Asymmetric Use of Information About Past and Future: Toward a Narrative Theory of Forecasting

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Abstract

Story-telling helps to define the human experience. Do narratives also inform our predictions and choices? The current study provides evidence that they do, using financial decision-making as an example of a domain where, normatively, publicly available information (about the past *or* the future) is irrelevant. Despite this, participants used past company performance information to project future price trends, as though using affectively laden information to predict the ending of a story. Critically, these projections were stronger when information concerned predictions about a company's future performance rather than actual data about its past performance, suggesting that people not only rely on financially irrelevant (but narratively relevant) information for making predictions, but erroneously impose temporal order on that information.

Keywords: Intuitive theories; folk psychology; judgment & decision-making; behavioral economics.

Introduction

There is little more fundamental to our humanity than story-telling. Story-telling emerges early in development, is cross-culturally universal, and goes (at least) as far back as history itself. Further, stories powerfully shape our cognition: They pervade our memories and form the backbone of our identity (Bartlett, 1932).

Conversely, we must often make decisions in domains for which we have no evolved intuitions and limited expertise. For example, financial markets deal in highly abstract assets, such as streams of future dividends or bundles of loans. Moreover, the value of such assets depends not on the value of the underlying asset as such, but on what *other* people believe this value is. Compounding all this, traders in financial assets receive feedback that is extremely noisy given market volatility, making it difficult to learn from experience.

The root problem is that financial choices, like many others, often fall outside the domain of *risk*—in which possibilities can be readily enumerated and probabilities defined. They fall instead in the domain of *radical* or *Knightian* uncertainty (Knight, 1921) with no principled way to assign probabilities to possible outcomes: What is the probability that a company's technological innovation can be completed in a timely way, that consumers will take to a new product, or that an economic downturn will tighten consumers' discretionary spending?

Given the relative facility that people have for stories, compared with the challenges of understanding markets, several thinkers have proposed that storytelling influences our economic behavior. Nassim Taleb has argued that people fall prey to a *narrative fallacy* in which we confabulate narrative explanations for random phenomena (Taleb, 2007). The Nobel laureates Robert Shiller and George Akerlof have suggested that powerful stories capture the public's imagination in times of mania and panic (Akerlof & Shiller, 2009) and that these narratives generate feedback loops causing a boom and bust cycle.

Interviews with professional money managers (Tuckett, 2011) support the idea that professional investors rely on narratives to make investment decisions. Institutional investors face impossibly large amounts of information and must filter out only a minuscule fraction of this information to inform their decision-making. Moreover, these investors routinely make judgments not only about accounting data, but also about managers' abilities and intentions, the choices of governments, the outlook for the economy, and the whims of consumers. In situations of such profound uncertainty, what choice do investors have but to best guess what story fits the facts?

Despite this sense that narratives are crucial to choice (Chater & Loewenstein, 2016), little experimental work has implicated narratives in economic decisions. There is some evidence that narratives are used in other domains. For example, juries are more swayed when testimony is arranged to tell a story, holding the information constant (Pennington & Hastie, 1992) and consumers respond more strongly to information presented in a narrative rather than equivalent list (Adaval & Wyer, 1998).

Perhaps most suggestively, people often treat beliefs as "digital" rather than "analog," acting as though a possibility is certainly true even when it is uncertain (e.g., Johnson, Merchant, & Keil, 2015). For example, when people believe that there is a 70% probability that the government will loosen fiscal policy (but a 30% probability that the government will not), they predict future asset prices in accordance with the belief that there is a 100% probability of looser fiscal policy (Johnson & Hill, 2017). Thus, even as people acknowledge uncertainty, they nonetheless adopt a single narrative to make tractable the problem of prediction.

Here, we study lay investors' reactions to news about companies' performance. This is useful for contrasting theories of financial decision-making, because news announcements have been studied in great detail by financial economists and because plausible theories of investor behavior make sharply divergent predictions.

