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Teaching case: the process of methodological choices in a quantitative approach

Caso para ensino: o processo de escolhas metodológicas em uma abordagem quantitativa

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Keywords
Research methods.
Methodological choices.
Analysis techniques.

Abstract

This teaching case deals with the maturing of a research problem in the master's program in Business Administration and Accounting. The problem was approached according to a positivist and quantitative-analysis paradigm. The case's description follows a narrative form of exposition, with dialogues between a master's student and his academic mentor and professors. Our goal was to shed light on the points of tension and major choices that typically emerge in the first year of a master's program in the area. The case not only contributes to knowledge on how this interaction generally works, but also to a reflection on the choice of specific statistical techniques. It is suggested for use in disciplines such as research methodology and quantitative methods, dissertation seminars on master's course, and undergraduate research.

Palavras-chave
Métodos de pesquisa.
Escolhas metodológicas.
Técnicas de análise.

Resumo

O caso para ensino trata do processo de amadurecimento de um problema de pesquisa no programa de mestrado em Administração e Contabilidade, no paradigma positivista, em uma abordagem quantitativa. O caso adota uma narrativa e diálogos típicos entre um aluno de mestrado e seu orientador e professores, para expor os pontos de tensão e escolhas que emergem no primeiro ano de um típico programa de mestrado na área. O caso permite ao aluno conhecer uma típica interação no mestrado na área e refletir sobre a sequência de escolhas de técnicas estatísticas específicas. O caso de ensino é sugerido para disciplinas como metodologia de pesquisa, métodos quantitativos, seminários de dissertação no mestrado, e também para iniciação científica.

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Practical implications

This teaching case serves as support for the methodological choices of graduate projects in Administration and Accounting courses. It employs a quantitative-positivist approach to propose a dilemma regarding methodological choices, and discusses the appropriateness of these choices to the process of maturing a research problem and its support theory.

1 CASE DESCRIPTION

Leonardo is a 24-year-old graduate student in Business Administration. In addition to attending compulsory and elective disciplines, he is also part of one of his university's research groups. The group conducts research on Business Strategy and Performance. His ongoing dissertation is about the internal and external mechanisms of Corporate Governance. This subject has long been a part of his academic history, considering that, since graduation, he has been closely following the companies listed on the B3 stock exchange while taking a keen interest in all forms of corporate governance. His reason for entering the master's course was to deepen his knowledge on the subject, producing research on it within the context of the Brazilian scientific community.

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Participating in the research group alongside Leonardo are master's and doctoral students, as well as some professors in areas correlated to the group's object of study. In the group, Leonardo is able to discuss the ideas, theories and methodologies he intends to employ in his dissertation. In one of the group's meetings, Leonardo had his first contact with Dr. Rubens, PhD, who was to become his academic mentor during the duration of the master's course.

2 THE LONGEST JOURNEY BEGINS WITH A SINGLE STEP

It is the first meeting between student and mentor, and Leonardo presents his initial ideas for the dissertation project, also expressing his main concerns:

- Professor, I've read your three most recent articles. You have a lot of knowledge and experience in corporate governance, a subject I'm very interested in. I'd like to study the relationship between external mechanisms of corporate governance and the performance of Brazilian companies listed on the stock exchange. This is my research goal. However, I have doubts as to which method I should employ.

- It really is a very interesting subject, Leonardo – said Professor Rubens – *There's an extensive field of research dedicated to it, and much work to be done. The literature on corporate governance is broad. Although studies specialized on this subject are relatively new, its underlying theories, such as Agency Theory and Transaction Cost Theory, are widespread and fairly mature. In this context, quantitative exploratory researches may be of less value – causal studies may be more appropriate. This choice, of course, will also depend on your research question. I'll explain the process behind quantitative methods, specifically, since it seems to me that these are best suited to your case. You said you wanted to analyze the relationship between two (or more) variables, so let's go from there. It's like a funnel, if you will* – said the professor, taking a pen and a blank sheet of paper in his hands.

