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Discussion

# The problem is beyond psychology: The real world is more random than regression analyses

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Soyer and Hogarth (this issue) identify unexpected and severe errors of interpretation of the parameters in linear regression on the part of people on whose expertise we rely upon, namely those who are involved in econometric and statistical analyses in their professional work. Their results show two major issues: first, a divorce between the analytical definitions and their practical interpretation; second, the one-way effect of underestimation of the random character of the process generating the data (or, equivalently, the overestimation of the deterministic effect of the parameters). We (see Goldstein & Taleb, 2007) have identified both of these problems in the interpretation of the commonly used notion of standard deviation, used in finance as a proxy for "volatility", and have found similar errors on the part of persons of similar expertise. First, we observed that despite the fact that our participants could define the standard deviation mathematically, they erred in its practical application, as if there was a severe loss in the translation of an abstract mathematical term into its practical meaning. Second, as in the case of Soyer and Hogarth's study, we observed an underestimation of the role and effect of randomness. Our participants underestimated the standard deviation, while those in Soyer and Hogarth's study underestimated the practical effects of it. However, the most severe problem may lie elsewhere: the tools themselves underestimate randomness.

In the Soyer and Hogarth case, the matter at hand is standard regression and Gaussian probabilities, and participants are asked to make probabilistic interpretations using the Gaussian as the normative framework for the computation of frequencies, as is a general assumption in economics. Econometrics is dominated by standard deviations, and more generally by measures in the L2 norm,[1] based on squares of numbers (SD is the square root of the average of the sum of the squared deviations), all of which are grounded in a class that revolves around the Gaussian family: the Gaussian and related distributions that converge to it under a reasonable amount of summation, such as the binomial, Poisson, chi-square, and exponential distributions. The problem is that the Gaussian distribution is of limited applicability outside of textbook examples — it is the type of randomness that prevails in game setups such as coin tosses, or possibly in quantum mechanics. Using it leads to the underestimation of fat tails and the role of extreme events, and to predictions that underestimate their own errors. For instance, Taleb (2009) showed, using close to 20 million pieces of economic data (most economic variables over a period spanning the past forty years) that:

(i) the data have fat tails, meaning that the errors would be dominated by larger deviations than estimated;
(ii) the "fat tailed" nature of the data does not disappear under aggregation, meaning that the sum of the variables remains fat-tailed, which eliminates the hypothesis of convergence to Gaussian thin-tailedness; and
(iii) the fat-tailedness of the data is impossible to estimate, though we know that the process is fat-tailed.

Assume that we have agreed that kurtosis is a measure of the degree of fat-tailedness of the process (a scaled fourth moment of the distribution). For all variables, the kurtosis depends on a very small number of observations — for instance, nearly 78% of the total kurtosis of the US stock market for 10,000 observations of data depends on one single observation, implying that we are unable to figure out the fat-tailedness of the process within the L2 norm

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[1] A norm $Lp = \left(\frac{1}{n}\sum |x|^p\right)^{1/p}$.

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without a huge measurement error. For these reasons, the Gaussian framework fails us severely in economics.

Our point is that, while we should be concerned with experts' under-appreciation of the role of randomness in a regression framework, we should also be concerned with the way in which the assumptions of regressions lead to an underestimation of the real-world risk.

Now, the questions that naturally arise are: What if we used another, supposedly better-fitting distribution? Would that lead to proper estimation of the risks in the real world? Alas, the answer is, which distribution, and with which parameters? The problem with the "tails" is that they are not tractable and will be subjected to severe measurement errors. Even if we assumed, generously, that we had the right distribution, small errors in the calibration of the parameters lead to disproportionately larger and larger effects in the tails. Since these tail events determine a large share of the properties of almost all socio-economic data, we are left in the dark about the most important information. The conclusions are: (i) to focus on limiting exposures to these tail events, rather than invent distributions which fit comfortably with them and put people at risk; and (ii) to limit the use of such probabilistic statements to matters which are not affected by tail events.

Finally, we deplore the practice in behavioral economics and finance of imparting a behavioral anomaly to a mistaken statistical analysis, one that ignore fat tails. Take for instance the "equity premium puzzle", in which equities are held to be vastly outperforming stocks according to some metric. The puzzle goes away once one starts considering that such statements cannot be made about fat tailed processes, as the tools used to derive the existence of the anomaly are themselves erroneous, as was explained by Mandelbrot and Taleb (2010). There is a small probability of a catastrophic loss that is not taken into account in the analyses. Furthermore, the equity premium puzzle has vanished since the discussions about it, as the past decade has witnessed the severe underperformance of stocks. Accordingly, we believe that psychological analyses of many such phenomena can be severely misleading: the psychological should give precedence to the statistical.

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