Our experiment asked participants to make predictions

about the future stock prices of realistic, but fictitious, companies. For each company, participants learned that an hour previous to the most recent stock quotation, an announcement was made by financial analysts concerning either the company's performance in either the *past* quarter or its *future* quarter, which were either positive news or negative news. Participants were then asked to predict the future trajectory of the price, at intervals of one day, two weeks, and one year. Three distinct theories of financial decision-making offer divergent predictions about how participants would complete this task.

Rational expectations. According to financial theory, stock prices are the market's best guess as to the value of a security's future dividends. In an efficient market, stock prices change as new information is revealed that is relevant to determining the company's future profitability. However, unless an individual investor has access to information that is not public, that investor can do no better than chance at predicting future price movements: that is, stock prices take a *random walk* (Fama, 1965). This follows from the logic of arbitrage. If future stock prices were predictable on the basis of publicly available news information, then a "smart money" arbitrageur would be able to capitalize on this predictability by buying or selling shares of the stock before the market moved. Because there are many traders attempting to predict the trajectory of the market, such arbitrage opportunities last for only a very short time. Financial theorists have argued from this unpredictability that financial markets can be *efficient*, incorporating all known information into security prices.

Thus, neoclassical theory predicts that positive or negative corporate news announcements will be followed rapidly by a shift in the company's share price, and that prices afterwards will follow a random walk from that new price. Therefore, if a share price is quoted *after* a news announcement (as in our experiment), investors with rational expectations would predict that share prices gradually increase over time at a rate that is roughly the historical rate for a stock of equivalent risk. The nature of the news announcement is *irrelevant* to future share prices because all publicly available information is *already* embedded in the share price. This is true whether the announcement is positive or negative relative to previous expectations, and whether the announcement concerns actual past performance or predicted future performance.

Therefore, if people have rational expectations about future stock prices, there should be no difference between predictions given positive or negative surprises (since the predictions are made after the information has been priced in), nor for surprises about the past versus the future.

Behaviorally-informed expectations. An individual investor really *would* be hard-pressed to beat the market. Nonetheless, a variety of anomalies have been detected in stock price data, which, though modest in magnitude, diverge from strict efficiency (e.g., Sheffrin, 2002). Might people intuit these divergences and thereby make predictions that are actually *more* accurate than neoclassically rational expectations?

As it happens, stock prices do *not* follow a strict random walk after corporate earnings announcements. Instead, investors appear to initially *underreact* to earnings announcements (Bernard, 1992). That is, if a security outperforms expectations, the instantaneous increase in share price (predicted by market efficiency) is followed by a continued upward *drift* in share prices for a period of up a few weeks up to a few months (Bernard, 1992). The converse is seen when a security underperforms expectations: the initial drop in share value is followed by an extended downward drift in share prices. Put differently, earnings announcements trigger a period of short-term *price momentum*. Although these abnormal returns (relative to the market rate of return) are modest in magnitude (perhaps 2%), they are difficult to explain in a strict efficient markets framework.

Importantly, this initial underreaction over short timeframes gives way over longer timeframes to *overreaction* (De Bondt & Thaler, 1985). After a positive performance surprise, share prices will drift upward for up to a few months, but will drift back *downwards* afterwards. Conversely, after a negative performance surprise, share prices will drift downward for a time, but drift back *upwards* afterwards. That is, security prices drift *too far* in this initial period of up to a few months, and adjust back to an equilibrium price afterwards so that the long-run return of the security is no different from the market overall. What comes up (out of equilibrium) must come down (back to equilibrium) and vice versa. That is, price momentum is followed by *reversion*.

Various financial models have been proposed to explain this pattern, but there is no consensus on its causes. For our purposes, we simply note that agents with *behavioral expectations* would account for this pattern in their predictions. Although we certainly would not expect amateur investors to learn about these patterns from the academic literature, it may be plausible that investors could intuit them. After all, investors *cause* them.

Therefore, if people have behavioral expectations, we would expect a difference between predictions following positive and negative performance surprises at shorter time frames (2 weeks later) but not longer time frames (1 year later). Since we are not aware of any econometric work documenting divergences in price momentum between surprises in past versus future performance, we do not believe that a behaviorally-inclined participant would differentiate between past and future information.