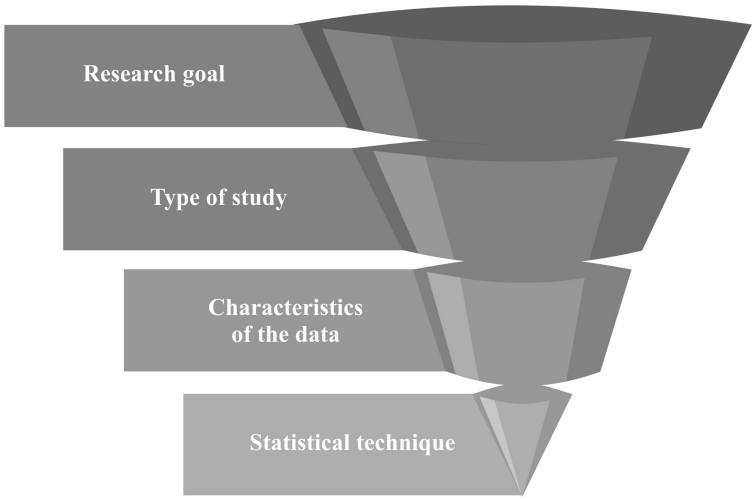

Figure 1. The process of methodological choice
Source: prepared by the authors based on Cooper & Schindler (2016).

Professor Rubens drew the figure that would, from that moment forward, guide Leonardo in his young career as a researcher. Before proceeding to make the young man even more nervous, the professor added:

- This will be your guide, Leonardo. By answering the questions posed by each of the funnel's four layers, you will arrive at the method and techniques adequate to your research. We already have some ideas about the first and second layers. You explained the study's goal. Regarding the type of research, there are four possible categories: informational, descriptive, explanatory and predictive. You need to take some time to deepen your understanding of this specific question, Leonardo. Are you going to be pointing out guidelines, based on governance mechanisms, for improving company performance? Or will you describe past data to find patterns? Your method of study must be consistent with your main goal. It's no use formulating explanatory hypotheses deduced from theory, in a hypothetic-deductive investigation, if your dissertation itself is only meant to describe data. Likewise, it makes no sense to propose a descriptive study while employing sophisticated causal explanation methods, with control of endogeneity and randomization. Think of your study as a company's production line. Its processes need to be aligned with each other, and very well justified.

- I see, professor. I'm going to do some reading to try and better delineate the study. Thanks for the help. I believe this will make things much clearer, said the young man, trying to absorb the considerable amount of information and dreading the significant work ahead.

- Leonardo, for the group meeting next month, I suggest you present the outline of your research intent, said the professor. You should explain the group what the study is about and how you intend to develop. It can really help mature the proposal.

- Of course, but what exactly should I be presenting, professor?

- Well, you may present your research goal, the theories you're going to refer to as the basis for your hypotheses, and the outline of the method you intend to apply. This may involve things like characteristics of the data, methodological approach and data analysis technique. You can follow the funnel model and seek subsidy in Hair et al. (2005), Black (1999) and Cooper and Schindler (2016). All of this can change throughout the research's development, but I think it's a good way to start.

- That's a deal, professor. I'll get to work preparing the presentation, Leonardo answered, trying not to let his insecurity show.

The meetings between Leonardo and his academic mentor were at an early stage. Professor Rubens was usually not very demanding of his master's students in the first semester, to allow them more time to study for their other subjects. Leonardo was a dedicated student who had previous knowledge of his research's subject—which he felt was exciting—but nagging methodological issues had always given him a hard time. He knew the study would move towards a positivist paradigm, but he had no idea as to which technique would be the most adequate.

"I don't know what to do! Even Hair's book alone describes ten different types of multivariate statistical techniques. Combine that with the univariate ones, and I've already lost count. How am I to make a choice here, Oh Dear Lord!," thought Leonardo.

