

Econometrics of strategy: a review¹

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1. Motivation

Strategy derives from top decision-making at war. When generals go to the battlefield, they go with a plan and with armed hosts of fighters to achieve victory.

When strategy scholars embark on a research project, they think they must ask interesting and important questions, but they also need to deploy the methodological weapons to convince gatekeepers (and themselves) that the claims of their manuscript are true and useful. The vast majority of strategy research uses econometrics as the weapon. By definition, “econometrics is the field of economics that concerns itself with the application of mathematical statistics and the tools of statistical inference to the empirical measurement of relationships postulated by economic theory” (Greene 1997, p. 1). How does the econometrics of *strategy* work?

This methodological question has not been answered in detail yet. By contrast, discussions about the substance of strategy have been laid out in multiple forums. Consider, as an early example, the Napa Valley conference in 1990 that led to Rumelt, Schendel, and Teece (1994). Or for very recent instances, consider the wide-ranging conceptual debates in the *Strategic Management Review*. Little, however, has been written about how strategy scholars have been crafting their econometric designs to address the questions that interest them. Methodological reviews are available in related fields (e.g., Angrist and Krueger 1999, Roberts and Whited 2013, Bowen, Frésard, and Taillard 2017). Putting together a detailed review of methods in strategy is not the purpose of this paper. Rather, the more modest goal here is to remind experienced readers---or to illustrate newcomers---about what makes a strategy paper convincing from an empirical standpoint.

This paper seeks to add value by offering a view of what high-quality empirical research is in strategy, providing a list of examples that warrant further study to help all in strategy with their methods, developing a simple typology of cutting edge approaches, and assisting the reader in navigating the complexity of these papers and the strategy literature at large to see the key decisions made by the authors of the papers in their econometric design.²

Who can judge what research is good enough to be reviewed? One approach would be to set *ex ante criteria* of high-quality empirical work and then cast a wide net to find papers that

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² A reviewer's comment delineating all these dimensions is gratefully acknowledged.

exemplify them. A very different approach is to start with a set of *scholars* from top strategy groups in the U.S. and pick one of their publications. The latter is the approach used here, which may be seen as arbitrary, although it benefits from the proven principle of market screening that on average should be informative.

Specifically, the sample of papers covered in some detail here was facilitated by the continued organization of a yearly summer strategy workshop in New York from 2009 to 2023 (replaced only in 2020 and 2021 by a Zoom program because of the pandemic) that brought together junior faculty from top U.S. business schools as speakers. Having been present in the audience of all these events uninterruptedly, the author of this paper gained insight into how a select group of researchers carried out frontier work in strategy over fifteen years. Needless to say, the selection criteria to participate in the workshop led to choose for this review a narrow subset of papers within the very broad strategy landscape, and this fact should not be interpreted as a neglect of many other approaches and contributions. Selecting some strategy publications from some of the speakers that were affiliated with a strategy department at some point of their career yielded a total of twenty papers, which is plenty to delve into an examination of the econometrics of strategy.

Choosing a small set of papers is deliberate. The method for a methods paper could have been quantitative, for instance, through a meta-analysis of the econometric section of thousands of strategy articles. Yet even quantitative fields that study firms and value creation benefit from qualitative reviews of methodological issues (e.g., Edmans 2023). This paper will touch on quantitative aspects of strategy research through a qualitative lens, focusing on the sound choices made by strategy scholars in their publications in top strategy journals. The tone is affirmative and constructive.

Indeed, through various approaches, strategy scholars have made important empirical contributions to the understanding of firms and markets. More than half of the empirical papers discussed here have tackled the endogeneity of strategic variables successfully enough to secure publication at top journals; all other papers made a convincing point without the need of exogenous variation in their design. Much can be learned from what all the papers reviewed here discovered.

In essence, high-quality empirical research in strategy tackles an interesting question using suitable data tightly connected with an appropriate econometric design to offer new results that can be interpreted with clarity. The virtue of this work is credibility.

Yet a sobering view of the prowess of econometric methods in strategy is advisable. Just a few yards off from the seminar room where the summer workshop was held, Ariel Pakes---a regular visitor in New York and the 2023 winner of the Nemmers prize in economics---was asking methodological questions to speakers in the industrial organization (I.O.) seminars. “If $y_{it} = \beta x_{it} + \epsilon_{it}$, what's in the error term ϵ_{it} ?,” would be a classic question. Admittedly, the econometric weaponry is abundant and strategy research only uses a small set of the arsenal. Yet it is also true that the 2021 Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel went to quasi-experimental methods scholars, consecrating the methodological value of what structural

I.O. researchers call “reduced-form work.” This may be the right time to take stock of what the econometrics of strategy has been able to show in recent years.

2. The components of an empirical paper in strategy

Let us start by reviewing the components of an empirical paper strategy. Figure 1 provides an outline. In any empirical paper, a question must be posed, the data to address it must be available, an empirical design is deployed to establish the relation between the variables of interest, and an interpretation of what the results of the design mean is offered.

What is a strategy question? Many dimensions of firm activity in the market are considered relevant to strategy: competitive advantage, price competition, differentiation, patent-based innovation, corporate diversification, corporate governance, vertical integration, top-management turnover, and a long et cetera. (Many of these themes intersect with fields different from strategy, such as I.O., finance or operations management.) Methodologically, however, a strategy question falls into the category of a new theory that requires some validation, or an old empirical debate that is still unsettled. Hence, the motivation to embark on a research project may be to shed light on a theoretical conjecture that had not been addressed in the past or, conversely, to focus on the tension in prior empirical arguments that has not reached a resolution. The potential theoretical contribution arising from these alternative approaches is very different. Hence, the onus on the econometric component of the empirical papers of these contrasting categories of questions is also different.

In particular, if a paper offers a new compelling theory and proves it without data, the econometric section can be seen mostly as an illustration rather than as an absolutely necessary component to make a contribution. In other words, the analytical completeness of proving a theory without data may be persuasive enough to see a contribution in the research project, to which the empirical section is a nice feature that shows that the logical consistency of the proven claims somewhat resembles what happens in the real world. Because very few empirical papers in strategy offer a new analytical theory that is demonstrated without data (only five of the twenty papers featured in Table 1 introduced below, use formal theory), this may be an area of opportunity for synergistic collaboration between scholars with complementary skills to make inroads into substantive questions in strategy.