Narrative expectations. Although both of the above positions would be in keeping with existing financial theory, in one way or another, we predicted a different pattern of predictions because we believe that people construct narratives to make sense of complex, uncertain systems (a position known as *Conviction Narrative Theory*, fleshed out in the General Discussion and in Tuckett & Nikolic, 2017). To motivate our predictions, we note that narratives are fundamentally *goal oriented* (and thus

emotionally valenced) and *temporally oriented*.

First, stories (like investments) are goal oriented. Their protagonists want to achieve certain objectives and developments in the narrative either facilitate or thwart these objectives. Therefore, stories take on an emotional valence as goals become closer or more distant. If people use narratives to generate predictions, then they should use the valence of information to inform their future predictions. Simply put, a happy development increases the chance of a good ending, whereas a sad development increases the chance of a sad ending.

Second, stories are temporally oriented. They have a beginning, middle, and end, and causality flows in a single direction. If we can be informed directly about the future, that is a better clue to how the story ends compared to what has already happened in the past. Indeed, several results suggest that the future is more psychologically "real" than the past (e.g., Caruso, Gilbert, & Wilson, 2008). When it comes to prediction, we would therefore expect future-oriented information to be weighed more heavily than past-oriented information, even if equally (ir)relevant normatively.

The narrative expectations hypothesis thus makes two predictions. First, both positive and negative trends should be projected into the future at all time horizons. Second, the effect of valence should be stronger when the news concerns predicted *future* rather than actual *past* performance: Predicted abnormal returns induced by news should be amplified (more positive or negative), following stronger predicted future performance.

Method

We recruited 225 American participants from Mechanical Turk; 40 were excluded due to inattentiveness.

About half (49%) of participants held some financial assets (such as stocks, bonds, or mutual funds) about half (53%) had taken at least one finance course, and 14% of participants majored in a business field. Thus, although Mechanical Turk participants are generally not expert investors, they reasonably represent the investing experience of the American public. Although this population is not nearly as experienced as professional traders, financial models often assume that low-information investors ("noise traders") drive market pricing anomalies. Thus, it is important to characterize these investors' actual beliefs and behaviors for building accurate economic theory, as well as for distinguishing among psychological theories of choice.

Each participant completed four items pertaining to different fictitious companies. The companies were balanced with the four experimental conditions (past/positive, future/positive, past/negative, and future/negative) using a Latin square.

For each company, participants first read background information about the company and its current price. For example, one item read:

> Remlon Software Corporation (stock symbol RWQ) is a Dallas-based company that designs and markets business software to medium- and large-size firms.
>
> Here is the most recent price quotation for shares in RWQ stock: $56.00.

Then, participants were asked to make baseline predictions about the price trajectory of the shares ("Given that RWQ shares currently trade at $56, please estimate what you think the share price will be on the following dates") at time horizons of "tomorrow," "in two weeks," and "in one year." These ratings were made on a sliding scale centered at the current price, and ranging from 50% less than the current price ($28 for RWQ) up to 50% more than the current price ($84 for RWQ). This measure was taken to measure participants' default expectations about the price trajectory of each stock (without performance data) as a comparison to the experimental conditions.

On the next screen, participants read a piece of news from financial analysts concerning the security, which instantiated our experimental manipulations of valence (positive or negative) and time (past-oriented or future-oriented information). Critically, in both conditions, the news information was said to have come out an hour *before* the price quotation. Thus, the market would have already incorporated this news into its valuations.

In the past condition, this information described past performance relative to average performance (bracketed text varying across the positive and negative conditions):

> *About an hour prior to the most recent price quotation ($56) for Remlon's stock (RWQ), the following piece of news was revealed:*
>
> Although average sales growth is expected for the next quarter, analysts determined that Remlon experienced [above-average / below-average] levels of sales growth over the past quarter.

