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The Academic Inbreeding Controversy: Analysis and Evidence from Brazil

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A B S T R A C T

This paper presents an embracing quantitative inbreeding analyses in the Brazilian higher education system (HES). Several studies were conducted about academic inbreeding in several countries with contradictory results on its effect in research productivity, indicating how controversial this issue is. This is the first comprehensive research based on data from more than 79,000 researchers from all fields of knowledge. We find that inbreeding can be found in all fields of science in Brazil. Results from a robust statistical analysis indicate that inbreds are significantly more productive than non-inbreds in all research publications, except in books. Particularly, we find that researchers that have spent a mobility period, either during doctoral studies or a scholarly visiting position, are more productive than other types of inbreds. The overall conclusion is that there is no evidence to support the detrimental view of academic inbreeding based on scientific productivity. We then discuss possible explanations to our findings and present suggestions of future research.

1. Introduction

Academic inbreeding, a term derived from Biology, can be defined as "the appointment of faculty members that graduated from the same institution employing them" (Altbach et al., 2015). In the long run, academic inbreeding could lead to what is known in Biology as inbreeding depression, that is, the reduction of fitness-related characters of offspring of related individuals in a given population (Charlesworth and Charlesworth, 1987; Charlesworth and Willis, 2009). It is argued that academic inbreeding can generate a lack of diversity in research, a local thinking rather a global one, and reinforcement of questionable administrative and academic practices. As a consequence, it has been stated as a potential problem to academic activities, particularly research.

The detrimental view of inbreeding has emerged in the US higher education system (HES) in the beginning of the 20th century (Horta et al., 2010). This view was embraced by the most prestigious HES around the world, supported by several researches connecting inbreeding to lower productivity levels (Caplow and McGee, 1958; Eells and Cleveland, 1935). Eisenberg and Wells (2000) found that inbreeds were cited between 7% and 13% less than other faculty members not belonging to this category, studying American Law Schools. Further, (Horta et al., 2010) reported a loss of 15% in peer-reviewed publications from inbreeds with all degrees from the same employing institution. By 1910, 64% of the faculty from Harvard University had been recruited from its own graduates (Pan, 1993). Eells and Cleveland (1935) found that 34% of the faculty were inbreed in a set of 214 American universities. Since then, the adoption of several policies by universities and educational government agencies decreased the inbreeding rate. The percentage of external candidates that obtained a permanent faculty position in the 80–90s were 93% in the US, and 83% in the UK (Navarro and Rivero, 2000).

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Although the detrimental view of academic inbreeding is prevalent in academic circles (Altbach et al., 2015; Horta et al., 2021; Horta et al., 2010), some empirical studies show that there is no significant statistical difference between inbreeds and noninbreeds in several countries (Badat, 2015Dutton, 1980; Lovakov et al., 2019; McGee, 1960; Pan, 1993; Shin et al., 2016; Smyth and Mishra, 2014; Wyer and Conrad, 1984). Further, academic inbreeding is widely used as a hiring practice by universities in Argentina, China, India, Korea, Japan, Portugal, Russia, Spain and Turkey (Altbach et al., 2015; Navarro and Rivero, 2000; Tavares et al., 2015). There are several reasons listed in the literature for the widespread existence of inbreeding, as follows (Altbach et al., 2015): immobility culture, peculiarities of the academic labor market (such as concentrated number of research universities and small differentiation of salary among HE institutions), traditionalism, and corporatism. Rocca (2007) points out that inbreeding mainly emerges in academia environments in which the importance of social connections is considered more important than academic merits.

Academic inbreeding is therefore a complex and controversial phenomena, involving several dimensions (Alipova and Lovakov, 2018). It is no surprise that the literature in academic inbreeding has significantly expanded since the 80s. Previously limited to the analysis of effects on productivity, the literature has expanded to several issues, related to the very definition of what academic inbreeding is, the relevance of social and cultural elements, and its relations with mobility. Horta et al. (2011) indicated that "organizational stability, identity, knowledge, and power structures are enforced by the sense of belonging to the universitys educational/research tradition and ethos formed through a learning path" (p. 42) are central issues to Japanese universities to hire former students. Shin et al. (2016) has indicated that some inbreed academics have shown a "have strong desire to teach at their home university" and a "strong commitments to their home university" (p.199) – translated by the idea of "sense of affiliation". McGee (1960) stressed, on the other hand, that a systematic non-conscious discrimination against inbreed faculty could be one of the main reasons to explain the difference of performance of inbreeds and non-inbreeds in the US that was formed through decades of dynamics in the national academic labor market. In summary, academic inbreeding can be considered as a social and cultural phenomenon (Horta et al., 2011).

However, although widely perceived as "normal" by some countries (Altbach et al., 2015), its possible detrimental effects are regarded as out of harmony with policies of equality and internationalization of HE promoted by governments and political/economical blocks. As universities around the world are under pressure for generating innovation and under scrutiny of international ranking, policy-makers are increasingly worried in establishing practices capable of attracting the best academic minds from inside or outside. Therefore, actions to deal with the alleged effects of academic inbreeding have been taken by several countries such as Spain (Bosch, 2001), Sweden[1], India[2], China (Altbach et al., 2015), and Czech[3].

Regardless of a country's view of academic inbreeding, only a critical analysis of its effects can help policy-makers to balance its negative and positive impacts within a given HES. This is the main motivation of this study in dealing with academic inbreeding in Brazil. Although inbreeding has already been a research topic in Brazil, previous studies were quite limited in terms of its scope, to a single research area (Barbosa et al., 2018), or based on simple descriptive data (Balbachevsky, 2016). Barbosa et al. (2018) have analyzed the relationship between inbreeding of coordinators and the grades attributed by the evaluation of the Post-Graduate Graduation in Accounting Sciences in Brazil. On the one hand, the results showed that academic inbreeding enables the best research institutions to maintain their prominent position in the development of research. On the other hand, for the less traditional research universities, academic inbreeding could influence in a negative way their performance in research. Balbachevsky (2016) approaches inbreeding marginally within her analysis on the profile of the Brazilian HES. The high number of educational institutions, in relation to research institutions, does not make this a problem that affects the system as a whole. Inbreeding has only been observed in the most important research institutions. However, no impact study on the Brazilian HES is presented.

The main objective of this research is to study the relationship between inbreeding and research productivity in the context of the Brazilian academic system. The database of more than 76,000 Brazilian researchers from all fields of science allowed us to adopt an across-section perspective. We have collected data from a web-based CV platform, allowing us to expand the sample to a very large number of researchers from several knowledge areas. To the best of our knowledge, this is by far the most comprehensive study in inbreeding, surpassing by a factor of about 10 the sample of 7,000 researchers in Horta et al. (2021). By using statistical models, we look out for possible differentiation in research productivity between inbreeds and non-inbreeds across different areas. Further, this is the first multivariate study, using a large research sample, to analyze academic inbreeding.

The main purpose of this study is to assess whether inbreeding has a detrimental effect in research productivity in Brazil, simultaneously considering different inbreeding categories and research areas. Another important contribution of this study is to incorporate "academic heritage" as an analysis variable in the context of academic inbreeding. This variable attempts to represents the intangible knowledge, academic networking, and financial resources incorporated by a researcher during his/her formation period in each research institution. The rationale here is that academic institutions might hold an explanatory power that can help explain scientific productivity of former students in comparison to non-inbreeds. Accordingly, a limited but specific social aspects of the phenomena could be made accountable by the heritage concept translated into a variable.

The paper is organized as follows. Section 2 describes the Brazilian academic context, focusing on its peculiarities. The methodological aspects, including the data and a brief presentation of the applied statistical methods, are described in Section 3. The results are presented in Section 4. Finally, a summary of the results and areas of future research are provided in Section 6.