By contrast, most questions in strategy research consist in propositions built from prior empirical work that did not resolve the claims that the new paper seeks to illuminate. Plenty of reasons can be thought of. In many cases, prior work focused on several explanatory variables to explain a phenomenon but lacked data on a potentially important factor that was left unstudied. Hence, the econometric design implies extending prior work by introducing a new variable and trying to control for the previously documented drivers of the phenomenon of interest. Similarly, it may have been the case that the dependent variables of prior work were insufficient, and introducing more would help understand the mechanisms why prior work found what it found. An analogous rationale exists for research questions that introduce moderating variables, or heterogeneous-impact variables, that were not available in prior work.

Yet a more damning view of prior empirical work is that it was wrong and needs a corrective. Methodological controversy in strategy is not very common, but there have been instances of replication of prior work that exposed flawed results, or restudies that yielded fruitful lessons. The research question of these papers, then, is basically the same question as in prior work but it is addressed with a better econometric design. The burden of econometric proof here is heavy and the political costs, probably also high.

Whichever the case---a new theory or an old empirical debate---, strategy questions deal with the relation between variables. In this regard, it may be useful to assess the recommendation by Oxley, Rivkin, and Ryall (2010) about publishing papers that provide stylized facts about strategy. One might be skeptical about the practicality of such recommendation. With over three thousand active academic members in the Strategy division of the Academy of Management---not counting students---, it is hard to fathom how the flood of stylized fact papers would be handled. How will journals rank the importance of the stylized facts of one submission versus another? More substantially, how is this a strategy fact, and not an economics fact, or an operations fact, or a finance fact? One may only guess that the advent of artificial intelligence and ChatGPT will provide plenty of stylized “facts” (true or false) at the fingertips of users. By contrast, the relation between variables is a harder, subtler task to take on that will continue interesting strategy scholars.

After a research question is addressed with data and with an empirical design, the interpretation of results---the last stage in Figure 1---wraps up an empirical paper. The output of a paper is a set of results: mostly, regression coefficients and test values. Because of their importance, all key quantitative results should be detailed, commenting on their magnitude and the statistical level of confidence with which they were obtained. This kind of discussion is enriched by a previous understanding of the field of strategy, which would help to describe how the empirical estimates fit with the question of interest, how they show what was expected, how they show something that was not expected, and what theoretical or methodological argument may explain the apparent contrast. It is sometimes disappointing, though not totally surprising, that discipline articles published in strategy journals do not cite prior strategy work more extensively when placing their findings in the literature.

A clear-eyed view of the internal and external validity of the results also belongs in the interpretation section. If the results are based on very narrow data, it is not obvious how they can relate to independent samples of comparable data in other settings.

Having very briefly discussed the beginning and the end of the sequence in a strategy paper, it is time to turn to the center. The two econometric components of empirical papers---the data and the design--- are briefly reviewed next.

3. Econometrics of strategy

Data

Access to rich, hard-to-obtain data is probably the best kept secret of successful researchers in almost any scientific field. Graduate strategy programs train students in theories and methods but they seldom include data-based courses what would effectively ease the path to finding a good research question and succeeding in developing it. Hence, scholars-in-training rely on the generosity of faculty members or on their own prior experience to come up with suitable data sets for their work. Efforts to improve the match between scholarly talent and useful data sources should be renewed.

In terms of a typology, over the last forty years, industrial economists nearly completely switched from using cross-industry data (Schmalensee 1987) to only using within-industry data (Einav and Levin 2010) in their papers on competitive behavior. In strategy, this change has not been so clear-cut. There are many papers that use broad data sets, in the sense that they cover many industries or many kinds of firms. Similarly, there are also many strategy articles that cover a single industry or even a niche segment of an industry to study the relation between variables and make a broader point. Digitization over the last three decades has been a boost in many industries, academic research being one of them; big data now are more easily accessible. Half of the papers reviewed here used more than a hundred thousand observations in their analysis. However, strategy work is not very heavy on large data sets.

Empirical design

Consider the relation between variables

$$y_{it} = \beta x_{it} + \epsilon_{it} \quad (1)$$

The benign interpretation of this relation is that it is linear and that the error term ϵ has a conditional mean $E[\epsilon|x]=0$ in its relation with the explanatory variables of interest captured by x (see Wooldridge (2010), chapter 4). Using this notation, four types of empirical design can be considered: methodological, correlational, quasi-experimental or experimental, and structural.

Methodological papers in strategy introduce new data, or more dimensions of the data, or a new technique, or a correction of prior work. Continuing with the running example of specification (1), methodological studies in strategy question the completeness or integrity of x , they generate x and y indirectly in cases when they are hard to obtain directly, or they challenge the specification to draw inference with the proposed functional form. Some of the best-known work in strategy has been methodological (e.g., Rumelt 1991). What makes this work appealing is that it combines technical ability with substantive previous knowledge about strategy.

Correlational papers assume away the endogeneity problem, at times pushing it back to an appendix or to robustness tables, to focus on the straightforward relation between variables. Authors in this vein of work believe that specification (1) can be trusted, though they try to assuage concerns using fixed effects, coarsened exact matching, propensity score matching, or synthetic controls in the absence of exogenous variation. Much work in strategy has been correlational to date. Is this kind of design too naive for the current state of science? Not necessarily; some frontier work in economics has relied almost exclusively on correlational evidence to make important points (e.g., Alstadsaeter, Johannesen, and Zucman 2019, Giglio et al. 2021).

Quasi-experimental papers introduce exogenous variation to try to identify the relation between variables. Authors question whether the error term in (1) is clean enough, so they prefer techniques that leverage on instances in which β can be more credibly estimated. Strategy scholars have long been aware of these techniques (Shaver 1998), though diffusion may particularly hinge on training in economics (Bowen, Frésard, and Taillard 2017). Differences-in-differences, instrumental variables, and regression discontinuity are some of the most popular techniques used (Angrist and Pischke 2008). Although excessive focus on identification has shortcomings, as broadly discussed by Coad (2021), strategy research is still far from overemphasizing identification techniques. Similarly, experimental papers can go to the field to collect data through randomized control trials (Glennerster and Takavarasha 2013), or can stay in the lab and ask human subjects to make strategy decisions for the study (Camerer 2003). Experiments of either sort are very infrequent in strategy.

Structural designs in I.O.---a field of economics that uses them routinely---start with a research question and ask how extant theory can help provide an answer. A specific theoretical model is then derived to account for the construct of interest which will be the subject of the contribution to the literature, usually looking at a single industry. Then, using identifying variation to separate supply from demand, or causes different from the one proposed, the empirical design focuses on estimation according to equilibrium restrictions. Structural estimation routines can be computationally demanding; the results are estimates of the parameters in the specific theoretical model proposed. Structural I.O. scholars consider the techniques reviewed in the above paragraphs “reduced-form” work; these scholars generally avoid drawing conclusions from that work. Because training in graduate I.O. is required to embark on this kind of work, and because generally I.O. scholars do not seek publication in strategy outlets, only a tiny fraction of strategy research is structural.

