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Journal of Econometrics 105 (2001) 249–286

JOURNAL OF Econometrics

www.elsevier.com/locate/econbase

Dangers of data mining: The case of calendar effects in stock returns

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Abstract

Economics is primarily a non-experimental science. Typically, we cannot generate new data sets on which to test hypotheses independently of the data that may have led to a particular theory. The common practice of using the same data set to formulate and test hypotheses introduces data-mining biases that, if not accounted for, invalidate the assumptions underlying classical statistical inference. A striking example of a data-driven discovery is the presence of calendar effects in stock returns. There appears to be very substantial evidence of systematic abnormal stock returns related to the day of the week, the week of the month, the month of the year, the turn of the month, holidays, and so forth. However, this evidence has largely been considered without accounting for the intensive search preceding it. In this paper we use 100 years of daily data and a new bootstrap procedure that allows us to explicitly measure the distortions in statistical inference induced by data mining. We find that although nominal *p*-values for individual calendar rules are extremely significant, once evaluated in the context of the full universe from which such rules were drawn, calendar effects no longer remain significant.

JEL classification: C120; C530; G140

Keywords: Data mining; Market efficiency; Bootstrap testing; Calendar effects

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0304-4076/01/$ - see front matter
PII: S0304-4076(01)00077-X

October. This is one of the peculiarly dangerous months to speculate in stocks in. The others are July, January, September, April, November, May, March, June, December, August and February.

Mark Twain (1894)

1. Introduction

Economic theory often is vague about the relationship between economic variables. As a result, many economic relations have been initially established from apparent empirical regularities and had not been predicted ex ante by theory. Like many of the social sciences, economics predominantly studies non-experimental data and thus does not have the advantage of being able to test hypotheses independently of the data that gave rise to them in the first instance. If not accounted for, this practice, referred to as data mining, can generate serious biases in statistical inference.[1] In the limited sample sizes typically encountered in economic studies, systematic patterns and apparently significant relations are bound to occur if the data are analyzed with sufficient intensity.

One of the most striking examples of a data-driven finding that was not anticipated by theory is the apparently very strong evidence of seasonal regularities in stock returns. Calendar effects were the first to be analyzed in the "Anomalies" section of the inaugural issue of *Journal of Economic Perspectives* (Thaler, 1987a, b). Indeed, theoretical considerations would suggest that researchers should not even be looking for such patterns in the first instance. According to standard economic theory, stock prices should follow a martingale process and returns should not exhibit systematic patterns, thus ruling out seasonal components unless these can be related to systematic variations in risk premiums, cf. Samuelson (1965), Leroy (1973), and Lucas (1978).

As reflected in the initial Mark Twain quote, investors have nevertheless long been fascinated by the possibility of finding systematic patterns in stock prices that, once detected, promise easy profits when exploited by simple trading rules. Moreover, Merton (1987) points out that "economists place a premium on the discovery of puzzles, which in the context at hand amounts to finding apparent rejections of a widely accepted theory of stock market behavior" (p. 104). Consequently, there is a long tradition among investors and academics of searching through stock market data; published academic studies on calendar effects go back to at least the early 1930s, e.g. Fields (1931,1934). As a result, common stock market indexes such as the Dow Jones Industrial

[1] Leamer (1978) discusses such pretest biases in considerable detail.