3 THE BEGINNING, THE END AND EVERYTHING IN-BETWEEN

A week went by, and amidst the lessons and activities of the master's course, Leonardo devoted little time to study for his dissertation. With less than two months until the research group meeting, he decided to ask one of his teachers for help. During the break, in the university's corridor, he looked for Professor Dr. Oliveira, who, in addition to teaching quantitative methods, was also part of Leonardo's research group:

- Professor Oliveira, excuse me! I'm having trouble finding the best method to analyze my data. I have a good grasp of a grand total of three statistical techniques, but they seem insufficient. Should I use any of the methods I already know? I found two or three studies which employed these methods, but I still do not know what's the best option. Which statistical techniques are best suited to each of the four types of quantitative study?

- Calm down, kid. The choice of methodology demands patience, and must be made only after much consideration. It is a very important step during the development of the study, because a wrong choice here compromises the whole analysis of the results. The choice of methodology cannot be simply a matter of convenience, but rather a question of which methodology is able to provide the best fit to your research goal and area of collaboration, as well as the characteristics of the data, among other factors. The fact that you understand factor analysis does not make it suitable for your study. The choice must be derived from your research question, the level of maturity of your theory, and the characteristics of the data to which you have access. Do you have the data or know how to get it?

- Yes, since joining the master's degree course, I've been collecting data every week. So I already have 14 years-worth of data from companies listed on the Brazilian stock exchange. I may still need to collect other data, but I'm quite sure my starting point is very satisfactory.

- Right. Then you could run your data through a statistical analysis software, in order to, first of all, identify whether the sample has a normal distribution or not.

- This term sounds familiar. I've stumbled on this kind of sample classification in one of the books Professor Rubens recommended me.

- It's an important initial classification. For example: some statistical techniques work only with parametrically distributed data. Normal distribution, for instance. Other techniques are exclusively for data with non-parametric distributions, which do not respect any order of distribution. Then you can go ahead and, based on the literature, find the other data classifications. For instance: are the data heteroscedastic? Also, how were the data collected? Via survey, or is it secondary data? Do you intend to use a treatment that approaches causality results and mitigates endogeneity problems, or will it be a relational research? What techniques have the studies in your area been using, and why?

Leonardo made use of his previous knowledge, acquired in the research methods course, and, following professor Oliveira's guidance, realized that his data had a normal distribution. However, the conversation made Leonardo even more confused. Now he would have to understand not only the problem of technique, but also the meaning of those complicated terms.

"Heteroscedastic data? Endogeneity? Where the hell did I get myself in!" he thought.

Among the studies on corporate governance he was aware of, few used the statistical techniques he had already mastered. He decided to press on, reading more studies related to the subject. He immersed himself in the three books indicated by the academic mentor, and in more reference articles, in order to uncover the most adequate method. With each page, he discovered more. It was quite exciting!

4 A LIGHT AT THE END OF THE TUNNEL

The deadline was fast approaching, and Leonardo felt the pressure mounting. With just over a month until the research group meeting, after a quantitative methods class, Leonardo asked Professor Dr. Gomes, who taught the discipline, to give him some advice regarding the method and techniques he should use in his study. Everything was getting more and more confusing, and now there was not much time left.

- Professor, I have to present the project to my research group. My mentor asked me to outline my research intent. But I'm still in doubt about which method to use. Can you help me?

- Of course. – The teacher replied. Gomes was accustomed to helping students with methodological issues. *"You're Rubens' student, right?" The one who wants to research the relationship between governance mechanisms and company performance? Say there, what's your data like?*

- So, as I told Prof. Oliveira, I've been collecting data since the beginning of the master's course. I may need to collect more, but I already have a good volume. It's secondary data with normal distribution. I basically intend to relate the dependent (performance) variables to the independent ones, i.e., the ones referring to the internal and external mechanisms of corporate governance – Leonardo explained, proudly showing his knowledge of data classification. *– I'm about to finish the last lessons of the quantitative methods discipline. I have knowledge on some methods and was even able to test some relationships using my data. I did some T-tests and ANOVA.*

- Good, you've covered some ground already. In this case, my recommendation is for you to do a bibliometric survey on your subject. It will guide you and indicate the methods and statistical techniques most used by researchers in your area. Then you'll be able to find the most adequate one. Both quantitative and qualitative research can be used in confirmatory analyses. For example, your article could be a case study, content analysis in qualitative research. You could also use multiple linear regression or other sophisticated techniques of quantitative analysis. Analyzing the results of your bibliometric research will help with these definitions. Other determining factors for choosing a method are your research goal and the characteristics of the data. It seems to me that univariate statistics won't get you very far. I do believe you need to define the control variables. I'm not sure if you and your mentor have already established those. The above said, multivariate data analysis techniques are more adequate to your situation. Do the bibliometric study. You'll understand what I'm talking about. And don't worry, it's normal to be confused about methodological issues at such an early stage of research – said Professor Gomes.

