Uncertainty is Beautiful

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E.F. Schumacher's *Small is Beautiful: Economics as if People Mattered* is a sweeping compilation of Schumacher's essays that lays out a multi-faceted argument for a different societal structure characterized by small, decentralized living and a reliance on human-centric technologies. Drawing on both Buddhist and Catholic teachings, Schumacher decries the degradation of natural resources wrought by the current structure of the world economy, especially in developed countries, and is skeptical of the predominant economic measures like gross domestic product (GDP) which, he argues, neglect individual human dignity and flourishing. But part of what makes *Small is Beautiful* so impressive is the range of topics he considers in building his argument, including education, technology, and corporate structure, to name just a few. For a statistician, one of the most interesting chapters of the book is "A Machine to Foretell the Future?," in which Schumacher examines predictability.

Throughout the book, Schumacher is hard on both economists and statisticians, critiquing the overemphasis on aggregate measures and the overreliance on complex mathematical models. However, this chapter uncovers a deep connection between statistics, uncertainty, and the beauty that Schumacher sees in small living. His vision of the role of statistics is perhaps best summarized by the following passage:

> When the Lord created the world and people to live in it—an enterprise which, according to modern science, took a very long time—I could well imagine that He reasoned with Himself as follows: "If I make everything predictable, these human beings, whom I have endowed with pretty good brains, will undoubtedly learn to predict everything, and they will thereupon have no motive to do anything at all, because they will recognize that the future is totally determined and cannot be influenced by any human action. On the other hand, if I make everything unpredictable, they will gradually discover that there is no rational basis for any decision whatsoever and, as in the first case, they will thereupon have no motive to do anything at all. Neither scheme would make sense. I must therefore create a mixture of the two. Let some things be predictable and let others be unpredictable. They will then, amongst many other things, have the very important task of finding out which is which."[1]

Schumacher conveys much in this reflection and, perhaps most importantly, an appreciation for the mixture of predictable and unpredictable phenomena that make up life. Though a world guided entirely by uncertainty would seem to render human reason moot, a dose of uncertainty staves off the horrific inevitability of a purely deterministic world. Therefore, contrary to how uncertainty is often viewed in daily life, there is a certain beauty in unpredictability. Schumacher also establishes two primary tasks for those seeking to use statistics. First, "before anyone makes a prediction, he should be able to give a convincing reason why the factor to which his prediction refers is inherently predictable."[2] Second, and only once the potential for prediction is established, should one set out using statistics to those ends.

Beginning with the former, there is one obvious rebuttal: often, it is not known whether an occurrence is predictable until an attempt is made at predicting it. That is, one way to learn the

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[1] E.F. Schumacher, *Small is Beautiful: Economics as if People Mattered* (New York: Harper & Row, 2010 [orig. 1973]), 239.

[2] Schumacher, *Small is Beautiful*, 239.

limits of predictability is to test them. Nevertheless, the exhortation acts as a helpful corrective, particularly when read in light of the daily deluge of predictions made about everything from tomorrow's weather to the changing fortunes of the stock market to the number of daily COVID-19 infections. Yet it also leads to another important question: what precisely does it mean for something to be predictable? Schumacher avoids a precise definition of "predictable," an understandable decision since, like related concepts such as "uncertainty" and "chance," it is so philosophically and theologically complex.[3] Nevertheless, he offers some suggestions as to what outcomes qualify as predictable.

First, he establishes that a prediction must, by definition, be about some future, unobserved outcome but based on past experience (i.e., data). The degree to which the future event is predictable is then predominantly determined by the quality and quantity of past data about its occurrences and non-occurrences. But as Schumacher elaborates, strong data alone do not make the future predictable "for into the making of the future there enters that mysterious and irrepressible factor called human freedom. It is the freedom of a being of which it has been said that it was made in the image of God the Creator: the freedom of creativity."[4] From this, he makes four conjectures about predictability: 1) only occurrences immune from human free will are potentially fully predictable; 2) relative predictability is achievable when studying aggregated routine human behavior; 3) relatively full predictability is possible when humans follow a plan; and 4) actions made by individuals are unpredictable due to their free will.[5] The point about human unpredictability is both important statistically and consistent with Schumacher's emphasis on the small. Statisticians like to aggregate data; in fact, statistician Stephen Stigler considers aggregation one of the seven pillars of statistical wisdom.[6] Aggregation, by definition, discards a view of the individual with a goal of seeing the forest through the trees. Summarizing data in this manner is often useful, if not necessary, although for many decisions it is also important to consider the characteristics of the individual trees as well. But Schumacher's point is deeper: human free will is the main ingredient which makes human behavior unpredictable and without it, everything would fall into his first category—occurrences which are potentially fully predictable.

