

# Exogenous Shocks in Leadership and Management Research: Types and Challenges for Empirical Strategy

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## Abstract

Empirical strategies leveraging exogenous shocks have substantial value, but they can be challenging to design and evaluate. One of the main reasons — at least in leadership and management — is the variance in how scholars think and use exogenous shocks. This work has a twofold objective. First, it aims to clarify the boundaries and nature of the exogenous shock concept. Second, it aspires to create a typology that illuminates the attributes differentiating exogenous shocks and helps authors and reviewers to appreciate how empirical strategy issues vary across types of exogenous shock.

*Keywords:* exogenous shocks, causality, observational data, natural experiments, empirical strategy.

# 1 Introduction

Exogenous shocks have started to play an increasingly central role in the agenda of leadership and management researchers. On the one hand, the Covid-19 pandemic has called attention to the consequences of major environmental shifts for organizations (Kniffin et al. 2021) and markets (Zhang, Hu, and Ji 2020). On the other hand, the ecological favor towards causal evidence has further stressed that exogenous shocks are an integral part of ‘smart’ empirical strategies (Angrist 2022).<sup>1</sup>

Our work elaborates on two analytically distinct but interrelated observations. First, the extant literature conveys different views on the concept of exogenous shock. Second, such a diversity of views appears to jeopardize the evaluation of empirical strategies drawing on exogenous shocks. Hence, we raise the following research questions: *What is an exogenous shock? How can we harness exogenous shocks to achieve valid empirical strategies?*

To address the first research question, we highlight the angle of the ‘natural experimentalist’ — say Nobel laureate Professor Joshua Angrist — according to which exogenous shocks are vital sources of randomization to carry out causal inference with observational data. Then, we conduct a critical review of the literature that uncovers the diverse views of leadership and management scholars on exogenous shocks.

We address the second research question by proposing an original typology of exogenous shocks that is based on three elements: (i) the extent of the intervention<sup>2</sup> emerging from an exogenous shock, which ranges between one or few units and the totality of a population’s units; (ii) the timescale of the intervention, namely, the amount of time necessary for an exogenous shock to become relevant *vis á vis* the research question at hand; (iii) the granularity of the intervention, which can either split the units into a control and a treatment groups or affect units with different a degree or intensity. We posit that specific combinations of these elements reveal types of exogenous shocks that present peculiar challenges in terms of empirical strategy.

Our work provides a twofold contribution. We clarify the concept of exogenous shock by illuminating its ontological status. Our point is that exogenous shocks are unobservable. In others words, they ‘exist’ in the nexus of naturally-occurring events (e.g., the sudden death of an executive) and ‘concrete’ theoretical or empirical problems (e.g., do social connections affect an executive team’s decision quality?). We also help authors and reviewers appreciate an exogenous shock’s key features and reason about how these features might threaten the validity of an empirical strategy aiming at inferring causal effects with observational data.

Section 2 succinctly illustrates how exogenous shocks are conceptualized and used in natural experiments and management literature. Section 3 introduces our novel typology of exogenous shocks. Section 4 describes how one can use our typology to harness exogenous shocks.

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1. An empirical strategy is a consistent configuration encompassing three elements: (i) empirical identification; (ii) data; and (iii) statistical estimator. Exogenous shocks influence (i) and (ii) and tend to associate with certain estimators, such as Difference-in-Difference or Abadie’s Synthetic Case Control Method.

2. All throughout the various sections of the document, we will use the terms intervention and treatment interchangeably.

Finally, section 5 wraps up around the major points we raise and suggests further methodological research avenues regarding the role of exogenous shocks in leadership and management research.

## 2 What is an exogenous shock?

### 2.1 Exogenous shocks in the literature on natural experiments

The literature on natural experiments offers several elements to appreciate the conceptual category of ‘exogenous shocks’ (for an overview of the natural experiment design, see for example Craig et al. 2017; Dunning 2012; Keele and Titiunik 2016; Withers and Li 2021; for a review of the application of this design, see Rosenzweig and Wolpin 2000; Sekhon and Titiunik 2012; Sieweke and Santoni 2020). Mainly, extant studies draw a line between an exogenous shock and the interrelated but distinct naturally-occurring event concept. While one can observe events such as diplomatic crises, institutional reforms, or terrorist attacks, exogenous shocks are situated in abstract models that illustrate how economic and social formations work in the real world (Morgan 2012). In other words, impactful naturally-occurring events, such as the Covid-19 global pandemic, could be challenging to fit within a model of interest and, therefore, do not lead to any exogenous shock. At the same time, a particular event could provide multiple models with an exogenous shock. For example, the reunification of Eastern Germany and Western Germany has been exploited to address diverse research questions, including the impact of income on health (e.g., Frijters, Haiken-DeNew, and Shields 2004), the transmission of preferences for entrepreneurship from parents to children (e.g., Wyrwich 2015), or the legitimization of inequality (e.g., Haack and Sieweke 2018).

Figure 1 pictorially depicts the idea that exogenous shocks emerge from purposive associations of naturally-occurring events and research questions. The quality of these associations can be substantive — when the environmental variation becomes an integral part of a study’s theorizing —, empirical — if an analyst exploits the variation to deal with endogeneity concerns — or entail a combination of substantive and empirical elements.

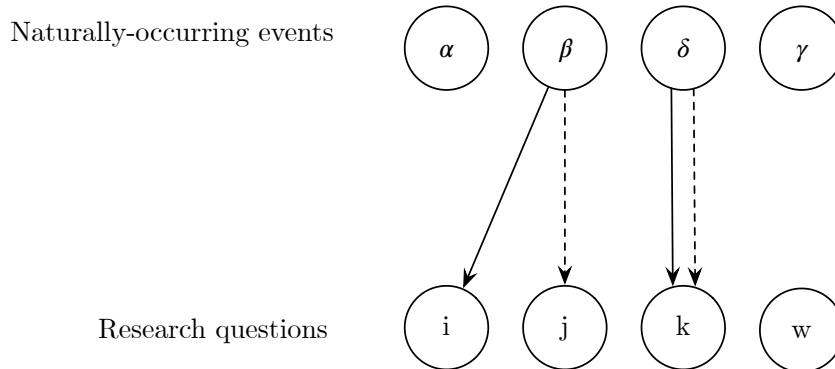


Fig. 1: Exogenous shocks map naturally-occurring events onto research questions via empirical and substantive relevance. Notes.—  $\longrightarrow$  = empirical relevance;  $\dashrightarrow$  = substantive relevance.

The lack of *substantive relevance* is one of the most common terrains where scholars

have criticized the use of naturally-occurring events. For instance, in his critical analysis of Instrumental Variable (IV) applications,<sup>3</sup> Deaton (2009) observes that:

*“[omitted] randomized evaluations of projects are useful for obtaining a convincing estimate of the average effect of a program or project. The price for this success is a focus that is too narrow to tell us ‘what works’ in development, to design policy, or to advance scientific knowledge about development processes.”* (page 3)

Hence, he argues:

*“[omitted] the analysis of programs or project needs to be refocused towards the investigation of potentially generalizable mechanisms that explain why and in what contexts projects can be expected to work. The best of the experimental work in development economics already does so, because its practitioners are too talented to be bound by their own methodological prescriptions. Yet there would be much to be said for doing so more openly. I concur with the general message in Pawson and Tilley (1997), who argue that thirty years of project evaluation in sociology, education and criminology was largely unsuccessful because it focused on whether projects work instead of on why they work.”* (page 4)

Coming from an econometric background, Heckaman and Urzua (2010) share Deaton’s concerns about IV as a lever to approximate the experimental ideal:

*“The problem that plagues the IV approach is that the questions it answers are usually defined as probability limits of estimators and not by well-formulated economic problems. Unspecified ‘effects’ replace clearly defined economic parameters as the objects of empirical interest.”* (page 28)

In his comprehensive work on natural experiments, Dunning (2012) pragmatically points out:

*“[omitted] the causes that Nature deigns to assign at random may not always be the most important causal variables for social scientists. For some observers, the proliferation of natural experiments therefore implies the narrowing of research agendas to focus on substantively uninteresting or theoretically irrelevant topics.”* (page 3)

A positive example showing how to turn a naturally-occurring event into a shock with substantive relevance is Miguel, Satyanath, and Sergenti’s (2004) study of the effect of economic

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3. It is commonly accepted that natural experiments comprise the ‘Instrumental Variable’ design along with the ‘Standard Natural Experiment’ and ‘Regression Discontinuity Design’ (Dunning 2012; Sieweke and Santoni 2020).

growth on civil wars in Africa. Thanks to the ingenious choice to consider rainfall data, the authors broaden the conversation on institutions and economic growth. Particularly, rainfall variations facilitate an IV design that copes with longstanding endogeneity issues regarding the co-evolution of institutions and macroeconomic factors. Hence, the authors can empirically investigate a new and essential theoretical relationship, namely, the effect of economic growth on the likelihood of civil war.

