Natural Experiments in Management Research: Emerging Practices and Evaluation Guidelines

Simone Santoni[•○] and Jost Sieweke[⋆]

[•]Bayes Business School (formerly Cass)
[○]Soundcloud
[⋆]Vrije Universiteit Amsterdam

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INTRODUCTION

The quest for empirical identification in management research has created substantial attention around 'natural experiments,' a form of causal inquiry that has been traditionally popular in economics (Meyer 1995; Rosenzweig and Wolpin 2000) and political science (Dunning 2008). The premise to conduct a natural experiments is the presence of a 'naturally' occurring event — such as new regulations and laws, natural disasters, or economic and political crises — that heterogeneously influences the units of a population (Dunning 2012; Robinson, McNulty, and Krasno 2009). Insofar as such event generates random or as-if random variations in the environment, scholars have can mimic the experimental ideal in which units are split into a treatment and a control group, or, alternatively, receive different levels of the treatment. Ultimately, this opens up the possibility to infer causal effects when the substantive relationship at hand is difficult to investigate in a laboratory setting and/or would require operating costly, impractical, or unethical field experiments.

Despite naturally occurring events can turn into opportunities to conduct causal research, there are limited guidelines that help management scholars to prepare and review papers that implement the natural experiment research design. In order to fill this gap, we highlight the strengths and weaknesses of natural experiments as operated in the field of management studies and propose actionable suggestions to assess and communicate the validity of natural experiments.

To do so, we critically review the population of 147 natural experiments published across seventeen top-tier management journals.[1] Particularly, our reviews aims to address the following research questions: *R1 — How do management scholars claim the random or as-if random nature of environmental variation at the core of a natural experiment? R2 — How do they claim the empirical and substantive relevance of a natural experiment? R3 — How do they claim the credibility of the statistical model encapsulated in a natural experiment design?*

This work is organized as follows. The next two sections briefly introduce the key features of the 'standard natural experiment,' [2] along with the evaluative framework we use to analyze the individual natural experiments. The following section describes the selection of the reviewed studies. Then, we present the key insights that emerge from our analysis and conclude with a suggested check-list that help management scholars to exploit the opportunities of causal inference offered by naturally occurring events. The online appendix contains companion Python code to operate and assess natural experiments.

[1] TODO: We're updating the literature search at May 31, 2021.

NATURAL EXPERIMENTS AND CAUSAL EMPIRICAL RESEARCH

The standard natural experiment resembles the design of a randomized experiment. In fact, the naturally occurring event (such as an earthquake, see for example Belloc, Drago, and Galbiati 2016) is supposed to determine the treatment status of the statistical units (treated Vs control), each of which has both a pre- and a post-

[2] In his comprehensive, cross-disciplinary analysis of the literature, Dunning 2012 identifies three forms of natural experiments: Standard natural experiments; instrumental variables (Angrist, 1990); regression discontinuity designs (Thistlethwaite & Campbell, 1960). In the interest of clarity and integrity, our review concentrates on standard natural experiments, whose origin goes back to the highly acclaimed and impactful research Dr John Snow (Snow, 1855) conducted on the diffusion of cholera in the mid 19th century London. In this paper we use the term 'natural experiment' to exclusively refer to standard natural experiments.

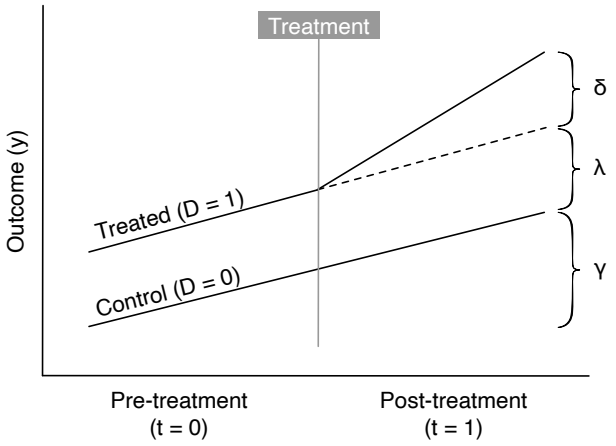

Figure 1: Visual representation of the standard natural experiment. Notes.— The underlying population regression function is $y = \gamma t + \lambda D + \delta tD$, where γ, λ, and δ represent the systematic difference in the outcome across the treated and control cases, the trend effect and the difference in the outcome that is due to the treatment. For sake of clarity, we represent the case in which $\delta > 0$.

treatment observation. As shown in Figure 1, it is possible to estimate the causal effect of the treatment by contrasting the pre-post change in the outcome variable y across the control group (γ) and the treatment group ($\gamma + \delta$).

