The explanatory power of representative agent earnings momentum models.

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Abstract

This paper examines the predictive performance of two representative agent models of earnings momentum using the US S & P 500 sample frame in the years 1991-2006. For successive sequences of quarterly earnings outcomes over a three year horizon of quarterly increases/decreases, etc. we ask whether these models can capture the likelihood of reversion and, secondly, the stock market response to observed quarterly earnings change sequences for our chosen sample. We find evidence of a far greater frequency of persistent quarterly earnings rises and hence a more muted reaction to their occurrence. Persistent losses are both far less common and more salient in their impact on stock prices.

This paper applies two of the simplest representative agent earnings momentum models (Rabin (2002), Barberis, Shleifer and Vishny, 1998) to predict stock market responses to earning announcements on the S & P 500 constituents sample in the years 1991-2006. The models used are very parsimonious and tractable. A good theory explains much by little in terms of assumptions and complexity and our paper inquires whether there is more to earnings momentum than these very simple models explain. We examine some of the contrasting predictions of the two models on offer to discern which model fits the historical data best. As large and still growing literature documents the failure of stock markets to adequately process earnings information (see De Bondt, 1993). To be deemed "anomalous" the stock market's response to earnings must deviate from that of a reasonable, or rational, investor. A reasonable investor in the standard Finance literature is one who forms his expectation of earnings in accordance with Bayes' rule. So earnings "surprises" in the standard Finance model are movements in earnings that do not accord with Bayesian projections. One commonly studied earnings anomaly is long-term over-reaction to earnings, based on over-extrapolation of recent earnings trends (DeBondt and Thaler, 1985, Doukas and McKnight). Our paper studies the matching short-run anomaly of stock-market under-reaction based on a failure to fully impound recent information about earnings into stock prices (previously studied by Chan and Jagedeeesh, 1996). It does so by examining the evidence of monthly earnings responses to sequences of quarterly earnings announcements on the S & P 500 in the years 1991-2006.

Related work is reported by Da, Gurun and Warachka, 2011) who do not invoke any explicit theoretical frame to interpret their results. Our paper presents complimentary evidence to facilitate future theory-driven empirical investigation of this topic.

1 Models of earnings momentum

The representative agent framework envisages a prototypical, "everyman", investor facing different states of the world at different dates, say famine and feast, or momentum and reversion regimes. The investor conditions his response to earnings announcements according to the state of the world they currently believe to hold. To understand S & P 500 companies responses to quarterly earnings change sequences we examine the predictive power of two such representative agent models one by Matthew Rabin and another Nick Barberis and co-authors (Rabin, 2002 and Barberis *et al*, 1998). We ask which model, if either, finds support in observed data?

1.1 Rabin's law of small numbers

Rabin (2002) considers the responses to information of an investor who is a standard Bayesian apart from believing that the Urn, or population, from which he draws the observed sample of (say earnings) outcomes is sampled without replacement. This induces a form of the "gambler's fallacy" that it is time one's "luck turned" after observing a streak of successive (usually bad) outcomes. Rabin terms such an aberrant projection of outcomes a belief in the "law of small numbers". This is, of course, simply a spoof of the true rule of inference entitled the law of large numbers. We follow Rabin's homely feel in calling believers in the law of small numbers Freddie. The focus now becomes how a Bayesian and Freddie differ in their projection of (earnings) outcomes given the recently observed earnings sequence.

1.1.1 Bayesian inference about earnings outcomes

Consider a bayesian investor faced with a recent sequence of quarterly earnings changes, say two consecutive increases in quarterly earnings–per–share, or an increase followed by a fall. What weight does such an investor put on a further increase in quarterly earnings (pr_{rise})? The answer is of course given by the bayesian posterior inferred from multiplying the likelihood of a rise in earnings this quarter ($\Delta E_t(+)$) by its prior probability, given past quarterly earnings outcomes ΔE_{t-1} . So Bayes' rule infers future sequences of quarterly earning rises or falls by mapping past quarterly earnings outcomes into the posterior probability attached to future ones as follows

