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Golden rule of forecasting: Be conservative

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ABSTRACT

This article proposes a unifying theory, or the Golden Rule, of forecasting. The Golden Rule of Forecasting is to *be conservative*. A conservative forecast is consistent with cumulative knowledge about the present and the past. To be conservative, forecasters must seek out and use all knowledge relevant to the problem, including knowledge of methods validated for the situation.

Twenty-eight guidelines are logically deduced from the Golden Rule. A review of evidence identified 105 papers with experimental comparisons; 102 support the guidelines. Ignoring a single guideline increased forecast error by more than two-fifths on average. Ignoring the Golden Rule is likely to harm accuracy most when the situation is uncertain and complex, and when bias is likely. Non-experts who use the Golden Rule can identify dubious forecasts quickly and inexpensively.

To date, ignorance of research findings, bias, sophisticated statistical procedures, and the proliferation of big data, have led forecasters to violate the Golden Rule. As a result, despite major advances in evidence-based forecasting methods, forecasting practice in many fields has failed to improve over the past half-century.

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1. Introduction

Imagine that you are a manager who hires a consultant to predict profitable locations for stores. The consultant applies the latest statistical techniques to large databases to develop a forecasting model. You do not understand the consultant's procedures, but the implications of the forecasts are clear: invest in new outlets. The consultant's model is based on statistically significant associations in the data. Your colleagues are impressed by the consultant's report, and support acting on it. Should you?

To answer that question, and the general question of how best to go about forecasting, this paper proposes a general rule: a *Golden Rule of Forecasting*. The short form of the Golden Rule is to *be conservative*. The long form is to *be conservative by adhering to cumulative knowledge about the situation and about forecasting methods*. Conservatism requires a valid and reliable assessment of the forecasting problem in order to make effective use of cumulative knowledge about the situation, and about evidence-based forecasting procedures.

The Golden Rule applies to all forecasting problems, but is especially important when bias is likely and when the situation is uncertain and complex. Such situations are common in physical and biological systems—as with climate, groundwater, mine yield, and species success—business—as with investment returns—and public policy—as with the effects of government projects, laws, and regulations.

Work on this paper started with a narrow conception of the application of conservatism to forecasting: reduce the amount of change that is forecast in the presence of uncertainty. That philosophy is the basis of regression analysis, which regresses toward the mean. The narrow conception created its own contradictions, however, because reducing the amount of change predicted is not conservative when a larger change is more consistent with cumulative knowledge. Consider, for example, that it would not be conservative to reduce growth forecasts for a less-developed nation that has made big reductions in barriers to trade and investment, and in the regulation of business. Deliberations on this point led to the definition of conservatism proposed for the Golden Rule. To the authors' knowledge, the foregoing definition of conservatism has not been used in the forecasting literature, but it is consistent with Zellner's description of a "sophisticatedly simple model" being one that "takes account of the techniques and knowledge in a field and is logically sound" (Zellner, 2001, p. 259).

2. The Golden Rule Checklist

The checklist of 28 operational guidelines provided in this article follows logically from the definition of conservatism. The checklist can help forecasters to be conservative by applying the Golden Rule.

Subsequent searches for papers with comparative evidence relevant to the 28 guidelines involved internet literature searches, investigating references in important papers, asking key researchers, and posting requests on the internet. Email messages were then sent to the lead authors of articles cited in substantive ways in order to check whether any relevant evidence had been overlooked and to ensure that the evidence is properly summarized. Reminder messages were sent to

Table 1
Golden Rule Checklist with evidence on error reduction.

		Guideline	Comparisons*		
			N	Error reduction	
				n	%
1.		**Problem formulation**			
1.1		Use all important knowledge and information by…			
1.1.1	□	selecting evidence-based methods validated for the situation	7	3	18
1.1.2	□	decomposing to best use knowledge, information, judgment	17	9	35
1.2		Avoid bias by…			
1.2.1	□	concealing the purpose of the forecast	–		
1.2.2	□	specifying multiple hypotheses and methods	–		
1.2.3	□	obtaining signed ethics statements before and after forecasting	–		
1.3	□	Provide full disclosure for independent audits, replications, extensions	1		
2.		**Judgmental methods**			
2.1	□	Avoid unaided judgment	2	1	45
2.2	□	Use alternative wording and pretest questions	–		
2.3	□	Ask judges to write reasons against the forecasts	2	1	8
2.4	□	Use judgmental bootstrapping	11	1	6
2.5	□	Use structured analogies	3	3	57
2.6	□	Combine independent forecasts from judges	18	10	15
3.		**Extrapolation methods**			
3.1	□	Use the longest time-series of valid and relevant data	–		
3.2	□	Decompose by causal forces	1	1	64
3.3		Modify trends to incorporate more knowledge if the…			
3.3.1	□	series is variable or unstable	8	8	12
3.3.2	□	historical trend conflicts with causal forces	1	1	31
3.3.3	□	forecast horizon is longer than the historical series	1	1	43
3.3.4	□	short and long-term trend directions are inconsistent	–		
3.4		Modify seasonal factors to reflect uncertainty if…			
3.4.1	□	estimates vary substantially across years	2	2	4
3.4.2	□	few years of data are available	3	2	15
3.4.3	□	causal knowledge is weak	–		
3.5	□	Combine forecasts from alternative extrapolation methods, data	1	1	16
4.		**Causal methods**			
4.1	□	Use prior knowledge to specify variables, relationships, and effects	1	1	32
4.2	□	Modify effect estimates to reflect uncertainty	1	1	5
4.3	□	Use all important variables	5	4	45
4.4	□	Combine forecasts from dissimilar models	5	5	22
5.	□	**Combine forecasts from diverse evidence-based methods**	15	14	15
6.	□	**Avoid unstructured judgmental adjustments to forecasts**	4	1	64
Totals and unweighted average			109	70	31

*N: number of papers with findings on effect direction.
n: number of papers with findings on effect size. %: average effect size (geometric mean).