[1] https://universitetslararen.se/2018/05/03/riggade-utlysningar-vid-larosatena-strider-mot-grundlagen.

[2] https://www.universityworldnews.com/post.php?story=20171020151319671.

[3] https://www.universitas.cz/en/people/304-problems-facing-czech-scientists-academic-inbreeding-red-tape-and-poorly-designed-evaluation.

2. Institutional background

The Brazilian HES is young and characterized by institutional diversity (Balbachevsky, 2016). The first Brazilian university was founded in 1920. Initially, the system was only composed by public and catholic universities, employing several foreigner professors. In the seventies, graduate studies were introduced in prestigious universities to motivate the formation of Brazilian doctoral academics, replacing the foreigners. The system was significantly expanded in the nineties with the introduction of softer regulations (McCowan, 2007). This expansion included the emergence of several private institutions, a consequent increase in tertiary education enrollment, and a substantial quality difference among institutions.

In a census reported by the Ministry Education in 2017, Brazil had 296 public higher education institutions and 2,152 private institutions. Thus, the majority of the higher education institutions are private colleges. In general, the quality of the private system is considered low (Balbachevsky, 2016). Research in the Brazilian HES is highly concentrated, around 80% of the country's graduate programs are offered on federal and state universities/polytechnics. Doctor-degree holders are thus more frequent in the public institutions, while in the private network most holds master-degree.

The recruitment process for a tenure position in the public institutions is based on public tender as to any public servant. The PhD is a prerequisite based on the current legislation. The job vacancies are announced in the universities' websites and widely disseminated through specialized websites. The process of evaluating candidates is carried out by a committee board, composed by only one internal professor, and, at least, two external professors from other institutions of recognized expertise. The evaluation of the candidates is based on a specific tender notice, defining how each evaluation item, such as publications and academic experience, will be scored. By national legislation, it is not possible to impose restrictions in terms of the institution that awarded the PhD degree, as long as it is officially recognized, for a candidate to apply for a vacancy (Balbachevsky, 2016). Thus, no hiring limiting policy for those that would be considered an inbreed is legally feasible in Brazil as it would be considered a bias against someone based on his or her prior academic formation.

All candidates, regardless of their previous experience or productivity, enter the lowest career level. The approved candidate needs a three-year probationary period and is then considered effective and receive a promotion. The salary levels are the same for all federal public universities, and there is no differentiation of salaries based on any sort of merit-based attribute. The same is true for the universities maintained by each sub-national states. Although some private institutions use the same employment process as the public ones, the majority is based on a more market-oriented selection process, where the offered rank is based on the experience of the candidate. The private market is huge for teaching but relatively small for research activity and, in general, with work conditions that are not so attractive as few private institutions are interested in research (Balbachevsky, 2016).

Although recruitment process is formally based on merit and open to competition, there are perceptions that informal ties might influence hiring decisions. As observed in other countries, such as Portugal, Italy and France (Horta, 2013; Pezzoni et al., 2012), the process might be perceived as presenting an ambiguous "mix of state control and professional corporatism" (Tavares et al., 2017). The interest of senior professors in hiring their own former students, the belief that academics already integrated into the institution will perform better, and the spread belief in traditional universities that their own graduates are the best candidates Altbach et al. (2015) are practices that would corroborate with the idea of inbreeding as a deliberate process at the expense of the formal regulations of recruitment based on academic merit.

The mobility of academics in the Brazilian HES is very low. There is no incentive for academics to change institutions or to be away from their family environment. Furtado et al. (2015) observed that only 20% of the researchers work more than 500 km (a short distance, considering the country's size) away from the institution where they started their academic trajectory. Most researchers settled in jobs less than 100 km from the university where they started their careers. The phenomenon was also noticed among researchers who did doctoral and postdoctoral studies abroad: 81% returned to Brazil and settled in their regions of origin. Further, academic inbreeding is not a main concern in Brazil (Balbachevsky, 2016), considering the whole HES. Since very few institutions are able to grant graduate degrees, the majority of them employ PhD academics from a select and smaller set of research oriented universities. However, this figure can change when we consider only the research-oriented institutions, where several of their own former PhD students are employed due to the previously pointed issues, presenting more than 20% of their faculty as inbreeds. This HES setting provides a complex institutional context in which academic inbreeding takes place.

3. Method

3.1. Data and taxonomy of categories

Data about academic career and history of employment of Brazilian researchers is obtained directly from the Lattes platform which, in 1999, replaced the prior paper-based and non-integrated electronic systems. Lattes is internationally perceived as a powerful example of good academic practice, and an important and embracing database for analysis and evaluation of the Brazilian HES (Damaceno et al., 2019; Perlin et al., 2017; Picinin et al., 2016). Currently, Lattes has over 3.5 million registered CVs from all knowledge areas, where 6.5% are from PhD academics. The information is provided by the researcher. However, as the Lattes CV can also be used as a performance assessment tool, there is a strong incentive for researchers to keep their profiles updated. Researchers are also held legally responsible for posting false information.

We developed a software for mining data in Lattes that renders us an unique sample significantly larger than any other previously considered in academic inbreeding studies. The software is capable of collecting information for every researcher, such as PhD origin, PhD completion time, years since PhD completion, current job address, list of published papers and many other information.

Table 1
Taxonomy categories used to analyze academic inbreeding in Brazil.

Category	Definition
Pure inbreeds	Academics that have obtained all degrees – Bachelors, Masters and PhD – in the same HE institution they are employed
Inbreeds	Academics that have only obtained their PhD in the same HE institution they are employed
Mobile inbreeds	Academics that have spent a period doing research during their doctoral studies or a pos-doc in another HE institution than the one that has both given their first appointment and awarded their PhD degree
Silver-corded	Academics that were employed in another institution they have obtained their PhD degree before being employed by the latter institution
Non-inbreeds	Academics that are employed in a different institution they have obtained their PhD

Unfortunately, a large database of academic CVs comes with some inconsistencies in data quality. All information in lattes is inserted by the user, when first registering its curriculum or when adding content. In a large scale setting such as ours, this can result in omissions and wrongful information. When looking at the raw data, we find many cases of missing information on academic background, published materials and employment history.

To minimize the effect of omissions and wrong information, we use a simple set of filters. First, we remove researchers with PhD obtained before year 2000 and after 2016. The data was collected in mid 2017, not covering the whole year of 2017. Second, we removed all cases with missing information about employment history or academic background. Third, to make sure we only look at Brazilian researchers, all scholars of any type of *inbreed* (details later) that have their first academic position abroad, are also removed from the sample. Our final sample consists of full-time academics holding a PhD ($N = 76,922$), and all their related academic work.

For all data of academic output from Lattes – articles, books and supervisions – we restrict the information covering only the years after initial employment. Moreover, in order to account for extreme observations in such a large sample of data, we perform a winsorization procedure (Dixon and Yuen, 1974) in all dependent and independent variables with a 2.5% threshold at both sides of the distribution. This means that, for each variable, any observation in the left or rightmost tail of the distribution is fixed using the 2.5% or 97.5% quantiles. This methodological choice is justified by the large sample of data, which naturally comes with input errors and wrongful information. By using a winsorization procedure in all variables, we ensure the overall data distribution is well behaved, and minimize the impact of individual data points in the model's estimation. Across all different data sources, we used ISSN as a matching key of publication. That is, we use the ISSN of a journal to find its impact factor or Qualis. As such, all publications without ISSN are removed from the sample.

