The Efficient Markets Hypothesis: The Demise of the Demon of Chance?

Stephen J. Brown[1]

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Abstract: Many commentators have suggested that economists in general and financial economists in particular have some responsibility for the recent global financial crisis. They were blinded by an irrational faith in a discredited Efficient Markets Hypothesis and failed to see the bubble in asset prices and to give due warning of its collapse. There is considerable confusion as to what this hypothesis is and what it says. The irony is that the strong implication of this hypothesis is that nobody, no practitioner, no academic and no regulator had the ability to foresee the collapse of this most recent bubble. While few economists believe it is literally true, this hypothesis is considered a useful benchmark with some important practical implications. Indeed, a case can be made that it was the *failure* to believe in the essential truth of this idea which was a leading factor responsible for the global financial crisis**.**

[1] Stephen Brown is the David S. Loeb Professor of Finance at New York University Stern School of Business, e-mail: sbrown@stern.nyu.edu. He currently holds a Visiting Professorial Fellowship in the Department of Finance at the University of Melbourne. The author wishes to thank Ray Ball, Tim Brailsford, Robert Faff, Martin Gruber, Frank Milne, Meir Statman, Avanidhar Subrahmanyam, Jeffrey Wurgler and Guan Yang for helpful discussion, as well as participants at the European Financial Management Association 2009 Merton H. Miller Doctoral Seminar, Milan and the Deakin University 2009 Finance on the Move conference.

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1. Introduction

We are now approaching the fortieth anniversary of the publication of Eugene Fama's classic paper "Efficient Capital Markets: A Review of Theory and Empirical Work" (Fama 1970). While the term 'Efficient Markets Hypothesis' (EMH) means many things to many people, Fama and other financial economists who have followed on his work are very clear on what is meant by this term. As he explained in that paper and his later review paper (Fama 1991), the EMH has a very precise meaning. It is nothing more than the statement that security prices fully reflect all available information. A market in which prices fully reflect all available information is said to be efficient.

The publication of the 1970 paper was the high point for the EMH. Based on an early grant from Merrill Lynch, Lawrence Fisher and others at the University of Chicago had collected for the first time a comprehensive database of prices and returns of stocks trading on the New York Stock Exchange. This data challenged for the first time the conventional wisdom that it was rather easy to make money in the markets by following trends and other market ephemera. The importance of Fama's work and that of his students was to shift the burden of proof to those who would argue that asset managers and other skilled investors can indeed earn excess returns by trading securities.

From 1970, interest in the EMH started to decline, with the emergence of new research agendas.

Even at Chicago, the publication of Black and Scholes' work on option pricing, the application of this new technology to the big issues of corporate finance by Merton Miller and his students, and the seminal paper by Fama and MacBeth (1973) on equity asset pricing turned attention to other topics in Finance. The accumulation of evidence by Fama and his students showed that the EMH could not be true, at least in the simple terms expressed in the 1970 article. His 1991 review article is more or less a compendium of the ways in which the EMH fails as an empirical description of the way the markets work. At a theoretical level, the argument is even more compelling. If prices fully reflect all available information, Grossman and Stiglitz (1980) observe that there is no incentive to acquire information. Therefore, there is no mechanism though which prices could indeed adjust to new information. Indeed Fama himself in his 1991 review article (Fama 1991) agrees. The strictest form of the model does not allow for any trading costs or for the costs of acquiring information. An economically more sensible version of the EMH says that prices reflect information to the point where the marginal benefits of acting on information do not exceed the marginal costs of doing so, a view he attributes to Jensen (1978).

The stock market crash of 1987 was a serious challenge to the few remaining EMH diehards. It became evident that on a short term trade by trade basis, trading influences prices in a way that appeared to be contrary to the EMH. The empirical analysis of trade by trade equity prices led to a completely new area of academic inquiry into the microstructure of equity markets. In a similar way the stock market bubble of the dot-com boom bursting in March 2000 appeared to be the final straw. The publication of *Irrational Exuberance* by Shiller (2000) was exquisitely timed to come out just a few weeks before that particular bubble burst. The content and timing of that

book led to its wide acceptance in the academic community, and the study of the behavioral factors that influence prices is a standard part of the current academic writing in financial economics. Indeed, this is the new consensus, as influential in its way as was Fama's work published thirty years earlier.

It is therefore odd that commentators around the world have attributed the global financial crisis to the fact that both academics and practitioners maintain a craven belief in the EMH, a manifestly discredited view of the markets[2]. Jeremy Grantham, a noted practitioner with GMO, an institutional asset management company, recently expressed this view

"The incredibly inaccurate efficient market theory was believed in totality by many of our financial leaders, and believed in part by almost all. It left our economic and government establishment sitting by confidently, even as a lethally dangerous combination of asset bubbles, lax controls, pernicious incentives and wickedly complicated instruments led to our current plight. 'Surely, none of this could be happening in a rational, efficient world,' they seemed to be thinking. And the absolutely worst part of this belief set was that it led to a chronic underestimation of the dangers of asset bubbles breaking."[3]

Politicians around the world, but particularly in Australia, were quick to make similar claims. In

[2]See Nocera (2009) and Fox (2009)

[3] Quoted in Nocera (2009). It is interesting to note that the period of the crisis (August 2007 through May 2009), none of the US Equity GMO funds had a positive alpha (measured relative to the S&P500 or to the Fama and French three factor model), judging from the monthly returns reported in the CRSP Mutual Funds Database.

a remarkable essay, Kevin Rudd, the Prime Minister of Australia wrote

"Neo-liberal policy prescriptions flow from the core theoretical belief in the superiority of unregulated markets - particularly unregulated financial markets. These claims ultimately rest on the "efficient-markets hypothesis", which, in its strongest form, claims that financial-market prices, like stock-market prices, incorporate all available information, and therefore represent the best possible estimate of asset prices. It follows, therefore, that if markets are fully efficient and prices fully informed, there is no reason to believe that asset-price bubbles are probable; and if these do occur, markets will self-correct; and that there is therefore no justification for government intervention to stop them occurring"[4]

It is understandable that practitioners and politicians would make statements of this nature. After all, practitioners would prefer that the burden of proof be moved back to those who would claim that superior performance is a matter of luck rather than skill. Politicians would rather blame the global financial crisis on an idea. They would far prefer to do this than to blame the crisis on bad people, bad institutions or ineffective regulatory action. The fact that these statements are made at all is a testimony to the power and resilience of this idea. It is useful at this point to examine what is meant by the EMH and whether it has any useful implications either for our understanding of the markets or for practice.