4. An illustration using twenty articles

4.1. Selection criteria

Between 2009 and 2023, a total of eighty-one scholars participated as speakers in a summer strategy workshop held in New York every year (including Zoom events in 2020 and 2021). Each year, the by-invitation-only program was put together by a small group of strategy faculty at a New York-based business school. Only about six papers were presented at each yearly workshop. Considering this pool of eighty-one as the starting set of scholars whose work would be reviewed in this paper, only authors with a strategy affiliation at some point in their career and only empirical papers published in a strategy journal were considered. The choice of specific authors and papers was arbitrary within these conventional bounds.

Was the initial universe of authors representative of strategy scholarship? To the extent that the workshop organizing committee largely invited U.S.-based scholars affiliated with top business schools, the pool of scholars whose work is covered is a small sliver of the broader community of strategy authors, though it can be viewed as representative of editorial boards at top journals nowadays. Moreover, to the extent that the workshop organizers and speakers mostly viewed

strategy questions from an economic standpoint, the target journal many of them saw themselves aiming for was *Management Science*.

4.2. The selected sample

The twenty papers selected for this review are featured in Table 1. Twenty-five percent of them were published or are to be published in the current decade; the rest were published before 2020. The journals where the works were published are *Administrative Science Quarterly*, *Management Science*, *Research Policy*, *Strategic Management Journal*, and *Strategy Science*. Only one quarter of the papers use formal theory. Eighty-five percent of the papers use panel data. Ninety percent of the papers include data on U.S. firms or industries; 60% of papers exclusively use U.S. data. The maximum number of observations studied in a given paper ranges from 120 to 4,976,233. In terms of team composition, only 30% of the articles were written by a single author, and all those papers emerged from dissertation work. The rest of the papers were written by mostly assistant professors, though some included senior coauthors.

4.3. Six types

How does the econometrics of strategy work? The sample of twenty papers described above illustrates a typology that combines the breadth of the data and the orientation of the empirical design reviewed in the previous section. Figure 2 details these six combinations.

Broad methodological

Bryan, Ozcan, and Sampat (2020) addresses a very broad economics and management literature on patent-based innovation by introducing information that was largely neglected in patent text capture: in-text citations to prior scientific work. New data are at the core of this paper. Concretely, the contribution of the authors is the development of an algorithm to extract the in-text citations of patents, which delivers a database on 2.7 million citations linking patents to scientific articles in 248 journals across twenty fields. The key substantive insight by the authors is that in-text citations in patents serve a role more similar to that of academic citations than front page citations in patents. Hence, the paper opens a path to understand a dimension of knowledge flows that was not easy to study before because of technical difficulties in extracting the data.

Empirically, the paper offers more than abundant new data to the scholarly community: it also substantiates the value of the new information compared with an existing variable such as front-page citations in patents. By connecting the new variable with well-known measures of value, the authors offer a balanced assessment of the benefits and limitations of the new information they are introducing into the literature. This transparency is useful and helps readers reach their own conclusions about how the newly introduced in-text citation content can be successfully exploited in research and practice. The crux of the empirical work, however, lies in the provision of the algorithm for data extraction. This is a paper that makes other papers possible.

Narrow methodological

Lieberman, Garcia-Castro, and Balasubramanian (2017) seeks to provide an empirical basis to the value creation and appropriation paradigm that appeared in strategy in recent years. Considering the measurement of value creation and stakeholder value appropriation a Gordian knot, the authors provide a path for this calculation using accounting identities based on public financial statements. The idea is that the economic gain generated by a firm must equal the incremental value distributed among stakeholders: employees, shareholders and capital providers, suppliers and customers. Using easily accessible financial data from the airline industry in the U.S. and from the global automobile industry, the paper offers estimates on firm-level yearly differentials of how much value was created and how it was distributed. It can be seen as the opposite of the paper reviewed above for its use of very small public data sets.

But even if the paper does not use a single regression, it makes a clear empirical point: firms differ in their actual value capture behavior, as judged by the accounting decomposition that is transparently performed in the two industry data sets. The empirical handle of the paper, given the impossibility of assessing total value, is the measurement of changes in firm-level variables to gauge value creation and value capture. That is a useful insight. Moreover, in the empirical design, the data match the technique well. By making all accounting measures from company statements uniform, and by focusing the analysis on one single industry at a time, the authors make the decomposition effective and document differing patterns in value capture. The paper emphasizes how the analysis can be applied in other settings relevant in strategy. This kind of decomposition can be broadly useful in strategy consulting or top-level policy evaluation work, which tends to be short on quantitative data and long on qualitative frameworks. This is a paper that enhances practical strategy work.

Bennett and Snyder (2017) takes on the management literature on learning from failure to declare that something is amiss. The usual regression design in that literature asks whether current failure may be statistically related to prior success or prior failure, with variable specifications cast to capture those dimensions. However, the authors raise the possibility that existing analyses may not have found real learning from failure. Instead, they argue that the significant coefficients on prior failure may be due to a mechanical correlation or to the unit root problem that is well-known in time-series econometrics. This inquiry is important both for the specific literature the authors invoke---learning from failure---and for any study of strategy dynamics. To make their case, the authors use simulations of the mechanical link between prior failure and current performance, and simulations of the unit root problem. They further illustrate their methodological critique with real data on liver transplants, declaring that they cannot tell whether the regression results using prior failure as an explanatory variable are evidence of true learning from failure or of unrelated mathematical problems. The authors also offer some advice regarding how to alleviate these problems; when they apply their advice to their own liver data, they do not find statistically significant results on the role of prior failure.

The simulated data and the liver data used in this methodological paper can be considered narrow. Yet the literature the authors address in their critique is very broad and is built around granular data sets that allow to estimate dynamic effects in a panel structure. Without the need of exogenous variation, Bennett and Snyder (2017) convincingly alerts readers that the learning from failure literature is ripe for a redesign. This is a paper that helps readers avoid faulty research.

All three methodological papers reviewed here draw connections with substantive prior work that helps them make their contribution. Judged in isolation, a paper that introduces a new variable that was hard to get, a paper that implements an accounting identity using easy-to-get public data, and a paper that discovers spurious correlations and unit root problems may be seen as relatively straightforward. Yet that is easy to say after the fact. The effective match between the question, the data, the empirical design and the interpretation in methodological research in strategy can yield substantial fruit.