The initial studies about academic inbreeding used a binary classification (inbreed and no-inbreed) based on individual academic degree (Dutton, 1980; Eells and Cleveland, 1935) or the institution where the PhD was granted Berelson, 1960; Horta et al., 2010). However, the expansion of such studies to several countries required better taxonomy categories to cope with the found diversity. New categories were introduced, connecting inbreeding to mobility (Horta, 2013). A detailed discussion about different taxonomies is beyond the scope of this study. A good discussion about this topic is provided by Gorelova and Yudkevich (2015). Based on previous studies (Horta, 2013; Lovakov et al., 2019), Table 1 provides the strict definitions for different types of inbreeding used to analyze academic inbreeding in Brazil. All definitions in Table 1 use the same information: institution where the PhD was granted, institution of first employment after PhD, postdoctoral time and institutions (if it exists), and institution of last employment. For such, we only consider institutions where there was a full (permanent) dedication from the scholar. In Brazil, it is not unlikely for researchers to attain temporary teaching positions before securing a permanent academic job.

3.2. Variables used in the study

The statistical model used in this research will relate different measures of academic productivity to the inbreed categories. The dependent variables focus on quantity and prestigious dimensions of the academic productivity of each researcher. The data were normalized in a way to prevent the years of employment of an academic from introducing a bias in the analysis, benefiting more experienced academics.

NPublic Number of published articles with ISSN for each researcher, normalized by the number of career years, measured as the number of years between first employment and 2017.

SJR Median value of the SJR value, considering all publications of a researcher. The SJR is a broad and popular impact factor retrieved from scimagojr.com in 2020-10-23. As presented in Waltman (2016), there are several citation impact indicators in the literature. Further, this review indicates several aspects that need to be considered when choosing a proper indicator, such as normalization from different fields, size dependency, and the academic controversy of using indicators in the assessment of publications and authors. In our study, we assumed a more pragmatical view of this relevant issue. The main idea of this variable is to compute a single value that represents the prestige of the several publications of researchers in different inbreeding categories in attempt to statistically identify differences among these groups. Following Waltman (2016), we choose a indicator that rather match well with our objectives than a sophisticated technical criteria. Median was used as a good central tendency measure for skewed numerical distributions as the case of SJR.

PercA1A2 Percentage of publications from a researcher in the higher divisions of Qualis, A1 and A2. Qualis is the official, community driven, Brazilian assessment of a journal's quality using quantitative and qualitative factors. Its highest division is A1 and A2. All journal's publications were matched using ISSN and the latest Qualis, accessed in 2020-10-23. Qualis also sets a numerical standard constantly used in research evaluation. It can change among areas but usually A1 papers get 100 points, A2 results in 80 points, B1 in 60 points and so on.

NBooks Number of full length books (excluding book chapters), published for each researcher, divided by the number of years between 2017 and employment date.

NSupervisions Number of successful graduate (M.Sc and Ph.D.) supervisions per year of a researcher as the main advisor, divided by the number of career years of researcher. This only counts for concluded studies, that is, the supervised student finished the course and received his academic title. All unfinished supervisions are not counted.

hindexGS The September 2020 h index metrics from Google Scholar (GS) of each researcher, matched by its full name. Towards a better comparison, we divided the h value from Google by the number of career years, decreasing the effects of size dependency pointed out by Waltman (2016). All data were collected in September 2020, and the *hindexGS* refer to the h index of each researcher in the date of collection. The h metrics provides a way to monitor the visibility and influence of a researcher in scholarly publications, and refers to the largest number *h* such that at least *h* articles of an author were cited at least *h* times each. Although extremely controversial as a measure of a researcher's reputation as discussed by Wildgaard et al. (2014), we again opted for a more pragmatical view of collecting and computing this information. In general, each citation database computes its own h factor based on its citation data. Although data on Google Scholar are problematic for bibliometric studies, since citation can be easily inflated (Labbé, 2010; Waltman, 2016), and disambiguation problems are common, the h index metrics of a researcher is easily obtained, being convenient for our study. We acknowledge that the GS citations are not of the same quality or weight of proprietary databases, such as Clarivate Analysis or Scopus. However, as demonstrated by Meho and Yang (2007), GS results do not significantly change the relative ranking of scholars, and therefore it is suitable for our study. Its also worth to point out that, unlike Google Scholar, other commercial databases such as *Scopus* and *Web of Science* do not provide free access using an API, which invalidates their use for the large sample of researchers in the study. Data was gathered directly from Google Scholar. We matched researchers in between both repositories – Google Scholar and Lattes – using their full names. A closer inspection in the resulting table shows a particular problem of misplaced citations. Researchers with popular last names, such as *Silva* or *Santos*, are the ones with highest h indexes. This happens because any work with their initials and not discredit by the author will be picked up by Google's algorithm. To solve it, we counted the occurrence of each last name and filtered out those within the 15 most frequent surnames, including *Silva, Oliveira, Santos* and many others. After cleaning the data for frequent last names, we are left with 14,146 researchers with citation data, including the h index from Google Scholar.

As for the right side of the statistical model, the explanatory variables, we first followed the definitions given in Table 1 for the inbreed type and build dummy variables that take value one if the researcher belongs to a particular group of inbreeds, and zero otherwise. For control variables, we used well established variables from the main literature in academic productivity.

A special attention should be given to the heritage effect, that is, the impact of the institution granting the PhD over future productivity of the researcher. The productivity of a fresh PhD is likely to be positively related to institution where the PhD was obtained. This effect is not directly related to inbreeding, justifying its control in the statistical model. For that, we use the following two variables related to quality and quantity of publication in the PhD granting institution: $HeritageQualis$ and $HeritageNPublic$. Next, we describe all explanatory and control variables used in the study.

DMale Dummy for gender (male), using the first name of the researcher. The gender matching algorithm is based on R package *GenderBR* (Meireles, 2018). It works by importing a large database from IBGE's 2010 census (IBGE is the Brazilian a government agency for statistical data, being the main provider of data and information about the country), which contains first name and associated gender for a large number of individuals. It then calculates the proportion of male and female for each unique first name. For a given string (name), a person is set to be female if more than 90% of the occurrences for that name are female. All proportions below the 90% threshold for male or female are set as NA (*not available*). When applying the gender matching algorithm to the Lattes data, we were able to match 96.5% of the names in the dataset. The gender variable has been found significant in explaining academic productivity in previous studies (van Arensbergen et al., 2012; Prpić, 2002), justifying its inclusion.

DPhDAbroad Dummy variable taking value one if a researcher obtained his/her PhD outside of Brazil, and zero if not. For the Brazilian case, there is strong evidence that the location of institution granting the PhD is positively related to the impact of research Perlin et al., 2017). Since we are looking at inbreed impact, which is directly related to the PhD granting institution, we consider relevant to filter the impact of the PhD obtained abroad from the inbreed effect.

DPostDoc Dummy binary variable that indicates if a researcher has taken a post-doc position before his/her first academic hiring position. We add this variable to consider the impact on research productivity that a postdoc position can offer to a young researcher. Note that a postdoc position is taken into account when building the *Mobile inbreed* dummy variable, so we must make sure the postdoc effect does not contaminate the result.

HeritageQualis For each institution and year, we calculate the percentage of publications in levels A1 and A2 of Qualis from researchers in different fields. We later matched it with researchers by year and institution granting the PhD. This is a novel variable, used as control for heritage effects, that indicates if the quality of the publications of a newly researcher is strongly related to the quality of publications of its PhD granting institution. Such an effect is independent of the inbreed impact, and should filter it out of the data. In a sense, this variable adds institutional control for the institutions where the faculty are working.

HeritageNPublic For each institution and year, we calculate their number of publications. We again matched this data using the researcher's PhD granting year and institution. Following previous logic, we also add the number of publications as a control variable to filter out the heritage effect.

SciField Matrix of dummy variables for the major area of science of a researcher, taking values one or zero. As different areas have different incentives for publications in books, academic journals and magazines, this dummy variable filters any possible field effect in the dependent variables. The scientific fields were classified following the Lattes platform, namely: Biological Sciences, Health Sciences, Agricultural Sciences, Engineering, Exact and Earth Sciences, Applied Social Sciences, Linguistic and Arts, Human Sciences, and 'Others'. The researchers were classified based on their own information recorded in Lattes.

