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Physics Envy and Natural Experiments in Business and Economics

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Abstract: Research in Business is becoming increasingly quantitative and business scholars are aspiring to achieve the same standards of academic excellence that hard disciplines demand. Researchers in the domains of Economics, Finance, Human Resource, Marketing and Industrial Organisation, among others, are trying to mimic the principles of Physics by building complex mathematical models and conducting experiments. Since the scope for field experiments in Business and Economics is limited, scholars of these disciplines are increasingly employing natural experiments for research that aims to explore causal relationships in observational studies. Natural experiments are means to overcome some of the obstacles that researchers face while making causal inferences. To compare the actual with counterfactual, the difference-in-difference methodology has seen many advances in recent years. However, mimicking research in Physics comes at a cost. Businesses often deal with situations that have significantly more uncertainty than what Physics addresses. So when researchers in business studies employ techniques that are inappropriate for the level and type of uncertainty involved, conclusions are often revealed to be wrong.

Key words: Physics envy · Natural Experiment · Difference-in-Difference · Mathematisation · Internal validity · External validity

INTRODUCTION

Research, in particular, quantitative research in Business is a new phenomenon. Not long ago business schools were more like trade schools at the higher end and Business Research would have been considered an oxymoron. Till the 1960's, business schools were entrusted with the charge of educating the ignoramus and producing "ideal managers" which was sought to be achieved by emulating other good managers. Top-tier universities did not accord business schools the status they accorded to law schools. School of Industrial Management at MIT (now the famous 'Sloan') conveniently utilised the services of the manager of the nearby General Motors assembly plant for teaching [1]. There were few full time teachers and research was, of course, irrelevant in a setting that hardly provided a comprehensive and professional education. The business community did not fully realise that in the decades ahead managers would need a higher order of analytical ability, a more sophisticated command of analytical tools, a greater degree of organisational skill, a greater capacity to deal with the external environment of business and an enhanced ability to cope with rapid changes. While no one doubted that for most people a strong vocational training, which equips the person to do a first job situation with modest intellectual demand, is essential it was becoming clear to many academics that this was not the job of the collegiate school of business and if the business was indifferent, the academic world had a responsibility to address this problem [2]. This issue also attracted the attention of general purpose philanthropic foundations (where former academics and staff members with strong academic credentials constituted a major contingent in foundation leadership) resulting in the publication of the Ford Foundation [3] and the Carnegie Foundation [4] reports. Both reports criticised Business School courses as being overly descriptive and lacking in serious analysis. Lack of theoretical research, non-intellectual curriculum and teachers with unclear mission were major criticisms in both of these influential "Foundation reports". The press, especially the *New York*

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Times and *Business Week,* provided extensive coverage to these reports forcing business schools to have serious look at the existing educational system.

Since most content in these reports was based on studies conducted by the business schools themselves, it was impossible for these institutions to ignore the reports or respond to the accusations without appearing to be self-serving and defensive. In the event, the business schools decided to transform themselves into academic institutions of substance. This was the 'Sputnik moment' in U.S. business education and research and the business schools responded with enthusiasm. This was also the time when business schools were being established in Europe. Business came to be seen not merely as a profession but as an important academic discipline as well. Good business schools now profess a dual mission: to educate practitioners; and, to create knowledge through research. The emphasis is on the latter because while good schools can offer good teaching (with the help of adjunct professors and guest faculty, if necessary), the frontiers of research are expanding and increasingly grounded in academic rigour. Few, if any of today's top-ranked business schools, would hire a tenure-track professor whose primary qualification is managing a business with distinction or is reputed to teach well. Nor would they hire a person who would write articles for practitioner journals, like *Harvard Business Review* unless the candidate also has demonstrated the potential to publish in top ISI category *academic* journals. Though these publications are usually not directly relevant in the classroom or workplace, accumulation of tiny facts through ongoing research accrete to a larger and more general scientific understanding of organisational behaviour and the environment in which businesses function. According to the Association to Advance Collegiate Schools of Business (AACSB International), business school research impacts the pace of advancement of knowledge in business which in turn impacts innovation and the competitiveness of business [5]. Adoption of this "scientific model" or "research based model" (RBM) as it has come to be known, has raised the standing of the business schools within the university vis-à-vis other schools. Instead of merely offering high quality teaching, top business schools offer "high level of scholarship through research supported learning process" and their mission statements aspire "to create ideas that deepen and advance our understanding of management" (Harvard).