Conversely, in the future condition, the news described expected future performance:

> Although average sales growth was observed for the past quarter, analysts anticipate that Remlon will experience [above-average / below-average] levels of sales growth over the next quarter.

Below this information, participants were asked to make a new prediction, using the same scale and time horizons as the baseline prediction.

After the main task, participants a set of recognition memory check questions, and participants answering more than 30% of these questions incorrectly were excluded from analysis (N = 40). However, the conclusions of the key significance tests are not altered when these participants are included in the analysis.

Results

For statistical analyses, we converted price estimates into percentage changes relative to the initial price, as

shown in Table 1. Overall, the results support the narrative account. Participants predicted much more bullish price changes after a positive surprise, relative to the baseline, and much more bearish price changes after a negative surprise. Moreover, for the positive surprises, these predicted changes were larger in light of future- rather than past-oriented performance information.

Table 1: Results

		1-day	2-weeks	1-year
Baseline		1.7% (2.6%)	4.3% (4.9%)	8.7% (9.9%)
Positive Surprise	Past	5.5% (7.8%)	9.3% (9.6%)	14.7% (15.4%)
	Future	6.5% (7.7%)	11.2% (9.0%)	17.5% (15.4%)
Negative Surprise	Past	–2.7% (6.7%)	–4.6% (7.9%)	–5.7% (12.8%)
	Future	–2.9% (7.5%)	–4.4% (8.6%)	–6.1% (14.1%)

Note. Entries are predicted changes from current value, as percentages. Possible scores range from –50% to +50%. The baseline column gives the mean of the baseline predictions made across the four within-subjects conditions, since they were made prior to the manipulation. SDs in parentheses.

Baseline predictions. At the baseline, prior to reading any news information, participants expected a moderate price increase over 1-day (+1.7%), 2-week (+4.3%), and 1-year (+8.7%) time horizons. Although the 1-day and 2-week predictions are rather optimistic, the 1-year prediction is consistent with historical market returns. For example, the S&P 500 index has historically increased in value at an average nominal rate of 10% per year. Since we do not know the riskiness of our (fictitious) securities relative to the market as a whole (and hence their risk premia), 8.7% is not a bad guess for its expected annual return. This baseline tells us that our participants' expectations are not, in general, far out of line.

Valence of news. That said, it was hardly the case that participants' predictions matched neoclassical economic theory. Table 1 shows that predictions markedly differed depending on the valence of the news.

Looking at the positive surprise items collapsed across time conditions, participants predicted increases of +6.0% at a 1-day timeframe, +10.3% at a 2-week timeframe, and +16.1% at a 1-year timeframe. These predictions were significantly more positive than the baseline predictions [ts > 8.9, ps < .001, ds > 0.61], in violation of market efficiency. Strikingly, the divergences between the baseline and the positive surprise predictions were largest at *longer* time intervals. That is, the performance surprise led to a predicted premium of +4.3% at 1 day and +6.0% at 2 weeks, with the latter premium significantly larger [$t(184) = 5.28$, $p < .001$, $d = 0.25$], with a yet larger premium of +7.4% at 1 year [$t(184) = 2.92$, $p = .004$, $d = 0.15$]. In other words, the alleged predictive signal associated with the news announcement actually grew *larger* rather than smaller over longer time frames. Thus, participants predicted strong price momentum, with investors underreacting to news announcements—a belief that is at least qualitatively consistent with empirical studies of asset prices. However, whereas in reality these trends reverse in the longer run, participants predicted an *ever-increasing* effect of positive news announcements.

The story was similar for negative surprises, but even more dramatic (in line with other asymmetries between positive and negative events; e.g., Baumeister et al., 2001). Collapsing across time conditions, participants predicted *decreases* of –2.8% at 1 day, –4.5% at 2 weeks, and –5.9% at 1 year intervals. Needless to say, these predictions diverged sharply from the baseline predictions [ts > 9.2, ps < .001, ds > 0.93] and from the positive surprise condition [ts > 10.4, ps < .001, ds > 1.3]. And once again, the predicted shortfall relative to baseline increased at longer time horizons, with a shortfall of –4.5% at 1 day versus –8.8% at 2 weeks [$t(184) = 9.50$, $p < .001$, $d = 0.54$] and an even larger shortfall of –14.6% at 1 year [$t(184) = 8.68$, $p < .001$, $d = 0.48$]. Participants again predicted both short- and long-term momentum, rather than long-term reversion as has been found empirically.