Regarding the *empirical relevance* of a naturally-occurring event, the literature on natural experiments shows a strict view: an event qualifies as an exogenous shock if and only if it allows to operate an empirical strategy with a control group (Cook, Campbell, and Shadish 2004). In other words, there should be an adequate time window<sup>4</sup> in which the intervention T emerging from the exogenous shock affects a fraction of a population’s units only. Such a condition is the *sine qua non* to evaluate the impact of the intervention using Neyman’s potential outcome framework (1923 (1990)), an unbiased estimator of the average causal effect  $T - C$  that is based on three quantities: (1)  $\hat{T}$ , the average response if all subjects were assigned to treatment; (2)  $\hat{C}$ , the average response if all subjects were assigned to control; and (3) the difference  $\hat{T} - \hat{C}$ .

The study of John Snow of London’s cholera outbreak of 1853-54<sup>5</sup> emphasizes the importance of using exogenous shocks that heterogeneously affect the units of a population. In 1852, the Lambeth Waterworks company — one of the major utility companies supplying water to several parts of the city — relocated their waterworks from Hungerford Market to fifteen miles upstream in the Thames, thereby “*obtaining a supply of water quite free from the sewage of London*” (Snow [1855] 1965, page 68). Contrarily, Southwark & Vauxhall, a company competing with Lambeth Waterworks in several districts of London, left its intake pipe downstream in the Thames at Battersea. Snow obtained records on cholera deaths in households throughout London, as well as information on the company that provided water to each household and the total number of houses served by each company. Figure 2 reports one of the most compelling pieces of empirical evidence included the study: fatal attacks are compared before and after the exogenous shock (Lambeth Waterworks moved their intake pipelines in 1952) and by water supply (see the column reported on the far-right hand section of the table). Consistently with Neyman’s model, the analyses of Snow disentangle the ‘true’ effect of the shock on cholera communication from time-invariant attributes regarding the households served by different water suppliers, and, perhaps more importantly, from the time-variant factors such as the state of the cholera outbreak at other points in time. Should the naturally-occurring event have affected the totality of households in London, unlikely Snow’s work would have addressed the problem of confounders convincingly.

A related but distinct aspect of *empirical relevance* concerns the ‘exogenous’ nature of the naturally-occurring variation. The literature on natural experiments emphasizes that relevant

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4. We discuss the temporal aspects of exogenous shocks’ effects in Section 3 and Section 4.

5. The project of Snow — aiming to prove that cholera did not transmit through the air, the so called ‘miasma hypothesis’— developed along two arms: he used geospatial visualizations to show that attacks clustered around Broad Street water pump in London’s Soho district; then, he conducted the standard natural experiment briefly summarized that we briefly summarize in the main text.

TABLE XII.

Sub-Districts.	Deaths from Cholera in 1849.	Deaths from Cholera in 1854.	Water Supply.
St. Saviour, Southwark .	283	371	Southwark & Vaux- hall Company only.
St. Olave . . . . .	157	161	
St. John, Horsleydown .	192	148	
St. James, Bermondsey .	249	362	
St. Mary Magdalen . .	259	244	
Leather Market . . .	226	237	
Rotherhithe* . . . .	352	282	
Wandsworth . . . . .	97	59	
Battersea . . . . .	111	171	
Putney . . . . .	8	9	
Camberwell . . . . .	235	240	
Peckham . . . . .	92	174	
Christchurch, Southwark	256	113	Lambeth Company, and Southwark and Vauxhall Comp'y.
Kent Road . . . . .	267	174	
Borough Road . . . .	312	270	
London Road . . . . .	257	93	
Trinity, Newington . .	318	210	
St. Peter, Walworth . .	446	388	
St. Mary, Newington . .	143	92	
Waterloo Road (1st) . .	193	58	
Waterloo Road (2nd) . .	243	117	
Lambeth Church (1st) . .	215	49	
Lambeth Church (2nd) . .	544	193	
Kennington (1st) . . .	187	303	
Kennington (2nd) . . .	153	142	
Brixton . . . . .	81	48	
Clapham . . . . .	114	165	
St. George, Camberwell	176	132	
Norwood . . . . .	2	10	Lambeth Company only.
Streatham . . . . .	154	15	
Dulwich . . . . .	1	—	
Sydenham . . . . .	5	12	
First 12 sub-districts .	2261	2458	Southwk. & Vauxhall.
Next 16 sub-districts .	3905	2547	Both Companies.
Last 4 sub-districts .	162	37	Lambeth Company.

Fig. 2: An extract of the statistical analyses reported in the study of John Snow 'On the mode of communication of cholera' ([1855] 1965). The table, reported on page 90, considers both pretest and posttest datapoints — Lambeth Waterworks moved their intake pipes in 1952 — for treated and control households.

events are not necessarily sudden, such as the death of a business leader because of heart attack (e.g., Nguyen and Nielsen 2010),<sup>6</sup> uncontrollable, such as earthquakes (e.g., Belloc, Drago, and Galbiati 2016), or random, such as lotteries (e.g., Poulos 2019). Extant studies show that legal changes and policy interventions can be purposefully used as exogenous shocks to address particular research questions (e.g., Beaman et al. 2012; Chauchard 2014; Matsa and Miller 2013). Dunning (2012, page 236) advances a three-step procedure to assess whether a naturally-occurring event can be plausibly considered exogenous or ‘as-if random’. First, researchers should investigate whether units had information that they would or would not receive the treatment. Second, researchers need to check whether units had incentives to self-select into the treatment group or control group. Third, researchers should analyze whether not only units had incentives but also capacity to self-select into a treatment status. For the assessment, Dunning (2012) suggests using both qualitative evidence (e.g., documents, interviews) and quantitative evidence (e.g., balance tests).

For example, Snow ([1855] 1965) presented various sorts of evidence to establish the pre-treatment equivalence of the houses that were exposed to pure and contaminated sources of water supply:

*“The mixing of the (water) supply is of the most intimate kind. The pipes of each Company go down all the streets, and into nearly all the courts and alleys. A few houses are supplied by one Company and a few by the other, according to the decision of the owner or occupier at that time when the Water Companies were in active competition. In many cases a single house has a supply different from that on either side. Each company supplies both rich and poor, both large houses and small; there is no difference either in the condition or occupation of the persons receiving the water of the different Companies... It is obvious that no experiment could have been devised which would more thoroughly test the effect of water supply on the progress of cholera than this.”* (pages 74 - 75)

At the same time, qualitative information on the context and the process that determined the source of water-supply source was also essential for Snow. For instance, he emphasized that absentee landlords decided which competing water companies would have served a particular address. Thus, many residents had limited opportunities to ‘self-select’ into a source of water supply — thus, confounding characteristics of residents appeared unlikely to explain the large differences in death rates by company (see Figure 2). Moreover, the Lambeth company committed to moving their intake pipe upstream on the Thames before the cholera outbreak of 1853–54, when existing scientific knowledge did not link water sources to cholera risk. Such a supply choice implied that more than 300,000 people of all ages and social strata were

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6. The identification of sudden deaths poses definition issues (e.g., Azoulay, Graff Zivin, and Wang 2010; Oettl 2012). In the interest of consistency, Nguyen and Nielsen (2010) report they “rely on the medical literature, which defines sudden death as an unexpected and non-traumatic death that occurs instantaneously or within a few hours of an abrupt change in the person’s previous clinical state.” The causes of sudden deaths they consider are ‘heart attack,’ ‘stroke,’ and ‘accident or murder.’ In addition to such deaths, they consider also “accidental and traumatic deaths that are unanticipated by the stock market and unrelated to firm conditions” (page 553).



*“divided into two groups without their choice, and, in most cases, without their knowledge; one group being supplied with water containing the sewage of London, and, amongst it, whatever might have come from the cholera patients, the other group having water quite free from such impurity.”* (Snow [1855] 1965, pages 74–75)

Drawing on the methodological insights included in Snow’s study, Figure 3 visually illustrates the idea that both events that are unknown/unknowable to units and events that are known to units can provide scholars with an exogenous variation suited to address the research question at hand. However, ‘known events’ may raise endogeneity concerns regarding the possibility of a unit affecting the direction and magnitude of a naturally-occurring variation and self-select into the treatment or control group.