YearK Dummy variable for the years between 2000 and 2016, taking value one if a researcher finished the PhD in year k. We use this variable to control for any specific year effect over the dependent variables such as a systematic change of productivity incentives.

3.3. Statistical Models and Methods

Our modelling approach uses different versions of Generalized Linear Models (GLMs) (Nelder and Wedderburn, 1972) to investigate the impact of inbreeding practices over academic productivity. In its most generic formula, the GLM model can be represented by the following equations:

$$E\left(Y_i\right) = f\left(X_i\right) \tag{1}$$

$$X_i = \alpha + \sum_{j=1}^{5} \phi_i Dummyinbreed_{i,j} + \sum_{k=1}^{K} \beta_i Control_{i,k} \tag{2}$$

where Y_i is one of the measures of academic productivity defined in previous section, $Dummyinbreed_{i,j}$ is a dummy variable for inbreed category j of researcher i, $j = 1, \dots, 5$, $i = 1, \dots, 76,922$.

We use a different GLM link function depending on the nature of the dependent variable. On one hand, for all positive variables such as average number of publications and SJR, we use a Gamma distribution GLM with a log-link based function. On the other hand, for proportion variables, such as *HeritageQualis*, we use a GLM with a logit specification. All models are estimated using the standard maximum likelihood technique.

Further, we use Propensity Score Matching (PSM) method for pairing the inbreed groups against non-inbreeds. PSM is a statistical tool for modelling differences between groups of the data using a pairing technique that imposes a balanced dataset – same number of cases in all groups within the regression (Rosenbaum and Rubin, 1983; Zong et al., 2020). By matching the data using control variables, we attempt to reduce the confounding bias and mimic randomization. That is, for every researcher in one of the inbreed groups, such as *Pure-inbreed*, we find a *Non-inbreed* case that closely matches the values of the control variables described before. The idea is to select a portion of the dataset of researchers that are very similar in all control variables, except in their academic inbreeding formation. We later use this filtered dataset to test if the control group has a different impact on the dependent variables. One of the advantages of using PSM is that good matches are not difficult to find since the pool of candidates is very large – the majority of the dataset is for *Non inbreeds* researchers. After matching the data using PSM, we estimate the following GLM model to capture the impact of inbreeding over academic productivity:

$$E\left(Y_i^*\right) = f\left(X_i^*\right) \tag{3}$$

$$X_i^* = \alpha + \Phi_i Group_i \tag{4}$$

where Y_i^* is one of the measures of academic productivity described in previous section, but with cases (rows) filtered using PSM. Most importantly, $Group_i$ is a dummy binary variable that takes value one if researcher i is part of the inbreed group used in the sample matching technique, and zero otherwise. Coefficient Φ_i indicates the effect of an inbreed formation over a sample of paired researcher academic productivity that are very similar except in their inbreed group.

4. Results

All calculations presented here were conducted in the statistical platform R, version 4.1.2. A statistical description of the variables is available in Table 2, presenting median values of the variables, classified by inbreed categories. First, we see that the non-inbreed cases represent the large majority in the dataset, approximately 81% of all researchers in the sample. As for the inbreed categories, *inbreeds* are the most common cases (11.83%), followed by *Pure inbreed* (5.94%), *Silver-Corded* (0.81%), and *Mobile inbreed* (0.31%). As for the median year of PhD completion, we see that the *inbreed* cases represent an older generation when comparing to the Non-inbreeds. While the median year of **PhD completion** of *inbreeds* is 2011, it is 2009 for the *Non-inbreeds*. On the other hand, *Pure inbreed, Silver-Corded* and *Mobile inbreed* cases are, on average, from older generations when comparing to the *inbreed* case.

As for productivity in research articles, we see from Table 2 that researchers in the inbreeding categories have the same or slightly higher median values for the number of publications, and all measures of impact of publications – SJR and PercA1A2. The same behaviour is also observed concerning the Google's h index (see Fig. 1, where mobile inbreeds present the highest median value of

Table 2
Descriptive Statistics.

Variable	Full Sample	Inbreed	Pure Inbreed	Silver-Corded	Mobile Inbreed	Non-Inbreed
Number of Academics	76521 (100.00%)	9051 (11.83%)	4542 (5.94%)	616 (0.81%)	239 (0.31%)	62073 (81.12%)
% PhD Abroad	4.43%	0.00%	0.00%	0.00%	0.00%	5.46%
Median Year of PhD	2009	2011	2009	2006	2006	2009
Median Publications per Year	0.75	0.75	0.8	1.2	1.5	0.75
Median SJR	0.132	0.268	0.272	0.276	0.665	0.0925
Median Qualis Points	40	43	43.4	47.5	60.9	39.4
% with H index (Gscholar)	20.25%	19.94%	19.68%	31.33%	33.47%	20.17%
Median H index (GScholar)	9	9	10	12	14	9
Median Perc. of Qualis A1-A2	0.00%	0.00%	0.00%	1.65%	14.29%	0.00%
Median Perc. of Qualis B1-B2	15.38%	20.00%	23.53%	28.80%	41.98%	14.29%
Median Number of Books per Year	0	0	0	0	0	0
Median Supervisions per Year	0	0	0	0.357	0.5	0
% of Male	48.92%	40.86%	43.26%	54.55%	53.14%	50.43%

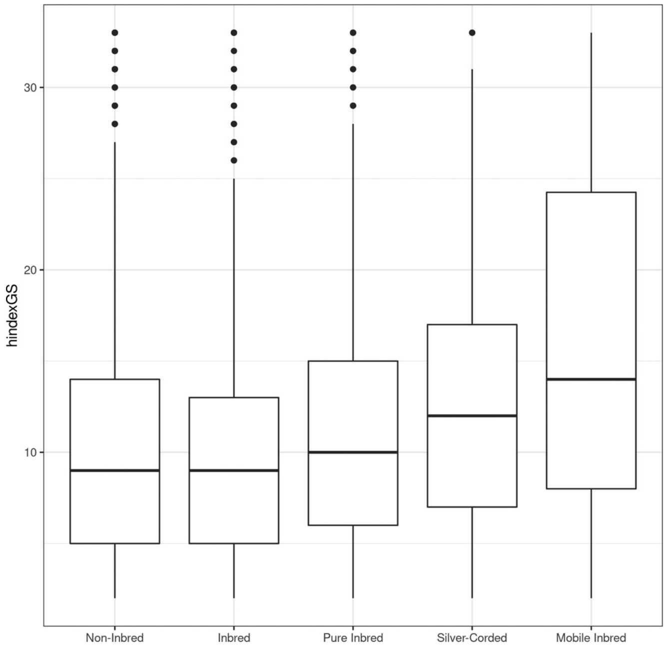

Fig. 1. Density of hindexGS.

all analysed categories. However, for books and supervisions, we find many zero medians and no clear direction of impact of inbreed formation. Further, Table 2 reports **gender** effects across the inbreed groups: most *inbreeds* and *Pure inbreeds* are female, while *Silver Corded* are male. This result was not a surprise, considering the conservative issues rooted in the Brazilian society, in which women are held responsible for child care and housework (Baccarini et al., 2019).

Table reports the results from GLM model in Eq. (1). To keep the content manageable, we omit the estimation results for control variables $SciField$ and $YearK$. These can, however, be sent upon request. As for model's diagnostics, we manually checked the residuals distribution and also checked for multicolinearity using variance inflation factors (VIF). As expected, we did not find any unusual residual or any explanatory variable with VIF higher than 5.