$$p_{rise} = \frac{pr[\Delta E_t(+)| \times \Delta E_{t-1}(+)]}{[(pr[\Delta E_t(+)| \times \Delta E_{t-1}(+)]) + (pr\Delta E_t(+)| \times \Delta E_{t-1}(-)]) + (pr(\Delta E_t(+)| \times \Delta E_{t-1}(0))]} \tag{1}$$

so the inferred posterior probability of a rise is simply the probability of a rise in earnings as a proportion of all possible outcomes, be they past rises, falls, ($\Delta E_{t-1}(+)$, $\Delta E_{t-1}(-)$) or simply no change in earnings ($\Delta E_{t-1}(0)$). We refer readers to the original paper for the details of this derivation.

To illustrate this we adopt a simple example from Rabin (2002) to illustrate the process of Bayesian updating of expectations. Consider an investor who believes any of three earnings outcomes (rise, fall or no change) are currently equally likely $pr_{rise} = pr_{fall} = pr_{nochange} = \frac{1}{3}$. The investor's unconditional prior is a third for each state, but that investor also believes that the probability of observing a rise is conditioned on past earnings quarterly earnings changes. So the likelihood of observing an increase in earnings this quarter varies with the previous quarter's reported quarterly change. We assume a company whose earnings fell last quarter is believed, by the investor, to have a 25% probability of its earnings rising in the next quarter, a company whose earnings remained unchanged last quarter is believed to have half a chance of earnings rising this quarter and finally, a company whose earnings rose last quarter is given a 75% chance of earnings rising again in the next quarter. Applying our Bayesian revision rule to this case we obtain an inferred posterior probability of a sixth of observing a rise in quarterly earnings given a fall in earnings last quarter.

$$pr_{fall|rise} = \frac{1/4}{1/4 + 1/2 + 3/4} = \frac{1/4}{1.5} = 1/6 \tag{2}$$

Similar reasoning implies a posterior probability of a rise, given no change in earnings last quarter, of a third, $pr_{rise|nochange} = \frac{1}{3}$ or $\frac{\frac{1}{2}}{1.5}$, so the investor's prior and posterior probability, after observing the no change outcome, are the same. Finally, a bayesian infers a posterior probability of a half, or $\frac{\frac{3}{4}}{1.5}$, of observing consecutive quarterly earnings rises.

1.1.2 Inference under the law of small numbers

Recall Freddie, a believer in the law of small numbers, is simply a bayesian who believes he samples from a Urn, or population, that is sampled without replacement in each consecutive period only to be replenished between the second and third draw. This is simply a formal modelling device employed to mimic the "overinference" of Freddie who infers likely patterns where there are none.

In the particular numerical example used to illustrate bayesian revision above, there are three states (quarterly earnings rises, falls and no change) and 3 balls bearing the names of those states , drawn on two consecutive occasions. Hence, in our numerical example employed before, the inferred posterior probability of observing a quarterly earnings rise next time, given a fall in the prior quarter, declines from $pr_{fall|rise} = \frac{1}{6}$ to zero ($\frac{\frac{1-1}{4-1}}{\frac{1-1}{4-1}+\frac{2-1}{4-1}+\frac{3-1}{4-1}}$ or $\frac{0}{0+\frac{1}{3}+\frac{2}{3}} = \frac{0}{1} = 0$), or of a company whose earnings did not change last quarter is ($\frac{1}{3} = \frac{\frac{2-1}{4-1}}{\frac{1-1}{4-1}+\frac{2-1}{4-1}+\frac{4-1}{6-1}} = \frac{\frac{1}{3}}{0+\frac{1}{3}+\frac{2}{3}}$) for Freddie (as for his bayesian counterpart) and, finally, to ($\frac{2}{3}$ or $\frac{\frac{3-1}{4-1}}{\frac{1-1}{4-1}+\frac{2-1}{4-1}+\frac{3-1}{4-1}} = \frac{\frac{2}{3}}{0+\frac{1}{3}+\frac{2}{3}}$) as the inferred posterior probability of successive quarterly earnings increases.

