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Academic artists' engagement and commercialisation

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Abstract

Academic artists are researchers who create artistic work. They form part of the cultural life of cities and contribute to welfare not only through research but also through art. They may commercialise their art or use it to engage in scientific knowledge diffusion. We seek to understand the relationship between art, academic commercialisation and engagement, and detect barriers to academic art. The resources needed to develop and diffuse art in addition to conducting research may be incompatible with a career focused on science quality or an organisational logic based on teaching and pure basic research. We study the responses to a survey of some 7,000 Spanish academics and compare university researchers to other researchers. More than half of the researchers surveyed create artistic work; however, whereas engagement is the norm rather than the exception, commercialisation is rare. Working in a university and producing good quality science run counter to being an artist. The detrimental effect of science quality on being a commercial or engaged artist turns positive after a certain threshold, which suggests polarisation among academic artists. Among commercial artists, this polarisation seems to apply specifically to university researchers. We discuss the implications for the valorisation of art across knowledge transfer channels and in research evaluations.

Keywords Knowledge transfer · University-industry interaction · Science quality · Public understanding of science

JEL Classification O32 · O33 · O36 · Z10 · Z11

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1 Introduction

Artists and academics form part of the city's creative class, which conditions firm location and local prosperity (Florida, 2019). Industry and innovation hubs benefit from the buoyancy stemming from the ideas and thinking of artists and academics. Some individuals combine both identities: academic artists, researchers who produce scientific knowledge and create artistic work, e.g. literary writing, photography, painting, sculpture, digital arts, etc.[1]

However, artistic contributions tend to score low (if at all) in the evaluation of scientific promotion. On the contrary, the resources needed for art may be incompatible with a career focused on science quality or an organisational logic based on teaching and pure basic research. Academic artists may be not generally accepted by their scientific communities and rather tend to keep art in their domestic sphere. The objective of this paper is to explore barriers to academic art based on science quality and organisational logic.

As a corollary, we will introduce this relatively new concept, 'academic artists', in Knowledge Transfer Studies. The small literature on researchers with artistic production or hobbies uses labels different from 'academic artists' and focuses on other fields and research questions. Creativity Research has emphasised the evidence and psychological reasons behind historical and most awarded scientists' taste for arts and crafts (Root-Bernstein & Root-Bernstein, 2004, 2013; Root-Bernstein et al., 1995, 2008). Organisation Studies have shown some interest on identity management of Art Scholars with a background in the artistic profession (Lam, 2018, 2020). Knowledge Transfer Studies have emphasised the need to explore novel transfer channels (Hayter et al., 2020), but art remains underexplored. Azagra-Caro, et al. (2020a)'s work on scientific writers categorised fiction writing as a non-formal knowledge transfer mechanism. Through qualitative and case-study evidence, they proposed that organisational logic plays a role, and that university researchers are less likely to transfer knowledge through fiction than non-university researchers. We expand that work in several ways: we analyse all artists, not only fiction writers; we focus on academics rather than artists, providing a systematic analysis of the relationship between science quality, organisational logic and academic art; we distinguish two types of knowledge transfer: commercialisation and diffusion; and we use a large quantitative sample of academics to address the research questions.

We develop our theoretical background through the lens of university-industry interactions and the literature on academic commercialisation and engagement (Perkmann et al., 2013, Sect. 2). To analyse the development of artistic activities, we establish an analogy with knowledge transfer mechanisms, which also face tensions with science quality and organisational logics. Some mechanisms are linked to commercialisation (like patents or spin-offs) and others are linked to engagement (like contract research, informal contacts, etc.). Academic commercialisation implies market acceptance for outputs of academic research, whereas academic engagement is knowledge-related collaboration by academic and non-academic agents (Perkmann et al., 2013). Academic art involves aspects of commercialisation and engagement. We define 'commercial' academic artists as those whose creative work is paid or commercially exploited and 'engaged' academic artists as those whose creative work diffuses scientific knowledge or is a source of scientific ideas.

[1] Many renowned artists have worked at universities, mainly to teach in their artistic speciality. However, our focus is on individuals whose main identity is as an academic. We also avoid to focus on Art scholars; in this field, academic and artistic identities are more blurred and we are interested in use of art as an interaction channel in other fields. In this sense, we differentiate from the work by Lam (2018, 2020), who focuses on Art scholars.

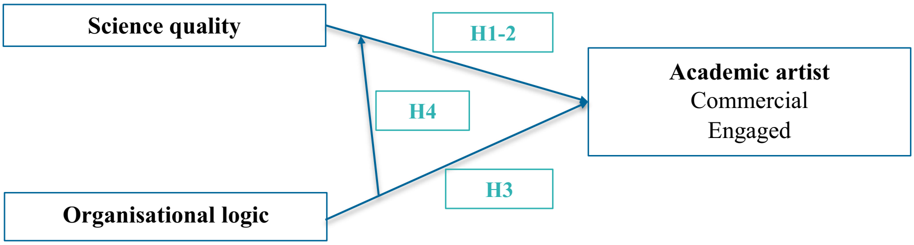

Fig. 1 Conceptual approach to academic artists' engagement and commercialisation

We study the responses to a survey of some 7,000 Spanish academics and compare university researchers to other researchers (Sect. 3). More than half of the researchers surveyed create artistic work; however, whereas engagement is the norm rather than the exception, commercialisation is rare. We obtain results via standard, ordered and bivariate probit regressions, and our analysis reveals that academic artistic production is indeed subject to barriers based on science quality and organisational logic, similar to barriers faced by knowledge transfer mechanisms, especially when academics commercialise or diffuse knowledge through art (Sect. 4). Finally, we discuss the implications for the valorisation of art across knowledge transfer mechanisms and in research evaluations (Sect. 5).

2 Literature review

The next subsections deepen in the links between science quality, organisational logic and academic art. Figure 1 may help visualising the relationships.

