A multidimensional classification of market anomalies: Evidence from 76 price indices

John R. Doyle[a], Catherine Huirong Chen[b],*

[a] Cardiff Business School, Cardiff University, Aberconway Building, Colum Drive, Cardiff CF10 3EU, United Kingdom
[b] Middlesex University Business School, The Burroughs, Hendon, London NW4 4BT, United Kingdom

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ABSTRACT

This paper makes the first attempt to present explicit empirical evidence that market inefficiency can be multi-dimensional. Testing the Efficient Market Hypothesis (EMH) over 76 stock indices using 17 best established indicators (e.g. runs test), we show that most indices exhibit some type(s) of anomaly and that indicators differ from each other in terms of statistical power and/or the type of anomaly detected. A principal components analysis (PCA) demonstrates that indicators group along orthogonal dimensions, and hence a market can exhibit short-term memory, long-term memory and/or calendar effects, which are all distinct sources of possible inefficiency. This research presents statistical evidence on the extent and nature of market inefficiency, offers possible explanations for conflicting previous findings, and provides new insights into studying market efficiency.

"Happy families are all alike; every unhappy family is unhappy in its own way" Leo Tolstoy.

1. Introduction

This article shows that inefficient markets, like Tolstoy's unhappy families, may be inefficient in several different ways.[1] This perspective not only offers a possibility to reconcile some conflicting

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* Corresponding author. Tel.: +44 2084114910; fax: +44 2084116011.
E-mail addresses: doylejr@cf.ac.uk (J.R. Doyle), c.chen@mdx.ac.uk (C.H. Chen).

[1] In this paper we conceived that a market is inefficient if it exhibits statistically significant anomalies in price movements. This position contrasts with market inefficiency as exploitable anomalies, which is more restrictive in that it adds a complex mix of extrinsic factors to define exploitability, as explained later.

findings regarding market efficiency in the literature, but also provides new insights into portfolio investment and future research on weak-form market efficiency.

The efficient market hypothesis (EMH) has been a dominant organising principle in financial markets research for several decades. To test EMH, researchers have sought out new data from new markets and over extended time-spans; have analysed at the micro level of minute-by-minute prices or of individual trader transactions; have devised new statistical techniques; or/and have made insightful use of new explanatory variables. Yet there is still disagreement about the central proposition of EMH: are markets efficient? Research still emerges that resolutely rejects EMH, or just as resolutely defends EMH. For instance, Worthington and Higgs (2006) claimed: "The serial correlation and runs tests conclude that all of the [15 Asian] markets are weak-form inefficient"; whereas Lean and Smyth (2007), using a subset of these same markets, claimed the opposite: "The overwhelming conclusion is that stock prices in the [eight] Asian markets studied are characterized by a random walk."

Several principal reasons explain how conflicting findings might arise. First, there are different understandings on how to define market efficiency. Some researchers claim that markets are inefficient if they find irregularities in market movements; while others define it more restrictively, saying that a market is inefficient only if exploitable opportunities constantly exist. Second, researchers tend to examine too few markets that are too homogeneous. Understandably this gives research a focus, but it limits the generality of any findings. Third, researchers tend to assess market inefficiency using a very limited set of indicators (used in this paper to mean statistical tests of EMH), often only one. Different indicators may have different statistical power to detect inefficiency, and the greater the power disparity among indicators used in different studies, the greater the risk of different conclusions. Fourth, most previous studies have tacitly assumed that markets may be inefficient in only a single way, and by implication, that all indicators are tests of this uni-dimensional inefficiency. However, if markets are inefficient in a variety of ways, with different indicators tapping different dimensions of inefficiency, then the need to sample a sufficient variety of both markets and indicators becomes crucial.[2] Past literature has never before explicitly tested these possibilities.

As argued by Lo (1997), even after decades of research and thousands of journal articles, economists have not yet reached a consensus about whether financial markets are efficient or not. We are not naively claiming that this paper could resolve the debate and it is not our key aim to be one of many testing whether markets are efficient or not. Instead, the main objectives of this paper however lies in: to benchmark indicators as to their ability to detect anomalies (Objective 2); and to explore whether multi-dimensionality of anomalies is a robust phenomenon (Objective 3). To achieve these objectives, it is the necessary first step for us to test whether markets exhibit certain statistical anomalies (Objective 1), which for the convenience, we call market inefficiency[3] in this paper.

We selected a large number of diverse stock markets (more strictly, 76 price indices), and 17 indicators that have been widely used and well-accepted in the finance literature. The inefficiency of each index was measured by each indicator in turn, producing a 76×17 matrix of either z-scores or Chi-square scores, depending on the indicator/test. To clarify the scope of this paper, note that most previous research stops processing after analysing a small subset of such a matrix. By contrast, obtaining the matrix is just the starting point for further analyses here. The information in the 76×17 matrix was synthesized, e.g. through principal components analysis (see Section 3), to achieve our three research objectives.

Our results show there is a wide difference in the statistical power of the indicators, which explains why researchers who use different indicators may come to different conclusions. Across the globe, markets are found to exhibit certain anomalies. Moreover, these anomalies can be categorized orthogonally: i.e. market inefficiency can be multi-dimensional.

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[2] Conflicting findings may also occur because data was sampled in different time-periods, but this paper does not explore this possibility.

[3] We acknowledge that a market exhibiting statistical anomaly or regularities does not necessarily mean that it is inefficient, if according to for example Richard Roll's definition: "an inefficiency ought to be an exploitable opportunity. If there is nothing investors can properly exploit in a systematic way, time in and time out, then it is very hard to say that information is not being properly incorporated into stock prices" (as quoted in Malkiel, 2000). We further discuss this point in the discussion and conclusion section.