The overall impact then of a belief in the law of small numbers is to shift the distribution of inferred posterior probabilities of earnings rises rightwards. So from a posterior probability of $\frac{1}{6}$ for rises following a fall in quarterly earnings, a $\frac{1}{3}$ for a company recording no earnings change last quarter and finally, a $\frac{1}{2}$ for consecutive quarterly rises towards a analogous distribution for Freddie of, zero , a sixth and two thirds. Figure 1 graphically represents this rightward shift in posterior probabilities.

Freddie's distribution of quarterly earnings changes expectations are skewed to the right of a bayesian who puts more weight on continuations of recent earnings trends (two-thirds rather than a half) and less weight on reversals of trend (a probability of zero rather than a sixth). Freddie overinfers earnings trends relative to his rational/Bayesian counterpart.

So this model predicts the least investor earnings surprise for extreme momentum cases, which over time Freddie has come to expect. In our empirical tests we focus on this implication of the Rabin (2002) explanation of earnings momentum. Does the Rabin model illuminate the phenomena of how investor's earnings expectations shape price formation in a more than merely theoretical sense? Is the impact of earnings momentum primarily felt once a sequence is initiated (a reversal averted) or primarily as earnings momentum intensifies?

1.2 Transitions between momentum and reversion regimes

While for Rabin the representative investor, Freddie, is an imperfect bayesian in the projection of earnings for Barberis and co-authors Barberis *et al* the investor is "always wrong but never in doubt". In their model investors believe they are observing an earnings process that constantly cycles between eras of momentum and reversion, despite the fact in reality earnings always follows a random walk. So while earnings follows a process $E_t = E_{t-1} + y_t$ where y_t is an earnings shock/innovation, which is always zero in expectation, investors nevertheless believe y_t contains a trend in momentum states or a tendency to mean-revert in reversion states. Hence while quarterly changes in earnings always follow a random walk and innovations in earnings are always zero in expectation the investor wrongly believes themselves to be in one of two states, either reversion or momentum (so s=R or M). So the Barberis *et al* model makes more dramatic claims about investor rationality than Rabin's (2002) model requires. Investors simply *never learn* the true nature of the earnings process (assumed to be a random–walk) and only vary in the nature of their self delusion, sometimes feigning a belief in momentum and at other times in earnings reversion.

Clearly the difference between momentum and reversion regimes is the degree of confidence attached to observing a continuation or reversion in past earning innovations, y_t. In the reversion regime the chances of earnings shocks of the same sign, π_t, is believed to be low(so $\pi_t = \pi_L$ lying between zero and a half, so $0 > \pi_L < 0.5$), with any earnings news being likely to be swiftly reversed. In the momentum regime the opposite expectation is held by the investor (so $0.5 > \pi_H < 1$). So the contrasting regimes take the form given in Table 1.

Investor's in the Barberis *et al* believe they are either in the momentum or reversion regime in each quarter despite the fact quarterly earnings always follow a random-walk. Consistent with this delusion investors infer probabilities of leaving the state they are in. So let λ_R be the probability of leaving the reversion regime and hence that of entering the momentum regime anew and λ_M be the probability of leaving the momentum regime and entering the reversion regime this quarter. Barberis *et al* focus on the case when both λ_R and λ_M are low and hence the quarterly earnings regime rarely changes, although this is not a structural requirement of model. The transition matrix for switching between reversion and momentum regimes is given by Table 2.