2. What is the EMH?

[4]Rudd (2009). A similar sentiment was expressed in an op-ed piece contributed by Lindsay Tanner, Minister of Finance in Australia (Tanner 2009).

There is a great deal of confusion in the public discussion of the EMH[5]. The statement that prices "reflect all available information" implies that no trader has any kind of informational advantage in the security markets. If this is so, then the price today reflects the common or 'market' expectation of what the security would be worth tomorrow. The EMH does not imply that prices are set in some kind of competitive market equilibrium. It does not specify the mechanism by which prices "reflect all available information" and so does not imply that market prices are "right", or that market expectations are formed in some rational way. For this reason the EMH is silent on whether current market expectations reflect a bubble. Most certainly it gives no guidance to policy makers who might seek to detect when a bubble is forming and when it might collapse.

This does not deny that a competitive equilibrium in security prices does indeed imply the EMH. It is just that the reverse implication does not follow. In a purely speculative market the only reason to trade is to make a profit on special information. The resulting change in price would contradict the existence of a competitive equilibrium. It follows then that in an equilibrium where noone has any reason to trade, the market price of each security reflects the common or market information shared by all investors. The hypothesis is usually thought of in terms of the behavior of security prices over time. Ingersoll (1987) notes that in this context the hypothesis dates back to at least the start of the last century to a Sorbonne thesis written by Louis Bachelier (Bachelier (1900)). Bachelier was the first to develop the equations of Brownian motion which he felt had particular application in describing the movements of security prices.

[5]Ball (2009) and Statman (2009) both observe that much of the public discussion of the EMH reflects some confusion about what the hypothesis is and what its implications are.

However, the first arguments in favor of this view of the markets were empirical rather than theoretical in nature. Indeed, from a theoretical point of view the notion of competitive equilibrium is clearly counterfactual. Investors trade securities, never more so than in times of financial crisis. It is for this reason that the early empirical work by Fama and others was very surprising. His work was simple, elegant and easy to understand. In light of the conventional wisdom that it was rather easy to make money trading securities, it was astonishing to find that something like the EMH was very nearly true. Much of the later work summarized in Fama (1991) documents the small and transient ways in which the data appear to contradict the EMH. As Lucas (2009) observes, even the smallest of deviations are interesting and important as they provide profit opportunities for the largest of investors. But the bottom line holds. Small investors, with limited capital and limited access to special information may as well assume that the EMH is a complete and accurate description of the way in which the equity markets work.

To understand Fama's contribution, it is useful to represent the EMH as a statement about individual and market expectations. Suppose the EMH is true, and today's price p_t reflects all relevant information pertaining to future prices. Let Φ_t represent the common information all investors have after observing the current price p_t. Then according to the EMH no trader's specific information Φ_{it} would give him or her any kind of price advantage in the markets. In other words

$$\ln p_t \leq E[\ln p_{t+\tau} \mid \Phi_{it}, \Phi_t] = E[\ln p_{t+\tau} \mid \Phi_t] \qquad (1)$$

As we note above, the hypothesis is generally presented in terms of the behavior of security prices over time

$$E[r_{t+\tau} \mid \Phi_{it}, \Phi_t] = E[r_{t+\tau} \mid \Phi_t] > 0, \quad r_{t+\tau} \equiv \ln p_{t+\tau} - \ln p_t \tag{2}$$

which follows since the current price p_t is contained in the market information Φ_t.

If the trader's specific information z_{it} is already incorporated into the market price, then

$$\underset{\Phi_t}{E}\left\{[r_{t+\tau} - E(r_{t+\tau} \mid \Phi_t)]\, z_{it}\right\} = 0 \tag{3}$$

since according to the EMH this information is already contained within the common information Φ_t that determines prices[6].

Equation (3) gives immediate empirical content to the EMH. Consider filter rule tests of the kind reported by Fama and Blume (1966) which examine the returns to a trading rule strategy based on the pattern of past prices. If we represent a buy decision based on the pattern of past prices as $\delta_t = 1$, a sell decision as $\delta_t = -1$ and a hold decision as $\delta_t = 0$, then the average return to the filter rule in excess of a buy and hold benchmark can be thought of as an empirical analogue to $\underset{\Phi_t}{E}\left\{\left[r_{t+\tau} - E\left(r_{t+\tau} \mid \Phi_t\right)\right]\delta_t\right\}$. Equation (3) would indicate that this average return should be

[6]The expectation in (3) is conditional on Φ_t. If z_{it} is contained in Φ_t it is a constant and thus comes out of the expectation operator. What is left within the expectation is zero by definition. Equation (3) is sometimes called an 'orthogonality condition' in which context z_{it} is referred to as an 'instrument'.

zero. Indeed, returns to such trading rules are very small and do not exceed the cost of implementing the necessary transactions. Tests of this nature where trading rules are limited to an examination of the pattern of past prices are referred to as 'weak form' tests. Event studies, pioneered by Ball and Brown (1968) and Fama *et al.*(1969) adopt the convention that 'good news' is represented by $\delta_t = 1$, 'bad news' by $\delta_t = -1$ and 'no news' as $\delta_t = 0$. A test that the resulting average residual equals zero is therefore a direct test of Equation (3) where the signal includes all information available to the investing public. Such tests are referred to as 'semi-strong' tests of the EMH. Insider trading studies of the kind reported in early work of Jaffe (1974) extend the analysis to consider trading rules based on non-public information. These studies, referred to as 'strong form' tests of the EMH generally find a pattern of positive returns, which would repreent a contradiction to Equation (3) and a violation of the EMH.

