Investors' Cognitive Mechanisms within the Drug Development Industry

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Abstract

Over the last 20 years the drug development industry has been rapidly changing with the formation of young companies generally pursuing the development of one or two innovative drugs. This market alteration from `big pharma` game (e.g. Pfizer or Novartis) to specialized firms created by technological breakthroughs, economic justification and changes in medical insurance. Quick overview of current sector structure reveals that most of it companies are young firms developing early stage drugs, i.e. dream is the most valuable asset they held. These dreams are publically magnified with the wealth of information, especially with the substantial role of social networks, what leads to high investors` attention. These factors, along with low interest rate in current world markets, lead to market optimism in this high risk sector. The wealth and availability of young innovative firms` information, changes then the way investors pay attention to information and even how they chose their winning stocks - from long value investment in traditional companies to what seems like an event driven strategy. To wit, we observe that higher trading is held around regulatory events. Exploring these milestone events reveal what seems like a speculative "micro bubbles". In this paper, we try to portrait a whole picture on the attention hypothesis and merge it with these "micro bubbles" we assume to be in the drug development industry.

Keywords: Attention; Behavioral Finance; inefficient market; Corporate News; Event Study; Financial Markets; Pharmaceutical Companies; Probability Weighting Functions.

1. Introduction

"As long as the centuries continue to unfold, the number of books will grow continually, and one can predict that a time will come when it will be almost as difficult to learn anything from books as from the direct study of the whole universe. It will be almost as convenient to search for some bit of truth concealed in nature as it will be to find it hidden away in an immense multitude of bound volumes."

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Denis Diderot, "Encyclopédie" (1755)

In the last few decades, research by cognitive psychologists challenged the rationality paradigm, has started to penetrate economic modeling. Vast experimental documentation of cognitive limitations has been accumulated (cf. [50], [7] and reference therein), raising the questions: Does behavioral decision models, which capture hope or expectation to risk in experimental settings, can help us comprehend investor behavior in financial markets.

1.1. Structure

In the next sections we try to portrait a whole picture on the attention hypothesis we have developed around this pricing patterns, regarding financial market behavior around seminal milestone events within the innovative pharmaceuticals sector firms. We try to encompass it from several aspects: first, we lay a general psychological framework for Attention theory describing cognitive mechanisms such as the rule of selective attention in processing information in short-term.

Second part is exploring financial aspects of selective attention, present in four main mechanisms: investors` biases and heuristics (naïve vs. sophisticated investors); accrual anomaly (the negative association between accounting accruals, the non-cash component of earnings, and future stock returns), under and over-reaction; and investors` anchoring.

2. Materials and methods

2.1 Psychology framework - Attention theory

The concept of attention has its roots in the nineteenth century where the study of the attention effects was a favorite topic for introspection. Only by the end of the 1950s, the situation had altered radically, and the newly legitimized concept of attention was a central topic in an emergent cognitive psychology [29]. The concept, in general, defines an individual's notable ability to resist distraction as a manifestation of selective attention. Likewise, our research describes investors` attention-grabbing focus to market events as can be seen as selective attention.

The main function of the term "attention" in post-behavioristic psychology is to provide a label for some of the internal mechanisms that determine the significance of stimuli and thereby make it impossible to predict behavior by stimulus considerations alone [29]. The main idea of attention within cognitive psychology is that the organism appears to control the choice of stimuli that will be allowed, in turn, to control its behavior. To wit, the organism *selectively attends* to some stimuli or aspects of stimulation, in preference to others [47].

We can also explain it by focusing individual attention. It changes from instant to instant in an organized fashion. The act of looking provides us a basic example of this sequential organization of selective attention. The world extends 360 degrees around us, our field of vision spans about 210 degrees, but vision is sharp only within a small foveal region of about 2 degrees [29], and the rate at which this narrow beam of sharp vision can be moved is limited to about 3-5/second. The question is where to direct this beam?