The central dilemma for the representative investor in this sort of world is to form a best guess of which earnings regime currently prevails (denoted q_t, the probability of being in the reversion regime). In reality earnings always follow a random–walk making this a false choice. Yet to make this decision over a false choice the investor must optimally infer the probability of being in the reversion regime and so see the pattern of announced earnings change direction next quarter. The investor's best guess of being in the reversion regime is given by application of Bayes' rule as follows

$$q_t = \frac{(1-\lambda_R) \times q_{t-1} + \lambda_M \times (1-q_{t-1})) \times \pi_L}{((1-\lambda_R) \times q_{t-1} + \lambda_M \times (1-q_{t-1})) \times \pi_L + (\lambda_R \times q_{t-1} + (1-\lambda_M) \times (1-q_{t-1})) \times \pi_H} \tag{3}$$

for a sequence of opposing quarterly earnings changes when $q_{t-1} < q_t$, because the observed sequence confirms the investor's (false) belief they are in a reversion regime, and

$$q_t = \frac{((1-\lambda_R) \times q_{t-1} + \lambda_M \times (1-q_{t-1}) \times (1-\pi_L)}{((1-\lambda_R) \times q_{t-1} + \lambda_M \times (1-q_{t-1}) \times (1-\pi_L) + (\lambda_R \times q_{t-1} + (1-\lambda_M) \times (1-q_{t-1}) \times (1-\pi_H)} \quad (4)$$

when quarterly earnings moved in the same direction this quarter and last and so the investor attaches a lower probability to his belief he is in the reversion regime, $q_{t-1} > q_t$.

Table 3 presents a numerical illustration of the revision process based on Table 5 in the original Barberis *et al* paper. As the number of repeated sequences of improvements occur (so $y > 0$) the probability attached to being in the reversion state declines, q_t falls, for an investor who accords with the constraints of the Barberis *et al* model. Similarly, repeated alternations of the sign of quarterly earnings changes confirms the representative investor's (false) belief that he is in the reversion regime, q_t rises. As the number of repeated sequences of improvements occur (so $y > 0$ or $y < 0$ repeatedly) the probability attached to being in the reversion state declines for such an investor. Similarly, repeated alternations of the sign of quarterly earnings changes confirms the investors (false) belief that he is in the reversion regime, so q_t rises.

A particular example considered by Barberis *et al* is when the probability of getting out of the reversion (i.e. entering the momentum) regime is low compared to that of leaving in the momentum regime (entering into the reversion regime). The particular numerical example considered in Table 3 not leaving the reversion regime is both unlikely (λ_1=10%) and three times as low as the probability of leaving the momentum regime (λ_2=30%). Here the state is allowed to fluctuate between the momentum and reversion regime at dates 1 to 10 and thereafter enters the momentum regime until the end of the trial at date 14. Between dates 11 and 14 q_t the investor's inferred posterior probability of being in the reversion regime falls by 5%, reflecting recent consecutive changes in earnings of the same sign. This assumption, regarding the updating of q_t, is open to exploration via comparative static exercises based on inducing variations in exit state probabilities, λ_R and λ_M to alter predicted behaviour in conformity with the observed data. This variation in the rate of transition can itself be optimally updated and constitutes a degree of freedom available to characterise observed market behaviour not available in Rabin's (2002) model. Hence the temporal stability of reversion probabilities becomes a way of differentiating the Barberis *et al* and Rabin models of how earnings momentum persists and impacts upon equity returns. So Rabin focusses upon the length and intensity of earnings sequences, but says little about how the probability of reversion is determined. Barberis *et al* explicitly address what determines the transition probability between momentum and reversion regimes but within each regime have little to say about variations in the intensity of investor response as the earnings sequence lengthens.

One very clear property of Barberis *et al* model is the *the symmetry of* *earnings reversion expectations within the momentum regime for both quarterly earnings rises and falls.* The signs of earning-per-share change sequences do not matter, what matters in the Barberis *et al* models is the sequence length. The credibility of this assumption is one way of distinguishing between the empirical value of the two alternative representative agent models of how earnings momentum emerges in the stock market.

1.3 Which model best captures the key characteristics of observed earnings momentum Barberis *et al* or Rabin?

We have outlined two very different representative–agent based models of earnings momentum which of them best fits the stylised facts of earnings momentum? In the following sections we present evidence on two of the most basic stylised facts that help decide which of the two models on offer best characterises observed earnings momentum, at least as it is manifested within the US S & P 500 in the last two decades. These are

1. Is the distribution of earnings sequences symmetric, so that all that matters is the distinction between momentum and reversion regimes as the Barberis *et al* paper seems to imply? Or does both the duration of earnings sequences and their intensity differ markedly according to the direction of the recorded earning change?