In a general analysis of the obtained results, the following aspects can be highlighted: (i) male researchers produce a higher quantity of journal publications (NPublic) and books (NBooks), and finish more supervisions (NSupervisions). Further, they present higher h index scores from GS. This result partially confirms previous studies (Perlin et al., 2017 and Prpić, 2002); (ii) A PhD Abroad also positively impacts SJR, hindexGS and the quantity of books and supervisions (iii) *PostDoc* variable impacts positively and significantly almost all measures of productivity, except Nbooks, where it is only positive but without significance. This means that researchers with a previous postdoc successfully guide more graduate students, publish more articles and in more prestigious journals, considering SJR as a metric; (iv) when looking at the heritage variables, we find a strong correlation between quality of publications of the institution granting the PhD and the researcher. When looking at model (4), we find the coefficient for *Heritage (%A1 A2)* to be the largest (10.356). Notice, however, a negative impact of *Heritage (number of papers)* over quality (SJR, PercA1A2) of publications in models (2), (3) and (4). We find this result intuitive as there is a trade off between quality and quantity of publications. As such,

Table 3
Estimation Results with Matched Data by PSM (Eq. 3).

	Dependent Variables:					
	NPublic (1)	SJR (2)	PercA1A2 (3)	NBooks (4)	NSupervisions (5)	hindexGS (6)
Panel A: **Inbreed** as grouping factor						
Group (Inbreed)	- 0.011	0.027	0.001	- 0.001	0.040	0.010
Constant	0.149***	- 0.850***	- 2.218***	- 3.014***	- 1.380***	2.328***
Observations	18,102	18,102	18,102	18,102	18,102	3,578
Panel B: **Pure Inbreed** as grouping factor						
Group (Pure Inbreed)	0.052**	0.154***	0.245***	0.042	0.164***	0.082**
Constant	0.142***	- 1.020***	- 2.470***	- 2.963***	- 1.228***	2.378***
Observations	9,084	9,084	9,084	9,084	9,084	1,679
Panel C: **Mobile Inbreed** as grouping factor						
Group (Mobile Inbreed)	0.515***	0.545***	0.921***	- 0.165	0.613***	0.232*
Constant	0.220***	- 0.936***	- 2.317***	- 2.852***	- 0.960***	2.568***
Observations	478	478	478	478	478	117
Panel D: **Silver-Corded** as grouping factor						
Group (Silver-Corded)	0.440***	0.390***	0.588***	0.119	0.344***	0.164**
Constant	0.046	- 1.194***	- 2.521***	- 2.785***	- 0.968***	2.427***
Observations	1,232	1,232	1,232	1,232	1,232	310

Note: *p<0.1; **p<0.05; ***p<0.01.

our results suggests that institutions granting the PhD may be a good predictor of the future quality in the research productivity of the researcher.

Concerning the effect of the four inbreed categories and *Non-inbreeds* (represented by each respective dummy variable) over academic productivity on the whole sample, the most interesting result is that the great majority of coefficients are positive and significant, indicating that, on average, *Non-inbreeds* publish less papers, in lower ranking journals and perform less supervisions. As an example, the marginal effect[4] (Greene, 2003; Wasserstein et al., 2019) of being a mobile inbreed over number of publications per year (NPublic) is 0.48. When comparing this value to the median of 0.75 publications per year for Non-inbreeds (see Table 2), we see that mobile inbreeds do publish a higher number of articles per year than non-inbreeds. The same positive marginal effect holds for quality of publications, models (2), (3) and (4).

This result does not follow the detrimental perception of academic inbreeding pointed out by several studies (Dutton, 1980; Horta et al., 2010; Inanc and Tuncer, 2011). It seems that Brazilian academy lives well with academic inbreeding. This results is better explored in the next section. Analysing the specific inbreeding categories, the coefficients for inbreed cases – *inbreed, Mobile inbreed, Pure inbreed* and *Silver Corded* – are mostly positive and significant, except for books. However, it is interesting to note that they do not follow a single pattern, justifying the use of a diverse conceptualization to explore the inbreeding phenomena as pointed out by previous research Berelson, 1960; Horta, 2013).

Clearly, silver-corded and mobile inbreed faculty present, in general, better coefficients for almost all measures of productivity in comparison with inbreed and no-inbreed faculty. Particularly, the largest and positive coefficients are found for the *Mobile inbreed*, which are the most positive and significant for all dependent variables except *NBooks*, indicating that some mobility during the academic life introduces some oxygenation both to researchers who carry out the mobility and their associates. Communication channels and new research partnerships are built, with a direct consequence in the increasing of the number of publications in both international and national prestigious journals. It is also possible to state that the previous insertion of silver-corded and mobile inbreed in their hiring institutions combined with mobility goes well with the Brazilian academic culture. It seems that the research collaborations created by the mobile inbreed during his/her study with previous professors and PhD students might be of relevance, being a possible partial justification for the best results obtained by this category.

Table 4 reports the estimation result of Eq. (3) for the matched data sets using PSM. Each panel in 4 reports the use of a different inbreed definition as grouping factor for matching the researchers against another in the group of *Non-inbreeds*. The inclusion of variable *hindexGS* required a significant decrease in the number of observations, since the majority of researchers in the sample has an h index of zero in the Google Scholar database for all analysed categories.

The results in Table 4 are very similar with those in Table, considering the same set of variables. Coefficient $Group$ is positive for almost all cases, across different panels. The only exceptions are the negative coefficients of $NBooks$ (panels *inbreed* and *Mobile inbreed*) and $NPublic$ (panel *inbreed*). Following the results in Table, group *Mobile inbreed* (panel C in Table 4) once again presents the highest values of positive coefficients across all inbreed cases. Overall, results in Table 4 strongly supports the results reported in Table, evidencing the robustness of the obtained results.

As a robustness test, we also conduct the same analysis within each science field. In Fig. 2, we provide a descriptive analysis by organizing researchers according to major science field informed in the Lattes platform. Two areas stand out for the *Inbreed* case: Biological Sciences with 17.87% and Health Sciences with 16.03%. For the *Pure inbreed*, we find a very similar pattern, but

[4] We use R package *marginaleffects* (Arel-Bundock, 2022) for computing all marginal effects.

Table 4
Estimation Results with Matched Data by PSM (Eq. 3).

	Dependent Variables:					
	NPublic (1)	SJR (2)	PercA1A2 (3)	NBooks (4)	NSupervisions (5)	hindexGS (6)
Panel A: **Inbreed** as grouping factor						
Group (Inbreed)	- 0.011	0.027	0.001	- 0.001	0.040	0.010
Constant	0.149***	- 0.850***	- 2.218***	- 3.014***	- 1.380***	2.328***
Observations	18,102	18,102	18,102	18,102	18,102	3,578
Panel B: **Pure Inbreed** as grouping factor						
Group (Pure Inbreed)	0.052**	0.154***	0.245***	0.042	0.164***	0.082**
Constant	0.142***	- 1.020***	- 2.470***	- 2.963***	- 1.228***	2.378***
Observations	9,084	9,084	9,084	9,084	9,084	1,679
Panel C: **Mobile Inbreed** as grouping factor						
Group (Mobile Inbreed)	0.515***	0.545***	0.921***	- 0.165	0.613***	0.232*
Constant	0.220***	- 0.936***	- 2.317***	- 2.852***	- 0.960***	2.568***
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Panel D: **Silver-Corded** as grouping factor						
Group (Silver-Corded)	0.440***	0.390***	0.588***	0.119	0.344***	0.164**
Constant	0.046	- 1.194***	- 2.521***	- 2.785***	- 0.968***	2.427***
Observations	1,232	1,232	1,232	1,232	1,232	310
Note:					*p<0.1; **p<0.05; ***p<0.01	