2.1 Science quality and academic artists: initial negative relationship

The relationship between science quality and university-industry interaction is bidirectional. Here, we focus on the effects of science quality on university-industry interaction and on art. University researchers have given amounts of time and resources to enable their interactions with companies. A focus on science quality will reduce the resources available for these interactions. It is possible, also, that the pursuit of science quality at university results into more cutting-edge research than firms can absorb. Science quality focuses on longer-term value whereas interactions with firms prioritise science aimed at short-term, tangible goals. These arguments would suggest a negative relationship between scientific quality and university interactions. There is some evidence supporting a negative relationship between scientific quality and interactions channels, for example, spin-off creation (Buenstorf, 2009; Toole & Czarnitzki, 2010), consulting (Fudickar et al., 2018) or industry funding (Hottenrott & Thorwarth, 2011) and, especially, if combined with public funding (Hottenrott & Lawson, 2017), and in basic sciences (Scandura & Iammarino, 2021).

Other arguments suggest the opposite. Science quality tends to grant university researchers with prestige, and prestige attracts firms. University researchers are likely to be selective about the firms they choose to interact with and work only with those requiring good quality science. For these reasons, we would expect a positive relationship between scientific quality and university-industry knowledge transfer. There is evidence supporting a positive relationship between scientific quality and industrial funding for departments in the applied sciences (Scandura & Iammarino, 2021), academic patenting (Acosta et al., 2019; Azoulay et al., 2009; Fischer et al., 2018; Martínez et al., 2013), patent licensing (Buenstorf, 2009) and spin-off creation (Fischer et al., 2018).

In the case of academic art, we expect a negative relationship to prevail. Researchers focused on science quality will not devote time and resources to a competing task like art, which scores less in the evaluation of merits. The pursuit of scientific quality may require focus, depth and awareness of what other researchers and research stakeholders consider interesting at a very precise moment, and fast reactions in case of shifting interests. Researchers with this motivation will devote all their work and even leisure time to this target, which will reduce the possibility to develop artistic activities. Even if researchers are willing to produce art, the higher the quality of their science, the more cutting-edge its results may be, and the more difficult their translation into art may be. Unlike the case of R&D contracts, it is not very likely that art will increase resources enough to compensate for its extra burden and thus generate a virtuous circle. All this suggests that science quality will have a negative effect on academic art.

This effect will be higher if academics commercialise or engage into scientific knowledge diffusion through art. In addition to creating the artistic piece, a commercialisation attempt, similar to other market activity, requires extra resources. Similarly, engagement through art requires additional effort to diffuse the artistic work while carrying out research duties and accumulating recognition and prestige. Therefore, art commercialisation and engagement indicate *depth* of commitment to art (in the sense of Laursen & Salter, 2006), the same as creativity research considers commercialisation as a sign of commitment to art (Carson et al., 2005). A focus on science quality involves more work and/or more overtime working which detract from *depth* of commitment to art, represented by art commercialisation and engagement, which may be stigmatising vis-à-vis quality peers (Azagra-Caro, et al., 2020a; Becker, 1963; Lam, 2010). This depth will make science quality a barrier to be a commercial or engaged academic artist.

Hypothesis 1 Science quality is negatively related to being an academic artist, a commercial academic artist or an engaged academic artist.

2.2 Science quality and academic artists: positive relationship after a threshold

There might be non-linearities in the relationship between scientific quality and university-industry interactions that also apply to academic art. We expect a negative relationship up to a certain threshold after which good quality science will involve knowledge transfer, that is, we expect a curvilinear U-shaped relationship. There is a need for some training in order to benefit from interaction and that, having established a reputation, the academic researchers might overcome their peers' usual dislike for commercialisation (Haeussler & Colyvas, 2011) and plan scientific quality that will add to or sustain their collaborations (Schaeffer et al., 2020). It has been suggested that star scientists benefit from complementary resources that are not available to ordinary researchers. These include a citation premium from interorganisational authorship (Zucker & Darby, 1996) and greater involvement in knowledge transfer activities (Giones et al., 2020; Olmos-Peñuela et al., 2014). There is evidence showing that higher scientific impact is associated to long-term university-industry relationships (Garcia et al., 2020) and that for established researchers (senior, male, with more resources and larger stocks of publications) 'science and commerce go hand in hand' (Haeussler & Colyvas, 2011: 50).

We expect that being an academic artist will show a similar U-shaped relationship with scientific quality, that is, an initial negative relationship which turns positive after a certain threshold.

At some point, scientific quality can be beneficial for artistic creation. High quality researchers may have more to say about and have the ability to produce art without much extra effort. Their facility for scientifically impactful ideas likely allows them to be more creative artistically (Root-Bernstein & Root-Bernstein, 2004, 2013; Root-Bernstein et al., 1995, 2008). It may be the case that prestige attracts research collaborators and that the star scientist is required to make minimum input which leaves room for the art. This is another dimension of the Matthew effect in scientific credit and recognition (Merton, 1968), academic entrepreneurship (Van Looy et al., 2004), science funding (Bol et al., 2018; Ranga et al., 2016) and funding of university-industry interaction (Azagra-Caro et al., 2010).

Hypothesis 2 Science quality is positively related to being an academic artist, a commercial academic artist or an engaged academic artist after a minimum quality threshold.

2.3 Academic artists and organisational logic

Academic researchers work in different types of organisations: universities, research institutes, health facilities, firms, foundations, etc. University researchers are the most numerous and have distinctive characteristics: in universities, teaching and knowledge transfer are respectively more and less institutionalised than in the other organisations. The organisations most similar to universities are public research organisations (e.g., the French CNRS, the Italian CNR, the Spanish CSIC, the German Max Planck Society, etc.), because promotion based on scientific research quality is also the norm compared to other types of organisations. However, public research organisations typically work on use-inspired basic research or applied research, enjoy larger shares of industry funding and have a shorter-term orientation (Edler et al., 2011; Gulbrandsen & Smeby, 2005; Teirlinck & Spithoven, 2012). The evidence shows that university researchers are less likely than public research organisation researchers to participate in entrepreneurial activities such as consulting, patenting and applying for company funding (Haeussler & Colyvas, 2011). In the medical field, university researchers compared to non-university researchers, perceive research for industry as conflicting with societal impact (Azagra-Caro & Llopis, 2018).