The teacher's proposal really sounded great. *"I have to go beyond the seminal and often-cited articles. I'll investigate the overall scenario of publications on this subject.*" By searching in the Web of Science database, Leonardo found 249 articles. The large number quickly dissipated his initial enthusiasm.

"I'd never be able to read all of that! And even if I'm able to find the most common method, how do I know if it will be adequate to my specific dissertation? How could I even think this master's degree thing was a good idea? Help! How long do I have? One month?? It's not enough time!"

Leonardo regained control of himself and decided to set up a schedule of daily activities, so that he could finish the task at hand as soon as possible. He wanted to make sure the data would be useful in confirming his research hypotheses. Thus, after reading more on the subject and following Prof. Gomes' suggestion, he found several techniques that appeared suitable to his research. Interestingly, Leonardo found that previous studies had often used regression to analyze their data.

In the midst of reading so many articles, Marcelo, who was also part of the research group, approached Leonardo in the university study room, and asked with curiosity:

- Leonardo, what are you working so hard on?

- I'm doing a bibliometric research, to identify the method and statistical technique most appropriate for my dissertation. I am sure it'll be a quantitative study. Take a look at this: there are 249 articles, and all the studies that attempted to analyze the same kinds of relationships I want to analyze used quantitative methods. It's now a question of choosing the right statistical technique.

- I see. And do you intend to choose a given technique because it's the most commonly used one? Like, the majority wins?

- No, I think I'm going to innovate, Marcelo. So far, regression appears to be the most used technique. If at the end of the bibliometric study it remains so, I will propose something revolutionary, something completely new. For instance: I could use multivariate analysis of variance, MANOVA.

- You see, Leonardo: if regression is so recurrent, there's probably a reason for it. What we're doing here is science, my friend. We are not allowed to create something new without due reason, just because we want to innovate. Research methods can be innovated, but this innovation has to follow justified and, more importantly, accepted scientific itineraries.

- Yes, I think I'm being a little naive – acquiesced Leonardo, realizing how complex scientific evolution actually was.

It was not uncommon for Leonardo to find himself in such treacherous terrain, reaching for the spur of scientific innovation. These moments often came with existential crises. Still, he was not discouraged. His search continued. With the bibliometric survey finished, he would present the results to his mentor and, together, they would determine the next steps.

A few days went by. Leonardo finished the bibliometric research, and wrote a small letter of results. He was still distressed, but, by that point, distress was nothing new to him. The novelty was in everything else. Lack of research experience, the complexity surrounding research decisions, and the natural insecurity of a young man produced an ideal environment for the anxieties he was experiencing. But he had at last finished the bibliometric research, and the results were at hand. What were his findings?

5 REFLECTIONS

Leonardo wanted to show the research group something definite, based on his bibliometric research. One day before his presentation, he decided to speak with Professor Rubens, the academic mentor. Uncertain about how conclusive an answer the bibliometric study would provide, he went to Professor Rubens' office. Leonardo took a deep breath, held it for a few seconds, building the courage to finally knock at the door:

- Who's that?, Rubens asked from within the room.

- It's Leonardo, he answered.

- Come in.

The room seemed smaller.

- So, everything ready for tomorrow? Asked the mentor.

- I'd like to show you the results of a bibliometric survey I did. It helped me identify the method and statistical technique most used in studies similar to mine (I mean, studies relating external mechanisms of corporate governance).

- So, what are your findings?