## 2.2 Exogenous shocks in leadership and management research

To understand how management scholars conceptualize and use exogenous shocks, we conducted a systematic survey of the literature. Consistently with recently published reviews (e.g., Gonzalez-Mulé and Aguinis 2018; Rindova et al. 2018), we restricted our search to a selection of prominent journals such as Academy of Management Journal, Administrative Science Quarterly, Entrepreneurship Theory and Practice, Journal of Business Ethics, Journal of Business Venturing, Journal of Management, Journal of Management Studies, The Leadership Quarterly, Management Science, Organization Science, Organization Studies, Research Policy, Strategic Entrepreneurship Journal, Strategic Management Journal, Strategic Organization. Using Scopus, we retrieved articles published up until December 31, 2021 presenting the bi-gram ‘exogenous shock\*,’ in the title, abstract, *or* set of author’s generated keywords. The search resulted in 49 unique items. <sup>7</sup>

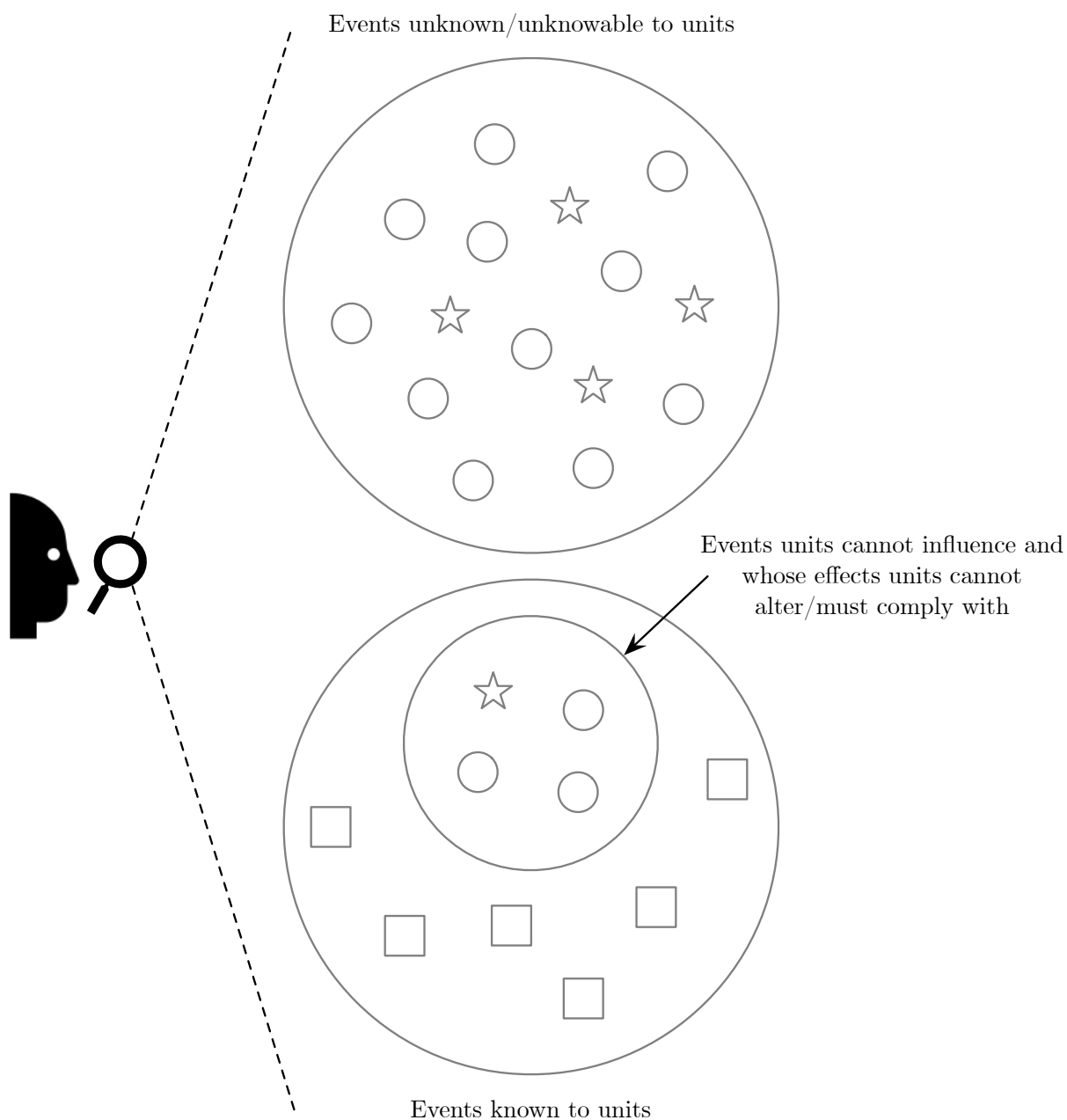
Having considered the full manuscript of each retrieved articles, we discarded 18 articles that did not fall within the reviews’s remit. Particularly, we excluded from the sample two studies in which the search token appears once and appears not to focus on or use the conceptual category of ‘exogenous shock’ (Kriauciunas and Kale 2006; Uzzi 1997); one work focusing on managers’ cognitive representation of a shock (Barreto and Patient 2013); four non-empirical papers (e.g., McSweeney 2009); two qualitative studies (Glynn and Lounsbury 2005; Jenkins 2010); one field experiment (Cui, Zhang, and Bassamboo 2019); eight Management Science articles dealing with finance, marketing, or operations subjects (e.g., Tham, Sojli, and Skjeltorp 2018). Figure 4 illustrates the distribution of sample studies across journals.

Two authors independently coded the retained studies against the dimensions included in Figure 1, that is, (1) the exploited naturally-occurring event (e.g., 9/11, Sarbane-Oxley Act); (2) the leading research question (e.g., ‘how do changes in an employee’s relational capital influence mobility and entrepreneurship decisions?’); and (3) the relationship between (1) and (2), which can be substantive — when the exogenous shock is an integral part of the research question/plays a key role for theorizing — or empirical — when one leverages an environmental

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7. Data were retrieved on January 17, 2022.





*Fig. 3:* The interpretation of a naturally-occurring event as an exogenous shock is contingent on the research question one wants to address and the intrinsic attributes of the event. Notes.—☆ = exogenous shocks, i.e., naturally-occurring events that have empirical and/or substantive relevance *vis á vis* a target research question; ○ = naturally-occurring events are not relevant to address a target research question; □ = endogenous naturally-occurring events, i.e., environmental variations that do not help to deal with the problem of confounders.



*Fig. 4:* Distribution of studies that claim to use an exogenous shock across management journals. Notes.—  $N = 31$ ; in the interest of consistency, we excluded ‘exogenous shock’ studies published in Management Science addressing finance, marketing, or operations subjects. The following journals do not have any ‘exogenous shock’ study: Administrative Science Quarterly, Entrepreneurship Theory and Practice, Journal of Business Venturing, Journal of Management, Leadership Quarterly, Research Policy.

variation to cope with the problem of confounders, but the exogenous shock is unrelated with the substantive scope of the study — or both. Having completed the independent analysis of sample studies, the two authors merged their coding choices and reconciled their different views regarding the role of the exogenous shock in four papers.<sup>8</sup> Table I reports the outcome of our coding, including a summary of how the naturally-occurring event qualifies as an exogenous shock (see the column ‘Summary’, reported on the right-hand side of the table).

Regarding the first dimension of our coding, the most popular categories of events are ‘legal change’ and ( $N = 11$ ) and ‘turnover’ ( $N = 6$ ) — see Figure 5. Concerning ‘legal change,’ scholars have relied on events such as the staggered passage of anti-takeover laws (Cabral, Francis, and Kumar 2021; Wang, Zhao, and He 2016), change in immigration rules (Choudhury and Kim 2019), the Garn-St. Germain Act (Haveman, Russo, and Meyer 2001), the Sarbane-Oxley Act (Gupta et al. 2020), SEC’s regulation change (Jia, Gao, and Julian 2020), the change of inheritance, gift, and estate taxes (Kang and Kim 2020), the staggered adoption of the Inevitable Disclosure Doctrine in U.S. (Kang and Kim 2020), a revision of U.S. Higher Education Amendments (Krishnan and Wang 2019), reductions in import tariffs (Li and Zhan 2019), demonetization measures (Natarajan, Mahmood, and Mitchell 2019). Turnover events comprise sick leave episodes of key employees (Chen and Garg 2018; Chown and Liu 2015; Drexler and Schoar 2014), political leadership churn (Byun, Raffee, and Ganco 2019; Gedefaw Birhanu and Wezel 2020), and sudden deaths of executives (Ke et al. 2019). Other recurrent events include terrorist attacks (Corbo, Corrado, and Ferriani 2016; Li and Zhan 2019; Vergne 2012) and scandals (Cai and Shi 2019; Hilary and Huang 2021), and change in financial analysts’ coverage (Chatterji and Toffel 2010; Qian, Lu, and Yu 2019).

As shown in the Venn diagram included in Figure 6, the large majority of the cases

8. The coding spreadsheet is publicly available at: [https://www.dropbox.com/.../coded\\_studies.xlsx?dl=0](https://www.dropbox.com/.../coded_studies.xlsx?dl=0).