The RBM rests on the intellectual premise that business schools not only teach managers, they facilitate societal advance by supporting scientists who push back the boundaries of knowledge. One consequence of this rigorous scholarship is the increasing importance accorded to the quantitative side of business research. It then follows that not only has Economics become more mathematically oriented but the study of other disciplines has been transformed as well. For example in the field for marketing, intuition and judgement are increasingly being replaced by the probability theory and operations research models. Globally, the emergence of rigorous empirical management research has led to welcome changes in the attitudes and practices of working managers [6]. The business scholars now aspire to achieve the same standards of academic excellence that hard disciplines demand.

While no one argues for the business schools to be like glorified trade schools, many scholars feel that the business schools in their quest for legitimacy and identity have gone too far [7]. Top business schools have a number of tenured full professors whose only practical experience of management is managing their own research budget and assistants. The trustees and deans of business schools have begun to question the relevance of the costly and lengthy research being conducted and the utility of hiring of costly and unproductive faculty members seeking tenure [8]. Another effort towards mimicking Physics is the quest for experimentation. Undergraduate students present themselves as an unlimited supply of guinea pigs. Business researchers, especially in the fields of Economics and Finance build models of financial markets and other economic systems that are as predictive as models of physical sciences, thus creating a false sense of mathematical precision. While experimental economics and experimental finance have not been able to gain much respect or popularity, scholars in Economics as also other social sciences are increasingly turning towards what have come to be called natural experiments which are observational studies that can help determine causality. This paper analyses the role of Physics envy and natural experiments in Business and Economics.

MATHEMATISATION AND PHYSICS ENVY

Physics envy implies a hierarchy of disciplines with physics at the top. Nobel laureate economist Paul Krugman [9] in the preface to his book *Peddling Prosperity* describes how an economist described his personal view of reincarnation:

"If you are a good economist, a virtuous economist, you are reborn as a physicist. But if you are an evil, wicked economist, you are born as a sociologist."

Under the hierarchical system, while the quest for Physics in Biology "distorts so much of the philosophical thinking about biology" [10], the economists not only try to model their discipline on Physics but try to mimic epidemiology as well by borrowing medical terms like contagion, Dutch disease and liquidity injection to lend their work an air of scientific rigour [11]. There is a yearning to be like Physics which appears to be precise, self-contained, logical and mathematical. For business scholars, it is the place to be in.

Theoretical Physics is the inaccessible ideal towards which economic theory strives and this striving is a powerful stimulus in the mathematisation of economic theory [12]. While explaining the general principle of comparative static analysis, Paul Samuelson pointed out that this is essentially the method of thermodynamics [13]. Samuelson goes on to explain that Economics and Physics could share the same formal mathematical theorems, viz. Euler's theorem on homogeneous functions, Weierstrass's theorems on constrained maxima, Jacobi determinant identities underlying Le Chatelier reactions and so on [14]. Mathematisation of Economics led to a series of breakthroughs. The emergence of Econometrics ensured that theory continued to guide empirical research as it does in physical sciences. Option pricing formula used in Finance is also the solution to the heat equation. Recently 'econphysics' has emerged as a sub-discipline that uses the techniques of scaling arguments, power laws and statistical mechanics.

QUEST FOR EXPERIMENTATION

Experimentation has been most widely used in the natural sciences leading to spectacular advances in knowledge. An experiment is the deliberate intervention by an investigator in a situation so as to be able to draw inferences about the relationships under study. Experimentation has been found to be much less successful in the social sciences. The main reason for relative sterility of experiments in the area of social research is the unbridgeable gap between the behaviour of elements of nature like electrons and that of human beings. As the Physicist Richard Feynman was fond of saying: "Imagine how much harder Physics would be if electrons had feelings". It is very difficult to persuade human subjects that they are not part of an experiment. The particles of Physics do not choose to behave as they do whereas human behaviour has volition [15]. Field experiments also lend themselves to criticism because some people or areas may get a favourable treatment for no valid reason and also because that people dislike their lives being used as a laboratory.