Similarly, we expect that university researchers will find it more difficult than researchers in other organisations to become artists. University researchers have to compete with non-university researchers, often in inferior conditions, similar to the competition between university and non-university entrepreneurs (Ayoub et al., 2017). University scientists may have to suffer worse conditions than non-university researchers because, under a university logic, art is not highly valued in evaluation of merit, and peers may interpret engagement in artistic activities as frivolous. In other words, art could reduce the university researcher's reputation with non-artistic university peers given that, for the former, merit is based on publication in top journals. Production of art could be seen as a waste of time. Within a non-university logic, a piece of art may be an acceptable way to demonstrate research competence and third parties who are not academics, may consider it a complementary asset. These societal actors may attach more importance to art since most do not read many scientific articles. This would explain why university researchers might confine their art to their spare time, whereas for non-university researchers it may be part of their profession (Azagra-Caro, et al., 2020a).

Hypothesis 3 University researchers are less likely to be academic artists, commercial academic artists or engaged academic artists, than non-university researchers.

We have theorised that researchers keen to build a reputation for good quality science will tend to avoid artistic activities. University science faculty will especially avoid art since scientific reputation is more important for them than for non-university researchers who may be more interested in financial gain and problem-solving (Lam, 2010). The pressure to publish can increase to the point of dereliction of other duties, working excessive hours and performing research in order not to be punished by omnipresent evaluators (Gonzales et al., 2014). However, we have indicated, also, that prestige may make room for art if the researcher has sufficient resources. Specifically, university researchers may experience this because reputation gains exacerbate differences among individuals (Kwiek, 2019). For instance, reputation among university researchers leads to tenure, which has no equivalent in other research professions (Bozeman & Gaughan, 2011). Among university researchers, reputation and, especially, professorships allow faculty to become principal investigators on research projects and to supervise more PhD students. In academia, multiple co-principal investigator projects typically include a prestigious senior academic to support the junior PI who leads the funding proposal.

Hypothesis 4 Being a university researcher intensifies the curvilinear effect of science quality—(a) first negative, (b) then positive—on being an academic artist, a commercial academic artist or an engaged academic artist.

3 Data and methods

The study population is Spanish researchers, defined as authors of scientific publications, affiliated to a Spanish organization and taken from the corresponding authors on publications in the Web of Science (WoS) listings from 2013 to 2016. The corresponding author is usually one of the lead authors and lead contributors to the content of the manuscript (Mattsson et al., 2011) or is perceived as so (Bhandari et al., 2014). Editors appoint corresponding authors as reviewers (Weiss, 2012) and they are considered reliable sources of knowledge about the publication and the underlying research (Wren et al., 2006). Thus, corresponding authors match our concept of academic researcher, that is, academic regardless of organisation type, and the idea of researchers who identify as academic rather than artistic.

We gathered some 65,000 valid e-mails. To launch the survey, we obtained ethical certificates from our two mother organisations, CSIC and the Polytechnic University of Valencia. We ran a first pilot in July 2017, a second pilot in April 2018 and the definitive survey was administered between July and November 2018. We received over 7,300 responses, that is, a response rate of 11% and a sample size with a 95% confidence level and a 1% margin of error, which is representative of the population.

Our first dependent variable is *academic artist*, which is a dummy equal to 1 if the researcher has created some artistic work in at least one art field. The survey included a

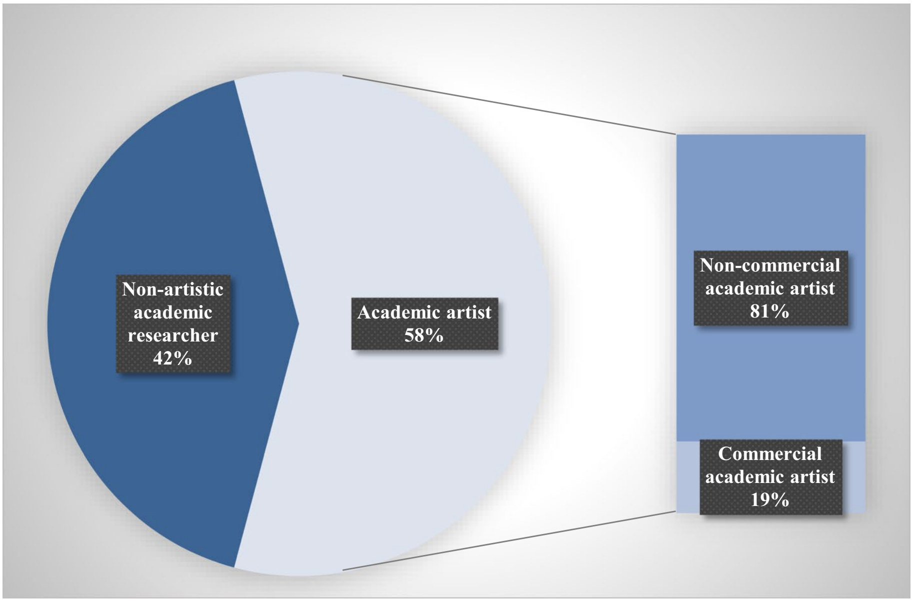

Fig. 2 Distribution of academic artists (n = 7,324)

Short Creativity Achievement Questionnaire (SCAQ), adapted from Carson et al. (2005). Respondents chose those art fields they had practised (see list and distribution of responses in Appendix Table 5), and our measure shows whether they indicated a minimum of one. Figure 2 shows that 58% of the researchers are academic artists.

Our second dependent variable is *commercial academic artist*, equal to 1 if the academic artist was paid to create the work or he/she exploited it in the market. Figure 2 shows that commercialisation is relatively infrequent: 11% of all researchers (19% of academic artists) are commercial artists.