2. Regardless of the frequency, or intensity, of consecutive earnings changes how surprised are investors by them and, consequently, what is their price impact? So does it matter for price momentum what the consistency, direction and intensity of earnings changes are?

2 Data and research method

Our sample frame is companies within the S & P 500 in the years 1991 to 2006, for some 525 companies, yielding 23,143 company-quarters of earning-per-share changes in all in our final sample. Some 837 S & P 500 constituent companies have quarterly earnings change data in our sample and our final sample companies derive from including only companies for which we can calculate share-price performance including benchmark adjustments. Earnings per-share data were collected from the I/B/E/S database to reconcile earnings outcomes with investor expectations of them (see Keane and Runkle, 1990). Since our focus is largely upon the distribution and impact of quarterly earnings-per-share (Q_t) sequences we work here with simple earnings-per-share changes. We used an annually smoothed quarterly earnings metric of the form

$$(Q_t + Q_{t-1} + Q_{t-2} + Q_{t-3}) - (Q_{t-4} + Q_{t-5} + Q_{t-6} + Q_{t-7}) \quad (5)$$

While we excluded a few extremely large changes in earnings per-share, removing quarterly earnings changes exceeding 200%, which seemed indicative of errors in the IBES database, we do not systematically exclude or windsorise returns. Table 4 and 5 present some basic summary statistics for our sample data. This table exposes the fact while the average earning-per-share change for S & P 500 firms in the sample is fairly small and positive there is very wide variation around that mean value. Earnings changes are markedly skewed, indicating the predominance of quarterly earnings per-share rises compared to falls. The strong positive correlation between quarterly earnings changes, ΔE_t and the length of the earnings sequence, Consis, is clear from Table 5.

The stock market response to quarterly earning-per-share changes are captured by returns, calculated from *Datastream* prices subject to a Fama-French 3-factor asset pricing model (see Fama and French, 1993) using weights from rolling annual regressions for each sample company over five years of monthly data and the factors given for the US market on Professor Ken French's data library website[1]. While this must induce some survivorship bias we already very much focussed on successful firms as our sample is drawn from the US S & P 500.

We calculate investor returns using the buy and hold return metric popularised by many event-day studies in corporate finance. Since many institutional investors are required to hold S & P 500 companies, or some subset thereof, in their portfolios we emphasise the buy-hold investor returns metric in the interpretation our results reported below, as opposed to analogous CAR performance metrics.

3 Results

3.1 The distribution of consistent earnings rises and falls and the stock market response to them.

We begin our analysis of the two questions we wish to focus upon in Figure 2 which provides a histogram of the percentage frequency distribution of earnings sequences in our sample. The asymmetric and uneven distribution of quarterly earnings-per-share changes in our sample data is very striking. About 22% of our sample data derives from companies reporting quarterly earnings increases of at least three years, or twelve quarters, or more. This of course affirms a long line of market-based accounting research on meeting and beating earnings targets and the required earnings management to do so (see Bartov, Givoly and Hayn, 2002)

Figure 3 plots mean quarterly earnings-per-share changes over 3 years of consistent earnings rises and falls. The cumulatively larger nature of repeated falls in quarterly earnings-per-share is very clear in our data while the scale of repeated quarterly earnings growth stabilises to smallish values after a year. Consistent quarterly declines seem to cumulate fairly alarmingly, while consistent quarterly earnings growth appears to be a fairly stable, possibly even

[1] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data library.html

manageable, form of corporate reporting in our sample data. Figure 4 simply reconstructs Figure 3 using median, rather than mean, quarterly earnings changes. The basic pattern of Figure 3, cumulative quarterly earnings falls becoming more dramatic in scale while cumulative quarterly earnings growth stabilise to small values, is confirmed by Figure 4. This suggests that the pattern does not result from a few rogue, outlier, observations which imply no broader trend in the data. We conclude that it is most probably not wise to pool consistent quarterly earnings rises and falls into the same state as the Barberis *et al* model does. The requisite symmetry this sort of model implies is not present in our sample data. This is because the cumulative impact of quarterly earnings falls is far more dramatic than smaller consecutive quarterly earnings rises. Further, consistent quarterly earnings rises are so common, constituting almost a quarter of our sample data, as to make it unlikely they will have a dramatic stock market impact.