2.2 Information processing and selective attention

Memory is considered to be a large and enduring collection of nodes that become complexly and increasingly inter-associated and interrelated through learning. Most of these nodes are normally passive and inactive and are termed long-term store when in the inactive state. The set of currently activated nodes is termed short-term store. Long-term store in thus a permanent, passive repository for information [1]. Short-term store is a temporary state; information in short-term store is said to be lost or forgotten when it reverts from an active to an inactive phase. Control of the information-processing system is carried out through a manipulation of the flow of information into and out of short-term store. These control processes include decisions of all sorts, rehearsal, coding, and search of short- and long-term store [39].

Long-term store contains learned sequences of information processing that may be initiated by a control process or by environmental or internal information input but that are then executed automatically with few demands upon the capacity of short-term store. This automatic process can be activated in response to a particular input configuration, where the inputs may be externally or internally generated and include the general situational context, or it will be activated automatically without the necessity of active control or attention by the subject. For example, a red traffic light might initiate a braking response when the perceiver is in a car, and a walking, halting, or traffic-scanning response when the perceiver is a pedestrian. Since an automatic process operates through a relatively permanent set of associative connections in long-term store, any new automatic process requires an appreciable amount of consistent training to develop fully. Furthermore, once learned, an automatic process is difficult to suppress, to modify, or to ignore.

Schneider and Shiffrin (1977) argued for another type of automatic sequence that modifies ongoing controlled processing by attracting attention to a specified locus or node. In particular, when subjects in search tasks are consistently trained to recognize certain inputs as targets, these inputs acquire the ability to initiate automatic attention responses. These attention responses then direct attention automatically to the target, regardless of concurrent inputs or memory load, and enable a correct detection to occur.

Automaticity is also an important phenomenon in skill acquisition. Skills are thought to consist largely of collections of automatic processes and procedures. For example, skilled typewriting involves automatic recognition of words, translation of words into keystrokes, and execution of keystrokes (Logan, 1988). Automaticity is commonly viewed as a special topic in the study of attention. It considers automatic processing to occur without attention [29], and it interprets the acquisition of automaticity as the gradual withdrawal of attention [39].

Our study argues that cognitive resource scarcity, i.e. attention, influence economic events processing by investors. Upon the above literature, it will then argue for short-term information processing of framed events. This short-term attention can be activated in response to a particular input configuration.

2.3 Attention theory mechanisms

Cognitive psychology describes Attention by two main mechanisms: as a mental filter [47] and as a pool of

mental resources [29]. Treisman`s theory of attention, the feature-integration theory of attention, features are registered early, automatically, and in parallel across the visual field, while objects are identified separately and only at a later stage, which requires focused attention.

The thesis assumes that the visual scene is initially coded along a number of separable dimensions, such as color, orientation, spatial frequency, brightness, direction of movement. In order to recombine these separate representations and to ensure the correct synthesis of features for each object in a complex display, stimulus locations are processed serially with focal attention. Any features which are present in the same central "fixation" of attention are combined to form a single object. Thus focal attention provides the "glue" which integrates the initially separable features into unitary objects. Once they have been correctly registered, the compound objects continue to be perceived and stored as such.

Also, the theory claims that, without focused attention, features cannot be related to each other. Applying this mechanism to behavioral finance can describe firm`s evaluation in layers or as a number of separable dimensions as filter valuation of financial sectors or size or earnings and ex`. I.e. investors can see firms not as a whole, but as objects which are identified separately and only at a later stage, as Triesman stated, investors require focused attention to firm valuation.

Khaneman (1973) described attention as a pool of mental resources, in which an individual has limited attention capacity. On this vast tent of attention literature we focus on two aspects: "Arousal" and task-overload effect. Khaneman suggested that the intensity of attention is related to the level of arousal, and it is largely controlled by the properties of the stimuli to which the organism is exposed. I.e, the more stimuli are, the more arousal.