Our third dependent variable is *engaged academic artist*, which is equal to 1 if the academic artist diffuses knowledge through art. The survey used the 12-item Science Through Art Questionnaire (STAQ, see Appendix Table 6), based on the case study in Azagra-Caro, et al. (2020a). It includes items on direct knowledge diffusion (degree to which the researcher uses art for diffusing scientific knowledge), indirect knowledge diffusion (degree to which the researcher diffuses scientific knowledge by word-of-mouth with art business people, other artists and the public) and reverse knowledge diffusion (degree to which the researcher gets ideas from art business people, other artists and the public for future scientific production). Reliability was high with a Cronbach's alpha of 0.88. We calculated the mean of the 12 items, which ranged between 1 and 5, and transformed it into a binary variable, equal to 1 if the average was equal or higher than 1.5.

We have responses from the full sample on *academic artists* and *commercial academic artists*. However, the questionnaire about *engaged academic artists* was administered to a subsample of *respondent* academic artists who agreed to answer this second part of the survey: over 2,500 responses, that is, 59% of the total number of academic artists. We compared the characteristics of the academic artists who responded to the second part of the survey with those who did not and found no major variation (i.e. probit regression of volunteer answer to this second part showed no significant differences according to our control variables, e.g. gender or age). Figure 3 shows that 55% of academic artists engaged in scientific diffusion through art.

Among our independent variables, the first is *science quality*, which addresses Hypothesis 1. We measured it as Field Normalized Citation Score (FNCS). In a first step, for each paper, we divide the number of forward citations (2-year window: publication year and the following two years) by the average number of forward citations received by all Spanish papers in that thematic category and that year. For example, a paper published in 2016 received one citation in 2016, 2017 and 2018; this paper belongs to two categories: 'Mathematics, Applied' and 'Mathematics'; all Spanish papers published in 2016 in those two categories received, respectively, an average of 1.25 and 0.97; the FNCS would be $((1/1.25)+(1/0.97))/2=0.91$. In a second step, we grouped all the papers for every corresponding author and averaged the FNCS. Finally, because the distribution was unbalanced, we transformed it into quartiles, so the final variable ranges between 1 and 4.

We included science quality squared, to account for non-linearities in the effects of science quality, which addresses Hypothesis 2.

The second independent variable is *university researcher*, which equals 1 if the respondent works at a university and 0 otherwise, and addresses Hypothesis 3; 55% of the researchers worked at a university. The remaining 45% includes research organisations (18%), health organisations (16%), companies (4%), government (4%) and non-profit organisations (3%).

The interactions between *university researcher* and *science quality* or *science quality squared* allows us to address Hypothesis 4.

For the full sample of researchers, we control for a wide range of institutional (science field, country and region of residence), sociodemographic (sex, age, nationality, language, education, civil status, number of children), occupational (employment situation and type) and organisational (number of organisations, ownership regime, directive positions) variables. Table 1 presents the descriptive statistics and Tables 7 and 8 the correlations. The

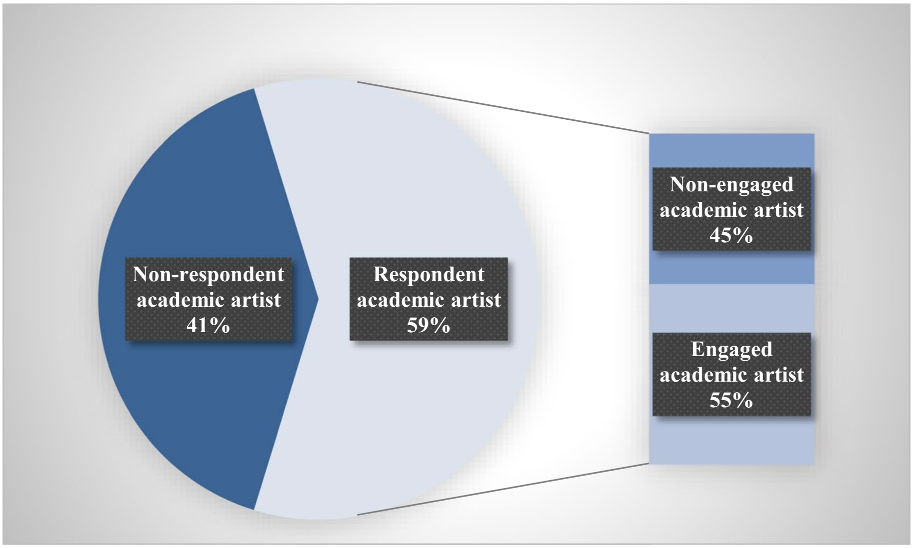

Fig. 3 Distribution of respondent academic artists (n = 4,288)

Table 1 Academic researchers: descriptive statistics of variables

Sample	Variable role	Level	Variable name	Description/explanation	Mean	Std. Dev	Min	Max
Full sample (n = 7,324)	Dependent variables	Individual	Academic artist	A researcher who publishes in academic journals and creates artistic work	0.58	0.49	0.00	1.00
			Commercial	An academic artist whose creative work is paid or commercially exploited	0.11	0.31	0.00	1.00
			Engaged *	An academic artist whose creative work diffuses scientific knowledge or is a source of scientific ideas	0.54	0.50	0.00	1.00
	Independent variables		Science quality (H1)	Average Field Normalized Citation Score of the researcher's publications, grouped in 4 quartiles	2.50	1.12	1.00	4.00
			Science quality squared (H2)		7.50	5.68	1.00	16.00
			University researcher (H3)	At least one university affiliation	0.55	0.50	0.00	1.00
	Control variables	Institutional	Multidisciplinarity	Number of science fields	1.28	0.45	1.00	2.00
			Science field	Medicine	0.22	0.40	0.00	1.00
				Life Sciences	0.13	0.31	0.00	1.00
				Other Natural Sciences	0.21	0.38	0.00	1.00
				Engineering	0.12	0.30	0.00	1.00
				Art and Literature (Social Sciences and Humanities is the benchmark)	0.03	0.16	0.00	1.00
			Region of residence	Madrid	0.22	0.42	0.00	1.00
				Barcelona	0.10	0.31	0.00	1.00
				Valencia ('other Spanish regions' is the benchmark)	0.08	0.28	0.00	1.00
			Foreign residence	Non-Spanish residence	0.06	0.24	0.00	1.00