Schumacher goes on to offer some ideas on the proper role of statistics in making predictions. In statistical parlance, predictions require the use of a statistical model—a mathematical equation that represents a simplified specification of a real-world relationship or process, based on a set of assumptions. As the chapter title suggests, Schumacher is suspicious of the ability of complex statistical models to make predictions about the future.[7] Arguing for simple exploratory calculations, he explains that "no amount of refinement will help one come to

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[3] For a review and discussion of the many possible definitions of these terms written from a statistician's perspective, see David J. Bartholomew, *God, Chance and Purpose: Can God Have it Both Ways? (Cambridge University Press, 2008).*

[4] Schumacher, *Small is Beautiful*, 243.

[5] Schumacher, *Small is Beautiful*, 245-46.

[6] Stephen M. Sigler, *The Seven Pillars of Statistical Wisdom* (Cambridge, Massachusetts: Harvard University Press, 2016).

[7] Schumacher specifically objects to the use of "electronic computers" frequently in this chapter. However, note that Schumacher was writing in 1973, at a time before computers were prevalent. Though his suspicion of computers is tied to his advocacy for human-centric technology, in the context of making predictions today his objection is likely better read as an objection to complex statistical models in general, rather than to the use of computers.

the fundamental judgement—is next year going to be the same as last year, or better, or worse?"[8] To be sure, all predictions have to weigh the degree to which past data are representative of future outcomes. However, statistical models offer an advantage in this regard over rudimentary, back-of-the-envelope calculations since they allow one to formally incorporate uncertainty in the equation, typically through what is called an error term. In the subfield of Bayesian statistics, prior beliefs can even be explicitly incorporated into a model through choices about the probabilities used in the model.[9] Difficulties of using past data to predict future events are particularly thorny in modeling rare and extreme events, such as economic crashes and earthquakes, which has led to an entire subfield of statistics called extreme value theory.[10] Yet, to Schumacher's point, while these more complex statistical procedures are certainly better at modeling real phenomena than mental calculations are, they are better suited for exploring relationships between variables and assessing the uncertainty therein than at predicting the precise date or time of a future event.

Schumacher also expresses wariness over the tendency for statistical predictions to mislead and to obfuscate the many assumptions upon which their calculations are built. Expressing this concern, he writes, "Once you have a formula…there is an awful temptation to squeeze the lemon until it is dry and to present a picture of the future which through its very precision and verisimilitude carries conviction."[11] He is certainly not the only one wary of the beguiling mystique of statistical models and the potential for statisticians to disregard the limitations, uncertainty, and assumptions built into their predictions. Indeed, with the recent explosion of big data, data science, and society's growing reliance on data and statistics, these and other concerns about the misuse of data and statistics have received even greater attention.[12]

Rather than making explicit predictions or forecasts, Schumacher prefers to see statistics used for what he calls feasibility studies, in which one "merely explore[s] the long-term effect of certain assumed tendencies."[13] This seems to be what today is often call scenario analysis, whereby you adjust a set of inputs to your equation to see the range of possible outputs. But statistical models are frequently, if not predominantly, used for the types of exploratory analysis that Schumacher has in mind, even when prediction is one of the end goals. Furthermore, because statistical models inherently incorporate uncertainty (this being a distinguishing feature between statistical models and other deterministic mathematical models), their predictions are not definitive but rather suggestive, and should be accompanied by the appropriate uncertainty bounds (e.g., in statistical jargon, confidence intervals or standard errors). Statistical models, aided (ironically) by the development of computational power, are also often used explicitly as feasibility studies using simulations, which allow one to repeatedly perform these what-if calculations by randomly generating the inputs and repeating the process tens or hundreds of thousands of times. Perhaps Schumacher's point is best summed up by the famous quote from eminent statistician, George Box, who wrote just a few years later, "All [statistical] models are

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[8] Schumacher, *Small is Beautiful*, 247.