Broad correlational

Belenzon and Berkovitz (2010) studies whether innovation depends on firms' affiliation with a business group. In particular, the authors posit that if ownership links with a business group facilitate innovation through a financial mechanism, then the statistical relation between group affiliation and innovation outcomes should be stronger in industries where firms are more dependent on external finance. The data considered in the study cover a large sample of firms across various European countries in key dimensions: business group affiliation, patents, and accounting information between 1995 and 2004. The question of how financial resources interact with business group affiliation speaks to various literatures in finance, economics and strategy. The import of the message depends on how the authors estimate the influence of business group affiliation on patenting behavior.

In this regard, without introducing exogenous variation to identify business group affiliation, the authors propose various measures to assuage endogeneity concerns. In particular, they introduce a control variable reflecting the pre-sample mean of patents each firm had, hence obviating the need of a firm fixed effect. Moreover, firms that change their status of business group affiliation during the sample years are excluded; the analysis only keeps firms for which business group links are static. Hence, no firm fixed effects are introduced, and the regressions use country, industry, and yearly dummies. The findings point to a beneficial role of business groups for innovation. The authors interpret their results as offering a substantive contrast with conglomerate-driven destruction of innovation found in prior research. The correlational nature of the design, building on a very broad data set and tackling a question of wide interest, is sufficient to offer a sound contribution to the literatures of interest.

Galasso and Simcoe (2011) asks whether overconfident CEOs tend to be more innovative. To start out, the authors develop a theoretical model on career concerns in which innovation functions as an indicator of managerial ability. In a two-period game, the CEO decides whether to stay the course of the firm or try for an innovation and face the reactions of the market. Under certain parameter values, the authors prove that overconfident CEOs are more likely to innovate than non-overconfident CEOs, and that the impact of overconfidence depends on product market competition. These insights pique the interest of readers: are the data consistent with these propositions?

Fortunately for the authors, the extant literature supplied a ready-made measure of overconfidence. Without introducing exogenous variation---and similarly to the paper just

reviewed---, the authors use pre-sample data to control for firm heterogeneity in initial conditions. No firm fixed effects are used: only year dummies and two-digit industry dummies enter the specification. Through the introduction of various control variables, alternative measures of overconfidence, and some careful probing of the empirical specification, the paper shows a robust positive association between CEO overconfidence and innovation. This paper is ingenious in its joint use of formal theory and regression-based evidence to make a point that is broadly useful to various streams of literature.

Jia, Shi, and Wang (2013) studies business groups in China highlighting a coinsurance mechanism, which is shown to be different from the propping-up or tunneling mechanisms mostly investigated in the prior literature on corporate governance and finance. Internal transactions among firms that are members of the same business group are the phenomenon of interest here. Using a broad data set cast at the firm-year level, the paper shows how guarantees, lending, and non-loan transactions are related with credit crunches affecting the controller (i.e., largest shareholder) of the firm. The empirical design uses linear regressions with firm and year fixed effects. In addition to showing that the coefficients point in the direction of a coinsurance mechanism, the authors evaluate a regulatory change that sheds further light on the validity of their arguments. At a given date, the Chinese government issued a policy that reduced the amount of loan guarantees and intercorporate loans that firms could give to their controllers. This policy significantly reduced the incentives for coinsurance, and the authors showed---with a difference-in-differences framework---that credit crunches of the controllers after the policy change had a negative impact on firm performance. This is clear evidence of coinsurance, distinguishing it from tunneling.

The context of the paper includes much institutional detail, so the empirical implementation pays attention to various moving parts. Moreover, the breadth of the question of what makes business groups successful required the use of variables that are not common in strategy research, such as loans, guarantees, or stock collateralization. Through a careful modeling of the relationship between variables, the paper delivers a powerful message about a setting that was starting to become known to the broader research community: business activity in China. The creative use of a policy change to buttress the basic correlational evidence is noteworthy.

Bhaskarabhatla et al. (2021) is unique in its use of theory to shed light on an apparently contradictory pattern in the empirical analysis. The context is the match between patent inventors and the firms that employ them. The paper starts off with a straightforward estimation of inventor-level and company-level capabilities fixed effects using rolling windows of ten years to avoid contamination with future success. A critical step for much of the estimation is the move of inventors from one firm to another, which makes estimation possible. The initial empirical finding is that high human capital inventors appear more likely to work for firms that have low innovation capabilities but other high human capital workers; hence, they find negative assortative matching. What is going on? The authors develop a formal theory of submodular, rather than supermodular, inventor-firm matching. In their view, the benefit provided by high capability firms is more valuable to low capability inventors. By contrast, high capability inventors cluster at firms with low innovative capabilities because of financial compensation considerations. Although the authors do not have evidence on financial compensation, they make the assumption that inventors do care for this dimension, and the results ensue.

The question of what drives innovation at firms is very broad, and the tension between firm capabilities and personal capabilities is of first-order importance. Without introducing exogenous variation, the authors effectively deploy a well-known correlational framework to estimate inventor and firm fixed effects, and they weave a nuanced story about the direction of matching. The authors make their estimation procedure transparent, and they use decile-based variables and appealing plots to offer convincing evidence about negative assortative matching at firms. The fact that the theory comes at the end of the paper rather than at the beginning reveals a flexible approach to tackling an important research question with complementary methods.

Narrow correlational

Luo (2014) develops a theory of when a screenwriter should sell an idea to a movie studio: early in its development or late after the story is completed. The primitives of the model include the writer's observable quality, the goodness of the idea for a movie, the proportion of the expected surplus of a selling effort that goes to the writer, the cost to write the idea and the cost for the buyer to meet the writer. The game includes four stages and it is resolved by backward induction, leading to two theoretical propositions that motivate empirical hypotheses. First, writers with different abilities will prefer to sell at different stages of the idea. Second, writer quality is positively related with the economic performance of the movie, especially in the case of late script sales. The paper then goes on to introduce script sales data, relating them to a proxy for writer quality. Through linear regressions, the author finds evidence on the first proposition: a curvilinear relation between writer quality and the probability of a late-sale choice. Moreover, corroborative evidence is shown on the second proposition through the reinforcing interaction effect of late-sale movies and high writer quality.