It is important to note that all of these studies were completed at the University of Chicago in the late 1960's and early 1970's, not as a result of some theoretical analysis of the implications of competitive equilibrium in security markets, but rather as a direct result of the empirical analysis of data on equity security prices which had just became available through the Center for Research in Security Prices. Indeed Fama (1970) attributes the 'weak form', 'semi-strong form' and 'strong form' language to Harry Roberts who was an eminent statistician at Chicago and a pioneer at that time in developing computational tools to assist in exploratory data analysis.

Indeed, the EMH, at least as expressed in Equation (3) is rather central to the empirical finance literature that has been published over the past 40 years. A check of Google Scholar reveals that

there are 15,500 working papers and publications containing the phrase "Efficient Market(s) Hypothesis". There is great interest in the scientific issue of the extent to which the EMH corresponds (or more precisely does not correspond) to the available data. There is even greater interest in the practical implications of this hypothesis. There are 17,500 working papers that contain the phrase "Event study" or "Event studies"[7]. These studies tend to show just how quickly information can become impounded in stock prices[8]. Event studies dominate the empirical literature of corporate finance, which examines the wealth impact of different corporate policies. By defining material information as anything which moves security prices, event studies have a central role in determining materiality in the context of the release of accounting information and in the legal analysis of corporate fraud events[9].

Less obvious is the central role of the EMH in the empirical analysis of asset pricing. Suppose it is possible to derive a trading rule based on information z_t available at time t to profit from the deviation of future returns from their expected value. This would imply either that the EMH is false, or that our model for expected returns $E(r_{t+\tau} \mid \Phi_t)$ is misspecified. This insight allows us to *estimate* $E(r_{t+\tau} \mid \Phi_t)$ by asserting that the EMH is descriptively accurate. Equation (3) corresponds to the orthogonality condition used to estimate the model for expected returns using

[7]These Google Scholar references were as of January 6, 2010.

[8]A good survey of event studies can be found in MacKinlay (1997)

[9]The legal application of event studies is surveyed in Tabak and Dunbar (2001).

Generalized Method of Moments[10]. Equation (3) also corresponds to the first order conditions for Maximum Likelihood estimators of the parameters of $E(r_{t+\tau} \mid \Phi_t)$ that lead to regression-based estimators of risk and risk premia in the CAPM and APT contexts. Again as before, there is a scientific interest in the question of the extent to which the market prices (or does not price) risk. However while empirical measures of risk and risk premia are of central importance to financial economists they are also of great practical concern in the context of financial planning and capital budgeting.

Given the central importance of the EMH in empirical finance, it is important to examine with some care the case against the EMH. The failure of the EMH has profound implications for both legal analysis and corporate practice[11]

3. The EMH and the Random Walk Hypothesis

How can we reconcile the EMH with the widespread perception that market returns are in fact predictable and that hedge funds in particular are particularly adept in exploiting this predictability? The money management community has been particularly vocal in its rejection of the EMH on these grounds. In an important survey paper Timmerman (2007) examines the empirical evidence of predictability. Two major conclusions follow from this very careful study. First, sophisticated prediction tools do not fare well relative to naïve models in predicting

[10]See for example Cochrane (2001) which contains a useful summary of this literature.

[11]Ferrillo et al. (2004) observe that the use of event studies in determining damages in corporate fraud cases is now heavily dependent on the courts accepting the EMH as descriptively accurate on a security by security basis.

returns based on past sample means. Second, there appear to be only short-lived episodes of quite limited return predictability. These conclusions are consistent with all we know from the theoretical developments in financial economics over the past 40 years and more.

The increasingly sophisticated apparatus presented in the financial asset pricing literature has as its objective deriving models that might most accurately describe the cross section of expected security returns. The sample mean return can be considered a reasonable estimator of expected returns, and so it is not surprising that it is a very robust straw man when comparing alternative predictive models. The apparent disconnection between the financial markets and real economic activity has encouraged a behavioral view of the markets and the hope and promise of limited predictability. However, the important paper of Lettau and Ludvigson (2001) explains that at least part of this tension arises from the strong assertion of stationarity. Allowing for conditional expectations, which can change through time as economic conditions fluctuate, explains much of this disconnect. This suggests that only sample means based on the most recent historical data are relevant for predicting future returns. Further, it suggests that some benefit might be drawn from conditioning the predictions on current state variables characterizing the state of the economy. However, while this is of some scientific interest, it provides limited guidance for practitioners, as the alternative investments necessary to capitalize on this perception of predictability presumably depend on the same state variables.

Part of the problem here results from the confusion between the EMH and a related but different hypothesis referred to as the Random Walk hypothesis. Early investigators did not make this

distinction particularly clear, and the otherwise excellent book by Malkiel (1973) appears to have cemented the two ideas into one in the public mind. The Random Walk hypothesis states that the first difference in the logarithm of security prices – returns – are independently and identically distributed random variables with finite variance. While this is a much stronger statement than the EMH it has the advantage of an established statistical technology to examine it. The results of the first empirical examination of this hypothesis were startling. Kendall (1953), in his analysis of the weekly changes in equity prices and futures contract prices observed

"The series looks like a 'wandering' one, almost as if once a week the Demon of Chance drew a random number from a symmetrical population of fixed dispersion and added it to the current price to determine the next week's price" (p.13)

Fama (1965) found similar results in his analysis of U.S. equity prices.[12] This result was counterintuitive for many academics and practitioners since 'the Demon of Chance' seemed to deny the role of human action in determining changes in stock prices. This led to many studies which sought to show that this result could not be true, and this challenge could be said to have been the progenitor of the study market microstructure, the way in which traders' actions influence stock prices[13], as well as the current efflorescence of research in behavioral Finance.

[12]It is important to note that Fama in his Chicago dissertation and later published work notes that the assertion of finite variance of return in the Random Walk hypothesis appeared to be violated

[13]For a good survey see Madhavan (2000)

The most definitive empirical rejection of the Random Walk hypothesis is that of Lo and MacKinlay (1988) who examine the implication of the hypothesis that monthly variances should be a fixed multiple of daily variances, and find that monthly variance of return is in fact significantly smaller than the appropriately scaled daily variance.