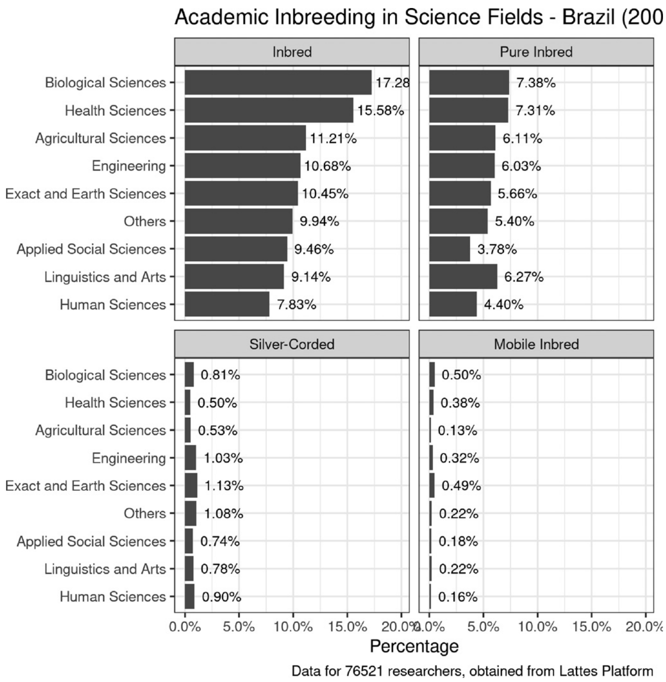

Fig. 2. Percentage of inbreed categories per science field.

with the field *Linguistics and Arts* also standing out. In certain sense, these results were expected due to the concentration of good research universities in Brazil in these fields, and the consequent small market for researchers. In specific subjects, like Medicine, the stratification is quite significant, with a large distance in quality between the best research universities, in general public ones, and the others medicine schools (see https://www.bbc.com/portuguese/geral-42186972). *Silver-Corded* and *Mobile inbreed* are present in smaller numbers in all science fields, specially the latter category. Further, they are more equally distributed among the science fields than the *Inbreed* and *Pure Inbreed* categories. The absence of academic mobility seems to be a strong characteristic related to inbreeding in Brazil in all science fields.

Also, we separately used the GLM model for each science field, only removing the dummy for the field itself. Table 5 reports the main results for the inbreed coefficients – all control variables are again omitted from the table for simplicity. Each column of Table 5 is a different science field. The results in this table follow, in general, the same pattern presented in Tables 2–4 with *Mobile inbreed* presenting the overall best scores concerning number of publications, prestigious of the published journals (represented by SJR), and publication impact (represented by the h index). Clearly, it is possible to observe some peculiarities concerning the different

Table 5
Estimation Results for Science Field (Eq. 3).

	Dependent variable:							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: **NPublic** as dependent variable								
Inbreed	0.168**	0.015	- 0.184*	- 0.060	0.006	0.030	- 0.034	0.017
Pure inbreed	0.067	- 0.021	- 0.165	0.161	0.142*	0.017	0.015	0.038
Mobile Inbreed	0.545	0.232	0.155	0.416	0.216	0.329	0.522***	0.729***
Silver Corded	0.053	- 0.203	- 0.534*	0.085	0.195	0.492**	0.067	- 0.088
Constant	- 1.133***	- 0.609***	- 1.498***	- 1.022***	0.297**	0.075	- 0.249**	- 1.201***
Area of Science	Engin	Human	Lingu	Appli	Healt	Agric	Biolo	Exact
Observations	1,690	2,297	653	1,563	2,121	1,924	2,573	2,575
Panel B: **SJR** as dependent variable								
inbreed	0.069	0.172	0.184	0.318	0.112	0.084	0.006	- 0.056
Pure inbreed	0.220*	- 0.112	0.018	- 0.580	0.066	0.018	0.149**	0.129
Mobile inbreed	0.631	- 0.857	- 0.289	0.686	0.095	0.718	0.575***	0.760***
Silver Corded	0.661***	- 0.504	2.021***	- 0.228	- 0.104	0.627***	0.346**	0.375**
Constant	- 1.012***	- 3.733***	- 3.998***	- 3.011***	- 1.321***	- 1.444***	- 0.692***	- 1.256***
Area of Science	Engin	Human	Lingu	Appli	Healt	Agric	Biolo	Exact
Observations	1,690	2,297	653	1,563	2,121	1,924	2,573	2,575
Panel C: **hindexGS** as dependent variable								
inbreed	0.091*	0.021	0.274*	0.021	- 0.009	0.048	- 0.077**	- 0.010
Pure inbreed	0.045	0.106	- 0.017	0.138	0.111**	0.105	0.007	0.093
Mobile inbreed	0.361	0.373	0.611	0.098	0.059	0.451	0.240	0.391*
Silver Corded	0.071	0.167	0.981**	0.021	0.074	0.378**	0.112	- 0.049
Constant	- 0.717***	- 0.773***	- 0.732*	- 0.732***	- 0.320***	- 0.224*	- 0.324***	- 0.709***
Area of Science	Engin	Human	Lingu	Appli	Healt	Agric	Biolo	Exact
Observations	1,690	2,297	653	1,563	2,121	1,924	2,573	2,575

Note: *p<0.1; **p<0.05; ***p<0.01.

science fields. For instance, inbreeding categories poorly perform in panel B for Humanities and Linguistic Fields, especially *Mobile inbreed*. Some areas present a larger difference among the scores of the inbreed categories, such as Agricultural and Exact Sciences, while others present smaller differences, such as Health Sciences and Engineering. Although some of these effects can be partially justified by the difference in the sample sizes of each inbreeding category for each science field (see Fig. 2), further experimentation will be required to explain both behaviors. Nevertheless, the overall results in Table 5 do not allow to identify different consistent patterns concerning inbreeding among the different science fields.

5. Discussion and policy implications

Overall, the results obtained in this study refute the detrimental view of academic inbreeding practices in scientific productivity. In the Brazilian context, our statistical analyses shows that inbreeds are no less productive than non-inbreeds in journal publications, and M.Sc. and PhD supervision. Thus, there is no support to the hypothesis of negative effect of inbreeding to scientific productivity in Brazil. This result is consistent with the findings in some other countries (Alipova and Lovakov, 2018; Lovakov et al., 2019; Shin et al., 2016; Smyth and Mishra, 2014).

Robust statistical analysis relating inbreeding and several measures of productivity indicate that **inbreeding with some mobility works well** in the Brazilian HES, since silver-corded and mobile inbreed categories performed better than the remaining ones. Our analysis suggests that mobility can be beneficial to scientific productivity in Brazilian academy Horta, 2013; Horta and Yudkevich, 2016). We recommend the Brazilian universities and government agencies to continue or establish new incentive research programs of long scholar visits to prestigious international research institutions as mean of enhancing the research capabilities.

But these results should be cautiously approached. They cannot be interpreted as any sort of recommendation to hire only former students by a university. The current hiring system in research universities in Brazil, based on public tender and open competition, was designed to prioritize academic merit. However, although the hiring process is highly formal, the process can also influenced, in practice, by a disseminate "localism" (Sivak and Yudkevich, 2015) culture among senior professors. This fact is not a surprise given the small market for newly trained researchers, due to the concentration of research in few universities, and the culture of immobility among Brazilian researchers (Balbachevsky, 2016; Horta, 2013). Both factors together might be creating a favourable environment to inbreed candidates to secure good job positions, and consequent future research careers. Further, it is noteworthy that it is not possible to take any formal countermeasure or policy against academic inbreeding in the current hiring processes. All academic positions should be accessible for applications independently from where the candidate has obtained his/her PhD degree. Blocking someone to a job opportunity based on the argument of being a former student of an academic institution is not allowed by national legislation. By the same token, creating an artificial advantage specifically for former students would also be considered illegal – at least in cases of public tender. Brazil is thus a particularly interesting research country to test and explore the relationship between hiring process and academic inbreeding.