- After an extensive literature search, the most widely used and appropriate method appears to be the hypothetical-deductive. Basically, 92% of the articles are quantitative and, among these, 73% proceed to develop hypotheses for testing. Multiple linear regression was the most frequent statistical technique (64%), alongside estimators such as OLS (ordinary least squares) and GMM (generalized method of moments). I could employ longitudinal data, together with the various articles I found during my bibliometrics survey. I think my data fit these characteristics. After all, what I have to do is create testable hypotheses, right? I'm also dealing with longitudinal data containing multiple variables. But I really wanted to innovate, Professor. To use a different statistical technique. I know this requires serious justification, but if I decide to use the same methods and techniques as everyone else, won't my work just be one more among many, with nothing special to it?

Professor Rubens was surprised by Leonardo's efforts and his interest in innovating. He straightened up in his chair, put a hand on his chin and, looking at the horizon, said:

- Hmmm ...

While Professor Rubens's eyes glanced at an indeterminate point, Leonardo stared at the computer screen, which displayed a table with his findings. Had the whole ordeal been worth it? Were his talks with professors and colleagues a good idea, or just another source of confusion? Is bibliometric research really necessary? And what about that uneasy drive to innovate in the choice of method and techniques? Was it a path worth following, given the characteristics of his research?

6 TEACHING NOTES

These teaching notes are for teachers who plan to use this case in the classroom. Moreover, the case should be tested in the classroom, under the same teaching conditions for which it was conceived. Based on this testing, it can undergo changes and improvements (Roesch, 2007). The mediator teacher can also select the thematic axes present in these notes and apply them to each specific class.

Educational goals

The presented case was structured so as to foment discussion between students and teachers, methodologically directing students' research in their initial phase of elaboration. The case seeks readers' identification with its characters, whether the student researcher, the doctoral student who also assists their colleagues, the teacher who recommends a certain path, the methodology course teacher, or the academic mentor.

Based on three thematic axes, the following educational gains are expected:

1) The student's empirical and theoretical maturation;

2) Deepening of technical knowledge on quantitative methods;

3) An understanding of the adequacy of a given statistical method to the student's research objective, and adherence of proposed models to the standards of the specialized community researching a certain phenomenon.

The empirical data in the present case were created in a playful way. In the same vein, the plot was adapted from real events, reported by teachers and students of a master's program and academic doctorate in Administration. The same situations, however, occur in other programs and areas. Sources were informal conversations with professors of master's courses and doctorates in the area of social sciences, as well as student reports and experiences lived by the authors. All the names of the characters are fictitious. The case was applied and tested in a class of the Methods course of a Master's program.

Case application

The case is intended for master's degree students in the areas of Administration, Accounting Sciences, and other correlated fields. It can be applied in specific disciplines such as: methodology, quantitative methods and dissertation seminar courses.

Recommendations for a teaching plan

This case can be analyzed in the classroom in groups with a minimum of two and a maximum of five students. We do not recommend individual application. In a group, students will be able to debate issues, as well as identify possible choices, doubts, and concerns about their own work. Group discussion will enrich the understanding of the case, both at the individual and collective levels. Chart 1 presents a suggested lesson plan, with sections identifying the stage, objective, and activity.

Stage	Objective	Activity
Presentation	In order to achieve more realistic and coherent answers, prior reading on quantitative method concepts is suggested.	Reading and discussion
Development	This stage of the process is intended to promote a debate involving all students, generating reflections on the dilemmas faced by master's academics in regards to choosing the proper methodology of their final dissertations.	Each group presents to the teacher the most relevant points of their discussion, and the conclusions they reached in relation to the methodological dilemma
Final stage	The final stage is comprised of 3 thematic axes, with 2 questions each. We suggest dividing the class into three groups, each responsible for a given approach. The teacher will act as mediator and should intervene alongside the two groups in the audience, discussing the decisions and choices of the presenting group.	Discussion of suggested issues

Chart 1. Suggested lesson plan..
Source: Prepared by the authors.

Suggested issues for discussion, separated into thematic axes

1 – Students' empirical and theoretical maturation

1a) How can research group presentations contribute to the scientific development of students such as Leonardo and his colleagues?