Table 1 (continued)

Sample	Variable role	Level	Variable name	Description/explanation	Mean	Std. Dev	Min	Max
		Sociodemographic	Woman researcher	Sex of the researcher	0.43	0.49	0.00	1.00
			Age	Number of years	46.76	10.24	18.00	97.00
			Foreign nationality	'Spanish only' is the benchmark	0.08	0.28	0.00	1.00
			Non-Spanish first language	'Spanish only' is the benchmark	0.23	0.42	0.00	1.00
			PhD	PhD title	0.89	0.31	0.00	1.00
			Married or domestic partner	'Couple or single' is the benchmark	0.64	0.48	0.00	1.00
			Number of children under age	Father/motherhood	0.79	0.99	0.00	5.00
		Professional	Employed	Yes/no (unemployed)	0.96	0.19	0.00	1.00
Employed (n = 7,064)			Working for others or for others and self	Used to break down the sample. 'Working for self only' is the benchmark	0.98	0.26	0.00	1.00
Working for others or for others and self (n = 6,908)		Organisational	Number of organisations	Multiple affiliation	1.20	0.50	1.00	5.00
			Directive position	Yes/no	0.28	0.43	0.00	1.00
			Public organisation	Yes/no	0.84	0.34	0.00	1.00

*n = 2,543

Table 2 Probit regression of academic artist

	1 Full sample	2 Working for others
Science quality (H1)	−0.03**	−0.03**
	(0.01)	(0.01)
Science quality squared (H2)	0.01	0.00
	(0.02)	(0.02)
University researcher (H3)	−0.09***	−0.13**
	(0.03)	(0.05)
Uni. res. * Science quality (H4a)		−0.01
		(0.03)
Uni. res. * Science quality sq. (H4b)		0.04
		(0.03)
Multidisciplinarity	0.11***	0.10***
	(0.04)	(0.04)
Medicine	−0.17***	−0.18***
	(0.05)	(0.06)
Life Sciences	0.03	0.05
	(0.06)	(0.06)
Other Natural Sciences	−0.22***	−0.18***
	(0.05)	(0.06)
Engineering	−0.23***	−0.20***
	(0.06)	(0.06)
Art and Literature	0.32***	0.31***
	(0.11)	(0.11)
Madrid	0.12***	0.13***
	(0.04)	(0.04)
Barcelona	−0.00	−0.01
	(0.05)	(0.05)
Valencia	−0.03	−0.03
	(0.06)	(0.06)
Foreign residence	0.21***	0.24***
	(0.07)	(0.07)
Woman researcher	−0.17***	−0.15***
	(0.03)	(0.03)
Age	−0.01***	−0.01***
	(0.00)	(0.00)
Foreign nationality	0.10	0.07
	(0.06)	(0.06)
Non-Spanish first language	0.09**	0.09**
	(0.04)	(0.04)
PhD	−0.06	−0.10*
	(0.05)	(0.06)
Married or Domestic Partner	−0.07*	−0.07*
	(0.04)	(0.04)
Number of children under age	−0.04**	−0.04**
	(0.02)	(0.02)

Table 2 (continued)

	1 Full sample	2 Working for others
Employed	−0.14	
	(0.09)	
Number of organisations		0.14***
		(0.03)
Directive position		0.09**
		(0.04)
Public organisation		−0.07
		(0.05)
Constant	0.80***	0.55***
	(0.14)	(0.13)
Observations	7324	6908
χ^2	210	203
p	0.00	0.00

*$p<0.10$; **$p<0.05$; ***$p<0.01$. Robust standard errors in brackets. No multicollineartiy according to VIF. Main effects of variables with interaction terms are centered

final sample excludes outliers of some of these controls, e.g. abnormally high age or large number of children.

However, not all variables apply to all types of respondents: only employed researchers can have an occupational status, and only those working for others can have organisational characteristics. This defines a different subsample of 'working for others' with more control variables that we also present in the results.

4 Results

4.1 Academic artists

Table 2 presents the results for estimating the probability of being an academic artist. Column 2 includes more control variables for the subsample of researchers working for others. Science quality conflicts with being an artist, without non-linearities. University researchers are less likely than other researchers to be artists. Column 2 includes the interaction terms between university researchers, science quality and its square value. None is significant.

Among control variables, in the case of the multidisciplinarity, Art and Literature, living in the national capital, living abroad, being young, not having Spanish as a first language, working in several organisations and holding a directive position are all beneficial conditions for being an artist. However, being woman, being married and having several children are unfavourable to being an artist. Public or private ownership of the organisation is not important.

Table 3 Probit model with sample selection of commercial academic artist

	1 Full sample	2 Working for others
Science quality (H1)	−0.08***	−0.07***
	(0.02)	(0.02)
Science quality squared (H2)	0.03	0.03
	(0.02)	(0.02)
University researcher (H3)	−0.08*	−0.17**
	(0.05)	(0.07)
Uni. res. * Science quality (H4a)		−0.03
		(0.04)
Uni. res. * Science quality sq. (H4b)		0.12***
		(0.04)
Multidisciplinarity	0.06	0.06
	(0.05)	(0.05)
Medicine	−0.49***	−0.46***
	(0.07)	(0.08)
Life Sciences	−0.25***	−0.22***
	(0.08)	(0.08)
Other Natural Sciences	−0.31***	−0.22***
	(0.07)	(0.07)
Engineering	−0.28***	−0.21**
	(0.08)	(0.08)
Art and Literature	0.38***	0.39***
	(0.11)	(0.12)
Madrid	0.20***	0.19***
	(0.05)	(0.05)
Barcelona	−0.01	−0.03
	(0.07)	(0.07)
Valencia	0.05	0.08
	(0.07)	(0.08)
Foreign residence	0.08	0.07
	(0.09)	(0.09)
Woman researcher	−0.18***	−0.19***
	(0.04)	(0.04)
Age	−0.01***	−0.01**
	(0.00)	(0.00)
Foreign nationality	−0.08	−0.11
	(0.07)	(0.08)
Non-Spanish first language	0.15***	0.12**
	(0.05)	(0.05)
PhD	−0.01	−0.09
	(0.07)	(0.07)
Married or Domestic Partner	−0.10**	−0.11**
	(0.05)	(0.05)
Number of children under age	0.00	−0.00
	(0.02)	(0.02)

