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Golden rule of forecasting rearticulated: Forecast unto others as you would have them forecast unto you

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ABSTRACT

The Golden Rule of Forecasting is a general rule that applies to all forecasting problems. The Rule was developed using logic and was tested against evidence from previously published comparison studies. The evidence suggests that a single violation of the Golden Rule is likely to increase forecast error by 44%. Some commentators argue that the Rule is not generally applicable, but do not challenge the logic or evidence provided. While further research might provide useful findings, available evidence justifies adopting the Rule now. People with no prior training in forecasting can obtain the substantial benefits of following the Golden Rule by using the Checklist to identify biased and unscientific forecasts at little cost.

1. Introduction

In our article (Armstrong, Green & Graefe, 2015-in this issue), we propose the Golden Rule of Forecasting—"the Golden Rule" hereafter—as a unifying forecasting theory. The theory asserts that conservative forecasts will be less biased and more accurate than those that are not conservative. A conservative forecast is one that draws upon, and is consistent with, all relevant and important knowledge about the situation and forecasting methods. Operational guidelines are provided to help forecasters implement the Golden Rule and to help forecast users to assess the validity of forecasts.

Proposing a simple unifying theory for the broad and diverse field of forecasting is both ambitious and controversial, so challenges to the theory are expected and welcome. To that end, we are fortunate to have published, along with our article, four thoughtful commentaries from leading forecasting researchers. In addition, the commentators provided suggestions that led to major improvements in the article.

2. Fildes and Petropoulos

In two applications that they describe, Fildes and Petropoulos (2015-in this issue; henceforth F&P) suggest that following the Golden Rule may have produced less accurate forecasts than those obtained in contravention of the Golden Rule. F&P ask whether following the Golden Rule might lead to rejection of "a well-performing method" that has been validated for a given situation. Our answer is that the Golden Rule requires a priori analysis of the conditions of the forecasting problem. The method selection procedure F&P suggest is in accordance with many of the Golden Rule guidelines. For example, damped trend forecasting using de-seasonalized data—F&P's DDamped—satisfies most of the relevant Golden Rule checklist items. DDamped also performed best of all the methods that F&P tested and provided forecasts that were more accurate than the next-best method—ARIMA—for all eight of the classifications of time series by characteristics—segments—that F&P examined.

While F&P's examples favor the Golden Rule, following the Golden Rule may not improve forecast accuracy for every forecasting problem. One can, however, *expect* improvement by doing so. The Golden Rule article provides only a first step in the development of evidence-based guidelines for conservative forecasting: other guidelines and conditions are surely possible.

F&P are right that further research could contribute useful evidence for guidelines that currently lack evidence. In addition, further research might lead to more effective ways to state the guidelines, and to the identification of the conditions under which the guidelines are most effective.

F&P suggest additional studies that are relevant to the Golden Rule. In particular, they suggest Ord and Fildes (2013) in testing guideline 4.2. The suggestion is reasonable. Inclusion would change the papers-

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for-versus-papers-against score from 102-to-3 to 102-to-4. We expect that there are other relevant studies that are missing from the Golden Rule article. Readers who are aware of omissions are welcome to forward their suggestions for posting on GoldenRuleofForecasting.com.

F&P are also concerned with aspects of the guidelines on causal modeling, such as the recommendation to use all variables that are important, which they regard as conflicting with the thrust of the article, and this Special Issue, towards simplicity. While some researchers have suggested that more variables means more complex, our article argues that the number of variables alone does not make for complexity. The Golden Rule Checklist provides guidance on how to make use of knowledge on many variables in simple ways, and to thereby avoid complexity.

On the topic of causal methods, F&P mention research on principal components—indexes based on correlations among predictor variables—by Stock and Watson (2002). At first glance, this approach might seem conservative in that it includes more information, which is in line with Golden Rule Guideline 4.3. The approach, however, employs statistical rules rather than causal knowledge and thus, uses *less* prior knowledge—which violates the Golden Rule. Consistent with this, eight empirical comparisons found that the principal components method harmed forecast accuracy (Armstrong, 1985, pp. 223–225, 518, 580, 610, 628–629). The reasons Stock and Watson's findings differ from other research on principal components are unclear. We contacted the authors on two occasions, but were unable to clarify: (1) whether their forecasts were ex ante, (2) whether they used successive updating, (3) the number of forecasts in their ex ante test, (4) how the principal components were forecasted, (5) why they omitted such competitive methods as equal-weights regression using all of the variables incorporated in the principal components, or regression analyses using variables based only on theory, and (6) why they used the mean square error, which had long been shown to be unreliable for comparing forecasting methods (Armstrong & Collopy, 1992).