Social scientists are now turning towards natural experiments. In these experiments (sometimes called quasi-experiments) randomisation is done not by the researcher but occurs through an unanticipated natural event. This method can be traced back to the work of John Snow in Health Science [16]. According to the miasmic theory of cholera prevalent the time, it was believed that cholera was caused by bad air and methods such as digging up and removing carcasses of horses were tried to control cholera. To prove that cholera is caused by bad water rather than bad air, Snow compared the changes in cholera mortality rates in the districts served by two water companies which in 1849 sourced their water supply from the river Thames in central London. In1852, one of the companies moved its water works upriver to an area relatively free of sewage. Cholera mortality reduced in both areas in 1853 but much more so in the areas supplied by the company whose water works had moved upriver. With the exception of some occasional published and unpublished articles, natural experiments did not attract much attention in the social sciences literature until the 1990s. Since then, a large number of studies have come out in diverse disciplines and researchers have used this approach to improve causal inference in a wide variety of fields, including Accounting and Corporate Law [17], Corporate Social Responsibility [18], Decentralisation [19], Entrepreneurship [20], Human Resources [21], Innovation [22] and Strategy [23]. By now, the methodology has been more or less standardised though finer points continue to be debated.

Through a natural experiment researchers attempt to find a naturally occurring comparison group that can mimic the properties of a control group in a physical experiment. A natural experiment is analysed through Difference-in-Difference (DD) method to reveal the average change caused by the 'treatment'. DD estimates are derived by using Ordinary Least Squares (OLS) in panel data for several periods of time before and after an intervention. Let Y_{ist} be the outcome of interest for individual i in group s by time t and I_{ist} be a dummy for whether the intervention has affected the group s by time t. The following regression is estimated:

$$Y_{ist} = A_s + B_t + cX_{ist} + \beta I_{ist} + \varepsilon_{ist} \quad (1)$$

where A_s and B_t are fixed effects for groups and time periods respectively, X_{ist} are relevant individual controls and ε_{ist} is an error term. The estimated impact of the intervention is then the OLS estimate of β.

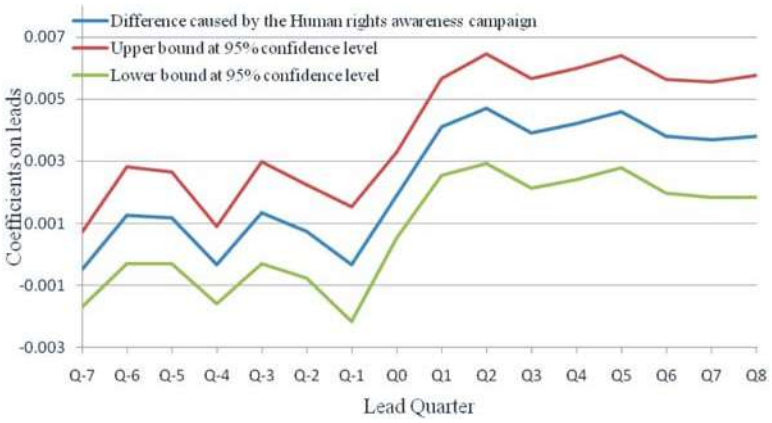

Fig. 1: Impact of Human rights awareness on entrepreneurship over time

DD can not only estimate the average effect of the intervention but also reveal whether the effects persist over time. To assess impact of human rights awareness on entrepreneurship, Figure 1 plots the coefficients of the following regression:

$$Y_{ist} = A_s + B_t + \Sigma \delta_i Q_i + \varepsilon_{st} \quad (2)$$

where Q_i is a set of dummy variables for lag and lead quarters relative to the time of implementation in a given district. The plot reveals that the awareness of human rights promotes entrepreneurship and the effect of human rights awareness campaign are not temporary blips but last over a period of time [24].

DD design has several extensions including DDD which can, for example assess the impact on, say, two different types of potential entrepreneurs. A 'discontinuity design' is an extension of natural experiment that exploits situations where probability of enrolment into treatment changes discontinuously with some continuous variable [25].

NATURAL, EXPERIMENT OR NEITHER?

Natural experiments exploit an event that happens to affect some subjects and not others. The researcher assumes that the naturally occurring intervention was assigned as if it was random [26]. There is a continuum of plausibility for natural experiments, defined by the extent to which 'treatment' assignment is 'as if' random. This raises major concerns relating to internal validity. First there is the issue of the possibility of endogeneity of the interventions [27]. Some authors go to great lengths to prove exogeneity but in many papers the issue is dealt with cursorily. There are concerns about the appropriateness of the control group and linearity assumption in DD estimation. Ongoing research in Econometrics is identifying problems as also solving some of the same. For example, methods are now available to minimise the problem of serial correlation [28] which was not tackled in older studies showing the findings statistically significant when actually they were not. No natural experiment can claim the internal validity of a Physics laboratory experiment. When business research was in its infancy, it was criticised for not being as rigorous as research in physical sciences [29]. Now, researchers in business using fancy mathematics are criticised for assuming certainty and predictability of Physics. In the field of Industrial Organisation, models are sensitive to simplifying assumptions about consumer preferences, asymmetric information and the ability of firms to make strategic commitments. Nobel laureate econometrician James Heckman doubts whether DD estimator can ever isolate a specific behavioural parameter [30].