Table 3 (continued)

	1 Full sample	2 Working for others
Employed	0.09	
	(0.11)	
Number of organisations		0.16***
		(0.04)
Directive position		0.08
		(0.05)
Public organisation		−0.17***
		(0.06)
Constant	−0.89***	−0.85***
	(0.17)	(0.16)
Observations	7324	6908
Censored observations	3055	2929
χ^2	182	201
p	0.00	0.00

*$p<0.10$; **$p<0.05$; ***$p<0.01$. Robust standard errors in brackets. No multicollineartiy according to VIF. Main effects of variables with interaction terms are centered. Step 2 of the sample selection model. Step 1 produces almost identical results to Table 2

4.2 Commercial academic artists

Table 3 reports the difference between commercial and not commercial academic artists. We could have modelled this on the full sample, but this might have caused biased estimations if commercial academic artists were not representative of all academic researchers. Instead, we considered, first, that researchers choose to be artists or not (Step 1), and then to be commercial or not (Step 2). The first decision was modelled in Sect. 4.1 (probability of being an academic artist). Here, we present the results for the second decision based on a Heckman selection model. A Wald test indicates that the two decisions are not independent, therefore, accounting for sample selection bias is appropriate.

Science quality is at odds with art commercialisation, and has a linear effect. Working at a university also has a negative effect on being a commercial artist. Sample selection bias means that these effects are net of the similar effects of these variables on the probability of being an academic artist. Hence, we can interpret them as *additive*, that is, the detrimental effects of science quality and university work on academic art are more pronounced for commercial than non-commercial academic artists.

The negative linear interaction of science quality on art commercialisation is no different for university and non-university researchers, but there is a positive curvilinear effect of science quality. Hence, art commercialisation has a positive relationship with science quality after a certain threshold, but only for university researchers, not other researchers. This is the most specific characteristic of university researchers confirmed so far.

Table 4 Bivariate probit regression of engaged academic artist

	1 Full sample	2 Working for others
Science quality (H1)	−0.06**	−0.05**
	(0.02)	(0.03)
Science quality squared (H2)	0.07***	0.07**
	(0.03)	(0.03)
University researcher (H3)	0.05	0.07
	(0.06)	(0.09)
Uni. res. * Science quality (H4a)		0.00
		(0.05)
Uni. res. * Science quality sq. (H4b)		0.02
		(0.05)
Multidisciplinarity	0.01	0.02
	(0.06)	(0.07)
Medicine	−0.58***	−0.57***
	(0.09)	(0.10)
Life Sciences	−0.18*	−0.16
	(0.10)	(0.11)
Other Natural Sciences	−0.49***	−0.42***
	(0.09)	(0.10)
Engineering	−0.62***	−0.60***
	(0.11)	(0.12)
Art and Literature	0.18	0.11
	(0.16)	(0.17)
Madrid	−0.02	−0.04
	(0.06)	(0.07)
Barcelona	−0.10	−0.14
	(0.09)	(0.10)
Valencia	0.02	0.06
	(0.10)	(0.10)
Foreign residence	0.18*	0.21*
	(0.10)	(0.11)
Woman researcher	−0.21***	−0.20***
	(0.05)	(0.06)
Age	0.01***	0.01***
	(0.00)	(0.00)
Foreign nationality	−0.09	−0.13
	(0.09)	(0.10)
Non-Spanish first language	0.04	0.03
	(0.06)	(0.07)
PhD	0.13	0.09
	(0.08)	(0.09)
Married or Domestic Partner	−0.05	−0.07
	(0.06)	(0.06)
Number of children under age	−0.00	−0.01
	(0.03)	(0.03)

Table 4 (continued)

	1 Full sample	2 Working for others
Employed	−0.01	
	(0.13)	
Number of organisations		0.15***
		(0.05)
Directive position		0.18***
		(0.06)
Public organisation		−0.08
		(0.08)
Constant	−0.22	−0.35*
	(0.22)	(0.21)
Observations	2543	2347
χ^2	238	242
p	0.00	0.00

*$p<0.10$; **$p<0.05$; ***$p<0.01$. Robust standard errors in parenthesis. No multicollineartiy according to VIF. Main effects centered in regressions with interaction terms. The bivariate estimation of 'Commercialisation' produces almost identical results to Table 3

4.3 Engaged academic artists

We have shown that engagement in knowledge diffusion through art is the norm rather than the exception among academic artists. Table 4 presents the estimations for the probability of being an engaged academic artist. Similar to commercial academic artists, we consider the possibility of sample selection and whether the decision to become an academic artist precedes the decision to being an engaged academic artist. The Wald test following the Heckman model rejects this possibility. We accounted for the possibility that commercialisation and engagement decisions are correlated by running a bivariate probit regression. In this case, the Wald test supports the modelling strategy (see Table 4).

Science quality is initially negatively related to academic engagement through art but this relationship becomes positive beyond a certain threshold. After the inclusion of the control variables, working at a university and its interaction with science quality have no distinguishable effects.

