faculty	0.027	0.215	0.899		0.018	0.21	0.93		0.02	0.21	0.93	
Perceived competition	0.135	0.354	0.703		0.132	0.36	0.71		0.11	0.36	0.76	
Gender	-0.204	0.255	0.424		-0.206	0.26	0.43		-0.21	0.26	0.41	
Age	0.002	0.008	0.823		0.002	0.01	0.85		0.00	0.01	0.78	
Academic status	0.000	0.000	0.876		0.000	0.00	0.94		0.00	0.00	0.96	
Number of co-authors	0.001	0.000	0.000	***	0.001	0.00	0.00	***	0.00	0.00	0.00	***
Research interdisciplinarity	0.100	0.088	0.258		0.107	0.09	0.24		0.10	0.09	0.25	
Research basic orientation	-0.119	0.078	0.128		-0.122	0.08	0.12		-0.12	0.08	0.13	
Intrinsic career motivation	-0.079	0.118	0.501		-0.080	0.12	0.50		-0.09	0.12	0.46	
Extrinsic career motivation	-0.045	0.074	0.541		-0.043	0.07	0.56		-0.04	0.07	0.55	
Research budget	0.009	0.020	0.642		0.010	0.02	0.62		0.01	0.02	0.61	
Dummies of scientific discipline included		YES				YES				YES		
Number of observations		876				876				876		
Deviance		282.44				282.41				281.79		
Multicollinearity index		22.50				22.72				23.18		

*Significant at 10%; ** Significant at 5%; *** Significant at 1%. Robust standard errors clustered at the academic unit level.