However the Random Walk hypothesis is not the EMH. The Random Walk hypothesis imposes a strong assumption of stationarity. Most tests of the Random Walk hypothesis amount to a statement about serial covariances

$\gamma_\tau = E\left\{\left[r_{t+\tau} - E(r)\right]\left[r_t - E(r)\right]\right\} = E\left\{\left[r_{t+\tau} - E(r)\right] r_t\right\} = 0, \tau > 0$. This expression

corresponds to Equation (3) on the strong presumption that the market information Φ_t is time

invariant[14]. For this reason time varying conditional expectations can present a problem for the Random Walk hypothesis but not the EMH. The real question is whether returns are predictable even accounting for time-varying conditional expectations. Practitioners certainly believe that they are.

It is important to note that predictability alone is neither necessary nor sufficient to establish a violation of the EMH. We must show the profitability of a trading strategy based on information available at the time the trades are made. Predictability is not necessary: the failure of simple linear models to find predictability suggests that more advanced nonlinear neural network

[14]This assumption implies that the unconditional expectation of return is the same as the expectation of return conditional on the market information Φ_t available at time *t*.

procedures might succeed. Advances in the neural network technology cannot exclude the possibility that there is some arcane pattern recognition algorithm used by a successful seat-of-the-pants trader that might dominate an overparameterized neural network procedure in an out-of-sample exercise. On the other hand, predictability if detected may not be profitable if the range of variation in the predictable component of returns matches the predictable rise and fall of the cost of funds used to exploit this predictability. As Malkiel (2003) observes, the internet bubble of the late 1990s was followed by many sharp-eyed analysts who had great difficulty executing an arbitrage strategy to take advantage of this phenomenon. This is perfectly consistent with our understanding of the EMH.

It is understandable why statisticians prefer predictability to profitability. It is dangerous to draw statistical inferences from the pattern of trading returns where the distribution of those returns depends heavily on the strategy used to exploit apparent predictability. The interpretation that an extreme tail event brought down Long Term Capital Management was based on a parametric representation of the process generating trading profits (Lowenstein 2000). Indeed Goetzmann *et al.* (2007) show that traders have a positive incentive to vary the statistical distribution of trading payoffs to influence the performance metrics by which they are judged.

In a quite remarkable early paper Cowles (1933) addressed both the issue of how to characterize the pattern recognition algorithm of seat-of-the-pants traders as well as the technology which might be used to examine the statistical significance of resulting trading profits. William Peter Hamilton, the editor of the Wall Street Journal from 1902 to 1929 had a reputation for successful

forecasting established over a long period of years. Experts analyzed his editorials on the state of the markets and concluded that he had essentially recommended buying into the market 140 times, selling the market 41 times and holding the market 74 times. While this strategy earned 12 percent per annum, this strategy lost 3.5 percent per annum relative to simply buying and holding stocks comprising the Dow Jones Industrial Average over the period. The same analysis applied to the recommendations of 24 financial publications yielded similar results. But were these losses statistically significant? Cowles proposed a novel bootstrap in strategy space to examine this question. In one instance, a forecaster had 240 weeks of experience. 239 cards were made up which recorded the trades implied by their forecasts, and were drawn at random to create a hypothetical trading record with the same frequency of buy and sell operations. The best forecasters had a realized performance insignificantly different from the hypothetical bootstrap strategy, while the worst performance was significantly worse than the random trading strategy.

*4. **Ex post** conditioning and the EMH*

The perception of stock market predictability comes in large measure from the undue faith many practitioners have in backtesting. Overfitting the past history of returns is one of the occupational hazards of the business and brings to mind the aphorism of G. K. Chesterton that "ten false philosophies will fit the universe"[15]. *Ex post* conditioning can also give rise to the perception of predictability, as the practitioner is necessarily a prisoner of history. A good example is the evidence of asset price bubbles. During the course of a bubble, prices appear to rise in a highly predictable way. But as Ross (1987) observes, we only learn of the bubble on its bursting.

[15]The Honour of Israel Gow" in *The Innocence of Father Brown* (1911).

Naturally prices must have risen up to the date of the market collapse, since the bursting of the bubble by definition occurs at the maximum price. Ross further shows that even in a random walk scenario[16], if we condition the analysis on an initial price greater than zero but less than the ultimate maximum price, the average price path must increase at an increasing rate in the period of time leading up to the bursting of the bubble. For this reason, the existence of bubbles and resulting appearance of transient predictability does not in any way invalidate the EMH.

It would seem that event studies provide the strongest possible evidence in favor of the EMH. Countless studies have shown that the stock market reacts rather quickly to new information, whether we measure returns on a monthly, weekly or daily basis. Some would argue that the evidence suggests that information is incorporated in prices within a few minutes[17].

A classic early event study is the one by Fama *et al.* (1969), the results of which are summarized in Figure 1. This figure appears in all of the major textbooks that discuss the EMH, and is often used to illustrate that the markets are semi-strong form efficient[18]. The sample consists of all stocks which experienced a stock split event, and the cross section average residual from a regression of return against a market index are cumulated from 29 months prior to the stock split to 29 months following the stock split. The average residual is the empirical analogue to

[16]Ross (1987) supposes that the log of price evolves as a simple absolute diffusion in continuous time.

[17]See for example Patel and Wolfson (1984).

[18]See for example Elton *et al.* page 422, Figure 17.3.

Equation (3)[19].