F&P are right to be disappointed with the failure of software providers to include evidence-based forecasting procedures. Imagine the losses to the economy that flow from poor sales forecasting. The situation might change if software users request that software providers follow the Golden Rule.

3. Goodwin

Goodwin (in this issue) is skeptical about the possibility of identifying a simple unifying theory for the field of forecasting. Moreover, he suggests that the term "conservative" does not properly describe the nature of the 28 Golden Rule guidelines.

Goodwin does not suggest an alternative term, however. The use of the term "conservative" in the Golden Rule article does differ somewhat from that of the *Oxford English Dictionary*, though it is consistent with at least some common usages of the term. Specifically, conservative is used in the Golden Rule in the sense of adhering to cumulative knowledge. Thus, following the Golden Rule helps to avoid conjecture and bias. Goodwin's commentary nevertheless inspired an alternative description for the Golden Rule, which became part of the title of this response: "Forecast unto others as you would have them forecast unto you."

Goodwin is correct on the need for decision-makers to consider the costs and benefits of implementing the various guidelines. Most of the guidelines should be inexpensive to implement. Some, however, are not; especially the need to conduct a priori analyses to identify all important knowledge. In other words, decision makers should consider what the marginal net benefit of increased forecast accuracy is for the problem at hand.

Goodwin suggests that further research should be done on the Golden Rule, especially with respect to whether the Golden Rule applies to the estimates of prediction intervals and to forecasts in the form of probability distributions. These suggestions are sensible, as is his suggestion that more research would help by providing more evidence on the specific conditions under which the Golden Rule is—and is not—effective in reducing forecast error.

4. Soyer and Hogarth

Soyer and Hogarth (2015-in this issue, henceforth S&H) suggest that there are several problems that might hinder the use of the Golden Rule. One problem, they suggest, is that the checklist does not provide sufficiently simple and specific instructions to be useful in practice. To illustrate their point they refer to item 1.1: "Use all important knowledge and information." That item is *not*, however, one of the guidelines—it is a heading for Guidelines 1.1.1 and 1.1.2 provided to show users the general organization of the guidelines. Nevertheless, they make a fair point that further study would help to improve the description of the guidelines.

Another problem S&H propose is that some of the guidelines would be overly burdensome to follow in practice, particularly the requirement to include all important variables. Doing so involves using systematic and unbiased procedures to search the literature, and to obtain information from heterogeneous experts. While the cost of following the guidance can be high, the cost of *not* following it is likely to be *much* higher for important projects. If forecasters choose to omit important information, they should fully disclose what was omitted and explain why. For example, the Club of Rome's 1972 *The Limits to Growth* report employed a model with 1,000 equations to forecast that natural resources would soon run out. Economists were quick to suggest that it would have been helpful if the forecasters had included the prices of resources in their model. Had they done so, their forecasts would not have been alarming—nor would they have provided the basis for one of the best-selling environmentalist books in history.

S&H's interpretation of research on the one-reason heuristic, which involves predicting by using only the most important variable, is arguable. The heuristic provides a good forecast *if* the forecaster knows which causal variable will be most important over the forecast horizon, and *if* that variable's effect exceeds that of all other variables combined. These conditions are consistent with the Golden Rule, since the forecaster needs to have complete information about which variables are important, and about the magnitudes of their effects.

One way to test the one-reason heuristic would be to compare its forecasts with those from the index method. The index method involves obtaining evidence on causal factors by a priori analysis. That is, the index method draws upon outside evidence, especially experimental evidence, and does not estimate relationships from the data at hand. Thus, the index method allows forecasters to use as many variables as theory and evidence show to be important.

The ongoing efforts of S&H to improve ways of communicating forecasts so as to help users interpret them are admirable. As their research shows, even leading experts in econometrics have difficulty in interpreting the outputs from basic regression analyses (Soyer & Hogarth, 2012).

As S&H suggest, when forecasters fail to forecast improbable events, the consequences for forecast users can be dire. Forecasts from regression analysis are susceptible to that risk because regression models tend to exclude important variables due to lack of data and to lack of historical variation in the some causal variables. Using the index method instead reduces the risk of failing to forecast an improbable outcome by including information about all factors that are known to be important.

The proper role of a forecaster is to provide decision makers with expected values and confidence intervals for relevant costs and benefits. In turn, rational decision makers should avoid making judgmental adjustments based on their opinions about what unusual things might happen. Indeed, based on the research to date, judgmental adjustments of objective forecasts are likely to harm forecast accuracy (Armstrong et al.,2015-in this issue, Golden Rule checklist item 6).