In Figure 5 we continue our analysis by showing how more extreme sequences of quarterly earnings-per-share changes are reflected in investor returns. Figure 5 plots investor buy and hold returns, adjusted by our Fama-French 3-factor benchmark, in the three months following the reported quarterly earnings change for increasing durations of quarterly earnings rises and falls over a three year period. Once again the average stock market response to successive earnings changes is highly uneven across consistent quarterly earnings rises and falls. For consistent quarterly earnings rises the response is always small and positive with little increase in the intensity of stock market response as the run of positive earnings changes lengthens. This suggests some degree of learning about the scale and direction of quarterly earnings-per-share earnings change sequences more consistent with the Rabin model. The stock market response amongst investors to consistent quarterly earnings falls is far more uneven, with no real discernible trend being present. This makes sense since quarterly earnings falls, especially large cumulative ones, are by their very nature transitory because the company either rights the trend, and returns to form, or faces liquidation once earnings falls become earnings losses. Companies with declining quarterly earnings over a long period must offer a higher rate of return to compensate investors for the risk of holding them if they are to survive. Payment of such compensation is fairly clear for the most extreme consistent group of earnings fallers, but fairly ephemeral, if present at all, for companies reporting only two, or less, years of earnings falls.

Figure 6 confirms the asymmetric stock market responses to quarterly earnings rises and falls using the median buy and hold Fama-French adjusted returns performance metric over a three month period following the quarterly earnings announcement. In this alternative test the payment of premium returns in order to compensate for the risk of repeated losses is clearly shown. Once more, as in the case of average returns, companies reporting repeated earnings falls for a period less than two years display no discernible pattern.

Table 6 breaks up the distribution of earnings sequences as each year of the quarterly run in earnings changes cumulates so we calculate the median, median and skew of the quarterly earnings changes and Fama-French adjusted investor returns performance metric for, 1 to 4, 5 to 8, and, finally, 8 to 12 quarters of consecutive falls/rises in earnings-per-share (each successive year of consecutive rises/falls). One characteristic of the data is very clear while quarterly earnings chances are sharply skewed throughout the range of cumulated rises and falls in earnings-per-share this is not reflected in investor returns to holding the stocks which report such strings of cumulative rises and falls in earnings. This suggests that *the distribution of earnings-per-share changes is both skewed and expected to be so* by investors. Hence the announcement of lengthening earnings rises/fall sequences by sample companies rarely causes very dramatic movements in their cost of capital.

3.2 Regression based tests.

In a final section we undertake some tentative regression based tests to establish whether the duration of past quarterly earnings rises/falls impact upon the amount of earnings generated stock market price momentum/under-reaction. Once again we employ buy and hold returns, corrected by the Fama-French 3-factors, covering a three month period following the announcement of the most recent quarterly earnings change as our dependent variable in all reported regressions. Of course the skewed nature of earning-per-share changes and sequences must make us careful about our interpretation of such regression based tests.

Table 7 presents the results of a basic regression of quarterly earnings changes on their matched three month ahead Fama-French risk-adjusted buy and hold returns. No evidence of stock price momentum in response to quarterly earnings announcements (i.e. earnings momentum) is found. Within the S & P 500 any observed short-term earnings-based momentum will very likely be arbitraged out in such a large and liquid market. More marked is the way the stock market response to quarterly earnings rises or falls as a sequence of earnings rises/falls lengthens. We already know from the graphical analysis of the previous subsection that while stock market responses to lengthy sequences of quarterly earnings rises are pretty stable the stock market response to lengthy declines in quarterly earnings is more erratic. Specifically, it appears companies reporting a long stream of quarterly earnings falls are forced to pay a premium for risk to their remaining long-suffering investors. In the regression-based test this is reflected by the strongly significant positive coefficient on the consistency/length of the sequence variable, consis. This premium payment is especially marked at the longest earnings fall sequences, say after two years or eight quarters of earnings declines.