External validity concerns inferences about the extent to which a causal relationship holds over variations in persons, settings, treatments and outcomes. For a Natural Experiment to produce "useful knowledge" beyond its local context, it must illustrate some general tendency, some effect that is the result of mechanism that is likely to apply more broadly. Unfortunately, results cannot automatically be extrapolated outside the context in which they were obtained. It is well known that there are significant differences between HRM practices of western multinationals and Asian multinationals [31]. Several studies are available from the point of view of developed countries' multinationals and

their management, but scarcely any from the perspective of Asian perspective. There is also the problem of scaling up which does not usually occur in physical sciences. In case of businesses, what is observed in small groups may not be relevant in large groups. Yet, many studies that tightly monitor internal validity employ much looser arguments to defend the transplantationof the experimental results to policy. The obvious answer to this problem is replication studies. Apart from the cost, replication studies have the problem of respectability. No academic journal of repute is likely to publish a replication study and therefore in a 'publish or perish' world inspired by RBM, no prudent academic will be enthused to take on replication studies which cumulatively can claim external validity. While the use of natural experiments for establishing causality is becoming more sophisticated and probably more reliable, the problems of internal validity and external validity still remain as 'con' is yet to be taken out of econometrics [32].

CONCLUSION

The Foundation Reports had criticised research in business schools for being excessively descriptive, lacking in analytical rigour and failing to produce theoretical generalizations [33]. Perhaps the pendulum has swung too far, especially in the fields of Economics and Finance. According to the eminent financial econometrician Andrew Lo, all economists suffer from the psychological disorder of Physics envy, which is present in their DNA [34]. The word envy has negative connotation in English language. However, modelling Economics and Finance after Physics has yielded spectacular advances including Game theory, General equilibrium theory, Economics of uncertainty, long-term economic growth, portfolio theory, rational expectations and option-pricing theory, to name a few. The same does not hold for Macroeconomics as revealed by the recent financial crisis which was essentially a macroeconomic and policy related issue. In the field of Industrial Organisation, empirical research provides little guidance to the regulators in respect of mergers. In most of business research, operationally meaningful equations are rare to find. Conservation laws, symmetry and the isotropic nature of space are some of the most influential ideas in Physics that simply do not have exact counterparts in other disciplines and business literature abounds with false generalisations. Elegance of solutions often takes priority over importance and usefulness of the questions that need to be asked. At the same time Physics envy is being used to blame economists for many ills of the world. Quants (quantitative analysts) are being blamed for the 2007 Wall Street crash. It is important to distinguish our emotional needs for finding the criminal from the formal process of assessing the models themselves, which being inanimate are inherently difficult to trust.

Because of the vulnerabilities that the recent financial crisis has revealed, mathematisation could become more practical though less elegant. Demand for quantitative literacy in business education will continue to increase but limitations of quantitative methods exist, which the recent crisis has revealed. Much of mathematisation occurred when tools were developed to address the issue of paucity of data. Now there is abundance of data in most fields and researchers are focussing on choosing the right tools and how best to employ them for analysis. Theory will clarify rather than complicate understanding and beyond identifying the causal effect there is likely to be more emphasis on understanding the mechanism at work. There is cause for optimism on both theoretical and empirical fronts. While physicists are inspired by mathematical elegance and driven by pure logic, forthcoming research in business and economics is likely to take into account the harsh empirical realities.

REFERENCES

1. Bennis, W.G. and J. O'Toole, 2005. How Business Schools lost their way. Harvard Business Review, 83(5): 96-104.
2. Nelson, H.G., 1961. Impact and Validity of the Ford and Carnegie reports on Business Education. The Accounting Review, 36(2): 179-185.
3. Gordon, R.A. and J.E. Howell, 1959. Higher Education for Business. Columbia University Press.
4. Pierson, F.C., 1959. The Education of American Businessmen: A Study of University-College Programs in Business Administration. McGraw Hill.
5. AACSB, 2012. Impact of Research: A Guide for Business Schools. AACSB International.
6. Williams, A.P.O., 2010. The history of UK business and management education. Emerald.
7. De Woot, P., 2009. Should Prometheus be bound? Palgrave McMillan.
8. D'Alessio, F.A. and B. Avolio, 2011. Business schools and resources constraints: A task for deans or magicians? Research in Higher Education Journal, 11: 1-37.