Assessing the Validity of Natural Experiment Designs

How do scholars evaluate a standard natural experiment research design? According to Dunning (2012, page 27), the validity of a natural experiment should be assessed against three criteria (see Figure 2). First, scholars should prove the random nature of the treatment, or, at least, defend the plausibility of as-if random. In the case of the *randomized standard natural experiment*, it is important that the assignment process is truly random. Although this may seem obvious, this condition is sometimes violated, even in the context of lotteries (e.g. Starr 1997). In the case of an *as-if randomization*, it is vital the assignment process, although not truly random, is independent of factors that are related to the outcome and it is not affected by unit's self-selection into treatment or control conditions. As Dunning points out, the researcher has to make a very compelling case for this assertion (or to drop the claim to a natural experiment). In depth knowledge of the context (e.g., industry regulatory frameworks), qualitative evidence about the naturally occurring event (e.g., a new law), and quantitative evidence at the event- and unit-level are oftentimes essential ingredients to defend the plausibility of as-if random assignment, and, ultimately, to sustain the natural experiment.

Second, the naturally occurring event should reveal the wider *"theoretical, substantive, and/or policy issues"* (Dunning 2012, page 29) that motivate the study. For example, the sudden, premature death of a star scientist (Azoulay, Zivin, and Wang 2010) create the premises for a natural experiment that quantifies the spill-over effect of collaborating with academics who are very prominent in the field.

Finally, the statistical model should fit with the characteristics of the naturally occurring event. In the case of a randomized standard natural experiment, simplicity and transparency should take precedence in the data analysis stage. Particularly, the Neyman's potential

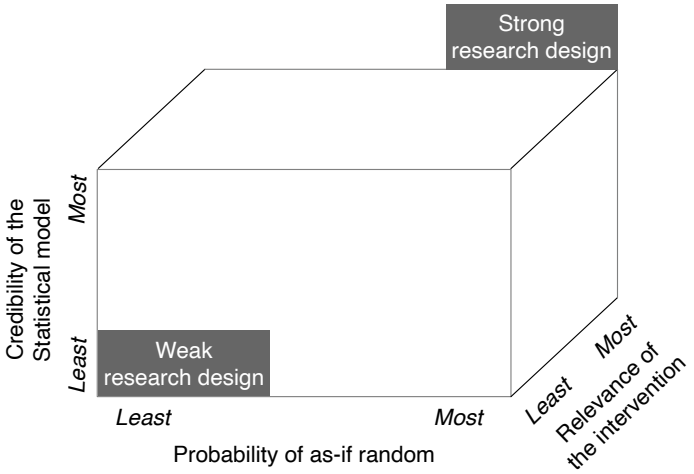

Figure 2: Visual representation of Dunning's validity framework (Source: (Dunning 2012, page 31))

outcomes framework (Splawa-Neyman, Dabrowska, and Speed 1990), namely, a treated Vs. control mean comparison test, should be used *prima facie*. At the same time, some statistical adjustments may be required even in presence of a random (or as-if random) treatment. For example, the Stable-Unit-Treatment-Value-Assumption (SUTVA) may be violated insofar as the treatment status of a unit 'i' interferes with the potential outcome of unit 'j'. This is a concern Belloc and colleagues (2016) seem to have in mind when they estimate the impact of earthquakes on the probability of institutional change at the city-level in the Middle-Ages northern and central Italy. In fact, both the distribution and timing of earthquakes are random. However, the probability a control city will move from autocratic regimes to self-government is also a function of the information key actors are exposed to, such as the transition choices made by a treated, neighbor city. In this case, statistical artefacts would be needed to take into account the correlation of residuals induced by the geographical proximity of any pair of units.