The paper has a clear theoretical intent, addressing a nuanced question about the optimal time to sell an idea. The institutional details are easy to understand because of the familiarity of the context: moviemaking, a narrow, much studied activity. The empirical implementation uses cross-sectional data on script sales and movie performance to confirm that the theoretical propositions bear out in the data. In essence, this paper shows how a theory combined with correlational evidence can make a concrete contribution to strategy.

Mollick and Nanda (2016) uses crowdfunding data on theater-related projects to assess whether crowds' decisions are similar to those of expert judges. The authors find a statistical similarity between the funding decisions by crowds and the evaluation of those projects by experts. Despite this similarity, however, there is much disagreement between the two sets of assessors; the authors find a couple of features of the advertised investment prospects that that crowds like but evaluators don't, concluding that there is an art to raising money from crowds. The empirical design is careful in guaranteeing that experts have some incentive to evaluate the prospects fairly, and the random assignment of projects to evaluators assuages concerns about endogeneity in matching. Finally, the authors offer some evidence based on qualitative analysis that the projects selected by both the crowd and the experts delivered on their promise.

The paper addresses a question that was ripe for empirical examination. Crowdfunding is a context in which crowds make investments decisions in a project; hence, the comparison

between crowds and experts is an important one. Although the setting is narrow, including just 120 data points on theater show investment projects, the empirical work is transparent, making use of kernel density plots in addition to regressions to address the research question effectively.

Broad quasi-experimental

Dahl, Dezső, and Ross (2012) asks whether organizations reflect the values of their leaders. Values are rather complex concepts to study and the authors declare that only suggestive evidence in the past has provided any support for their role. The empirical handle that the authors introduce is the fact that children may affect their parents' mindset: the birth and gender of a CEO's child may differentially influence the wages of his female and male employees as well as his own wages. Certainly, the question is very broad: the role of values should be relevant at all sorts of organizations. A sharp contribution of this paper is the match of Denmark's richness of personal and corporate data with the empirical design centered on the gender of CEO children to shed new light on the outstanding question about the personal values of CEOs.

Empirically, the authors analyze employee-year observations and introduce CEO-employee fixed effects that account for various sources of unobserved heterogeneity. The coefficients in the empirical design are identified solely based on changes within these dimensions. The relation of interest is how employee wages depend on the number of children of the CEO as well as on the gender of those children. The authors find that both female and male employees experience a negative impact on real wages after their CEO fathers a son. Moreover, when the first child of the CEO is a daughter, that birth has a positive moderating effect for male employees and for female employees; it also brings about a larger wage increase for the CEO. Overall, the granular examination of employee-level outcomes is a fruitful avenue to assess the impact of top management decisions. The paper effectively leverages on the exogeneity of child gender to study the difficult-to-observe inner reality of CEOs' values.

Bloom et al. (2014) studies the tension between communication and information technology. Building on an existing formal theory, the authors make assumptions about the time and knowledge required for firm production, the costly nature of acquiring knowledge and the communicability of knowledge to frame the problem of the firm. Specifically, a firm must decide the span of the hierarchy and the degree of worker autonomy to maximize profits. The proposition that emerges from this theory is that cheaper communication leads firms to centralize decisions, whereas cheaper information access leads to decentralization. The insight is that a technology that reduces information costs increases the autonomy of lower-level agents, whereas a technology that lowers communication costs reduces autonomy.

Armed with this theoretical finding, the authors propose an empirical design that uses their own surveys of plant managers as well as standard sources on plant-level information and communication technology. The empirical design seeks to study how the dependent variables (the autonomy of workers, the autonomy of plant managers, and the span of control of plant managers) depend on information access costs and communication costs, the two explanatory variables of the study. Information access costs are proxied by the availability of CAD/CAM technologies and enterprise resource planning. Communication costs are proxied by the availability of an intranet at firms. Through linear regressions on cross-sectional data, the authors

find confirmation of their prediction. Information access impacts worker empowerment, whereas communication technology reduces it. Moreover, information access increases the span of control of plant managers. To assuage endogeneity concerns, the authors introduce an instrumental variable for enterprise resource planning: the distance between each plant and Walldorf, where the leading provider of software is based. Analogously, the authors introduce the intensity of intranet use in the industry multiplied by the exogenously different prices of leased lines used for intranets as an instrument for plant-level intranet use. They find corroborative evidence on the validity of their proposition. This paper belongs to a stream of research that emerged from detailed firm data collection at firms, with a focus on highlighting organizational decisions and productivity. The richness of the empirical detail helps overcome the limitations of a cross-sectional data set. The paper also offers an attractive interplay of theory and empirical evidence.

Forman and McElherean (2023) introduces the concept of plural selling: the fact that firms transfer output to a downstream division as well as to outside customers. The authors ask: How is the organization of vertical production chains impacted by the advent of the internet? The sample period includes years before and after the rise of the commercial internet in 1995. The focus of the study is on production plants. The authors distinguish between external IT---when information is shared with customers and suppliers---and internal IT---information sharing across company units within firm boundaries---using census data and surveys. The relation of interest is between the share of production value destined to stay within the firm as the dependent variable and external IT as an explanatory variable. Because the period of the study starts before the internet existed, external IT is zero for all plants at the beginning of the sample. The endogeneity of external IT is addressed with three instrumental variables, namely, the measure of computer-aided functions at other plants within the same firm, the adoption of external IT by competing firms in the same industry at other locations, and an engineering estimate of the cost of providing telecommunication services based on a given location. The results show that external IT leads to a lower fraction of production value staying within the firm. The findings are accompanied by further tests of mechanisms.

Much prior work has asked questions about vertical integration using production data. This paper leverages on nuanced data on the use of the internet for coordination to address the literature with a sound empirical design based on uncontroversial instruments. The findings speak to the long-standing importance of opening up the black box of firm operations to study what drives firms' market outlook.

Narrow quasi-experimental or experimental

Rawley (2010) takes on an old literature on diversification by asking whether coordination costs undercut the potential economies of scope at diversifying firms and whether organizational rigidity is behind those coordination costs. The institutional context is the taxicab industry, which was restricted in the possibility to diversify. At a given point, a prohibition is lifted and firms are allowed to have both taxies and limousines, two related but clearly different segments of the transportation market. By relying on census data on all firms, the author delves into complete records on taxicab firms in 1992 and 1997, that is, before and after the regulatory change. The

performance metric analyzed is total factor productivity in quantities. The diversification decision is framed as entry by taxi firms into the limousine market---that is, by horizontally diversifying. To address the endogeneity of diversifying into limousines, the author uses concentration of limousines in the firm's market as the instrumental variable. Moreover, the tests identify organizational rigidity costs by comparing the productivity of diversified incumbents with that of diversified startups. The results suggest that within-firm changes in taxicab utilization are negative following diversification, and that the productivity advantage of incumbents over startups is reduced when both are diversified.