A related mechanism to arousal is a theory which identifies task over-load as attention with effort and a limited capacity. It entails two predictions concerning interference between concurrent activities: (1) interference will arise even when the two activities do not share any mechanisms of either perception or response; (2) the extent of interference will depend in part on the load which each of the activities imposes, i.e., on the demands of the competing activities for effort or attention.

2.4 The role of attention in capital markets

Attention hypothesis has major rule in financial markets. Positive autocorrelation of stock returns at short horizons [27, 25] and post-earnings announcement drift [9]. Three behavioral explanations of these phenomena rely on under-reaction due to slow diffusion of information, fluctuations in overconfidence and investor sentiment [5,6]. Other interesting explanation argues that investors are inattentive at longer horizons, while appear to neglect information about expected profitability beyond five years horizon [23, 24].

Barber and Odean (2008) tested the hypothesis asserting that individual investors are net buyers of attention-grabbing stocks, such as stocks which are being discussed in the news; stocks which are traded at abnormally high trading volume; or stocks which experience extreme returns. They hypothesize that attention-limited investors consider purchasing only stocks that have caught their attention, to wit, decisions driven by the investors' preferences are activated only on a subset of securities which 'caught their eyes.' Barber and Odean's

argument leans on the observation that most individual investors do not sell short, thus attention is a major factor determining the stocks they buy, but not those that they sell, leading to overpricing of stocks associated with attention-grabbing events.

Several studies, detailed henceforth, have arrived at empirical results commensurate with the attention hypothesis. These studies' attention 'generators' consist of variables such as high trading volume; advertising expenditure; unanticipated earnings announcements; stocks' upper price limit events (incorporating the three attention-grabbing events: high returns; high volume; and the event generating news); and stock recommendations in television shows. The common denominator of these attention grabbers is their relatively frequent reoccurrence, to wit, these events commonly take place in the market.

Geravis and his colleagues (2001) documented that stocks which are traded at abnormally high trading volume tend to subsequently appreciate over the month; Grullon and his colleagues (2004) found that the stocks of firms which spend a lot of money on advertising are held by more investors; Seasholes and Wu (2007) found that the prices of stocks traded at the Shanghai market temporarily rise following attention-grabbing events before mean-reverting to their pre-event price levels over the following five days. Moreover, they claimed and substantiated that when many events happen simultaneously, search costs are not reduced, the consideration set is not narrowed, and attention-based buying is therefore absent; and Engelberg and his colleagues (2011) found that stock recommendations broadcasted on Mad Money, Jim Cramer's popular television show, lead to large overnight returns which reverse in the subsequent months.

Barberis and Huang (2008) studied the asset pricing implications of Tversky and Kahneman's (1992) CPT, particularly focusing on the role of probability weighting functions. Their main result, standing in contrast to standard expected utility predictions, is that positively skewed security returns may be overpriced, and thus earn negative average excess returns. They argued for sub-additive of the probability weighting functions, causing overweighting of the tails of the distribution they are applied to.

As asserted by Barberis and Huang, their result that investors exhibit a preference for skewness suggests a unifying way of thinking about several seemingly unrelated facts, such as the low long-term average return on Initial Public Offerings (IPOs), probably because they are issued by young, growing, firms. The idea is that by taking a substantial position in an IPO, the investor gets a chance, albeit a small one, of a very large wealth-increase.

2.5 The myopic aspect of skewness investment

Myopic Loss Aversion (MLA) has been suggested by Benartzi and Thaler (1995) as an explanation for the "equity premium puzzle" which refers to the evidence that the risk premium on stocks is inexplicably high compared to yields on bonds and it is unreasonable to assume that risk aversion alone can explain it. The concept of MLA combines PT's loss aversion concept [28, 31, and 44].