*** Please insert Figure 1 about here ***

The impact of this paper cannot be underappreciated. For the first time, it seemed possible to put empirical content to the quantum of information in the markets, measured by the vertical displacement of cumulated average residuals in this picture. The fact that there was no further move in prices subsequent to the split was evidence that the information contained in the split event was captured in prices. In this sense the result confirmed the EMH. However, a closer examination reveals problems for the EMH. Prices appear to be increasing at an increasing rate prior to the split. The authors acknowledge this problem and argue that the split was announced one to two months prior to the date the split actually occurred. This might explain at least part of the observed run up of prices. However, the prices are increasing at an increasing rate for many months prior to the split, and we see the same pattern when we condition on the date the split was announced rather than on the date the split actually occurred[20]. Many event studies show

[19]One caveat is that in this study (and most subsequent studies) the average residual is measured conditional on the coincident realized return on a market index or other benchmark. A trader seeking to profit from information released on a given day cannot base their investment decision on the market return which will be known only at the end of that day. As long as the information event is uncorrelated with the return on benchmark this should not be a problem as the market effect will average out in the cross section of event related firms. However, if the events occur at the same point in calendar time (are 'clustered'), we can no longer interpret the average residual in terms of the EMH Equation (3) as the realized market return is not part of the market information captured in Φ_t.

[20]I have asked PhD students several times as an exercise to replicate this study, and the results in the study are robust to how we measure average residuals, whether we use split date or split announcement date, and also to updating the time period used in the original study to the

evidence of this pattern, and it is most pronounced when we study corporate control events[21]. Indeed, the runup in prices seems to be evidence of the profits made by corporate insiders trading on their privileged information in advance of the corporate announcement. The courts have accepted this evidence in determining damages in corporate fraud and insider information cases (Tabak and Dunbar (2001)). In short, Figure 1 appears to be strong evidence *against* the Efficient Market hypothesis.

Further evidence against the EMH can be observed in the period subsequent to the split. If we examine Figure 1 carefully we notice that subsequent to the stock split date, the cumulative average residuals trend down,. The pattern of cumulated residuals post announcement (referred to as 'post announcement drift') is particularly noticeable in corporate earnings announcement studies (for example, Ball and Brown (1968)) and raises the possibility that these results are due to overreaction to the stock split announcement, affirmation of the behavioral view of the markets.

Most event studies treat the corporate announcement as an exogenous event. Clearly this is counterfactual. If a corporate acquisition were to have been announced on a Monday, suppose that material information came in on Sunday – perhaps the death of the target CEO[22]. The

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most recent date.

[21]A detailed summary of this evidence can be found in Jensen and Ruback (1983)

[22]This example is not entirely hypothetical. Jim Henson's untimely death on May 16 1990 interrupted plans by Walt Disney to take over his company, and Walt Disney waited until 2004 to acquire the Muppets. See http://www.nytimes.com/1990/05/18/business/henson-death-clouds-disney-s-muppet-deal.html.

acquiring company would have a fiduciary duty to reassess and perhaps renegotiate the acquisition. Therefore, when a corporate acquisition is announced we can conclude that there were no negative material information released about the target in the period leading up to the acquisition announcement. Given that there is no negative news, all information relating to the target must have been either immaterial or positive. Is it then surprising that we see a positive runup of prices prior to the target acquisition announcement?

The endogeneity of the announcement is nowhere clearer than in the stock split study of Fama *et al.* (1969). There has been some interest in the question of why firms announce stock splits[23]. Whatever the reasons might be for a firm to announce a positive split, one thing is very clear. Very few firms split their stock when the stock price has fallen. This means that a split decision implies that in the period prior to the split the stock has either increased in value or its value has remained unchanged. To take the most extreme case, suppose that there is no information in the stock split decision. Stock splits are totally random except for the fact that we only observe a firm splitting their stock when the price on the stock split date equals or exceeds the average price over the last 29 months. Stock prices evolve according to the market model, the parameters of which are randomly chosen to match the descriptive statistics presented in Fama *et al.* (1969). The experiment is replicated 10,000 times. The mean value of the cumulated average residual is presented in Figure 2 along with the 95 percent confidence interval.

*** Please insert Figure 2 about here ***

[23]See, for example, Brennan and Copeland (1988)

When we superimpose Figure 1 on Figure 2 we see that there is very little difference between the findings of Fama *et al.* and what we would expect to find if there were no information in stock splits. The cumulated average residual is a little higher than we would expect, consistent with some information being imparted by the stock split announcement. However, the cumulated average residuals fall within the 95 percent confidence bounds at every point. We cannot rule out the hypothesis that stock splits convey information; but by the same token we cannot rule out the possibility that the apparent rise in prices is merely an artefact of *ex post* conditioning. This suggests that the rise in prices prior to the stock split is at best an imperfect measure of the information eventually to be revealed in the stock split announcement.[24]

If we examine Figure 2 we notice that subsequent to the stock split date, the cumulative average residuals trend down in exactly the same direction and magnitude reported in the Fama *et al.* (1969) study. Fama (1998) observes that the long run post announcement return results are fragile to the choice of methodology and that apparent overreaction to information is about as common as underreaction. This is implied by the EMH. It is consistent with the results we observe in Figure 2 where we see apparent 'overreaction' in a case where there is no information released on the event date. This raises the possibility that long term return anomalies might be an artefact of *ex post* conditioning.[25]

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[24]Fama *et al.* (1969) also consider a split of the sample based on reported dividends paid subsequent to the split announcement. Since this is a secondary sort on prices (the higher the price the higher the dividend paid) these results are also affected by *ex post* conditioning in that they are conditional on future prices yet to be observed as of the date of the split

[25]The analytics of how this might work is discussed in Brown, Goetzmann and Ross (1995).

The role of *ex post* conditioning is not limited to event studies. As mentioned before Lo and MacKinlay (1988) in their definitive rejection of the Random Walk hypothesis note that the monthly variance of return is in fact significantly smaller than the appropriately scaled daily variance. Suppose that prices evolve as a simple absolute diffusion in the log of prices (the continuous analogue to the Random Walk), with zero drift. Suppose further that there is a bankruptcy point, a lower bound on prices that serves as an absorbing barrier. Then Brown *et al.* (1995) show that the long term variance tends to $\frac{4-\pi}{2}$ or 0.429203673 times the appropriately scaled daily variance, regardless of how far the security is from bankruptcy initially. This is consistent with the empirical result reported in Lo and MacKinlay (1988). Another example that we have mentioned before is the case of the apparent increase in stock prices prior to an asset price bubble bursting (Ross (1987)). The pattern of prices in a bubble resembles the pattern of cumulated average residuals in Figure 1.