This paper reinvigorated the diversification literature in strategy. By carefully introducing performance measures and by combining institutional knowledge with useful classifications of firms, causal effects and mechanisms otherwise difficult to observe were provided. While the taxicab context is rather narrow and diversifying into limousines appears to be a very natural step, precisely the cleanness of the setting permitted the good comparability of performance across firms and over time.

Boudreau, Lacetera, and Lakhani (2011) studies innovation contests, a well-established mechanism to select talent in technology industries. A central question about these contests is whether increasing the number of participants is good or bad for outcomes. The authors set out to provide an answer to this question. In particular, a unique data set on software coding tournaments allowed for the study of multiple concurrent contests with different numbers of direct competitors, where the skill level and quality of the solution for individual participants are also observed. The questions are framed around the incentive effect of a larger number of competitors on individuals' effort, the smaller negative incentive effect of a larger number of competitors on maximum performance, and the more positive impact of the larger number of competitors on maximum performance when the innovation problem is more uncertain. The data set includes contests and individuals. The key explanatory variable is the number of individual competitors facing one another in the same virtual room. Exogeneity in this variable is facilitated by the institutional feature that the contest organizer had a room-assignment algorithm that would generate rooms with different numbers of participants, and this variation was not related to the peculiarities of the contest. Another strength of the design is the comparability across coding problems, which allows for the use of problem fixed effects. The results show a strong negative effect of the number of competitors on average performance scores. Moreover, a larger number of competitors did not influence significantly the maximum score of a contest. Finally, the more uncertain the problems---as proxied by the various fields of knowledge from which they drew---, the higher were the average score and the maximum score in the contest.

Strategy is about competition, and it is generally hard to find a credible instrument for the intensity of competition. This paper offers an effective way to study competitive intensity and individual effort by using a source of exogenous variation for the number of participants in innovation contests and by exploiting the richness of the setting to make a broader point. While software coding appears to belong to a narrow domain not too related with business firms, the selection of talent is increasingly relying on this type of mechanism, which enhances the topical value of the research results.

Seamans (2012) studies entry deterrence efforts by incumbent cable TV firms throughout the United States. Local governments can use tax-free financing to build a cable system around their municipal electric utilities and thus compete with business firms. Hence, incumbent cable TV firms may upgrade their systems to deter entry by offering better quality that enhances welfare, which should also reduce the impetus of potential municipal competitors to entry for public benefit reasons. The upgrade of cable systems is the dependent variable of the study. As the independent variable, the author uses a dummy for the presence of a municipal utility, and it is deemed an exogenous variable. Moreover, the empirical design uses variation in state laws that prohibit the municipal electric utility from cross-subsidizing its entry into cable, thus offering a sharp test of whether business firms' upgrades are motivated by deterrence. The telling sign for deterrence efforts is the delay following the upgrade of a cable system: if firms upgrade for business reasons, they should promptly offer a full service based on the upgrade, but if the move is merely strategic, there would be a delay between the moment of the upgrade and when telephony and broadband are offered. The results of the discrete hazard models using the upgrade dependent variable provide broad confirmation of a positive relation with the presence of municipal electric utilities. Moreover, the models including the interaction with the no-subsidy regulations point to a lower likelihood of upgrading when the risk of competition is reduced. Finally, delays are more noticeable when there is a deterrence motivation proxied by the presence of municipal electric utilities.

The competitive landscape is broad and sometimes includes the government as a potential rival. This paper reinvigorated the literature on non-market strategy by identifying a reason why firms in a specific setting worry about the presence of government-owned rivals. The neat empirical design also illustrated that a combination of correlational evidence with policy shocks is a fruitful avenue to address a difficult question such as entry deterrence.

Oettl (2012) builds on prior research that exploited scientists' deaths. The novel approach here---with immunology as the empirical context---is to offer a new taxonomy of star researchers that distinguishes helpfulness as a dimension of human capital productivity. Star helpfulness is gauged through the acknowledgment section of published articles. The empirical design is straightforward, using death events as shocks and introducing dyad fixed effects in addition to other granular controls. The death of helpful stars---those that had received more acknowledgments---has significantly large deleterious effects on the productivity of their bereft coauthors.

The introduction of new data from the acknowledgment section of papers opened a path to consider a typology unknowable until then. Combined with a sound empirical design in a detailed institutional context, the paper makes a clear contribution to a broad literature on teams and innovation.

Catalini (2018) addresses the microgeography of innovation by looking at office relocations that are exogenously driven. Because knowledge production is a collaborative process, the drivers of search costs and execution costs may influence knowledge outcomes. The author argues that colocation---the condition by which collaborators work physically close to each other---has a profound effect on both types of costs by lowering search costs and by lowering coordination costs. The empirical handle to study this phenomenon was a series of lab relocations at a

university in Paris that were plausibly exogenous to productivity or matching between collaborators. The idea is that lab pairs might collaborate more easily if the relocation placed them together. The estimation uses a difference-in-differences approach including lab-pair fixed effects, with an explanatory variable capturing whether the lab pair is colocated because of the moves. The results confirm that colocation has a strong influence on collaboration. By contrast, the separation after a previously colocated lab pair splits because of the moves does not affect collaboration. This nuanced difference points to a search costs mechanism operating in colocation.

Many drivers of innovation are difficult to identify empirically. Colocation is a broadly appealing factor yet exogenous shifters of location are rare. One strength of this paper is to have found an empirically appealing setting in which identification of cause and effect is clearer. The paper speaks to an important literature on what drives research productivity.

Choudhury, Starr, and Agarwal (2020) addresses the increasingly important topic of the value of machine learning in human decisions. The context is patent examination, an activity with broad ramifications for economic growth and firm profits. Patent applicants may try to game the system when they submit their application documents for review. For that reason, patent examiners must be very attentive during the application process, which is cognitively burdensome. The authors design an experiment with MBA students in which domain expertise and computer science knowledge may complement machine learning. The experiment asks MBA students to classify patent applications depending on whether they cite the silver bullet patent and this is the dependent variable of the study. As independent variables, the authors randomize the use of a machine learning technology and the use of expert advice by email. The authors find that when patent applications are characterized by strategic input incompleteness, the machine learning technology may be more likely to make biased predictions without domain-specific expertise. Human capital complements machine learning, in their view.