Mental accounting is the set of (implicit or explicit) cognitive activities that individuals and households engage in to serve the same function that regular accounting serves in an organization In the context of financial

transactions, the key mental accounting issues concern aggregation: how transactions are grouped both cross-sectional (e.g., are securities evaluated one at a time or as portfolios) and inter-temporally (how often are portfolios evaluated) [45]. A financial investor can be modeled as making a series of decisions about the allocation of his assets.

Mental accounting determines both the framing of decisions and the experience of the outcomes of these decisions. An investor who frames decisions narrowly will tend to make short-term choices rather than adopt long-term policies. An investor who frames past outcomes narrowly will evaluate his gains and losses frequently. In general, narrow framing of decisions and narrow framing of outcomes tend to go together, and the combination of both tendencies defines a myopic investor.

By now, MLA is considered as a robust behavioral pattern. Real market data has recently added to theoretical research, showing several aspects of MLA. Haigh and List (2005) argued that the MLA extent is larger for Chicago Board of Trade traders than for students and Eriksen and Kvaløy (2009) found the same pattern for financial advisors of a Norwegian bank. Kliger and Levit, (2009) showed that a manipulation of investors' evaluation period of financial assets affect their prices while Mayhew and Vitalis, (2014) suggested that although market experience mitigates the MLA effect, participants do not transfer these results to other settings.

Inspecting time horizon as a crucial factor presented at Gneezy and Potters (1997) and Thaler and his colleagues (1997) papers, showed that individuals are willing to invest more money into a risky gamble the longer the investment horizon (the less flexible they are to change their investment decision) and the less often they receive feedback. Time horizon as an influencing factor on investment decisions also rises fascinating other questions. How is the willingness to invest over a long time horizon influenced by repeated milestone events, such as in our research within the pharmaceutical sector? Do investors view those long-term events as aggregate events or only at a myopic view?

2.6 Method

The paper uses an event-study approach (ESA), which is an effective tool for assessing the information content of events, as well as shedding light on the issue of market efficiency or inefficiency. The underlying idea in common event studies is to track prices of securities whose issuing firms were involved in the studied event, in order to detect market-related reactions. The prices are tracked over a period that is potentially relevant for evaluating the effect of the event on the prices of the traded securities; this period is termed the event window. We present CAAR as the estimated cumulative average abnormal return from period t to t+n, and AAR is the estimated average abnormal return at period t. The CAAR is calculated on a basic *naïve benchmark* model assuming the normal return for all stocks to be the market return as represented by a broad stock market index, such as the S&P 500 and the healthcare index representing the whole pharmaceutical industry. In effect, the naïve benchmark regards as abnormal anything different from the average market behavior. It is termed *naïve* because it ignores basic economic assumptions, such as allowing riskier stocks to command higher expected returns due to investors' risk aversion. This *single-Factor benchmark* assumes linear relations between stocks' and market-index returns, and includes the parameters α_i and β_i, which are usually estimated by a linear

regression with the stock return as the dependent (explained) variable and the market return as independent (explanatory) variable. To obtain estimates that are not affected by the studied event, the data range for the regression must be chosen in a way that minimizes the possible influence of the event; that is, the range should not belong to the event window.

3. Results

We focus in this paper on the filing event of a new drug application to the Food and Drugs Administration (FDA). We explore 295 events in the years 2002-2014 (245 large size firms and 50 small size firms). Data extract from Yahoo Finance. Following clinical results, the host company files an NDA or BLA for biologic drugs as formal procedure; that is, the market anticipates the NDA/BLA filing. Likewise, in most cases, filing event is a follow-up to clinical phase results forming under IND. In our sample, the Negative CAARs of 0.92% occur from between two months to 50 days before the approval dates until the day after approval; slightly negative CAARs of 0.11% occur from two days until 10 days following the event. In Table 1 below, we present market reaction around filing event. Our findings indicate almost no reaction to the new information for large size drugs, and a market reaction for small-cap firms of 3.46% negative CAARs from the second day after approval until 50 days after. Thus, information is already spread in the market before filing milestone however we see a market reaction after milestone event.