1b) What did Professor Oliveira mean when he said: *"The choice of methodology cannot be simply a matter of convenience"*? What were the risks of this choice for Leonardo?

2 – Technical knowledge of quantitative methods

2a) Why was Professor Oliveira interested in the distribution of Leonardo's data? And if the data was not normally distributed, what choices would remain?

2b) Imagine Leonardo was developing a causal, and not a relational, research. Technically speaking, what would this mean for the analysis of his data? Would multivariate linear regression remain a valid option? Explain.

3 – Research-object adequacy of the statistical method and community-adherence of the proposed research model

3a) Explain why Professor Gomes recommended a bibliometric research to Leonardo as an auxiliary tool of methodological choice. What benefits did this bring about (if any)? What were the professor's reasons for this recommendation?

3b) Considering Leonardo's option for the quantitative method, evaluate if the direction indicated by the results of the bibliometric research would adequately fulfill Leonardo's research goal. Could Leonardo use a different technique than the one indicated by his bibliometric research?

Analyzes, directions and reflections to aid in the resolution of the case

1 – Students' empirical and theoretical maturation

1a) How can research group presentations contribute to the scientific development of students such as Leonardo and his colleagues?

It is an important contribution, especially in the discussion of confounding factors, that is, factors that can generate confusion when determining a study's variables. For Manski (1993), an initial set of confounding factors is generated by the likelihood of observational data being unable to allow for a complete control of attributes.

As for variables, independent and dependent: when they are well specified, it rests on the study's empirical design to control for confounding factors. Without this control, seemingly significant results may actually be false (Armstrong & Shimizu, 2007).

In addition to the definition of variables, the presentation of papers in research groups allows for an interaction between students and the evolution of theoretical and methodological knowledge, through feedback from those students who are already in the phase of writing their dissertations and have already faced difficulties similar to those of Leonardo.

In this sense, it is important for the teacher to foster moments such as: presentation of the development of the dissertation, testimonials and feedback from colleagues in different stages of research, discussions about theoretical aspects which are the focus of the research group, discussion on methodological issues, articles, methods and research techniques, the use of software that supports data analysis (such as R, Stata, ATLAS.ti, MAXQDA, NVivo, IRAMUTEQ, among others), as well as automation of the research process (software for citations, organization of references, proofreading and editing of the manuscript, for example: Mendeley, Zotero, EndNote, Latex, among others).

1b) What did Professor Oliveira mean when he said: "The choice of methodology cannot be simply a matter of convenience"? What were the risks of this choice for Leonardo?

A method should not be chosen because it is the only one the author knows how to use or because it pleases it is the most pleasing. The right choice is the one that provides a format for answering the research question in a parsimonious way (Cooper and Schindler, 2016). To be parsimonious is to avoid expecting that the multivariate technique "arranges" the relevant variables. This means ensuring that irrelevant variables—which may increase the technique's ability to adjust the sample's data—do not over-adjust the data, making the results less generalizable to the population, which, in turn, may lead to an increase in the degree of multicollinearity, making the interpretation of all variables more tricky (Hair et al., 2009).

Opinions should not be a recourse when more reliable evidence is available in documentary sources or by means of direct observation. Furthermore, efforts should be made to minimize the influence of personal bias in data selection and recording. The analysis of the data must be extensive enough to reveal its meaning. Such data should be classified in ways that help the researcher reach relevant conclusions, clearly exposing the results that led to these conclusions. When statistical methods are used, appropriate descriptive and inferential techniques should be chosen, the probability of error should be estimated, and the statistical significance criteria should be applied (Cooper & Schindler, 2016). The author should always provide a clear explanation of all the aforementioned steps.

2 – Technical knowledge of quantitative methods

2a) Why was Professor Oliveira interested in the distribution of Leonardo's data? And if the data was not normally distributed, what choices would remain?

Once the research method has been defined, the statistical technique and the statistical test most appropriate for each case are chosen. Among aspects that guide the choice of statistical technique, the following are worthy of mention: variable metrics (are variables numerical or categorical?), data distribution (normal or otherwise), statistical test associated with the data distribution (t-test, F-test, Mann–Whitney, Wilcoxon, among others) (Cooper & Schindler, 2016, Hair Jr., 2005). By knowing the distribution of his data, Leonardo could limit the scope of tests and statistical techniques appropriate to his research goal.