The paper is cast around a very specific experiment using MBA students to interact with expert advice and machine learning recommendations. The narrow setting, however, helps the authors control for many unobserved factors, and the randomization of treatment is crucial. Experimental work is rare in strategy; the question addressed by the paper points to a growing interest in understanding new technologies with broad application.

Chung, Zhou, and Ethiraj (2023) studies the interdependency between complementors in technology platforms. Technology allows suppliers to sign up simultaneously for multiple platforms to spread their fixed investments across a larger scale. When one platform is banned, how does this impact the level of activity of another platform by the same users? This is the question the authors pose, leveraging on a New York City restriction on Lyft that could potentially affect Uber, a competing service. In particular, Lyft blocked drivers from accessing its app in low-demand periods or locations. The authors use the heterogeneity in platform access restrictions across these different platforms. The results of a differences-in-differences estimation points to a significant contraction in Uber trip numbers following the Lyft restriction. The authors interpret this decline as evidence of within-complementor interdependencies.

Spillovers across competitors have always been of great interest in strategy. The empirical identification of causal effects is facilitated in this paper by company-level shocks motivated by a regulator and by the availability of granular data on platform usage. The creative comparison of treated subjects and alternative counterfactuals buttresses the credibility of the findings to speak to a broad literature on technology platform performance.

Structural

Grennan (2014) addresses the value capture literature in strategy by developing a structural estimation of bargaining ability in the coronary stent market. The theoretical construct of interest is transferable utility. The author restricts attention to the case of a monopsonist buyer, substitute suppliers, and no capacity constraints. The empirical analysis consists in estimating costs, willingness to pay, and the bargaining abilities of different market participants to predict the quantities of stents used by each hospital and the prices negotiated for each stent by each manufacturer-hospital pair. The novel measurement here is bargaining ability. In the empirical design, cost enters price as a constant term, whereas bargaining abilities are identified by the extent to which price changes as the added value of the stent changes. The structurally estimated bargaining abilities are found to vary significantly, and that variability explains price variation. The paper goes on to show multiple dimensions of bargaining abilities, linking them with some observable firm characteristics. The author leaves open the possibility that such abilities may involve links among competitive strategy, organizational structure and individual behavior.

Almost no structural I.O. work seeks publication in strategy journals or speaks to the extant strategy literature. The author's intent to make a contribution is noteworthy and opens a path to collaboration between scholars with complementary skills to search for breakthroughs that may be methodologically sound and substantive for the development of strategy questions.

Assessment and preview of changes

What patterns emerge from all these publications regarding the econometrics of strategy? Certainly, it would not be empirically sound to draw inference from the cases highlighted in Table 1 and Figure 2. However, conceptually it can be argued that narrow data sets are almost by definition well-suited for quasi-experimental, experimental, or structural work. Similarly, broad data contexts may be equally well-suited for correlational work or for quasi-experimental work, but almost never for structural work.

In terms of formal theory, in strategy there is not much demand for it. Despite the usefulness of formal theory to motivate, clarify or even predict the results of all types of empirical work, it is probably better to offer it sparingly given the lack of appetite for it. Moreover, some of the empirical methods discussed may be catering only to niche, sophisticated audiences. Structural work is not on the rise at strategy journals; field experiments do not abound; quasi-experimental approaches are not the prevailing norm, either. The tension between correlational work and quasi-experimental work has largely been resolved in fields other than strategy. Specifically, the former is in sharp decline whereas the latter is rapidly increasing. Strategy scholars can seize the

low-hanging fruit of a vast range of questions regarding firm value creation and capture left open by scholars in other fields.

Training in strategy PhD programs is highly heterogeneous. This implies that graduates from some schools are more heavily invested in econometric techniques than graduates from other schools. Hence, the political economy of the field implies heterogeneous views on what is high quality in strategy research. While perhaps one strategy journal stands out for welcoming empirical work that is more directly informed by economics, other journals may differ drastically in their appreciation of high quality. Fortunately for authors, not all journals interested in firm behavior fall within the bounds of strategy. Hence, strategy scholars and journal editors can be strategic in this regard: there is competition for new findings about firm behavior, and authors are free to send their manuscripts to a range of journals outside strategy depending on their career interests, risk tolerance, and seniority. Moreover, those authors who believe their training should be sharpened are free to pursue many avenues to acquire the ever-growing techniques of data collection and analysis. If anything, graduate school should nurture the capability of learning to learn.

Before closing, it may also be useful to confront impending methodological changes. The recent evolution of empirical work in economics---where econometrics by definition emerges from---may seem daunting to external observers. PhD studies in economics routinely take six years nowadays, and are preceded by two years of formal pre-doctoral work at well-funded economics departments. Job-market papers are much longer than before, and often involve two doctoral students as coauthors. Well-placed Ph.D. graduates in economics postpone the beginning of their tenure-track position for at least one year by taking a post-doctoral position at a prestigious institution.

More importantly, in economics the databases employed are becoming larger and richer thanks to artificial intelligence. Young scholars master multiple software languages and share their code in active online communities. Machine learning techniques are catching on as a way to let the data reveal patterns that may be further pursued with standard econometric designs. In essence, the credibility revolution in economics is taking hold by means of sophistication.

These tectonic shifts in the research environment in economics can cause at least two distinct reactions among strategy scholars. One is of deliberate neglect: if the strategy terrain is staked out as quite different from that of economics, it may sound safe to conclude that methodological shocks will not arrive in strategy, or will perhaps arrive with less impetus. Inspired by this view, editors of strategy journals will continue favoring correlational work, putting a premium on the hypothesis development or on the purported importance of the topic for strategy. If this view prevails, we would not see much methodological improvement over the next few decades.

Yet a more exciting view would be one of cautious optimism. The technological revolution that is boosting the quality and amount of data available for research could motivate a renewed impetus to tackle old strategy questions with a better econometric design. Think, for instance, of Rumelt (1991), the classic contribution on business-unit effects obtained with a small data set and no identification of cause and effect, which has called for new efforts to tackle the endogeneity of the question (Wang and Coeff 2022). Moreover, the methodological shift coming

from economics could motivate new questions with an innovative empirical approach. Because of their innovativeness, papers in this vein of work would be perhaps harder to evaluate but more rewarding in terms of their potential contribution. As a prerequisite to all those future innovations, it is important to understand how strategy scholars have offered sound empirical contributions with the methods at hand. This review has focused on the detailed discussion of some recent contributions.