In Fama (1991) there is an extended discussion of anomalies, the fact that the cross sectional dispersion of expected returns is better explained by size, leverage, E/P, and the ratio of book to market values, than by conventionally defined measures of market risk. Indeed if we consider models of expected return based solely on measures of market risk, it should be rather simple to generate exceptions to the EMH Equation (3) by skewing the portfolio to account for the descriptive characteristics of size and the other measures used to define these anomalies.

Fama and French (1992) present a strong argument that these anomalies represent a market-

based compensation for risk that is not captured by conventional measures of market risk. Lakonishok Shleifer and Vishny (1994) argue instead that it illustrates behavioral biases in a market where investors confuse price and quality. We do not take a position on this issue. As we have noted, the EMH is silent on how market expectations are formed, whether on the basis of a clear-headed analysis of corporate fundamentals, or have more of a 'castles in air' behavioral basis. For this reason the question of whether market-based measures of risk determine the cross section of expected returns is beyond the scope of this paper. Nevertheless it is interesting to note that the fact that we observe a security return reported on CRSP means that that firm is not in liquidation. This is another example of *ex post* conditioning. Brown, Goetzmann and Ross (1995) show that in this case the expected return of surviving firms will be biased up by a measure of how volatile the firm's equity is and the extent to which it is in financial distress. Many of the observed anomalies are correlated with measures of how volatile the equity is and how close it is to liquidation.

5. Conclusion

Many commentators have suggested that economists in general and financial economists in particular have some responsibility for the recent global financial crisis. They were blinded by an irrational faith in a discredited EMH and failed to see the bubble in asset prices and to give due warning of its collapse. The irony is that the strong implication of this hypothesis is that nobody, no practitioner, no academic and no regulator had the ability to foresee the collapse of this most recent bubble. While an unrealistic competitive equilibrium scenario implies the EMH, the EMH by itself does not imply anything about competitive equilibrium in the capital markets. It has

nothing to say about asset price bubbles.

Few people today believe in the literal truth of the EMH. Over the past 40 years there have been many studies which have challenged its empirical validity, many of which are catalogued in Fama (1991). Much of this evidence has stemmed from a confusion between the EMH and the closely related Random Walk hypothesis. The experimental design in many of these studies does not exclude the possibility that they are infected with a variety of *ex post* conditioning biases. However, the issue does not hang on whether the hypothesis is true or false, but whether it is *sufficiently* true to serve as a practical benchmark for money manager performance, to use for the purpose of ascertaining whether particular kinds of announcements convey material information to investors, and to estimate measures of equity risk. While sophisticated investors can always make money by exploiting the small and transient ways in which the markets deviate from the EMH, small and otherwise uninformed investors may as well assume that the hypothesis is literally true.

In the period leading up to the current financial crisis few practitioners believed that the EMH had any practical implications. It was believed to be rather easy to make money investing in short term trends. Hedge funds and other investors borrowed heavily to invest in the markets. Banks invested in beta thinking it was alpha. The resulting increase in the leverage and resulting heavy debt burden taken on by financial institutions was a leading factor in the recent global financial crisis (Acharya and Richardson (2009)). One might take the view that it was the *failure* to believe the EMH that was in fact responsible for the crisis!

References:

Viral Acharya and Matthew Richardson 2009 *Restoring Financial Stability: How to Repair a Failed System* (Hoboken: John Wiley & Sons).

Louis Bachelier (1900), "Théorie de la spéculation", *Annales Scientifiques de l'École Normale Supérieure* 3 (17), 21–86.

Ray Ball and Philip Brown, 1968 "An empirical evaluation of accounting income numbers" *Journal of Accounting Research* 6, 159-178.

Ray Ball, 2009 "The Global Financial Crisis and the Efficient Market Hypothesis: What Have We Learned?" *Journal of Applied Corporate Finance* 21(4), 8-16.

Michael Brennan and Thomas Copeland,1988 "Stock splits, stock prices, and transaction costs" *Journal of Financial Economics* 22(1),, 83-101.

Stephen Brown, William Goetzmann and Stephen Ross, 1995, "Survival' *Journal of Finance* 50(3),, 853-873.

John Cochrane 2001, *Asset Pricing* (Princeton: Princeton University Press).

Alfred Cowles, 1933 Can stock market forecasters forecast? *Econometrica* 1 309-325.

Edwin Elton, Martin Gruber, Stephen Brown and William Goetzmann, 2007 *Modern Portfolio Theory and Investment Analysis* (Hoboken: John Wiley & Sons).

Eugene Fama "Random walks in stock market prices" 1965b *Financial Analysts Journal* 21(5) 55-59.

Eugene Fama, Laurence Fisher, Michael Jensen and Richard Roll,1969 "The adjustment of stock prices to new information" *International Economic Review* 10, 1-21.

Eugene Fama, 1970 "Efficient Capital Markets: A Review of Theory and Empirical Work" *Journal of Finance*, 25, No. 2 (March 1970),, 383-417.

Eugene Fama and James MacBeth, 1973 "Risk, return and equilibrium: Empirical tests" *Journal of Political Economy* 71 607-636.

Eugene Fama, 1991 "Efficient Capital Markets: II" *The Journal of Finance*, 465),, 1575-1617.

Eugene Fama and Kenneth French, 1992 "The cross-section of expected stock returns" *Journal*

of Finance 46, 427-466.

Eugene Fama, 1998 “Market efficiency, long-term returns, and behavioral finance” *Journal of Financial Economics* 49 (3), 283-306.

Paul Ferrillo Frederick Dunbar and David Tabak 2004 “The ‘less than’ efficient capital markets hypothesis: Requiring more proof from plaintiffs in fraud-on-the-market cases” St. Johns Law Review 78 No.1, 81-129.