Time reference of news. Though not as strong as the effect of valence, participants also used the time reference of news, inconsistently with financial theory. Predictions tended to be more extreme (i.e., positive after positive news and negative after negative news) in light of future- compared to past-oriented information. Collapsing across valence, future-oriented predictions were 0.6% more extreme at a 1-day horizon [$t(184) = 1.84$, $p = .066$, $d = 0.14$ vs. 0% in a one-sample test], 0.8% more extreme at a 2-week horizon [$t(184) = 2.29$, $p = .023$, $d = 0.17$], and 1.6% more extreme at a 1-year time horizon [$t(184) = 2.50$, $p = .013$, $d = 0.18$]. Thus, overall our prediction was supported that future-oriented information would be weighted more heavily than past-oriented information due to the inherently temporal nature of narrative thinking.

However, these effects were not symmetric across valences, but were instead driven by the positive valence conditions. For positive news, there was a substantial effect of time reference at all horizons (1.0%, 1.9%, and 2.8%), whereas there was no significant effect at any horizon for the negative valence items (0.2%, –0.2%, and 0.4%). One possibility is that participants were hesitant to predict more negative price changes than –6% in light of information is only moderately negative, especially given that the stock market was looking quite bullish at the time of the experiment (March 2017). That is, our manipulation may have run into a tacit floor. If this is the case, then more

extreme negative events could potentially lead to a time-reference asymmetry. However, we have run several other experiments (described below) using a similar paradigm, and have tended to find effects of time reference for both positive and negative news. Thus, the null effect for negative news may be a false negative.

Discussion

People are natural story-tellers. Do these narrative instincts help people to make sense of financial data and to make economic choices?

The current results support the idea that people rely on narratives when predicting the price trajectories of financial assets. Whereas participants with rational expectations would predict increases in asset prices at the market rate of return, our participants sharply differentiated between positive and negative performance surprises, predicting dramatically superior growth in light of a positive rather than negative piece of news. This was the case even though the predicted price changes were made relative to the price *after* the news announcement. Instead, news information appears to trigger narratives in investors' minds. Since narratives are temporally extended, they can be used to make predictions.

In addition, participants differentiated between news concerning the past and future—a finding at odds with both rational and behavioral expectations. Positive surprises about past performance were seen as less positive than surprises about expected future performance. (In follow-up studies, negative surprises about the past were likewise seen as less negative than surprises about the future.) If people think about financial assets like economists—recognizing that is *expectations* about the future that matter, which are quickly priced in to asset prices, whether new information concerns the past or the future—then the temporal direction of performance surprises should not matter. But if people use news information as raw material for constructing narratives about the company, then information about the future would indeed be more diagnostic about the company's future than information about the past.

Could these results be reconciled with neoclassical financial theory on the basis of participants' inference about risk? According to standard financial models, investors prefer, for a given expected return, securities with lower variance around that expectation. That is, investors are risk-averse. According to this logic, our participants' tendency to predict higher returns for some securities than for others would be consistent with financial theory if they are due to inferences about risk.

However, this explanation is not workable. For the risk-inference account to hold water, people would need to believe that securities with *positive* performance surprises are riskier (in the sense of greater variance) than those with *negative* performance surprises. Further, the magnitude of the difference between the positive and negative surprises (of greater than 20% at a 1-year horizon) is empirically implausible as a risk premium. It is more plausible that participants would believe future information to be more risk-inducing than past information (justifying the higher expected return for positive future compared to past surprises). However, the risk account would also predict that future *negative* performance surprises should lead to stronger future returns compared to past negative surprises. The means generally went in the opposite direction (albeit non-significantly), and follow-up experiments found significant effects in the opposite direction. Thus, inferences about risk are unlikely to drive our results.