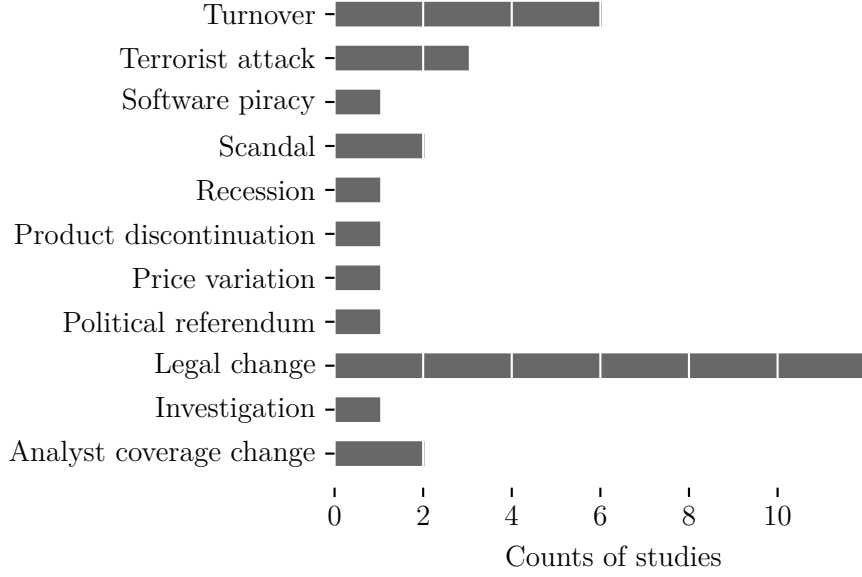


Fig. 5: Classes of naturally-occurring events presumed to create exogenous shocks.

included in our sample ( $N = 24$ ) claim to use exogenous shocks with an empirical role. For instance, Krishnan and Wang (2019) use Survey of Consumer Finances data to address the research question ‘does student debt influence the propensity to start a firm?’. The concept of exogenous shock is not important for the scope of their work and does not inform the proposed theorizing. At the same time, one may study the relationship between student debt and business creation in the context of an observational empirical strategy. However, the authors are concerned about the causal interpretation of their empirical estimates:

*“there may be unobserved characteristics that may drive our results. For instance, individuals with wealthier families may have lower student debt as well as the financial means to start a firm. Such unobservable family effects may explain the negative relation between student debt and entrepreneurship. Alternatively, individuals from wealthier families may borrow more if they expect to be able to pay back the loans easily (and such individuals are more likely to be entrepreneurs).”* (page 4528)

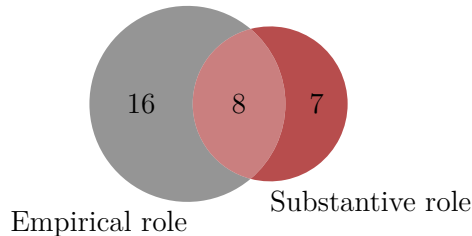


Fig. 6: Role of the naturally-occurring events presumed to create exogenous shocks.

Hence, they use a legal change as an exogenous shock to the cost of business failures for individuals with greater levels of student loans:

*“To address endogeneity concerns, we utilize the Higher Education Amendments (HEA) of 1998, which effectively rendered student loans completely non-dischargeable. We find that students that were already in four-year college at the time of this regulation and had significant student debt were less likely to start a firm. This test considers only individuals who were enrolled prior to the year of regulation (i.e., prior to 1998) in a four-year college. The idea is that, for the group of individuals who are already enrolled in college, the regulatory change is clearly exogenous, in the sense that it does not drive their choice to enter college. ”* (page 4532)

Half of the studies circa ( $N = 15$ ) assign a substantive role to exogenous shocks. For example, Haveman, Russo and Meyer (2001) articulate a framework that links organizations’ responses to discontinuous industry-level regulatory change. The theoretical section of the study maps the phenomenon of regulatory change onto the General Punctuated Equilibrium Model and provides expectations about the multiple consequences of regulatory change for individual organizations. The substantive role of the shock is self-evident in the formulation of the hypotheses, e.g.:

*“Immediately following any regulatory punctuation, CEO succession rates will not rise; instead, CEO succession rates will rise gradually as time passes.”* (page 259)

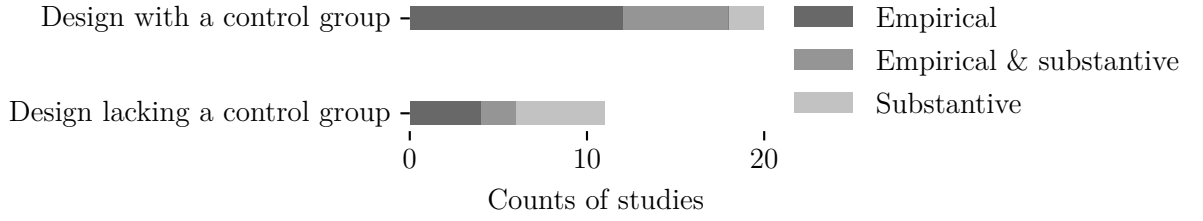
It is worth notice the authors emphasize the ‘exogenous’ nature of the Garn-St. Germain Act — the example of regulatory change at the center of the paper —, but they do not discuss what it means for the empirical strategy of the study, and, especially, in terms of empirical identification.

We also found a subset of studies ( $N = 8$ ) that claim to use an exogenous with empirical and substantive relevance. Byun, Raffaele, and Ganco (Byun, Raffee, and Ganco 2019) propose a hypothesis set that connect ‘discontinuous increases in the value of an employee’s relational capital’ with ‘employee turnover’ and ‘spinout’ formation. For example, their first hypothesis states:

*“Discontinuous increases in the value of an employee’s relational capital will be positively related to employee exit.”* (page 1371)

The authors can advance and test this and the other hypotheses thanks to naturally-occurring events regarding the politicians connected to lobbyists (i.e., ‘employees’). Here is a passage concerning the description of the independent variable of the study, ‘discontinuous increases in the value of an employee’s relational capital:’

*“We use appointments to committee chair and assignments to the four most powerful committees in Congress to capture connected politicians’ power changes in the*



*Fig. 7:* Distribution of studies across empirical strategies and exogenous shocks’ roles. Notes. — A design lacking a control group has pretest and posttest observations for one group only; a design with a control group has pre-test and post-test both for units that are affected by the exogenous shock and those that are not.

*legislative process. Discontinuous increase is a binary variable coded ‘1’ for the first year a politician connected to a lobbyist is selected to be a chair of a congressional committee or is assigned to one of the powerful committees in Congress and ‘0’ otherwise.”* (page 1375)

The series of political appointment decisions also play an empirical role, the Byun and colleagues point out:

*“Our identifying assumption is consistent with prior work and rests on the notion that the temporal change in power of connected politicians is exogenous, conditional on the observable characteristics of the lobbyists and their firms [omitted]. For the power change of a connected politician to be plausibly exogenous, whether and when the connected politician will experience the advancement has to be difficult to predict by lobbyists and firms. In addition, the change in lobbyist’s value creation due to a surge in the value of political connections should be uncorrelated with the accumulation of the lobbyist’s expertise, conditional on observables. Given the complicated and uncertain political process of chair selection and committee assignment, scholars have argued that committee and chair assignment satisfies these conditions with respect to lobbyists [omitted]. In fact, others have gone as far as to argue that the timing and ascension of committee and chair appointments are exogenous even to the politician herself [omitted]. Thus, it is reasonable to believe that using the power change of a connected politician to capture discontinuous increases in the lobbyist’s relational capital would alleviate identification concerns due to potential omitted variable biases.”* (page 1375)

Figure 7 illustrates the distribution of sample studies across empirical strategies and exogenous shocks’ roles. Circa one-third of the articles ( $N = 11$ ) operate an empirical strategy without a control group. Within this group, we found three articles that do not use the shock for empirical identification purposes. For example, Corbo, Ferriani, and Corrado (2016) use 9/11 as a “major environmental shock” (page 323), affecting the logic that shapes the formation of alliances in the airline industry. The impact of 9/11 on aviation companies is so sudden and

pervasive to impede the identification of units that can form a control group even for a limited amount of time. Although such a naturally-occurring variation does not facilitate empirical identification, it is relevant from a substantive standpoint. According to the authors, 9/11 allows them to explore novel theoretical intuitions regarding the change of interorganizational networks:

*“Our intuition is that patterns of interorganizational network ties provide a lens through which to view critical junctures that question extant logics and open prospects for change, enabling us to shed light on organizational responses to external events. To explore these ideas empirically and inform our understanding of the interorganizational dynamics characterizing fields that undergo cataclysmic upheavals, we focus on the global airline industry in the aftermath of the September 11, 2001 terrorist attacks (henceforth 9/11), which caused one of the most severe crises ever experienced by civil aviation worldwide. Given the exploratory, theory-building nature of the study we employ a hybrid empirical strategy that combines qualitative data analysis with quantitative social network analysis, enabling us to capture a more complete, holistic and contextual portrayal of the units under study [omitted].”* (page 325)

The remaining eight articles lacking a control group emphasize the empirical relevance of their naturally-occurring events. Seebeck and Vetter (2021) investigate the relationship between gender board diversity and corporate risk disclosure. The study uses the Brexit Referendum to create an intention-to-treat model where the future exit of the United Kingdom from the European Union is an exogenous shock on firm’s risk environment by which:

*“all firms face similar and tremendous risks related to the Brexit that need to be considered by public firms when preparing their annual reports according to the Financial Reporting Council (FRC 2016a, b) as well as section 414c(2)(b) of the companies act and section 4 of the UK corporate governance code.”*

The authors claim to advance the literature on gender diversity and corporate governance by dealing with the endogeneity of a firm’s risk reporting needs. Specifically, they assert their empirical strategy

*“is less likely to face the risk of omitted variables, allowing to provide more reliable evidence of an association between board gender diversity and corporate risk disclosure.”*

However, Seebeck and Vetter’s article does not implement Neyman Potential Outcome Framework because the study sample includes UK (FTSE 350) companies only, affected by the exogenous shock.