Justin Fox, 2009 “The Myth of the Rational Market: A History of Risk, Reward, and Delusion on Wall Street” (New York: HarperCollins Publishers).

William Goetzmann, Jonathan Ingersoll, Matthew Spiegel, and Ivo Welch, 2007, Portfolio Performance Manipulation and Manipulation-Proof Performance Measures, *Review of Financial Studies* 20 (5),, 1503-1546.

Sanford Grossman and Joseph E. Stiglitz, 1980, On the impossibility of informationally efficient markets, *American Economic Review* 70, 393-408.

Jonathan Ingersoll 1987 *Theory of Financial Decision Making* (Savage, MD: Rowman & Littlefield).

Jeffrey Jaffe, 1974, “Special Information and Insider Trading” *Journal of Business*, 47, No. 3, 410-428.

Michael Jensen 1978, “Some anomalous evidence regarding market efficiency,” *Journal of Financial Economics* 6, 95-101.

Michael Jensen and Richard Ruback 1983 “The market for corporate control: The scientific evidence” *Journal of Financial Economics* 11, 5-50.

Maurice Kendall 1953, “The analysis of economic time series – Part I: Prices” *Journal of the Royal Statistical Society: Series A (General)*116(1), 11-34.

Josef Lakonishok, Andrei Shleifer and Robert Vishny 1994, “Contrarian investment, extrapolation and risk” *Journal of Finance* 49(5), 1541-1578.

Martin Lettau and Sydney Ludvigson (2001) “Resurrecting the (C)CAPM: A Cross-Sectional. Test When Risk Premia Are Time-Varying” *Journal of Political Economy* 109 , pp,1238-1287.

Andrew Lo and A.Craig MacKinley, 1988, “Stock market prices do not follow random walks: Evidence from a simple specification test” *Review of Financial Studies* 1(1),, 41-66.

Roger Lowenstein (2000), *When genius failed: The rise and fall of Long Term Capital. Management*. New York: Random House.

Robert Lucas 2009 “In defence of the dismal science” *The Economist* (August 6, 2009),http://www.economist.com/businessfinance/economicsfocus/displaystory.cfm?story_id=14165405.

A. Craig MacKinlay 1997 “Event Studies in Economics and Einance” *Journal of Economic Literature* 35, 13-39.

Ananth Madhavan 2000 “Market microstructure: A Survey” *Journal of Financial Markets* (3), 205-258.

Burton Malkiel 1973 *A Random Walk Down Wall Street* (New York: W. W. Norton & Company).

Burton Malkiel 2003 “The Efficient Markets Hypothesis and its critics” *Journal of Economic Perspectives* 17(1) 59-82.

Joseph Nocera 2009 “Poking Holes in a Theory on Markets” *New York Times* (June 5, 2009), http://www.nytimes.com/2009/06/06/business/06nocera.html?scp=1&sq=efficient%20market&st=cse.

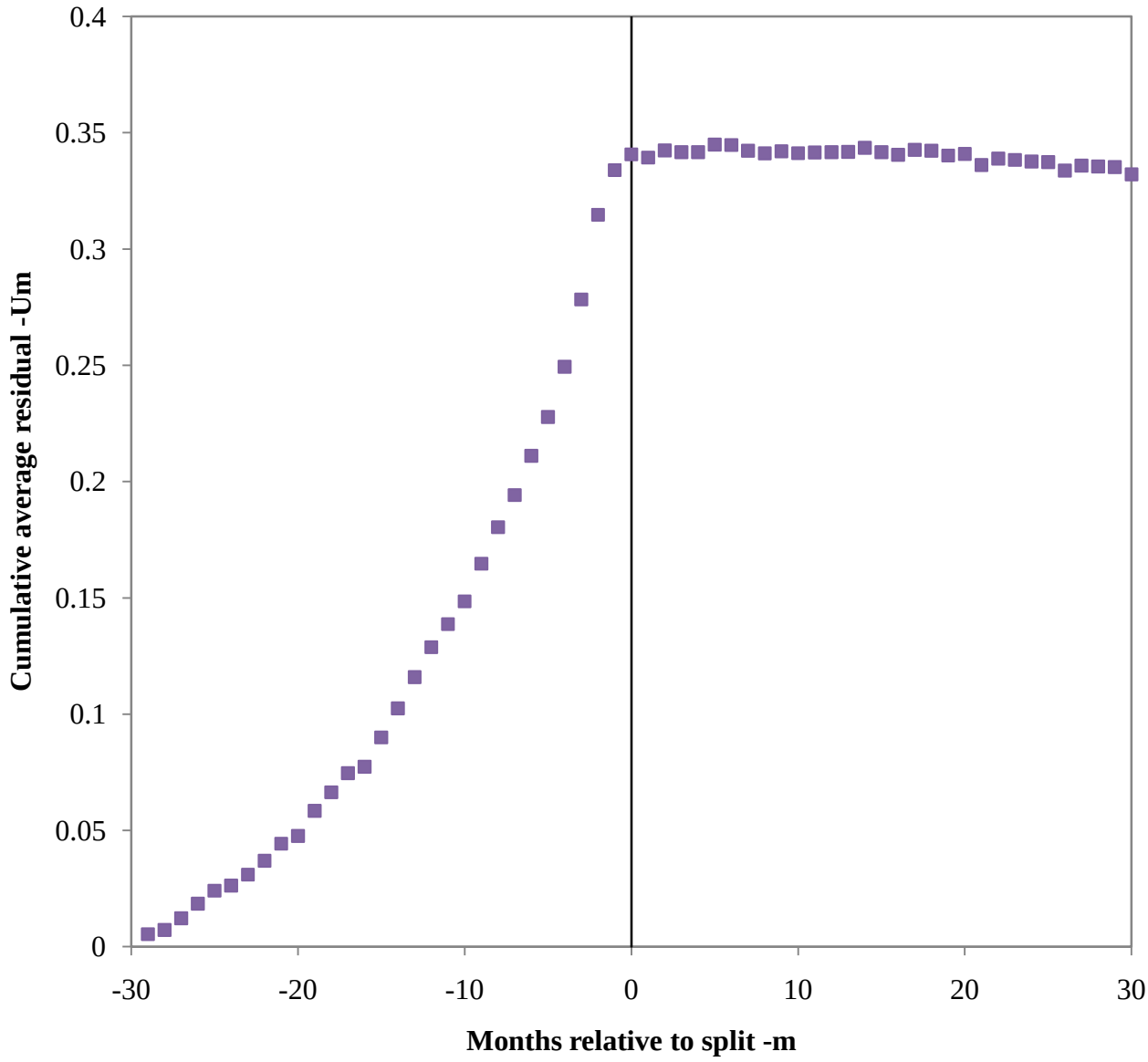
James M. Patell and Mark A. Wolfson, “The intraday speed of adjustment of stock prices to earnings and dividend announcements,” *Journal of Financial Economics* 13, 223-252.