Our research results also suggests the plausibility of considering the existence of an institutional effect in scientific productivity. The collective results of publication calculated based on heritage factors could be indicating a strong relation between the inbreed faculty productivity and his/her hiring university productivity as a whole. A plausible explanation is that inbreed faculty might immediately be inserted in the research community of the hiring university, without facing an adaptation process (Wyer and Conrad, 1984). On the other hand, non-inbreed faculty can pass through an adaptation process that might not be not so smooth in comparison to inbreeds. Scientific formation, social networking, infrastructure, funding, and access to other types of specific resources are some of the possible elements that can be inherited and might help explaining the average better scientific productivity of inbreed researchers in our case. Although our study specifically focused on the productivity output based on CV data set, in which the idea of heritage was limited to the stratification of publication quality and quantity, future research can be designed to further explore the relationship between institutions heritage and academic inbreeding.

Arguably, inherited elements can also be associated with the detrimental view of academic inbreeding, leading in the long term to specific deleterious effects to the academia, such as parochialism, cronyism, nepotism, favoritism, and scientific stagnation. However, our results empirically demonstrate that this association is not so direct, and can be questioned based on cultural, legal, and structural (CLS) issues of a specific HES. An understanding about the effects of inheritable social elements, considering different CLS environments, can be a possible way to deepen our knowledge regarding the complexity and contradictions related to hiring former students as faculty members.

Also, the maturity of the local HES cannot be overlooked. The Brazilian university is currently experiencing a serious crisis of acceptance by society. The overall inclusion and access of the population to higher education needs to improve considerably (Balbachevsky, 2016; McCowan, 2007). Moreover, Brazil is still struggling to become a relevant player in the generation of knowledge and technology. The number of papers published by Brazilian scientists is disproportionate to the size of the population, the number of papers in the most prestigious journals is still very small, and the number of patents resulting from academic research is insignificant (Sá et al., 2015). Brazilian science is overly concentrated in 15 universities that produce 60% of all academic production[5]. Although Brazil's participation in the last two decades from the 27th to the 18th position in the global ranking of science and technology, the impact of Brazilian scientific production has not changed (Pedrosa, 2020; Sá et al., 2015). In general, Brazilian researchers publish a reasonable number of article national and internationally, but with low citations per article. Notwithstanding the results related to scientific productivity, many challenges remains within Brazilian HES an the possible relations of that reality with academic inbreeding remain imprecise.

Finally, the results suggest that the denomination of "academic inbreeding" might need to be reevaluated. Even though the definition does not have a negative connotation itself, it is hard to dissociate the use of inbreeding with problematic issues (Horta and Yudkevich, 2016; McGee, 1960; Yudkevich et al., 2015). The idea of inbreeding understood as an biological metaphor helps visualizing the possibility of threats that can be cause to an academic institutional setting, but the evidences suggests that the analogy is far from being accurate due to the fact that political, cultural, economical, structural, and social elements also need to be considered as part of such process. Academic inbreeding should not be taken too strictly as it Biology counterpart and as having a similar inevitable deleterious outcome. "Alumni faculty" Li et al. (2015) could be an appropriate alternative to avoid prejudgement and misrepresentation when first approaching a research context. All eventual academic inbreeding effects should be derived from alumni faculty. However, not all alumni faculty, collectively, might be performing an accountable deleterious effect associated with academic inbreeding as stated in the literature.

6. Conclusions

This article investigated the impact of inbreed academic formation in the productivity of Brazilian researchers using a large database from Lattes platform and Google Scholar. This is the first detailed study to analyze the effects of academic inbreeding in the research productivity in Brazil considering all different fields of knowledge.

Based on a large sample and a statistical analysis approach, the main finding of this paper is that inbreed cases are in general more productive and outperform non-inbreeds in almost all measures of academic productivity, including the h index from Google Scholar. Furthermore, we find that *Mobile inbreeds* – researchers that worked somewhere else before joining their PhD granting institution – are the most productivity overall. Academic mobility can impact productivity and, along with the result regarding the positive effect of a studying period abroad, suggest that supporting international exchange programs such as post-docs are an efficient way of increasing overall scientific productivity.

Such a result indicates that there is no evidence to support the detrimental view of inbreeding in Brazil. However, our results cannot be taken by any mean as a neglect of the potential and factual threats that have been associated with academic inbreeding in the long-term. Problematic misbehavior such as nepotism, parochialism, cronyism, favoritism, and discrimination requires full attention of policymakers and academic institutions administrators. All unethical, discriminatory, illegal and unfair attitudes that have been highlighted by the academic inbreeding research literature should be strongly opposed by the scientific community. The main conclusion of our study is to state that academic inbreeding cannot be directly associated with the lack of scientific productivity. Accordingly, generalized negative assertions or any sort of discrimination regarding the hiring of former students as faculty based on this argument should be avoided as it is not supported by data evidence.

[5] https://jornal.usp.br/wp-content/uploads/2019/09/ClarivateReport_2013-2018.pdf.

Academic inbreeding remains as a controversial issue. Policy-makers and academic administrators should be aware of eventual long-run term effects, associated with stagnation and poor standards. We are going through a time of great pressure on science and particularly on universities. Society demands a university, at the same time, more integrated to its problems and capable of producing cutting-edge research. The answer to these demands goes through a reflection, in which academic inbreeding cannot be put aside, but effectively discussed. Notwithstanding the challenging context, generalized accusations or misrepresentation of inbreed faculty can be as harmful as the alleged dangers to the scientific work. We suggest that understanding the academic heritage effect can be a way to conceptualize and theorize the academic inbreeding process. More studies are required to dismiss the extant controversies regarding the hiring of former students and to advance in the academic inbreeding literature.

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CRediT authorship contribution statement

Denis Borenstein: Resources, Investigation, Data curation, Writing – original draft. **Marcelo S. Perlin:** Resources, Investigation, Data curation. **Takeyoshi Imasato:** Resources, Investigation, Data curation, Writing – original draft.