TABLE I  
SUMMARY OF STUDY EVENTS, RESEARCH QUESTIONS, AND EXOGENOUS SHOCKS

Study	Event	Research question	Relevance of the event			Summary
			Empirical	Substantive		
Birhanu & Wezel (2020)	Government changes following Arab spring social movement.	How does group affiliation influence firm performance under weak market institutions?	✓	×		The use of sudden government change is presumed to affect executives' capacity to influence political leaders.
Byun et al. (2019) . . . . .	Change in a politician's committee and/or committee chair assignments.	How do changes in an employee's relational capital influence mobility and entrepreneurship decisions?	✓	✓		Lobbyists may experience a discontinuous shift in the value associated with a connection if there are changes to a politician's committee and/or committee chair assignments. Then, the authors can investigate empirically the consequences of social capital change on lobbyists' career.
Cabral et al. (2021) . . . . .	Staggered passage of anti-takeover laws in U.S.	Does managerial job security affect the adoption of innovative practices and structures?	✓	✓		The adoption of an anti-takeover statute is a proxy of managerial job security, which changes across states and within individual states over time, and is supposed to affect the propensity to create a CVC program.
Cai & Shi (2019) . . . . .	Revelation of the sex abuse of children by Catholic priests in U.S.	Does a firm's religious environment influence outside parties' perceptions in contracting with the firm?	✓	×		Revelation of the sex abuse of children by Catholic priests is an exogenous shock to the religiosity of a region, which can influence the capital structure, credit rating, cost of debt, and covenants of local firms.



TABLE I (CONT'D)

Study	Event	Research question	Relevance of the event			Summary
			Empirical	Substantive		
Chatterji & Fabrizio (2016)	Department of Justice investigation against the five largest U.S. orthopedic device makers.	How does an open system of innovation affect the rate and direction of innovation?	✓	×		Department of Justice investigation increases the frictions in the market for ideas by regulating the interactions between physicians and the medical device firms under investigation.
Chatterji & Toffel (2010)	Change in the scope of KLD Database, a prominent source of CSR ratings.	How do managers react to poor corporate environmental ratings?	✓	✓		The change in KLD's scope creates a subset of companies responding for the first time to a CSR rating, which allows the authors to deal with mutual causality issues regarding a firm's CSR rating and CSR strategy.
Chen & Garg (2018)	Injuries occurring to star NBA players.	Does a star's temporary absence help the organization overcome myopia?	✓	✓		The absence of star players is presumed to impact the pattern of organizational routines at the team level.
Choudhury & Kim (2019)	Change in U.S. H1B employment visas.	How do migrant inventors influence knowledge production and reuse?	✓	×		The H1B quota change exempted universities and a selected list of other entities, creating heterogeneous effects in terms of supply of first-generation ethnic migrant inventors and the rate of codification of knowledge previously locked within migrant inventors' home countries.

TABLE I (CONT'D)

Study	Event	Research question	Relevance of the event		
			Empirical	Substantive	Summary
Chown & Liu (2015) . . . .	Turnover within U.S. Senate and 'iconoclastic' senators deviating from the institutionalized seating arrangement.	How does one's location in an organizational forum affect the likelihood to receive support from peers?	✓	×	Turnover within U.S. Senate and 'iconoclastic' senior senators create opportunities for freshman senators not to seat at the margins of the chamber. These elements affect the dyadic distance between senators, a factor that is presumed to affect the likelihood of joint support.
Corbo et al. (2016) . . . . .	9/11.	Does a major environmental shock affect the social structure of an organizational field?	×	✓	9/11 is supposed to affect the organization and functioning of civil aviation, which allows the authors to assess the extent with which network mechanisms shape the alliances connecting airline companies under different contingencies.
Drexler & Schoar (2014)	Sick leave episodes among loan officers	How (much) does employee turnover affect organizational performance?	✓	✓	Loan officers' sick leaves alter economic and social exchange between the firm and its clients.
Gupta et al. (2020) . . . . .	Sarbanes-Oxley Act (SOX) & Global Financial Crisis	Does CFO gender influence the likelihood of financial misreporting?	✓	×	The authors expect: i) SOX to lead to a larger decrease in financial misreporting for male CFO firms than female-CFO firm; ii) firms to face greater pressure to report favorable earnings during crisis periods, which is more likely to influence male compared to female CFOs (based on the logic that female CFOs will be less likely to engage in fraud regardless of stakeholder pressure).

TABLE I (CONT'D)

Study	Event	Research question	Relevance of the event			Summary
			Empirical	Substantive		
Haveman et al. (2019) . . .	California Legislature enactment of the nation's first comprehensive managed competition program, and Garn-St. Germain Act	How do organizations respond to discontinuous industry-level change?	×	✓		The authors use a series of regulatory changes to investigate how organizations respond to punctuated changes in the environment and with what performance consequences.
Hilary & Huang (2021) .	Revelation of the sex abuse of children by Catholic priests in U.S.	Does generalized trust affect the power of CEO contracts?	✓	×		Revelation of the sex abuse of children by Catholic priests reduces generalized trust for certain counties only, which helps to reveal the causal effect of generalized trust on the characteristics of executives' contracts.
Jia et al. (2020) . . . . .	2005 Regulation SHO by which SEC removes the uptick restriction for a set of randomly selected pilot firms.	Do managers use CSR to insure against stock price risk?	✓	×		SEC program changes stock risk price for pilot firms only, which helps to assess whether firms invest in CSR in response to greater stock price risk, and whether such investments provide intended insurance-like benefits.
Kang & Kim (2020) . . . .	Staggered changes in inheritance, gift, and estate taxes in U.S. & sudden deaths of business owners.	Do family-firms invest more in employee relations than non-family firms?	✓	×		Taxation changes provide family owners with incentives to continue their businesses, which helps to reveal the relationship between governance forms and investment in employee relations. Sudden death of family members alter a firm's status, which attenuates the concerns time-invariant characteristics jointly affect performance and ability to implement employee-friendly policies.

TABLE I (CONT'D)

Study	Event	Research question	Relevance of the event			Summary
			Empirical	Substantive		
Ke et al. (2019) . . . . .	Sudden deaths and retirements of executives.	How do social connections among executive team members affect management forecast accuracy?	✓	×		Sudden turnover events alter the social connections within a team of executives, and, in turn, help to reveal the causal effect of social capital on decision-making quality.
Koh et al. (2018) . . . . .	Staggered adoption of the Inevitable Disclosure Doctrine (IDD). in U.S.	Are confident CEOs more likely to report R&D expenditures than cautious CEOs?	✓	×		The staggered U.S. state courts' verdict on the IDD helps to reveal the relationship between CEO confidence and R&D disclosure by attenuating market competition.
Krishnan & Wang (2019)	1992 and 1998 Higher Education Amendments (HEA)	How does student debt influence the propensity to start a firm?	✓	×		1998 HEA alters the cost of discharging student debt through bankruptcy — which increases the cost of entrepreneurship, that is, new venture failure — while it is unlikely to affect financing availability to start a venture. Hence, the authors can assess the causal relationship linking student debt with propensity to create a new venture. 1992 HEA affects the volume of student loans thought the federal government. Students who spend more time in college during the post-1992 HEA regime will have more student loans. Hence, they will have lower likelihood to start a new venture.
Li & Tallman (2011) . . . . .	9/11.	Does a sudden change in the environment influence the economic returns of international diversification?	×	✓		9/11 is a “reorienting disruptive change” that alters international business logics, particularly, the economic and financial returns of international diversification.

TABLE I (CONT'D)

Study	Event	Research question	Relevance of the event			Summary
			Empirical	Substantive		
Li & Zhan (2019) .....	Reductions in import tariffs initiated by U.S. authorities.	How does product market threats affect stock crash risk?	✓	×		Reduction in import tariffs increases competitive pressure, which aggravates executives' incentive to withhold negative information and increases and make firms more prone to stock crashes.
Mahmood et al. (2017)	Global Financial Crisis.	How does centralization of intragroup equity ties affects the performance of group affiliates?	✓	✓		Global Financial Crisis creates environmental turbulence exogenously for Taiwanese firms, and, in turn, helps to appreciate the contingent role of equity tie centralization.
Natarajan et al. (2019) ..	Indian Government's demonetization measure.	How do middle managers influence resource allocation choices?	✓	×		The decision to withdraw almost 85% of bank notes in circulation (all 500-rupee and 1,000-rupee bills, the most common units of circulating currency) increased bank headquarters' control over ATM deployment, which resulted in tighter monitoring of middle managers' allocation decisions.
Qian et al. (2019) .....	Brokerage house mergers and closures in U.S.	How do financial analysts influence managers' choice to invest in CSR?	✓	✓		The closure or merger regarding a brokerage house reduces financial analyst coverage for some firms only, which allow the authors to assess the causal relationship between the (change in the) extent of analyst coverage and CSR.