9. Krugman, P., 1995. Peddling Prosperity. W.W. Norton and Company.
10. Dennett, D., 1995. Darwin's Dangerous Idea: Evolution and the Meaning of Life. Simon and Schuster.
11. Debrue, G., 1991. The Mathematisation of Economics. American Economic Review, 81(1): 1-7.
12. The Economist, 2012. Economic epidemiology: Predicting financial contagion Jun 16th.
13. Samuelson, P., 1947. Foundations of Economic Analysis. Harvard University Press.
14. Samuelson, P., 1998. How Foundations came to be. Journal of Economic Literature, 36: 1375-1386.
15. Heilbroner, R., 1999. The Worldly Philosophers, 7th ed., Penguin, London.
16. Snow, J., 1855. On the mode of Communication of Cholera, 2nd ed. John Churchill.
17. Venkatraman, R., J.P. Weber and M. Willenborg, 2004. What if Auditing was not a 'Low margin Business'? Auditors and their IPO clients as a Natural Experiments. MIT Sloan Working Paper.
18. Wang, M., C. Qui and D. Kong, 2011. Corporate Social Responsibility, Investor Behaviours and Stock Market Returns: Evidence from a Natural Experiment in China. Journal of Business Ethics., 101(1): 127-141.
19. Asthana, A.N., 2012. Decentralisation and corruption revisited: Evidence from a natural experiment. Public Administration and Development, 32(1): 27-37.
20. Rostam-Afschar, D., 2010. Entry Regulation and Entrepreneurship: Empirical Evidence from a German Natural Experiment. DIW Berlin Discussion Paper No. 1065.
21. Meyer, B., K. Viscusi and D. Durbin, 1995. Workers' Compensation and Injury Duration: Evidence from a Natural Experiment. American Economic Review, 85(3): 322-340.
22. Lin, J.Y., 1995. Endowments, technology and factor markets: A natural experiment of induced institutional innovation from China's rural reform. American Journal of Agricultural Economics, 77(2): 231-242.
23. Younge, K.A., T. Tong and L. Fleming (forthcoming). How Anticipated Employee Mobility Affects Acquisition Likelihood: Evidence from a Natural Experiment. Strategic Management Journal.
24. Asthana, A.N., 2011. Entrepreneurship and human rights: Evidence from a natural experiment, African Journal of Business Management, 5(23): 9905-9911.
25. Blundell, R. and M. Costa Dias, 2009. Alternative approaches to Evaluation in Empirical Microeconomics. Journal of Human Resources, 44(3): 565-640.
26. Dunning, T., 2008. Improving Causal Inference: Strengths and Limitations of Natural Experiments. Political Research Quarterly, 61(2): 282-293.
27. Besley, T. and A. Case, 2000. Unnatural Experiments? Estimating the Incidence of Unnatural Policies. Economic Journal, 110: F672-F694.
28. Bertrand, M., E. Duflo and S. Mullainathan, 2004. How Much Should We Trust Difference-in-Difference Estimates? Quarterly Journal of Economics, 119(1): 249-275.
29. Lorie, J.H. and H.V. Roberts, 1950. Some Comments on Experimentation in Business Research. The Journal of Business, 23(2): 94-102.
30. Heckman, J., 2000. Causal Parameters and Policy Analysis in Economics: A Twentieth Century Perspective. Quarterly Journal of Economics, 115(1): 45-97.
31. Nigam, R. and Z. Su, 2011. Management in Emerging versus Developed Countries: A Comparative Study from an Indian Perspective. Journal of Centrum Cathedra, 4(1): 122-133.
32. Leamer, E.E., 2010. Tantalus on the Road to Asymptotia. Journal of Economic Perspectives, 24(2): 31-46.
33. Shimp, T.A., 1994. Academic Appalachia and the Discipline of Consumer Research, Advances in Consumer Research Advances in Consumer Research, 21(1): 1-7.
34. Lo, A.W. and M.T. Mueller, 2000. Physics Envy May Be Hazardous To Your Wealth, Journal of Investment Management, 8(1): 13-63.