References

Alipova, O., & Lovakov, A. (2018). Academic inbreeding and publication activities of Russian faculty. *Tertiary Education and Management, 24*(1), 66–82.
Arel-Bundock, V. (2022). marginaleffects: Marginal effects, marginal means, predictions, and contrasts. R package version 0.3.1 https://CRAN.R-project.org/package=marginaleffects.
Altbach, P.G., Yudkevich, M., & Rumbley, L.E. (2015). Academic inbreeding: local challenge, global problem. *Asia Pacific Education Review, 16*(3), 317–330.
Badat, S. (2015). Academic inbreeding: The south african case. In *Academic inbreeding and mobility in higher education* (pp. 182–205). Springer.
Baccarini, M.P.O., Minillo, X.K., & Alves, E.E.C. (2019). Gender issues in the ivory tower of Brazilian IR. *Contexto Internacional, 41*, 365–396.
Balbachevsky, E. (2016). Brazilian higher education: Converging trajectory patterns in a diverse institutional environment. In *Biographies and careers throughout academic life* (pp. 31–45). Springer.
Barbosa, E.T., Lunardi, M.A., Bizatto, L.S., & Biavatti, V.T. (2018). Relação entre endogenia e a avaliação CAPES dos programas de pós-graduação em ciências contábeis no brasil. *Revista de Educação e Pesquisa em Contabilidade, 12*(2), 169–185.
Berelson, B. (1960). *Graduate education in the United States*. New York: McGraw Hill.
Bosch, X. (2001). *Tenure-track plan aims to end university inbreeding*. Nature Publishing Group.
Charlesworth, D., & Charlesworth, B. (1987). Inbreeding depression and its evolutionary consequences. *Annual Review of Ecology, Evolution, and Systematics*, 237–268.
Charlesworth, D., & Willis, J.H. (2009). The genetics of inbreeding depression. *Nature Reviews Genetics, 10*(11), 783–796.
Caplow, T., & McGee, R.J. (1958). *The academic marketplace*. Transaction Publishers.
Damaceno, R.J.P., Rossi, L., Mugnaini, R., & Mena-Chalco, J.P. (2019). The Brazilian academic genealogy: evidence of advisor–advisee relationships through quantitative analysis. *Scientometrics, 119*(1), 303–333.
Dixon, W.J., & Yuen, K.K. (1974). Trimming and winsorization: A review. *Statistische Hefte, 15*(2), 157–170.
Dutton, J.E. (1980). The impact of inbreeding and immobility on the professional role and scholarly performance of academic scientists. *Paper presented at the annual meeting of the american educational recreational research association (boston, MA, april 7–11)*. Retrieved from https://eric.ed.gov/?id=ED196714
Eells, W.C., & Cleveland, A.C. (1935). Faculty inbreeding. *The Journal of Higher Education, 6*(5), 261–269.
Eisenberg, T., & Wells, M.T. (2000). Inbreeding in law school hiring: Assessing the performance of faculty hired from within. *The Journal of Legal Studies, 29*(S1), 369–388.
Furtado, C.A., Davis Jr, C.A., Gonçalves, M.A., & de Almeida, J.M. (2015). A spatio temporal analysis of Brazilian science from the perspective of researchers career trajectories. *PloS One, 10*(10).
Gorelova, O., & Yudkevich, M. (2015). Academic inbreeding: State of the literature. In *Academic inbreeding and mobility in higher education* (pp. 17–44). Springer.
Greene, W.H. (2003). *Econometric Analysis*. Pearson Education India.
Horta, H., Veloso, F.M., & Grediaga, R. (2010). Navel gazing: Academic inbreeding and scientific productivity. *Management Science, 56*(3), 414–429.
Horta, H., Meoli, M., & Santos, J.a.M. (2021). Academic inbreeding and choice of strategic research approaches. *Higher Education Quarterly*. 10.1111/hequ.12328.
Horta, H., Sato, M., & Yonezawa, A. (2011). Academic inbreeding: Exploring its characteristics and rationale in Japanese universities using a qualitative perspective. *Asia Pacific Education Review, 12*(1), 35–44.
Horta, H. (2013). Deepening our understanding of academic inbreeding effects on research information exchange and scientific output: new insights for academic based research. *Higher Education, 65*(4), 487–510.
Horta, H., & Yudkevich, M. (2016). The role of academic inbreeding in developing higher education systems: Challenges and possible solutions. *Technological Forecasting and Social Change, 113*, 363–372.
Inanc, O., & Tuncer, O. (2011). The effect of academic inbreeding on scientific effectiveness. *Scientometrics, 88*(3), 885–898.
Labbé, C. (2010). *Ike Antkare one of the great stars in the scientific firmament*. LIG, University of Grenoble, France Ph.D. thesis..
Li, F., Miao, Y., & Yang, C. (2015). How do alumni faculty behave in research collaboration? an analysis of Chang Jiang Scholars in China. *Research Policy, 44*(2), 438–450.

Lovakov, A., Yudkevich, M., & Alipova, O. (2019). Inbreeds and non-inbreeds among Russian academics: Short-term similarity and long-term differences in productivity. *Higher Education Quarterly, 73*(4), 445–455.

McGee, R. (1960). The function of institutional inbreeding. *American Journal of Sociology, 65*(5), 483–488.

McCowan, T. (2007). Expansion without equity: An analysis of current policy on access to higher education in Brazil. *Higher Education, 53*(5), 579–598.

Meho, L.I., & Yang, K. (2007). Impact of data sources on citation counts and rankings of LIS faculty: Web of Science versus Scopus and Google Scholar. *Journal of the American Society for Information Science and Technology, 58*(13), 2105–2125.

Meireles, F. (2018). genderBR: Predict gender from brazilian first names. R package version 1.1.0 https://CRAN.R-project.org/package=genderBR.

Navarro, A., & Rivero, A. (2000). All sectors of society must work together to save biodiversity. *Nature, 407*, 659.

Nelder, J.A., & Wedderburn, R.W.M. (1972). Generalized linear models. *Journal of the Royal Statistical Society: Series A (General), 135*(3), 370–384.

Pan, S. (1993). *A study of faculty inbreeding at eleven land-grant universities*. Ames, Iowa, US: Iowa State University Ph.D. thesis..

Pezzoni, M., Sterzi, V., & Lissoni, F. (2012). Career progress in centralized academic systems: Social capital and institutions in France and Italy. *Research Policy, 41*(4), 704–719.

Perlin, M.S., Santos, A.A.P., Imasato, T., Borenstein, D., & Da Silva, S. (2017). The Brazilian scientific output published in journals: A study based on a large CV database. *Journal of Informetrics, 11*(1), 18–31.

Picinin, C.T., Pilatti, L.A., Kovaleski, J.a.L., Graeml, A.R., & Pedroso, B. (2016). Comparison of performance of researchers recipients of CNPq productivity grants in the field of Brazilian production engineering. *Scientometrics, 109*(2), 855–870.

Prpić, K. (2002). Gender and productivity differentials in science. *Scientometrics, 55*(1), 27–58.

Pedrosa, R.H.L. (2020). Technological innovation and the æthird missiong of universities. In *Higher education in latin america and the challenges of the 21st century* (pp. 109–152). Springer.

Rocca, F.X. (2007). In Spain, inbreeding threatens academe. *Chronicle of Higher Education, 53*(22).

Rosenbaum, P.R., & Rubin, D.B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika, 70*(1), 41–55.

Sivak, Y., Yudkevich, M., et al. (2009). Academic inbreeding: pro and contra. *Educational Studies, 1*, 170–187.

Shin, J.C., Jung, J., & Lee, S.J. (2016). Academic inbreeding of Korean professors: academic training, networks, and their performance. In *Biographies and careers throughout academic life* (pp. 187–206). Springer.

Smyth, R., & Mishra, V. (2014). Academic inbreeding and research productivity and impact in Australian law schools. *Scientometrics, 98*(1), 583–618.

Sivak, E., & Yudkevich, M. (2015). Academic immobility and inbreeding in Russian universities. In *Academic inbreeding and mobility in higher education* (pp. 130–155). Springer.

Sá, C.M., Kretz, A., & Sigurdson, K. (2015). Research and the third missionin light of global events. In *Higher education in the BRICS countries* (pp. 379–398). Springer.

Tavares, O., Cardoso, S., Carvalho, T., Sousa, S.B., & Santiago, R. (2015). Academic inbreeding in the Portuguese academia. *Higher Education, 69*(6), 991–1006.

Tavares, O., Lança, V., & Amaral, A. (2017). Academic inbreeding in Portugal: Does insularity play a role? *Higher Education Policy, 30*(3), 381–399.

van Arensbergen, P., van der Weijden, I., & Van den Besselaar, P. (2012). Gender differences in scientific productivity: a persisting phenomenon? *Scientometrics, 93*(3), 857–868.

Waltman, L. (2016). A review of the literature on citation impact indicators. *Journal of Informetrics, 10*(2), 365–391.

Wildgaard, L., Schneider, J.W., & Larsen, B. (2014). A review of the characteristics of 108 author-level bibliometric indicators. *Scientometrics, 101*(1), 125–158.

Wyer, J.C., & Conrad, C.F. (1984). Institutional inbreeding reexamined. *American Educational Research Journal, 21*(1), 213–225.

Wasserstein, R.L., Schirm, A.L., & Lazar, N.A. (2019). Moving to a world beyond “$p < 0.05$”. *The American Statistician, 73*, 1–19.

Yudkevich, M., Altbach, P.G., & Rumbley, L.E. (2015). *Academic inbreeding and mobility in higher education: Global perspectives*. Springer.

Zong, Q., Xie, Y., & Liang, J. (2020). Does open peer review improve citation count? Evidence from a propensity score matching analysis of PeerJ. *Scientometrics*, 1–17.