With non-normally distributed data, some statistical techniques can be pre-excluded. Each of the existing statistical techniques and tests comes with theoretical assumptions that must be respected for an unbiased and consistent inferential estimation. Therefore, questions regarding the nature of the data, such as Prof. Oliveira's question regarding normal distribution, help the student to reflect on the most appropriate technique and statistical test. The student should also attempt, wherever necessary, to mitigate conditions such as non-normality of the data, or even conditions with a more serious effect over the statistical efficiency of methodological choices, such as heteroscedasticity.

For example, to mitigate a non-normality condition, transformations can be applied to independent variables, dependent variables, or both. The technique of transforming variables (e.g., calculating its logarithm or square root and thus creating a new variable), helps to eliminate the undesirable characteristic in question and allows for better relational measures.

The size of the sample can also help reduce conditions of non-normality, since, according to the Central Limit Theorem, for continuous variables and samples larger than 30 normality is no longer a fundamental condition. Larger samples can reduce the harmful effects of non-normality (Hair et al., 2009). The author must consider that the algorithms behind each technique are premised on certain sample determinants, such as minimum sample size, distribution, among others.

2b) Imagine Leonardo was developing a causal, and not a relational, research. Technically speaking, what would this mean for the analysis of his data? Would multivariate linear regression remain a valid option? Explain.

This question refers to the following passage in the text: “So, as I told Prof. Oliveira, I’ve been collecting data since the beginning of the master’s course. I may need to collect more, but I already have a good volume. It’s secondary data with normal distribution. I just want to relate the dependent (performance) variables to the independent ones, i.e., the ones referring to the internal and external mechanisms of corporate governance.”

A relational hypothesis, as the name implies, describes a relationship between variables. Thus, in this case the research is intended to describe a relationship between two or more variables (Cooper and Schindler, 2016). This is to say, Leonardo sought some kind of implication of a predictable relationship between variables.

Causal researches should demonstrate that a variable is somehow responsible for the behavior of another. The causal variable, typically called the independent variable, does not have to be the only source of influence on the behavior of the dependent variable (Cooper & Schindler, 2016). This can be investigated throughout the research.

Therefore, Leonardo should aim for a research design in which regression covariations are presented as causal relations, including important control variables in the analysis of the proposed relation. Moreover, parameters estimated in the social sciences are, by nature, endogenous. This implies that some variables determining business choices, for example, are not random. This lack of randomization in the main treatment variable prevents it from being understood as a “cause and effect” variable when compared to a control group. Thus, Angrist & Pischke (2015) suggest the use of research designs that, although not causal by nature, approach causality by randomizing the variable of interest. Research designs such as regression discontinuity, difference in differences, instrumental variables, and matching allow the model to exclude alternative explanations (Angrist & Pischke, 2015). Or, at least, a good portion of these alternative explanations.

Also, in a causal research, the inclusion of panel data with control of fixed effects, allied to a given quasi-experiment, among other options, may allow for the control of part of the endogeneity attributed to models in the social sciences, improving the interpretation of results. Still, one should bear in mind that statistical controls and quasi-experimental designs only attenuate the problem of endogeneity. The inference of causality will depend on the other controls, and on the replicability and external validity of the findings.

3 – Research-object adequacy of the statistical method and community-adherence of the proposed research model

3a) Explain why Professor Gomes recommended a bibliometric research to Leonardo as an auxiliary tool of methodological choice. What benefits did this bring about (if any)? What were the professor’s reasons for this recommendation?

Historically, the quantitative study of a field of research has received different names. The adoption of the term “bibliometric” is commonly attributed to Pritchard (1969, p. 348), understood as the application of mathematical and statistical methods to books and other means of communication.

A more current definition is outlined by Van Leeuwen (2004, p. 374), who sees bibliometrics as the field of science that deals with the development and application of measures and quantitative indicators to science and technology, based on bibliographic information.