4.4 Cross-table comparison and hypothesis testing

According to our findings, up to a certain threshold, science quality is detrimental to being an artist, either commercial or engaged, which supports Hypothesis 1. After that threshold, the relationship between quality and art becomes positive for engaged researchers, which partially supports Hypothesis 2. Working at a university conflicts with being an academic artist and commercialising art, which partially supports Hypothesis 3. After a quality threshold, the relationship between quality and art becomes positive for *university* commercial researchers, which partially supports Hypothesis 4. Hence, we find strong evidence that science quality affects negatively the three types of academic researchers analysed (academic artists, commercial academic artists and engaged academic artists) and, overall, the evidence suggests that science quality affects positively academic art after a threshold, that the university organisational logic intensifies this effect and that this logic is, per se, at odds with academic art. However, the non-linear effects of science quality and university logics vary per type of academic researcher analysed. We discuss some of the differences in the next section.

5 Conclusions

The objective of this paper is to explore barriers to academic art based on science quality and organisational logic. The small literature on researchers with artistic production or hobbies has not addressed this issue, and the literature on university-industry interaction, which has addressed the role of science quality and organisational logic, has rarely included academic art as an interaction channel. By merging these two streams of literature, our analysis indicates that scientific quality and the university organisational logic (based on the combination of teaching and pure basic research) have negative effects on being an academic artist. Our most immediate precedent, Azagra-Caro, et al. (2020a)'s work on scientific writers, did not address the role of scientific quality. It found a similar negative effect of university organisational logic on knowledge transfer.

Another contribution of our work is the distinction between two types of knowledge transfer through academic art: commercialisation and diffusion, which we call engagement to place academic art in the literature on academic commercialisation and engagement. Our analysis shows that the negative effects of scientific quality and the university organisational logic on scientific art are intensified in relation to commercialisation or engagement. Conceptually, this is in line with our interpretation that both represent different dimensions of depth of researchers' artistic commitment.

Our result of a positive curvilinear relationship between science quality and art suggests the existence of power differences, as in other academic domains, including university-industry interactions (Gaughan & Bozeman, 2016; Gonzales et al., 2014; Kwiek, 2019). Artistic commercialisation and engagement are compatible with better quality science only after a certain threshold, which implies that much academic prestige, and relational and social capital are necessary to counterbalance the time costs involved in adding art to science. If the aim were to implicate researchers in art, this would require initiatives to allow participation of less powerful academics. This might be achieved by reducing the weight of curricula in the evaluation of funding proposals, including research projects and PhD grant applications, that is, allowing ideas and content to weigh higher than the individual.

Academic artists' engagement is affected with two differences compared to commercialisation: First, working at a university has different importance (significant for commercialisation, not for engagement). It might be that commercialisation is more difficult in universities compared to other organisations, whereas diffusion is not, so even if a negative effect of university affiliation is expected on both aspects, it is plausible that it is more significant for the former than for the latter.

Second, the positive curvilinear influence of science quality on engagement applies to all researchers (not only to university researchers). It is possible that polarisation between university researchers may be stronger than among other academic researchers. It is clear that there is a high level of polarisation in universities in terms of scientific prestige, along the dimensions of research productivity, income and internationalisation (Kwiek, 2019). If commercialisation is more difficult in universities, it might be that only the most prestigious individuals become involved, whereas the differences (and the related curvilinear effect) are attenuated in other organisations. If engagement is less problematic for university researchers, the need for prestige to overcome the related barriers may be similar to other organisations (thus, producing the same curvilinear effect for university and other researchers). Future research could further examine the differences in the significance of the determinants of art commercialisation and engagement, perhaps using mediation analysis.

Our work provides, to the best of our knowledge, the introduction of a relatively new concept—'academic artist'—in the field of Knowledge Transfer Studies. By doing so, we vindicate that artistic production could be considered as one of the mechanisms of university-industry knowledge transfer in studies that typically include patents, spin-offs, contract research, informal contacts, etc. Its inclusion seems especially important given that universities are increasingly using copyrights to protect their intellectual property (Rooksby & Hayter, 2019). To counterbalance the negative effects of scientific quality and university logic on academic art, knowledge transfer through art could achieve more weight in evaluations of researchers' curricula. Acknowledging new types of research impact through art could improve understanding and narratives about the benefits of researchers' involvement in society (Azagra-Caro, et al., 2020b; Hayter et al., 2020), especially in regions where research excellence and industry needs may not match (Bonaccorsi, 2017).

Some limitations of this work pave the way for future research. An immediate next step would be to analyse the societal impact of academic artists' engagement and commercialisation, including how academic art could contribute to innovation hubs. In addition, whereas the focus here is on organisational and science quality antecedents of academic art, sociodemographic aspects deserve more attention, e.g. gender and age. We have treated *engaged academic artists* as a single construct, but we could distinguish by type of engagement, as stated in the methodological Sect. 3 (direct, indirect and reverse knowledge diffusion). At least for university researchers, we could ask whether academic art and technology transfer through conventional means (e.g. contracts, joint projects, consultancy…) go hand-in-hand. Cross-country and longitudinal studies would be possible. The inclusion of academic art in Knowledge Transfer Studies brings these and further possibilities to the field.

Appendix: Questionnaires

See Tables 5, 6, 7 and 8.

Table 5 Artistic creativity achievement questionnaire (ACAQ)

Have you created any artistic work in these domains?	Number of 'Yes'
Plastic Arts (Drawing, Painting, Sculpture…)	1,490
Photography	1,835
New Media Arts (Digital, Computer, Multimedia Art…)	790
Music	605
Performing Arts (Dance, Theatre or Film Acting, Opera…)	680
Architecture	250
Creative Writing: Fiction (Poetry, Novel, Story, Playwriting, Scriptwriting…)	1,719
Creative Writing: Non-Fiction (Essay, Journalism, Biography… It excludes scientific publishing)	1,828
Websites (Blog, Archive, Chat, Databases…)	1,984
Theatre Direction or Production	211
Film Direction or Production	171
Other artistic areas	212

Inspired by Carson et al. (2005). Three mutually exclusive possible replies: "No", "Yes, I have created some artistic work, unpaid and not commercially exploited" and "Yes, I have created some artistic work, paid or commercially exploited"