DATA & METHODS

Sample of Studies

Consistently with review articles recently published in the Journal of Management (Gonzalez-Mulé and Aguinis 2018; Rindova et al. 2018), we surveyed selected, prominent journals such as Academy of Management Journal, Administrative Science Quarterly, Journal of Applied Psychology, Entrepreneurship Theory and Practice, Journal of Business Ethics, Journal of Business Venturing, Journal of Management, Journal of Management Studies, Leadership Quarterly, Management Science, Organization Science, Organizational Behavior and Human Decision Processes, Organization Studies, Personnel Psychology, Research Policy, Strategic Management Journal, Strategic Organization. Using the search engine embedded in each individual journal's web-page, we searched for any article reporting the quote

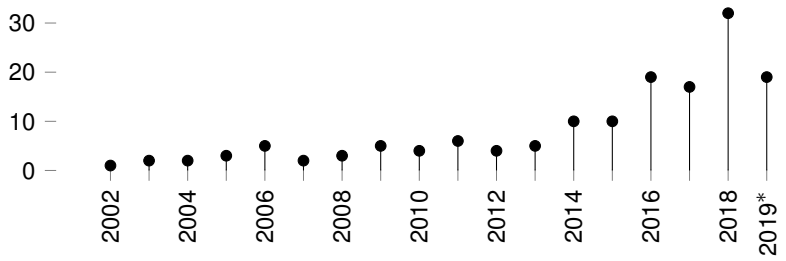

Figure 3: Inter-temporal distribution of natural experiment studies. The 2019 bucket, marked with an asterisk, contains both published and accepted, online articles.

"natural experiment" in the title, abstract, keywords, or full text of any document that was published after January 2000 or released as pre-print as of June 25, 2019.

We retrieved 366 publications; 147 were eventually included in the review. We excluded 33 non empirical publications, such as theoretical articles (e.g., Makadok 2011) or review articles (e.g., Shaver 2020), articles that recall the empirical evidence produced by previous natural experiments, articles that indicate natural experiments as a possible way to overcome the limitations or expand on the study at hand (e.g., Hsu 2006), articles using the instrumental variable design (**zoloty2018**), 2 articles based on the regression discontinuity design (e.g., Flammer 2015), and 12 qualitative studies adopting the logic of natural experiment (e.g., Powell and Baker 2017).

Furthermore, we filtered out articles whose authors claim to adopt a natural experiment research design whereas, in fact, they operate: (i) correlational designs2 on observational data (N = 53), data produced in the context of business simulations (N = 1), or game shows (N = 2); (ii) field experiments (N = 1); (iii) quasi-experiment/matching designs (N = 3); (iv) twin studies (N = 4). Figure 3 reports the inter-temporal distribution of the retained studies.

Coding Schema

Table 2 reports the variables against which we coded the studies included in the sample.[3]

[3] TODO: The studies published after June 2019 have to be coded.

RESULTS

Assessing the As-If Random Nature of the Treatment

This section focuses on the diagnostics that can be used to assess and argument the (as-if) random nature of the environmental variation at the center of the natural experiment. Specifically, this section surveys and articulates the following:

- diffusion/role of qualitative diagnostics to appreciate:
  - units' information about the treatment
  - units' incentives to self-select into the treatment (control) group
  - unit's capacity to self-select into the treatment (control) group

Domain	Variable	Values of the Variable
Study features	Demographics	Authors; journal; year
	Level of theorizing	Between- or within-units design
Research design features	Level of the empirical model	Between- or within-units design
	Nature of the variation	Random; as-if random; not random
	Analytical strategy	DiD; mean-comparison; IV
	Natural experiment source	Open coding (e.g., CEO sudden death)
	Conceptual development level	Single-, multi-, or cross-level
Plausibility of as-if random	Role of information	False/True
	Role of incentives	False/True
	Individual capacity to self-select	False/True
Relevance of the intervention	Justification for the natural experiment	Methodological role; substantive role; both
	LATE interpretation	False/True
Credibility of statistical model	Statistical adjustment via covariates	False/True
	Statistical adjustment via matching	False/True
	Derivation of standard errors	Standard s.e.; clustered s.e.
	SUTVA considerations	False/True
Use of qualitative evidence	To sustain relevance of the intervention	False/True
	To sustain plausibility of as-if-random	False/True

Table 1: Coding schema.