The differing stock market responses to lengthy quarterly earnings-per-share rises and falls motivates our preferred regression equation which we present in Table 8. In this regression we allow regression intercepts to shift, depending on the nature of the quarterly earnings sequence. So we include a dummy variable in the regression for the quarterly earnings sequence being either a sequence of over two years rises or falls (denoted More2year > 0 and More2year < 0), and a further dummy variable to capture quarterly earnings rises and falls regardless of duration (denoted Rise). Further, we include the year of the quarterly earnings change as a control variable to capture any temporal instability model. While the stock market response to quarterly earnings changes are strongly effected by the year in which they occur, with stock price responses being more muted as the years go on, there seems little difference in the average stock market response to quarterly earnings rises and falls. But while lengthening earnings rises and fall sequences differ little in their average response a separation in response becomes clearly present at the extreme of the earnings sequence distribution. Companies with prolonged quarterly earnings falls pay a premium to investors who remain with them, presumably as a compensation for the risk of the company failing while companies reporting consistent quarterly earnings growth enjoy a small discount on their cost of capital. These premia/discounts are not explained by the standard risk proxies embedded in the Fama-French 3-factor model

4 Conclusion

This paper presents some initial tentative evidence on the suitability for empirical application of two representative agent style models of the stock market impact of momentum in reported earnings. The early evidence we have leads us to favour Rabin's (2002) model based on the "law of small numbers" as against to Barberis *et al* (1998) model. We express this preference for two reasons. Firstly, because of the essential incredibility of a model that assumes investors never infer the true nature of the quarterly earnings process they face. Secondly, because of the centrality of the distinction of between earnings momentum and reversion regimes in the Barberis *et al* model. Our empirical work suggests that it is *both the duration of quarterly earnings momentum and its sign* which primarily determines their impact on stock prices rather than earnings momentum as such. Prolonged sequences of quarterly earnings falls seem particularly marked in exerting a risk premium from US S & P 500 constituent firms in our chosen sample period. Only Rabin's (2002) model allows us to effectively model the impact of extensive falls in quarterly earnings since it does not impose the symmetry in response to quarterly earnings rises and falls that the Barberis *et al* (1998) model seems to require.

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Figures & Tables

Table 1: *The Barberis et al model*

Reversion regime	$y_{t+1} = y$	$y_{t+1} = -y$
$y_t = y$	π_L	$1 - \pi_L$
$y_t = -y$	$1 - \pi_L$	π_L
Momentum regime	$y_{t+1} = y$	$y_{t+1} = -y$
$y_t = y$	π_H	$1 - \pi_H$
$y_t = -y$	$1 - \pi_H$	π_H

Table 2: *The transition from reversion to momentum and back*

Prevailing regime	In reversion regime next quarter	In momentum regime next quarter
Reversion	$1 - \lambda_R$	λ_R
Momentum	λ_M	$1 - \lambda_M$

Table 3: *Earnings expectations in the Barberis et al model.*

Date	q(t)	Length of Run
0	0.5	0
1	0.8	0
2	0.86	0
3	0.88	0
4	0.88	0
5	0.84	1
6	0.87	0
7	0.83	1
8	0.87	0
9	0.88	0
10	0.88	0
11	0.84	1
12	0.81	2
13	0.80	3
14	0.79	4

NBThis table is based on a illustrative simulation of their model presented by Barberis *et al* in which $\pi_L = \frac{1}{3}$, $\pi_H = \frac{3}{4}$ and λ_1=0.1 and λ_2=0.3.