[9] Andrew Gelman et al., *Bayesian Data Analysis*, 3rd ed. (CRC Press, 2013).

[10] Laurens de Haan and Anna Ferreira, *Extreme Value Theory: An Introduction* (New York: Springer 2006).

[11] Schumacher, *Small is Beautiful*, 248.

[12] For popular recent examples, see Cathy O'Neil, *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy* (Crown, 2016); Jerry Z. Muller, *The Tyranny of Metrics* (Princeton University Press, 2018). For a classic take on the misuse of statistics, see Darrell Huff, *How to Lie with Statistics* (W. W. Norton & Company, 1954).

[13] Schumacher, *Small is Beautiful*, 251.

wrong, but some are useful."[14] This is a useful lens through which to view statistical models and can help to both instill humility in presenting, and temper expectations in consuming, statistical predictions.

The uses and limits of statistical models have rarely been displayed quite so publicly as throughout the ongoing COVID-19 pandemic. As infections and deaths grew, so did the clamor for predictions, prompting something of an arms race among epidemiologists and other related scientists with statistical acumen. Predictions, both good and bad, proliferated. But while many scientists have been lampooned for their perceived failed attempts at predicting various outcomes related to the pandemic, a large portion of this resulted from often innocent mistakes made by members of the media while covering the efforts of these scientists. In a recent article in Quanta Magazine, science writer Jordana Cepelewicz explained that

> Because epidemiological models make statements about the future, it's tempting to liken them to weather forecasts—but it's also deeply wrong… when meteorologists forecast a hurricane's path, the decisions of people in the region to either evacuate or stay put don't affect where the hurricane goes or how strong it will be. In contrast, people's actions have a direct impact on disease transmission. The additional level of uncertainty about how people will respond to the threat complicates the feedback loop between human behavior, modeling outcomes and the dynamics of an outbreak.[15]

This is precisely Schumacher's point about the unpredictability of individual human behavior, and as a result, Schumacher would likely counsel that such cases are unpredictable. While there is no doubt that many miss this advice, the best scientists understand it, resist the public demand for bold predictions, and use statistical models for other purposes. Citing epidemiologist Adam Kucharski, Cepelewicz elaborates, "Scientists—not just in epidemiology, but in physics, ecology, climatology, economics, and every other field—don't build models as oracles of the future. For them, a model 'is just a way of understanding a particular process or a particular question…and working through the logical implications of [their] assumptions.'"[16] In other words, (good) statistical modeling looks a lot more like Schumacher's feasibility studies than like scientific soothsaying.

Schumacher tells the reader that "the reason for including a discussion on predictability in this volume is that it represents one of the most important metaphysical—and therefore practical—problems with which we are faced."[17] Understanding how and when to make predictions, how and when to properly apply statistics, is fundamental to assessing and reconfiguring society, particularly economic life. Schumacher provides a glimpse of how to do this by establishing some criteria to determine what is predictable and then offering caution about how to use statistical models for prediction. But just as importantly, he offers a reminder of why we ought to appreciate the unpredictable, concluding that "life, including economic life, is still worth living because it is sufficiently unpredictable to be interesting."[18] For students wondering why statistics is worth studying and, in particular, why it is important in a Saint

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[14] G. E. P. Box, "Robustness in the Strategy of Scientific Model Building," in *Robustness in Statistics*, ed. Robert L. Launer and Graham N. Wilkinson (Academic Press, 1979), 202.

[15] Jordana Cepelewicz, "The Hard Lessons of Modeling the Coronavirus Pandemic," *Quanta Magazine*, January 28, 2021, https://www.quantamagazine.org/the-hard-lessons-of-modeling-the-coronavirus-pandemic-20210128/#.

[16] Cepelewicz, "Hard Lessons."

[17] Schumacher, *Small is Beautiful*, 237.

[18] Schumacher, *Small is Beautiful*, 255.

Vincent education, Schumacher offers one answer: uncertainty, as a reflection of human free will, is beautiful.