- diffusion/role of quantitative diagnostics (e.g., balance test) to compare and contrast treated and control units along relevant dimensions

Assessing the Relevance of the Treatment

This section focuses on the empirical and substantive relevance of the environmental variation at the center of a natural experiment. Particularly, this section reviews and discusses the following:

- diffusion/role of qualitative diagnostics to show:
  - the empirical, substantive, and policy relevance of the natural experiment
  - the external validity (non idiosyncrasy) of the natural experiment
  - exclusion of 'bundling of treatments' (i.e., environmental variations affecting the outcome through multiple causal pathways)
- diffusion/role of placebo tests supporting the magnitude of the average treatment estimation on the treated (ATT)
- diffusion/role of local average treatment estimation (LATE) considerations

Assessing the Credibility of the Statistical Model

This section focuses on the credibility of the statistical model encapsulated in the natural experiment design. Specifically, this section surveys and articulates the following:

- diffusion/rationale of model based adjustments (instead of simple mean-comparison tests):
  - adjustment via control covariates
  - adjustment via matching
- diffusion of SUTVA considerations and associated model adjustments (see derivation of standard errors)

SUMMARY

This section wraps-up around the results of the literature review and provides actionable guidelines in order to better leverage the natural experiment design.

- better integrate qualitative evidence and institutional knowledge in order to establish the as-if random nature of the treatment
- provide a more systematic discussion of the conditions under which a treatment can plausibly be considered as-if random (see the point on units' information, incentives, and capacity to self-select into the treatment group)
- pay equal attention to the empirical and substantive relevance of the treatment (that is, the possibility to reveal and/or detail important theoretical mechanisms by exploiting naturally-occurring events)
- provide a thorough assessment of the strengths and weaknesses of relying on a certain naturally-occurring event — i.e., explaining what the pros and cons are in terms of empirical identification (see LATE aspects) and theorizing opportunities
- use model-based adjustments (such as matching and control covariates) when there is no ground to establish the (as-if) random nature of the treatment. Indeed, the comparative advantage of natural experiments over alternative designs (e.g., quasi-experiments) also comes from the possibility to conduct causal inference by means of simple, transparent statical models. In other words, there should be good reasons to move from a design-based causal inference strategy to a model-based one (e.g., piggybacking on models that jointly use matching, DiD, and a long list of control covariates)
- consider the interactions among as-if random, relevance, and credibility elements. For example, the credibility of a model should be assessed against the nature of the treatement (random, as-if random, not random) and the process through which it is adminstered (see SUTVA)

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APPENDIX A — SAMPLING

Study Retrieval

Journal	Address of the search page
Academy Of Management Journal .	https://journals.aom.org/search/advanced
Administrative Science Quarterly...	https://0-journals-sagepub-com/search/advanced?SeriesKey=asqa
Entrepreneurship Theory & Practice	https://0-journals-sagepub-com/search/advanced?SeriesKey=etpb
Industrial and Corporate Change...	https://0-academic-oup-com/icc/advanced-search?
Journal of Business Ethics.....	https://link.springer.com/search?query=&search-within=Journal&facet-journal-id=10551
Journal of Business Venturing.....	https://www.sciencedirect.com/journal/journal-of-business-venturing
Journal of Management.....	https://journals.sagepub.com/search/advanced?SeriesKey=joma
Journal of Management Studies....	https://onlinelibrary.wiley.com/search/advanced?publication=14676486&text1=
Management Science.....	https://pubsonline.informs.org/action/doSearch?SeriesKey=mnsc
Organization Science.....	https://pubsonline.informs.org/action/doSearch?SeriesKey=orsc
Organization Studies.....	https://journals.sagepub.com/home/oss
Research Policy	https://www.sciencedirect.com/journal/research-policy
Strategic Entrepreneurship Journal.	https://onlinelibrary.wiley.com/search/advanced?publication=1932443x&text1=
Strategic Management Journal.....	https://onlinelibrary.wiley.com/search/advanced?publication=10970266&text1=
Strategic Organization	https://journals.sagepub.com/home/soq
Strategy Science.....	https://pubsonline.informs.org/action/doSearch?SeriesKey=stsc
The Leadership Quarterly.....	https://www.sciencedirect.com/journal/the-leadership-quarterly

Table 2: Sample of target journals along with search page addresses.

APPENDIX B — SAMPLE OF STUDIES

Agarwal, Sumit, Jessica Pan, and Wenlan Qian. "Age of Decision: Pension Savings Withdrawal and Consumption and Debt Response". In: *Management Science* In press a (2019).

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Behr, Patrick, Darren J. Kisgen, and Jérôme Taillard. "Did Government Regulations Lead to Inflated Credit Ratings?" In: *Management Science* 64.3 (2018), pp. 1034–1054.
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