Table 4: *Summary statistics for sample data.*

Variable	Obs	Mean	σ	Min	Max	Skew
B & H return	23143	0.004	0.055	-0.512	0.511	-0.065
Δ EPS	23143	0.124	9.611	-372	534	15.397
Abnormal return(t)	23143	0.004	0.108	-0.727	0.782	0.728
Abnormal return(t+1)	23143	0.015	0.123	-0.860	5.487	4.709
Abnormal return(t+2)	23143	0.009	0.107	-0.685	1.69	1.694
Consistency-Length of sequence	23143	3.267	6.558	-12	12	-0.157

Table 5: *Spearman rank correlation between key variables.*

	B & H return	Δ EPS	Consistency-Length of sequence
B & H return	1		
Δ EPS	0.083	1	
Consistency-Length of sequence	0.064	0.622	1

Table 6: *Skewness of quarterly earnings-per-share changes & Fama-French adjusted returns by length and sign of earnings sequence*

Panel A: Quarterly earnings changes

Sequence length	Number of changes	Mean	Median	Skew
9 to 12 consecutive falls	796	-4.24	-0.99	-12.56
5 to 8 consecutive falls	2382	-2.21	-0.59	-13.83
1 to 4 consecutive falls	3594	-0.99	-0.38	-23.03
1 to 4 consecutive rises	6762	1.76	0.24	20.93
5 to 8 consecutive rises	3070	0.45	0.27	11.24
9 to 12 consecutive rises	6539	0.26	0.175	36.12

Panel B: Buy & Hold 3 monthly returns

Sequence length	Number of changes	Mean	Median	Skew
9 to 12 consecutive falls	796	0.003	0.006	0.23
5 to 8 consecutive falls	2382	-0.0015	0.001	0.036
1 to 4 consecutive falls	3594	-0.001	0.0004	0.075
1 to 4 consecutive rises	6762	0.002	0.004	-0.194
5 to 8 consecutive rises	3070	0.008	0.008	0.15
9 to 12 consecutive rises	6539	0.009	0.007	-0.029

Table 7: *Regression of Buy & Hold returns on change in earnings-per-share and sequence length.*

Constant	ΔEPS	Consistency	Consistency$\times\Delta$EPS	N	R^2
0.003	0.00005			23143	0.06
(10.00)	(1.14)				
0.002	0.00005	0.0005		23143	0.06
(4.78)	(0.68)	(8.77)			
0.002	0.00004	0.0004	-0.00001	23143	0.06
(5.03)	(0.28)	(8.54)	(-1.51)		

NB ΔEPS is the absolute change in quarterly earning-per-share, Consistency is the length of the earnings sequence, 1,2...,12 denoting earnings sequences lasting 1 quarter, 2 quarters, 12 quarters, etc. Reported t-values are subject to robust heterokedasticity correction following White (1980) .

Table 8: **Regression tests of preferred specification**

OLS estimates of price impact of consistent earnings patterns (N=23143)								
Constant	ΔEPS	Consistency	More2year >0	More2year<0	year	Rise	N	R^2
1.35	0.0004	0.0009	-0.005	0.010	-0.0007	-0.001	23143	0.05
(9.64)	(0.73)	(4.52)	(-3.00)	(4.19)	(-9.62)	(-0.62)		
Panel estimates of price impact of consistent earnings patterns (N=23138)								
Constant	ΔEPS	Consistency	More2year >0	More2year<0	Rise	N		
0.003	0.0004	0.0007	-0.003	0.007	-0.001	23143		
(2.77)	(1.13)	(3.45)	(-2.00)	(3.09)	(-0.62)			

NB year is simply the year in our sample period 1991-2007 in which the quarterly earnings sequence is recorded, Morethan2year >0 is a dummy that equals 1 for quarterly earnings rise sequences beyond eight quarters in length and zero otherwise, Morethan2year <0 is a dummy that equals 1 for quarterly earnings fall quarterly earnings sequences beyond eight quarters in length and zero otherwise, Profit is a dummy set equal to one for quarterly earnings rises/falls from of positive earning-per-share base and zero otherwise. The dummy year is not included in the panel regression as it is used to group data in that regression.