TABLE I (CONT'D)

Study	Event	Research question	Relevance of the event			Summary
			Empirical	Substantive		
Ramirez & (2018) . . . . .	Price variation in the global copper industry.	How does the value appropriated by employees varies in response to an exogenous shock to the price of the firm's product?	✓	✓		Copper mines' size is homogeneous. Hence, price fluctuations in the global copper industry are exogenous variations for individual mines and can reveal the mechanisms behind value distribution within organizations.
Seebeck & Vetter (2021)	Brexit Referendum.	Does board gender diversity affect corporate risk disclosure?	×	✓		The outcome of Brexit Referendum increases the amount of risk environment for all UK-based companies, which attenuates reverse causality concerns regarding board gender diversity on corporate and risk disclosure.
Tan & Netessine (2014) .	Adoption of a new staffing system.	How does workload impact worker productivity?	✓	×		The staggered adoption of a new computer-based scheduling system prescribes different staffing levels from those that managers might suggest because it uses more historical sales data than a manager can handle. Hence, authors can make cross-restaurant comparisons involving similar servers experiencing different workload levels.

TABLE I (CONT'D)

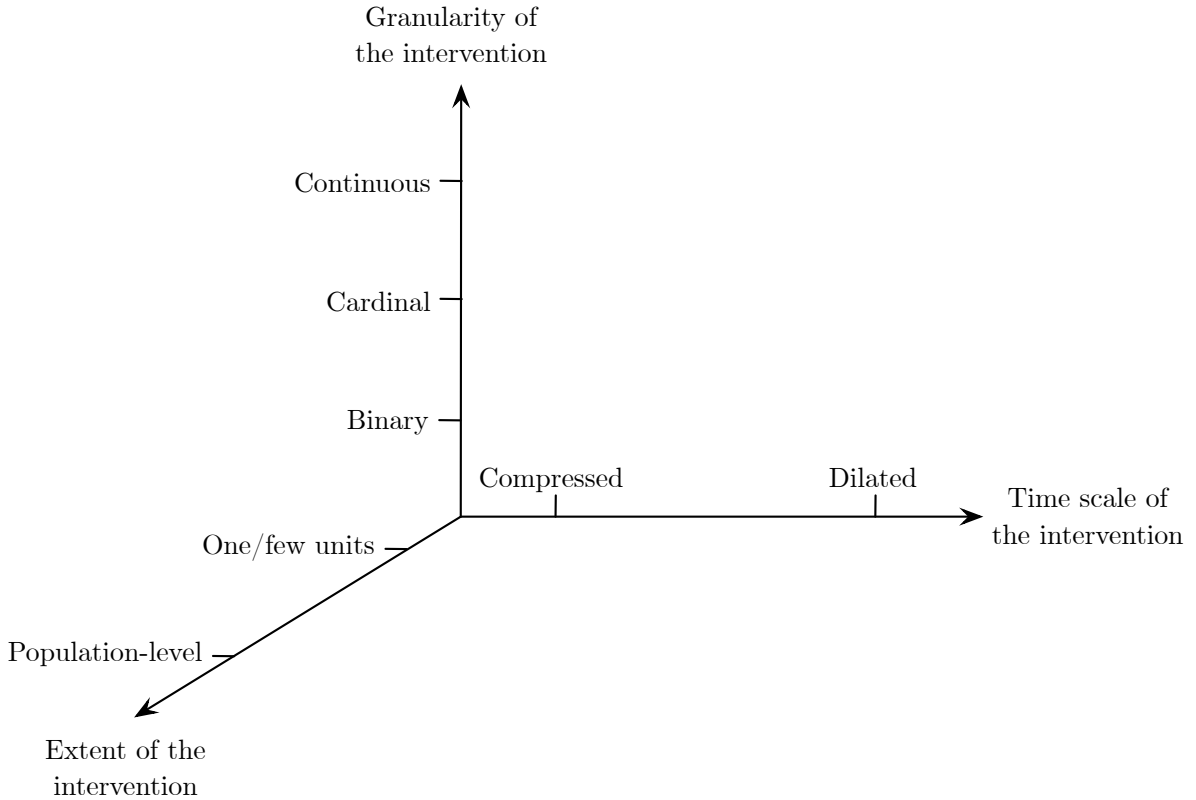
Study	Event	Research question	Relevance of the event			Summary
			Empirical	Substantive		
Vergne (2012).....	9/11.	Does straddling multiple product-market categories dilute stakeholder attention to the stigma of operating in the global army industry?	×	✓		Since attackers used commercial airlines hijacked by terrorists armed with kitchen knives, the definition of the weapons category was questioned in the post-9/11 period.” Hence, 9/11 allows the author to test whether the salience of the category ‘weapons’ weakens ‘the negative relationship between stigma dilution (i.e., the situation in which a diversified business operates also in a stigmatized sector, such as ‘arms’) and media disapproval.
Wang et al. (2016).....	Delaware’s 1996 ruling against hostile takeovers.	Do takeover threats affect a firm’s knowledge structure?	✓	×		A series of law cases make takeover less favorable for target firms incorporated in Delaware, allowing the authors to assess the impact of (an increase in) takeover protection on firm-level knowledge production.
Zhang et al. (2020).....	iOS 7 jailbreak.	Does a lapse in gatekeeping reduces knowledge sharing among developers?	✓	✓		The event is an exogenous shock to Apple’s gatekeeping policy, aiming to orchestrate developers’ value creation activities in the AppStore. That allows scholars to appreciate the impact of platform governance on knowledge sharing among developers.
Zheng & Wang (2020) ..	2014 Google blockade in China.	How does Google’s search engine influence the search process of inventors?	×	✓		The blockade of Google affects inventor’s information processing and, in turn, innovation output.



### 3 How do exogenous shocks differ?

This section of the study introduces a typology of exogenous shocks that help scholars evaluate a concrete shock’s essential features and link them with salient empirical strategy challenges. In so doing, we take the relevance of a naturally-occurring event ‘for granted.’ In other words, we assume the authors have already proven the added value of the environmental variation to addressing a target research question.

As shown in Figure 8, the typology is based on three dimensions of exogenous shocks: (1) the *extent of the intervention*, i.e., the fraction of a unit’s population that are presumed to be treated; (2) the *timescale of the intervention*, i.e., the amount of time an exogenous shock takes to treat units; (3) the *granularity of the intervention*, i.e., the different degrees with which an exogenous shock treats units.



*Fig. 8:* A typology of exogenous shocks. Notes. — The ‘timescale of the intervention’ axis is a continuum; we annotate it with reference points in the interest of interpretability.

The literature shows considerable variations regarding the first dimension, an *exogenous shock’s extent of intervention*. At one extreme of the gamut, there are cases such as pilot or unique policies and rare naturalistic or social events that affect one unit only. For instance, Nathan (2020) evaluates the causal impact of a flagship UK technology cluster program that carries out an original ‘light-touch,’ market-oriented intervention. The policy under investigation — which the author presents in as an as-if random variation<sup>9</sup> — regards one cluster London

9. Here is a passage from Nathan (2020) where the author describes the empirical identification strategy for

solely (that is, ‘Tech City’). The study of Abadie and Gardeazabal (2003) is another example of an exogenous shock affecting one unit only. The authors use the terrorist conflict in the Basque Country as a case study to investigate the effect of conflict on regional GDP.

In other circumstances, exogenous shocks regard a fraction of the units included in the reference population. Typical cases are empirical strategies that consider the death of business or political leaders (e.g., Bennedsen et al. 2007; Brown et al. 2017; Iyer 2010; Johnson et al. 1985; Jones and Olken 2005; Kang and Kim 2020; Ke et al. 2019; Lee, Kim, and Bae 2020; Nguyen and Nielsen 2010, 2014; Quigley, Crossland, and Campbell 2017). For instance, Iyer (2010) uses the heirless death of princes in the 19<sup>th</sup> as a random variate accounting for the transition of a district from the ‘indirect rule’ to the ‘direct rule,’ in which British administrators collected taxes and administered local governance themselves. The descriptive evidence reported in Iyer’s work indicates twenty districts out of 181 experience the heirless death.<sup>10</sup> One of the studies included in our systematic review of the literature (Jia, Gao, and Julian 2020) takes advantage of SEC’s pilot study consisting in exclusion of designated securities from the operation of the ‘tick’ test of Rule 10a-1(a) and any short sale price test rule of any exchange or national securities association. Such a temporary intervention resulted in a stock price risk surge for 512 firms belonging to the Russell 3000 Index.

The other extreme of the gamut regards exogenous shocks that interest the whole population of units. That could happen for different reasons. Sometimes, governments introduce legal changes in a non-staggered manner, making new laws binding at the same point in time for all firms located in the country. An example is Norway’s gender quota policy, the shock central to the work of Matsa and Miller (2013) on the implications of gender composition in executive teams. Public limited companies had two years to comply with the requirement of having at least 40 percent representation from each sex on their board. According to the descriptive evidence reported in the study, *“nearly all firms complied by February 2008, and all did by April 2008”* (page 140). Exogenous shocks that affect the entire population of reference can also emerge from events such as major catastrophes, pandemics, recessions, or global-scale terrorist attacks. Examples are Corbo et al. (2016) and Vergne (2012), — which rely on the variance created by 9/11 to investigate the change of the airline industry and the boundaries of the global arm sector respectively — and Gupta et al. (2020), which draws on the Global Financial Crisis as a source of pressures for CFOs to report favorable results,

The second dimension of our topology — intervention timescale — emphasizes the timing with which an exogenous shock is presumed to affect a relationship or mechanism of interest. To clarify this dimension, let us focus on one specific class of exogenous shocks: the death of individuals occupying prominent positions in organization or fields. The finance literature abounds of studies using sudden deaths amongst upper echelons to address the overarching

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the paper: *“By 2010 Ministers were claiming ‘something special’ for the Inner East London cluster (Cameron, 2010; Osborne and Schmidt, 2012). Other accounts depict policy origins as chaotic (Butcher, 2013; Nathan et al., 2019), and thus as good as random”* (page 5).