Among several reasons for using this method, we highlight the following: a) it is able to provide an overview of publications' intellectual structure; b) it may help identify significant structures and patterns in authorship, periodicals, research questions, theories, samples, geographical discoveries etc.; c) it may provide quantitative confirmation of subjectively derived categories in published surveys, as well as the possibility of further exploring the research scenario and identifying categories.

Benefits worthy of mention are the following: a) the discovery of the research method and statistical technique that is most commonly used (i.e., possibly the most adequate) in a certain field of research; b) "leaving value judgments aside, it seems clear that it is important to have a distribution that informs us about ... what we are most interested in knowing about" (Price, 1976, p. 39, own translation); c) the results of bibliometric research can also point to qualitative aspects, such as the implications of a certain research design or method for a study's critical reception (Herther, 2009).

Based on bibliometric methods, all the aforementioned reasons and benefits eventually develop into a higher-level analysis of research trends, productivity in different fields, or patterns of scientific connection (Ellegaard & Wallin, 2005). However, bibliometric methods do not replace extensive reading and synthesis. Bibliometrics can reliably establish connections between publications, authors or journals, producing tables, maps, and graphs of published research, but it is up to researchers and their knowledge of the field to interpret the findings – and this is the most difficult part.

3b) Considering Leonardo's option for the quantitative method, evaluate if the direction indicated by the results of the bibliometric research would adequately fulfill Leonardo's research goal. Could Leonardo use a different technique than the one indicated by his bibliometric research?

Leonardo now needs to make a decision on his dissertation's methodology. To do this, he must pay attention to two relevant pieces of information that appeared throughout the case. One of those is the main guiding factor for the choice of methodology: the research objective. At the beginning of the case, Leonardo reported that his objective would be to describe "the relationship between external mechanisms of corporate governance and the performance of Brazilian companies listed in the stock exchange." Therefore, he needs a method that allows for the mensuration of a relationship between variables. The second relevant information that appeared in the case was the methodological orientation indicated by the bibliometric research, which showed that, in Leonardo's area of research, studies are predominantly quantitative, hypothetical-deductive, and use the multivariate linear regression technique.

In this way, Leonardo would indeed be safe in opting for the direction pointed out by bibliometric research. Quantitative methodology allows for the relationship between variables suggested by the research objective to be tested. In addition, the hypothetical-deductive method is particularly interesting, since it allows for the creation of hypotheses which can then be tested statistically. Finally, multiple linear regression allows the researcher to relate two or more independent variables to a dependent variable. In Leonardo's case, relevant control variables could be added, in order to increase the explanatory strength of the model. Furthermore, within the regression itself, he could also carry out tests of robustness and attenuation of endogeneity, such as the previously suggested quasi-experiments (Angrist & Pischke, 2015), discontinuous regression, or the insertion of an instrumental variable. All of the above would require greater creativity in the elaboration of the research design.

Finally, Leonardo could choose an alternative method. However, academic research has to be guided by an important principle: the principle of parsimony (Hair et al., 2005). The methodological choice takes place by means of an adjustment, a methodological fit. This is not an exact science: the methodological choice is never perfect, but rather represents the more adequate choice, given the available options. From the standpoint of parsimony, the adequate method is the simplest of choices that is still sufficient to fulfill the proposed research objective. Therefore, since Leonardo's research problem requires the relationships between variables to be tested, the conclusion is that multiple linear regression, the technique most often used by articles in his area (as pointed out by the bibliometric study), would certainly be the most appropriate option.

Supplementary analysis

Hair et al. (2005) and Cooper and Schindler (2016) provide an excellent introduction to methods of research in administration, merging theory and practice. In particular, the section "Analysis and presentation of data" of both books can help students solve this case study, since it explains what is research in administration, the different types of studies and the distinction between good research and research performed without quality criteria. An authoritative explanation of quantitative methods, specifically, can be found in Hair et al. (2009) and, more broadly, in Angrist and Pischke (2015). The latter work deals exclusively with quantitative methods in the social sciences, with a focus on treatments for mitigating problems of endogeneity.

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