Table 1: Filing event CAARs for approved drugs at window t=-50,..,+50

Days relative to event	Number of days	All firms		Large-mid cap.		Small cap	
		CAAR, %	t-statistic	CAAR, %	t-statistic	CAAR, %	t-statistic
-50 to 1	52	-0.92%	-0.57	-0.72%	-0.69	-1.98%	-0.26
-40 to 1	42	-0.30%	-0.20	-0.36%	-0.39	-0.16%	-0.02
-30 to 1	32	-0.45%	-0.35	-0.68%	-0.83	0.42%	0.07
-10 to 1	12	-0.17%	-0.22	0.06%	0.13	-1.24%	-0.34
-2	1	-0.14%	-0.63	-0.23%	-1.58	0.22%	0.21
-1	1	0.09%	0.40	-0.01%	-0.08	0.53%	0.51
0	1	0.39%	1.75	0.06%	0.42	1.82%	1.74
1	1	0.30%	1.33	0.28%	1.98	0.36%	0.34
2	1	0.06%	0.27	-0.01%	-0.09	0.37%	0.36
3	1	0.10%	0.43	0.09%	0.65	0.11%	0.10
2 to 10	9	-0.11%	-0.17	-0.31%	-0.72	0.72%	0.23
2 to 20	19	-0.66%	-0.67	-0.85%	-1.37	0.26%	0.06
2 to 30	29	-1.12%	-0.93	-0.82%	-1.06	-2.35%	-0.42
2 to 40	39	-1.07%	-0.76	-0.56%	-0.63	-3.23%	-0.49
2 to 50	49	-0.84%	-0.54	-0.24%	-0.23	-3.46%	-0.47
No. obs.		**295**		**245**		**50**	

4. Discussion

The questions we referred to address the same theoretical problem: How do individuals evaluate and how should they evaluate sequences of risky investment opportunities or gambles? Exploring those framing decisions of the same product (drug in our case) reveals the tendencies outlines a myopic investor. Much of the literature on repeated gambles was inspired by Samuelson (1963) who reported a colleague's decision to reject a simple lottery, but to accept a sequence of 100 independent draws of the same lottery. Samuelson pointed out that such choices must be considered inconsistent within an expected utility framework if some simple conditions are satisfied. Many academics followed with normative analyses of risk aversion and the question how the number of repetitions of a gamble should influence its attractiveness.

This psychological evidence reviewed in Kahneman and his colleagues (1991) and Camerer (1989) indicates that an individual's well-being depends not only on his current consumption of goods, but also on how his current consumption. Other experiments have been used to test several hypotheses in financial settings of the 'reference point effect'. Copeland and Friedman, 1987, 1991, O'Brien and Srivastava, 1991, Camerer and Weigelt, 1992 tested different market efficiency assumptions. Smith, 1978 and Camerer and Weigelt, 1993 studied price 'bubbles'. Satin and Weber, 1993 investigated the effects of uncertainty about state probabilities ('ambiguity') on prices in auction markets. Weber and his colleagues 1997 showed that framing effects have a strong influence on prices in experimental markets.

5. Conclusions

Our research tries then to combine MLA and reference point effect, exploring the drug development industry during the course of pharmaceutical outcomes as sequence events series, focusing on one main milestone –filing event as the first stage at the FDA. Our findings, along with low interest rate in current world markets, lead to market optimism in this high risk sector. The wealth and availability of young innovative firms` information, changes then the way investors pay attention to information and even how they chose their winning stocks - from long value investment in traditional companies to what seems like an event driven strategy. To wit, we observe that higher trading is held around regulatory events. Exploring these milestone events reveal what seems like a speculative "micro bubbles". Limitations of the research may be in addressing behavioral patterns within capital market and not in labs where controls are differ in type; also limitation may be in our exploration of the drug development sector rather other sectors.

Acknowledgements

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