10. Iyer considers the twelve year timespan (1848 - 1856) where the Governor-General of India, Lord Dalhousie, enacted a new policy Doctrine of Lapse, annexation would result from the death of a ruler without a natural heir.

question ‘how do executives matter?’ (e.g., Cho et al. 2016; Dedman and Lin 2002; Duchin and Sosyura 2013; Faccio and Parsley 2009; Falato, Kadyrzhanova, and Lal 2014; Fee, Hadlock, and Pierce 2013; Fracassi and Tate 2012; Johnson et al. 1985; Nguyen and Nielsen 2010, 2014; Salas 2010). The intuition behind this body of work is that analyst and market reactions to unanticipated executive turnover reveal the ‘net contribution’ of business leaders to shareholder value. As Nguyen and colleagues (2014) note, stock price changes play a critical role as they

*“reflect the expected incremental value of cash flows under the deceased executive net of this pay, relative to the expected incremental value of the replacement net of his pay.”* (page 3000)

Since market expectations factor in broad arrays of time-variant elements (e.g., the search costs a firm may incur to fill the vacancy in), it is critically important to pick up an appropriate time window within which stock prices foster a *ceteris paribus*, pre-post shock comparison. Nguyen and colleagues (2014) evaluate the impact of executives’ sudden death using

*“daily returns from the Center for Research in Security Prices (CRSP) for an 11-trading-day period around the death. The event day is defined as the trading day of the executive’s death, or the first trading day following the death if it occurred on a nontrading day.”* (page 3000)

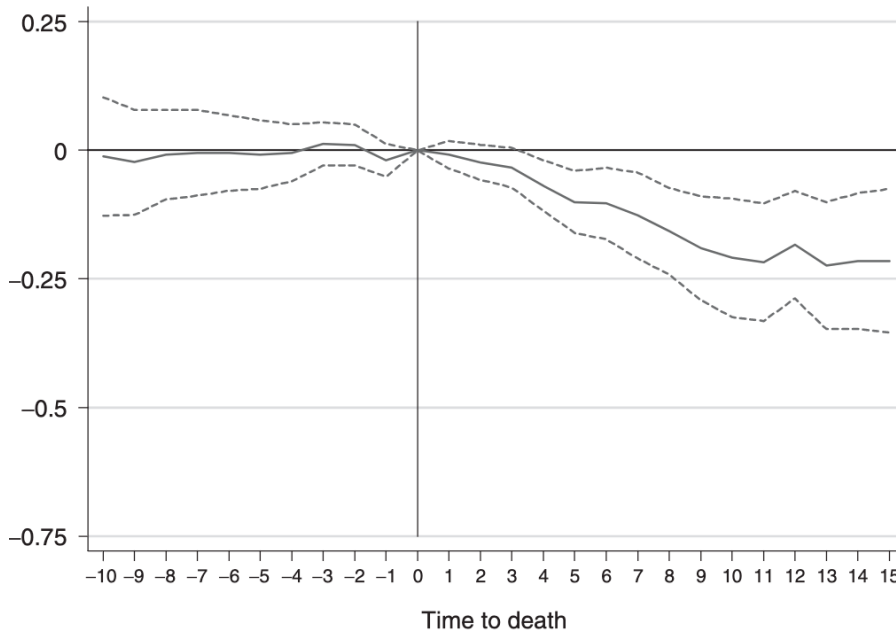
Such a strand of finance literature stresses two aspects. First, sudden executive deaths are essential sources of variance to estimate leaders’ economic and financial impact. Second, and more importantly for our typology, there is a relatively tight time-frame where executive sudden deaths are relevant; that is, they create exogenous shocks to address the question ‘how do executives matter?’

Studies across the fields of economics of science and sociology of science highlight a different temporal pattern by which sudden deaths alter reference processes or mechanisms and, in turn, acquire relevance. Several articles (e.g., Aizenman and Kletzer 2011; Azoulay, Fons-Rosen, and Zivin 2019; Azoulay, Graff Zivin, and Wang 2010; Azoulay, Wahlen, and Sivan 2019; Khanna 2021; Oettl 2012) take advantage of the start scientists’ premature death to estimate better the spill-overs that emanate from collaboration. The seminal study of Azoulay and colleagues (2010) quantifies these spill-overs in terms of a scientist’s differential of publications and research grants when collaborative ties collapse because of the death of an alter star scientist. Different to the finance literature, where executive deaths can create ‘instantaneous’ change in expectations about a firm’s future cash flows, Azoulay et al. (Azoulay, Graff Zivin, and Wang 2010) consider a broad timespan to reveal the effect of exogenous shock. On the one hand, spill-overs can ‘roll over’ after the death of a superstar collaborator. On the other hand, a scientist’s research takes sufficient time to change. These elements seem to guide the choice of the authors to evaluate the effects of the shock in a fifteen-year time window (see Figure 9).

At the same time, they also account for the intertemporal variation of the superstar extinction effect:

*“Following the superstar’s death, the treatment effect increases monotonically in absolute value, becoming statistically significant three to four years after death. Two aspects of this result are worthy of note. First, we find no evidence of recovery — the effect of superstar extinction appears permanent. Though we will explore mechanisms in more detail below, this seems inconsistent with a bereavement-induced loss in productivity. Second, the delayed onset of the effect makes sense because it plausibly takes some time to exhaust the productive potential of the star’s last scientific insights. In addition, the typical NIH grant cycle is three to five years, and the impact of a superstar’s absence may not really be felt until it becomes time to apply for a new grant.”* (page 568)

### B. Publications without superstar collaborator



*Fig. 9:* A visualization included in Azoulay et al. (2010) clarifying the timescale of the exogenous shock generated by the sudden death of a scientist’s prominent collaborator. Notes. — The figure, titled ‘Dynamics of Treatment Effects,’ is reported a page 569. Here is the note describing the key aspects of the figure: “The solid lines in the above plots correspond to coefficient estimates of conditional fixed effects quasi-maximum likelihood Poisson specifications in which the weighted publication output of a collaborator is regressed onto year effects, seventeen indicator variables corresponding to different age brackets, and interactions of the treatment effect with 27 indicator variables corresponding to eleven years before the year of death and prior, ten years before the year of death, nine years before the year of death, ..., fourteen years after the year of death, and fifteen years after the year of death and above (the indicator variable for treatment status interacted with the year of death is omitted).”

The third element of our typology regards the *granularity of the intervention* that stems

from the exogenous shock. The least granular intervention corresponds to a binary treatment that splits units into two experimental groups *à la* Snow ([1855] 1965). An intermediate level of granularity occurs when the exogenous shock is presumed to form more than two groups of units, each of which receives a certain amount of treatment. For instance, the study included in our review by Chen and Garg (2018) divides NBA teams into four strata: those not affected by a superstar injury (the control group) and those affected by a superstar injury implying ‘short,’ ‘medium,’ and ‘long’ absence. Finally, an exogenous shock may create a continuous treatment. An example is Drago and Galbiati’s (2012) paper on social influence and criminal activity. The authors use the Collective Clemency Bill, the Italian Parliament approved in 2006, as an exogenous variation in the incentives to commit a crime:

*“Upon approval of the bill, almost 22,000 inmates were released from Italian prisons. Of direct importance to the objective of this study, the bill stipulates that if a former inmate commits another crime within 5 years of their release from prison, they will be required to serve the residual sentence suspended by the pardon (varying from 1 to 36 months) in addition to the sentence for the new crime. In other words, the policy effectively transforms one month of an original sentence into an additional one month of sentence for future crimes committed at the individual level.”* (page 200)