5. Concluding remarks

A smorgasbord of techniques is widely available to study the relation between strategy-relevant variables. This paper leverages on the direct observation of how eighty-one scholars from top business schools conducted frontier empirical research in strategy between 2009 and 2023. A review of twenty papers published in strategy journals by some of them illustrates a typology resulting from the interaction of the breadth of the data and the nature of the empirical design. While this review focuses only on a small subset of very broad strategy scholarship, it serves multiple purposes. The paper offers a view of what high-quality empirical research is in strategy by providing a list of examples that warrant further study to help all in strategy with their methods. A simple typology of cutting-edge approaches is provided to assist the reader in navigating the complexity of these papers to see key decisions made by the authors in their econometric design.

Some of the econometric analyses are deceptively simple, yet compelling. Others appear more sophisticated in their pursuit of the true parameters of interest, also making a convincing case. All of them convey important lessons. In essence, high-quality empirical research in strategy tackles an interesting question using suitable data tightly connected with an appropriate econometric design to offer new results that can be interpreted with clarity. The virtue of this work is credibility.

Going forward, strategy scholars may benefit from seeking a more effective balance between their research question, data, method, and interpretation. The sharp identification of gaps in the literature may help harvest the low-hanging fruit left by others, both in strategy and in related fields. Adequate training in new data collection and analysis techniques can also result profitable.

Methodological changes in data collection and processing in economics should be welcome in strategy. With an attitude of openness, the investigation of how value creation and capture evolve through market competition will progress through the ingenuity and carefulness of scholars who continue to pay close attention to the econometrics of strategy.

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Table 1: Selected sample of twenty papers

	Authors	Year	Journal	Formal theory	Data structure	N. obs.	Start year	End year	Any US data	Only US data
1	S. Belenzon, T. Berkovitz	2010	Mgmt Sci	No	panel	477999	1995	2004	Yes	No
2	V. Bennett, J. Snyder	2017	Strat Sci	No	panel	111719	1989	2011	Yes	Yes
3	A. Bhaskarabhatla, L. Cabral, D. Hegde, T. Peeters	2021	Mgmt Sci	Yes	panel	2566626	1973	2010	Yes	Yes
4	N. Bloom, L. Garicano, R. Sadun, J. Van Reenen	2014	Mgmt Sci	Yes	c-s	1000	2000	2006	Yes	No
5	K. Boudreau, N. Lacetera, K. Lakhani	2011	Mgmt Sci	No	panel	162561	2001	2007	Yes	No
6	K. Bryan, Y. Ozcan, B. Sampat	2020	RP	No	panel	489346	1948	2018	Yes	Yes
7	C. Catalini	2017	Mgmt Sci	No	panel	295435	1980	2010	Yes	No
8	P. Choudhury, E. Starr, R. Agarwal	2020	SMJ	No	c-s	11050	2001	2012	Yes	Yes
9	H. Chung, Y. Zhou, S. Ethiraj	2023	Mgmt Sci	No	panel	504960	2015	2019	Yes	Yes
10	M. Dahl, C. Dezso, D. Ross	2012	ASQ	No	panel	4976233	1996	2006	No	No
11	C. Forman, K. McElheran	2023	Mgmt Sci	No	panel	59500	1992	2002	Yes	Yes
12	A. Galasso, T. Simcoe	2011	Mgmt Sci	Yes	panel	1035339	1980	1994	Yes	Yes
13	M. Grennan	2014	Mgmt Sci	Yes	panel	10098	2004	2007	Yes	Yes
14	N. Jia, J. Shi, Y. Wang	2013	Mgmt Sci	No	panel	11678	1998	2008	No	No
15	M. Lieberman, R. Garcia-Castro, N. Balasubramanian	2017	SMJ	No	panel	354	1980	2010	Yes	No
16	H. Luo	2014	Mgmt Sci	Yes	c-s	1834	1997	2005	Yes	Yes
17	E. Mollick, R. Nanda	2016	Mgmt Sci	No	panel	120	2009	2012	Yes	No
18	A. Oettl	2012	Mgmt Sci	No	panel	497895	1978	2008	Yes	Yes
19	E. Rawley	2010	SMJ	No	panel	2341	1992	1997	Yes	Yes
20	R. Seamans	2012	Mgmt Sci	No	panel	9216	2001	2009	Yes	Yes

Figure 1: Four components of an empirical paper in strategy

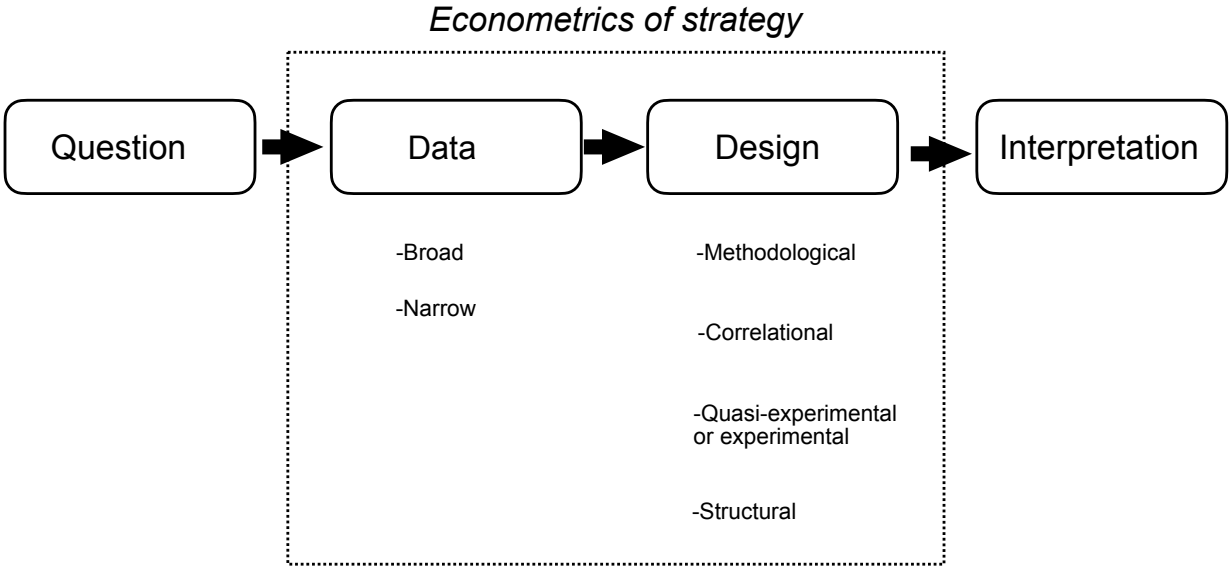


Figure 2: Illustration of econometrics of strategy using twenty papers