The results also conflict with behavioral expectations. Such investors would predict short-term price momentum, followed by longer-term reversals. Our participants diverged from this pattern in three ways. First, their short-term price momentum was wildly overzealous compared with econometric findings. Short-term momentum effects appear to be about 2% on average at their peak, far more modest than the abnormal returns of 5–9% relative to baseline that our participants predicted at a 2-week time horizon. Second, rather than reverting back toward the market return in the longer-term, participants' predictions were precisely the opposite, diverging increasingly at longer time horizons. Finally, we are not aware of any evidence that the time reference of company news empirically predicts stock prices, so it is unclear how the behavioral account would explain the temporal effect.

Another alternative explanation is that most participants are unaware of the idea that known news is incorporated into current prices (explaining the valence asymmetry) and that this is more true for future-oriented news (explaining the temporal asymmetry). One prediction made by this account is that the effects should disappear for those participants who are especially knowledgeable (e.g., the 14% of participants who majored in economics, finance, or other business fields). However, not only did the results hold up at higher levels of expertise, but expertise had *no* significant effect on the effect size.

Several other studies we have run in the same paradigm support these conclusions (Johnson & Tuckett, 2017). We found that participants also make choices consistent with narrative expectations—they are more likely to allocate assets to stocks that recently underwent a positive (rather than negative) performance surprise, with this effect stronger for future- rather than past-oriented news. Moreover, these effects are mediated by emotion, with positive surprises (particularly about the future) leading to positive affect, leading in turn to choices.

Both classical economic theory as well as existing behavioral economic theories, such as prospect theory, are poorly suited to explaining our results. Although prospect theory and its extensions capture much about human behavior in contexts where possibilities are enumerable and their probabilities are known (such as gambles), they have less to say about situations of Knightian uncertainty in which such probabilities are elusive or unknowable. We propose that in such situations, people use narratives as

their primary tool for making sense of information and making choices. This position has come to be known as *conviction narrative theory* (Tuckett & Nikolic, 2017).

On this theory, individuals faced with Knightian uncertainty marshal available information to form a narrative, drawing upon prior beliefs and lay theories, causal reasoning abilities, and trusted sources in the social environment. Because narratives are causally and temporally extended, they can be used to predict future events. And because narratives are affectively rich, they can generate approach and avoidance motivations that allow an individual to build sufficient conviction to maintain a sustained decision over time. Interview studies of professional money managers support these ideas and we believe these processes capture the phenomenology of choice under Knightian uncertainty.

The current studies add both to these qualitative data as well as to past and ongoing experimental work. We pointed earlier to prior work documenting narrative thinking in legal and consumer choice. In addition, ongoing work from our own research groups has begun to pinpoint how these processes work in financial decision-making. When predicting the future value of a stock under uncertain states of the world, investors tend to focus on a single possible state and act as though it *is* certain—choosing a narrative and sticking with it (Johnson & Hill, 2017). Investors are sensitive to the explanations offered by managers and analysts for changes in share prices and earnings, suggesting that these explanations can offer the raw material for making narrative projections (Johnson, Matiashvili, & Tuckett, 2018a). Our work has also begun to examine how people evaluate competing narratives. For example, rather than naively extrapolating past price changes into the future when forming price expectations, people use sophisticated techniques (albeit erroneous, from the perspective of financial theory) to match past price patterns to future predictions (Johnson, Matiashvili, & Tuckett, 2018b). Social influence also plays a role, as people use seemingly irrelevant cues, such as an expert's moral and political values, to assess which financial advisor to trust (Johnson, Rodrigues, & Tuckett, 2018).

The current findings add to this evidence, showing that investors are sensitive to news announcements in ways predicted directly by CNT but not by other frameworks, such as rational expectations or existing behavioral theories. We look forward to the possibility that future research will use this narrative framework to study other domains of economic activity and everyday life.

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