Table 6 Science through art questionnaire (STAQ)

(a) Through your artistic facet, do you diffuse scientific knowledge?
Yes, from my field of knowledge
Yes, from my speciality within my field of knowledge
Yes, from my publications in the ISI's JCR, with impact factor
Yes, from knowledge fields other than mine
(b) Does your artistic work let you contact with people outside your professional sphere like this?
I talk about my scientific research with entrepreneurs or managers from the artistic world (editors, producers…)
I talk about my scientific research with professional artists (painters, sculptors, writers, filmmakers…)
I talk about my scientific research with the public of my artistic work (readers, spectators…)
After having known my artistic work, entrepreneurs or managers from the artistic world have contracted me to develop my research facet
Entrepreneurs or managers from the artistic world that produced my artistic work exhibit my research facet as a plus for the promotion
Entrepreneurs or managers from the artistic world have given me research ideas that I have developed in my research facet
Professional artists have given me research ideas that I have developed in my research facet
The public of my artistic work has given me research ideas that I have developed in my research facet

Answers in a 5-point Likert scale from 0 (Never) to 5 (Very frequently)

Table 7 Correlation coefficients (1/2)

		1	2	3	4	5	6	7	8	9	10	11	12
1	Academic artist	1.00											
2	Science quality	−0.04*	1.00										
3	Science quality square	−0.04*	0.98*	1.00*									
4	University researcher	−0.04*	0.03*	0.03*	1.00								
5	Multidisciplinarity	0.05*	0.05*	0.05*	0.02*	1.00							
6	Medicine	−0.03*	−0.12*	−0.13*	−0.26*	−0.20*	1.00						
7	Life Sciences	0.04*	0.09*	0.07*	−0.06*	−0.04*	−0.23*	1.00					
8	Other Natural Sciences	−0.05*	0.13*	0.12*	0.00	−0.12*	−0.30*	−0.22*	1.00				
9	Engineering	−0.03*	0.07*	0.07*	0.12*	−0.06*	−0.21*	−0.16*	−0.21*	1.00			
10	Art and Literature	0.05*	−0.11*	−0.09*	0.08*	−0.04*	−0.10*	−0.08*	−0.10*	−0.07*	1.00		
11	Madrid	0.02	0.01	0.01	−0.12*	0.01	0.05*	0.01	−0.02	0.00	−0.01	1.00	
12	Barcelona	0.00	0.02	0.02	−0.07*	0.02	0.04*	0.03*	−0.05*	0.02	−0.02*	−0.18*	1.00
13	Valencia	−0.02	0.00	0.00	0.06*	0.00	−0.02*	0.00	−0.01	0.00	0.01	−0.16*	−0.10*
14	Foreign residence	0.06*	0.00	0.00	0.01	0.01	−0.08*	0.03*	0.07*	0.00	−0.01	−0.14*	−0.09*
15	Woman researcher	0.05*	0.02	0.02	−0.02*	0.02	−0.05*	−0.03*	−0.06*	−0.10*	0.06*	0.05*	0.01
16	Age	−0.04*	−0.01	−0.01	−0.06*	0.00	0.05*	0.03	−0.02	−0.07*	0.01	0.06*	0.01
17	Foreign nationality	−0.05*	−0.01	−0.01	0.02*	0.04*	0.04*	0.02*	0.03*	0.01	0.02	−0.03*	0.03*
18	Non-Spanish first language	0.03*	0.02*	0.03*	0.00	0.00	−0.05*	−0.01	0.02	0.01	0.02	−0.18*	0.28*
19	PhD	−0.04*	0.20*	0.18*	0.23*	0.08*	−0.23*	0.04*	0.11*	0.03*	0.00	−0.02	−0.01
20	Married or domestic partner	−0.06*	0.01	0.01	0.03*	0.01	0.07*	−0.03*	−0.01	−0.02	−0.04*	0.00	−0.02
21	Number of children under age	−0.01	−0.02	−0.01	0.01	0.02	−0.01	0.00	−0.01	0.00	0.00	−0.01	0.00
22	Number of organisations	0.06*	−0.03	−0.02	0.07*	0.04*	0.14*	−0.01	−0.10*	−0.07*	−0.01	0.03*	0.09*
23	Directive position	0.01	−0.01	−0.01	0.03*	0.04*	0.00*	−0.05*	−0.04*	0.01	0.05*	0.00	0.02
24	Public organisation	−0.06*	0.04*	0.04*	0.17*	−0.01	−0.05	0.02	0.09*	−0.02	0.01	0.00	−0.13*

*Signifcant at 5%

Table 8 Correlation coefficients (2/2)

		13	14	15	16	17	18	19	20	21	22	23	24
13	Valencia	1.00											
14	Foreign residence	−0.08*	1.00										
15	Woman researcher	0.00	−0.00	1.00									
16	Age	0.04*	−0.14*	−0.11*	1.00								
17	Foreign nationality	−0.04*	0.31*	0.02	−0.05*	1.00							
18	Non-Spanish first language	0.07*	0.08*	0.00	−0.03*	0.23*	1.00						
19	PhD	0.02	0.00	−0.05*	0.14*	−0.02	−0.01	1.00					
20	Married or domestic partner	0.03*	−0.09*	−0.10*	0.18*	−0.03*	−0.04*	0.12*	1.00				
21	Number of children under age	0.04*	0.00	−0.01	0.04*	−0.00	0.02	0.00	−0.01	1.00			
22	Number of organisations	−0.01	0.01	−0.03*	0.02	0.06*	0.04*	0.01	0.02*	−0.00	1.00		
23	Directive position	0.02	−0.10*	−0.06*	0.14*	−0.06*	−0.01	0.09*	0.11*	0.02	−0.06*	1.00	
24	Public organisation	0.05*	−0.10*	−0.04*	0.10*	−0.08*	−0.08*	0.09*	0.08*	0.01	−0.17*	−0.03*	1.00

*Signifcant at 5%

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