Robert Shiller 2000 “Irrational Exuberance” (Princeton: Princeton University Press) .

Meir Statman 2009 “Rational, Random-Walk, Unbeatable, Free, and Fair Markets: Just Don't Call Them Efficient Markets” Working paper, Santa Clara University

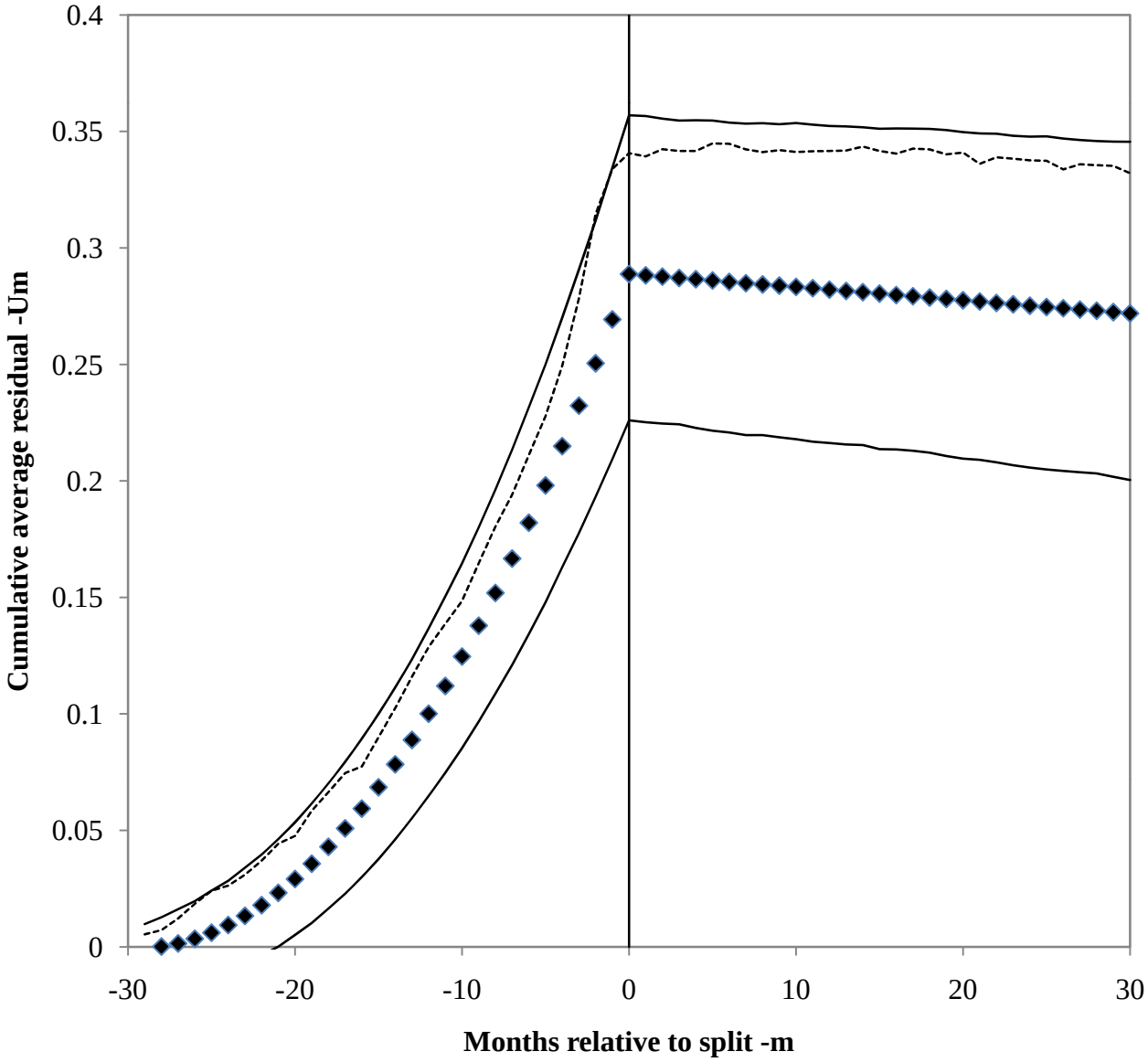
David Tabak and Frederick Dunbar, 2001 “Materiality and magnitude: event studies in the courtroom” in Roman Weil, Michael Wagner and Peter B. Frank (ed.) *Litigation services handbook: the role of the financial expert* New York: John Wiley & Sons, 2001.

Figure 1: Cumulative residuals around stock splits
Fama *et al.* (1969)



This figure is taken from Figure 2b. reported in Fama *et al.*(1969) p.13.

Figure 2: Cumulative residuals around stock splits
Mean and 95% confidence bands based on 10,000 replications



In this simulation experiment to replicate the results of Fama et al.(1969)stock prices evolve according to the market model, the parameters of which are randomly chosen to match the descriptive statistics presented in Fama et al.(1969). Stock splits occur when the stock price on the split date is greater than or equal to the average price over the past 29 months. The experiment is replicated 10,000 times. The mean value of the cumulated average residual is given here along with the 95 percent confidence interval (solid lines). The dashed line gives the corresponding statistic reported in Fama et al. (1969).