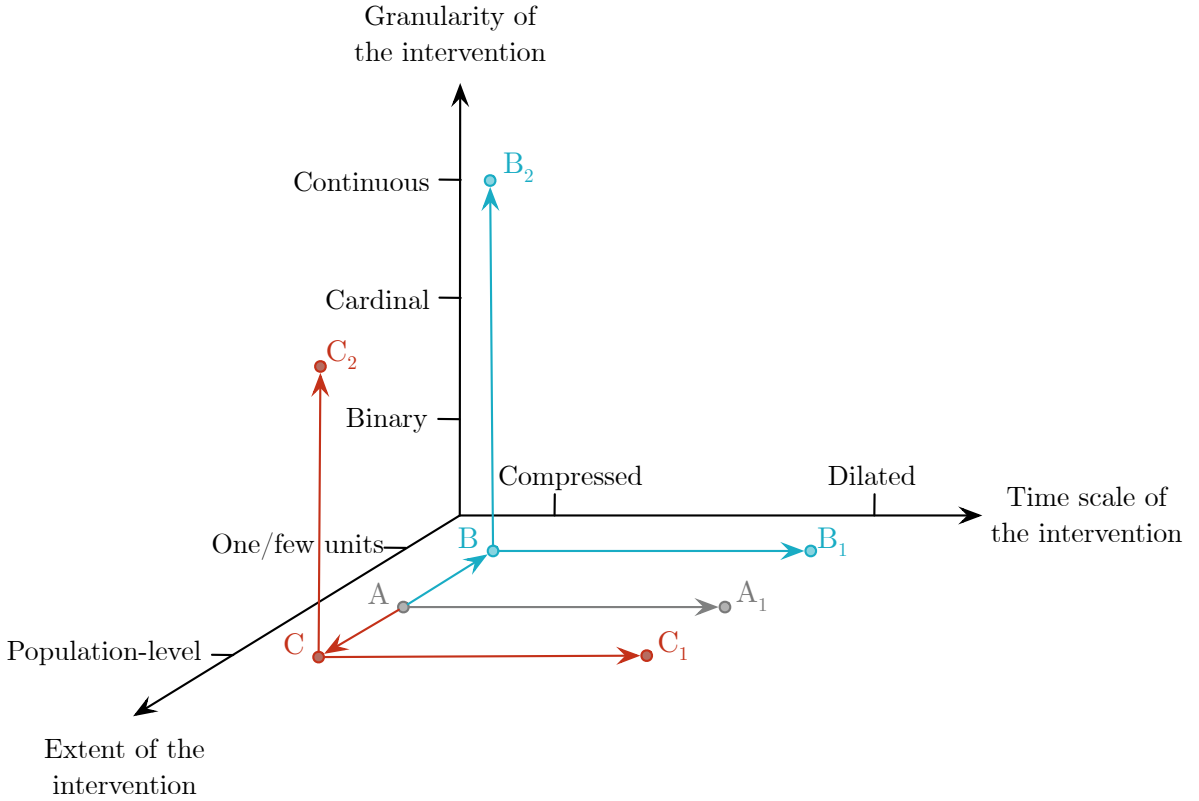
For Drago and Galbiati (2012), the shock does not originate from the new law. Instead, it comes from the interaction between the application of the law — commuting actual sentences in expected sentences for forty percent of the Italian prison population — and a prisoner’s residual sentence at date of release. Thanks to such an ingenious empirical strategy, the authors can show

*“Peers’ residual sentences greatly impact individual recidivism. The estimated impact of the average residual sentence of the group (excluding the individual himself) is comparable to the direct effect of the individual residual sentence. In particular, an average residual sentence of one additional month decreases the probability of being rearrested by 0.16 percentage points. The considerable size of the indirect effects is consistent with a social multiplier of two in crime.”* (page 200)

## 4 Harnessing exogenous shocks: empirical strategy challenges

This section emphasizes the empirical strategy challenges that are more likely to arise across exogenous shocks with different features. Mainly, we focus on three challenges: (1) the scope of applicability of Neyman’s Potential Outcome Framework; (2) the external validity of an average treatment effect; (3) interference between treated and control units, i.e., SUTVA violations. To do that, we map some ideal cases of exogenous shocks onto the typology presented in the previous section (see Figure 10).

Let us consider case A, where a binary intervention influences a significant number of units by altering meaningful empirical relationships or theoretical mechanisms in a short amount of time. That would be the typical ‘finance paper’ drawing on the variance generated by the sudden death of executives. For instance, Nguyen and colleagues’ (2014) paper is based on 149 sudden death events whose effects are presumed to manifest in a relatively short timespan (i.e., eleven days). Such a case poses minimal concerns in terms of empirical strategy. First, the population of units contains a sufficient number of controls to approximate the unobservable counterfactual (e.g., how a stock price would have evolved absent the unanticipated executive turnover). Second, the binary intervention variable is ‘well-behaved’ and does not create range restriction issues threatening the external validity of the empirical estimates. Finally, the tight timescale of the intervention reduces the chances that control units will be unintentionally treated or affected by treated units’ course of actions (that would be a vacancy chain at the executive level involving both treated and control companies, which is unlikely in a timespan such as the one Nguyen and colleagues (2014) consider).



*Fig. 10:* Comparative statics comprising ideal cases of exogenous shocks. Notes. — The key idea is that different cases present diverse degrees of concern about (1) the scope of applicability of Neyman’s Potential Outcome Framework; (2) the external validity of an average treatment effect; (3) interference between treated and control units.

Case  $A_1$  differs from A because of the timescale of the intervention, which has a temporally dilated impact on the empirical relationships and theoretical mechanisms at the center of the study. Azoulay and colleagues’ (2010) paper on ‘superstar extinction’ and knowledge spill-overs is consistent with this case. The author’s dataset contains 112 sudden, premature ends of elite

life scientists, whose effects on circa five thousand collaborators are modeled empirically over a fifteen-year timespan (see Figure 9). Similarly to A, chances are significant the population will contain suited control cases and external validity concerns will be least. However, interference issues may arise because of the persisting impact of the shock. For instance, the effects of super-star extinction events may propagate over time through the social structure of collaboration affecting treated units' collaborators supposed to belong to the control group. Azoulay et al. (2010) propose supplemental analysis to deal with possible SUTVA violations, they present in terms of the “*problem of leakage through the coauthorship network*” (page 579).

In general, relying on an exogenous shock such as B poses external validity concerns. Plausible causes are generic range restriction issues — i.e., a treatment group with a limited variance — and/or the presence of treated units showing idiosyncratic features. The former may appear in studies with few treated units (e.g., Aizenman and Kletzer 2011). The latter is common when naturally-occurring events regard complex systems such as regions/countries (e.g., Abadie and Gardeazabal 2003), business platforms (e.g., Zhang, Li, and Tong 2020), or industrial clusters (e.g., Nathan 2020). Insofar as the population contains comparable control units, an empirical strategy can still produce causal evidence in such a scenario. However, the estimated effect is a local average treatment effect (LATE) (Imbens 2010) since it “*it only characterizes causal parameters for particular units*” (Dunning 2012, page 290). A ‘cautious,’ LATE interpretation of empirical estimates is — if possible — even more critical in case B<sub>2</sub>, where the increased granularity in the treatment may exacerbate range restriction issues.<sup>11</sup> Alternatively, the treated unit might lack a match in the control group. Then, ‘Abadie’s Comparative Case’ method (Abadie 2021; Abadie, Diamond, and Hainmueller 2010, 2015; Abadie and Gardeazabal 2003) would be essential to create a synthetic counterfactual.<sup>12</sup>

Let us consider C. Sometimes, a naturally-occurring event’s attributes and role *vis á vis* the target research question impedes the identification of a control group. In our review, some studies that take advantage of the variance created by 9/11 for theorizing (Corbo, Corrado, and Ferriani 2016) or measurement purposes (Vergne 2012). In contrast, none uses 9/11 to create an exogenous shock study in the sense of a natural experiment. In other circumstances, the existence of surrogate populations allows researchers to bypass the problem of a total-spectrum exogenous shock. The gender quota study of Matsa and Miller (2013) is one of the most representative examples. The government of Norway applied the ‘40% policy’ in a non-staggered manner and made it mandatory for all public companies. The authors bypass the lack of counterfactuals by adjusting their empirical strategy in two ways. First, they consider two surrogate populations, namely Norwegian private firms and public firms located in Scandinavian countries (textitex-ante, similar to Norway in terms of culture and institutions). Second, they use a triple Difference-in-Difference estimator to create a composite counterfactual that

11. The key idea is that the distribution of study variables conditional on different level of the treatment may present significant sparsity.

12. As Abadie points out in his recent article (2021), the synthetic case control method was originally proposed “*with the aim to estimate the effects of aggregate interventions, that is, interventions that are implemented at an aggregate level affecting a small number of large units (such as a cities, regions, or countries), on some aggregate outcome of interest*” (page 392).



In Figure 11, we use a decision tree to summarize the intuitions presented in this section of the paper.



## 5 Coda

This paper aims to help authors and reviewers assess the validity of empirical strategies based on exogenous shocks. In the first arm of this project, we have clarified the exogenous shock concept’s boundaries and ontological status. Mainly, we have stressed the idea that exogenous shocks do not exist in the real world. Still, they emerge from the purposive association of naturally-occurring events with concrete research questions. As a *corollary*, it is not the intrinsic characteristics of a naturally-occurring event that make a powerful exogenous shock study. In other words, ‘relevant events’ are not necessarily sudden, such as the death of a business leader because of a heart attack, uncontrollable, such as earthquakes, or random, such as lotteries. Instead, the relevance of a naturally-occurring event is contingent on the empirical and theoretical problems at hand.

In the second arm of the paper, we have argued that not all exogenous shocks are born equal. Our original typology highlights three key features that differentiate exogenous shocks and help scholars anticipate which empirical strategy challenges are more likely to raise conditional on exogenous shock types. Primarily, we have focused on three issues that have received limited or no consideration at all amongst leadership and management studies: the scope of applicability of Neyman’s Potential Outcome Framework; the external validity of the average treatment effect estimate — i.e., the ‘LATE’ interpretation of statistical estimates; the existence of treatment interference issues resulting in SUTVA violations.

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