Betting against analyst target price*

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Abstract

Using a robust measure that captures the market's reaction to analysts' target price releases, we show that the initial stock price reaction corresponds to target prices, but the price drifts in the opposite direction for a long period, resulting in negative cross-sectional predictability. In the U.S. market from 1999 to 2002, the derived long-short portfolio generates a significant one-month ahead return of 0.75% and 10.00% over a year and possesses favorable features: its profit is higher among large and liquid stocks, originates from long positions, and lasts long. Empirical evidence suggests that the return reversal is caused by both discount rate shifts and mispricing correction following target price releases.

Keywords: Net number of optimistic analysts (NOA); target price; discount rate; mispricing.

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1. Introduction

Equity analysts' target prices, namely one-year ahead price forecasts, are widely referred to by investors and their informativeness is an important topic for both academics and practitioners. Previous studies typically test target prices' informativeness by examining the market's reaction to target price releases and unanimously document a significant short-term market reaction. Brav and Lehavy (2003), using target price data from 1997 to 1999, report significant abnormal returns around target price revisions and conclude that target prices have incremental informativeness beyond earnings forecasts and stock recommendations. Asquith et al. (2005) analyze the complete contents of *Institutional Investor* All-American analyst reports and find target prices provide independent information to the capital markets. Using a dataset from 2000 through 2009, Bradshaw et al. (2013) document significant market reactions to analysts' target price revisions after controlling for revisions of their earnings forecasts and stock recommendations.

However, the accuracy of target prices in the long run remains questionable as extant studies draw mixed conclusions. Asquith et al. (2005) document that approximately 54% of analysts' target prices are achieved or exceeded during the forecast period. Bilinski et al. (2012), using international data from 16 countries over the 2002 to 2009 period, find that the target price is reached by the stock price in 59.1% of cases during the forecast period, and its prediction error at the end of the forecast horizon is 44.7%. They also find that analysts with longer forecasting experience, following more firms, country-specialized, and employed by a large broker, issue more accurate target prices. Da and Schaumburg (2011) and Da et al. (2016) document substantial abnormal returns of a long-short trading strategy based on target prices within industry and suggest that target prices provide investors with valuable information, but the informativeness is limited to relative valuations within industry, not across all stocks.

On the other hand, Bonini et al. (2010), using data from the Italian stock market, find that the prediction errors of target prices are large and persistent, and more prominent when the firm size is large or the return implied by the target price is large. More recently, Bradshaw et al. (2013) find that target price implied returns exceed actual returns by an average of 15%, and absolute target price forecast errors average 45%. At the end of the twelve-month forecast horizon, only 38% of target prices are met, but 64% are met at some time during the forecast horizon, which leads them to conclude that analysts have, at best, limited abilities to persistently provide accurate target price forecasts.

Despite some evidence in the literature that advocates the forecasting power of target prices, it appears to be weak especially when we consider potential publication bias. This raises the question of whether the short-term market reaction is sufficient evidence of target price informativeness or is a manifestation of market overreaction. In fact, we find a significant long-term *negative* relation between realized returns and target price implied returns, which contradicts earlier findings, for instance, Brav and Lehavy (2003) and Da and Schaumburg (2011). After the short-term market reaction corresponding to target prices, stock prices tend to move in the opposite direction to target prices. Does this imply target prices are uninformative? We address this question in this paper. We first document the negative predictive power of target prices and offer potential explanations behind this seemingly counterintuitive finding.

To examine the cross-sectional predictability and the information content of target prices, we develop a new measure, the net number of optimistic analysts (NOA), which aims to capture the market's reaction to target price releases. NOA is defined for each stock as the difference between the number of optimistic analysts, namely those who issue target prices higher than the current price, and the number of pessimistic analysts, namely those who issue lower target prices.

As illustrated in Subsection 2.2, NOA reflects the impact of target price releases better than other widely used measures, such as the mean or median, in the sense that it accounts for investors' confidence in target prices and is robust to potential analysts' bias. The intuition behind NOA is as follows. When more analysts issue target prices on the same side (higher or lower than the current price), investors will have more confidence in the target prices and invest accordingly. NOA accounts for this investor confidence by comparing the number of optimistic analysts with the number of pessimistic analysts. By ignoring the magnitude but only considering the sign of the target price implied return, NOA is also more robust to analysts' biases compared to other measures that are sensitive to the magnitude. NOA is similar to Chiang et al.'s (2019) robust measure of earnings surprises but their measure does not take investors' confidence into account. Another advantage of NOA is that as large firms tend to attract more analysts and therefore have large absolute NOA values, a long-short portfolio strategy derived from NOA contains larger stocks and is easier to implement.

Employing a database of individual equity analysts' price forecasts in the U.S. market between 1999 and 2020, we provide empirical evidence that NOA possesses a strong negative predictive power. In the portfolio formation month, the stocks with the lowest NOA earn significantly lower returns than those with the highest NOA, but they earn significantly higher returns over post-formation months. A long-short portfolio strategy that buys the lowest NOA stocks (Low NOA portfolio) and sells the highest NOA stocks (High NOA portfolio) yields an economically and statistically significant average one-month ahead excess return of 0.75% (t-statistic = 3.87). Moreover, the risk-adjusted return of the NOA strategy remains significant when tested with five asset pricing models: Fama and French (1993) three-factor, Carhart (1997) four-factor, Fama and French (2015) five-factor, Hou et al. (2015) four-factor, and Stambaugh and Yuan (2016) four-factor models. This suggests that the well-known market, size, book-to-market, momentum, profitability, investment, and mispricing factors cannot explain the significant outperformance of low NOA stocks over high NOA stocks. A firm-level cross-sectional regression analysis reveals that NOA is not subsumed by other firm characteristics or risk factors such as the size, book-to-market ratio, or momentum.

The NOA anomaly is characterized by several favorable features that distinguish it from other anomalies and make the implementation of the long-short portfolio strategy easier.

Remarkably, the long-short portfolio exhibits a higher and more significant return when stocks are value-weighted. Double-sort analyses confirm that the return is more prominent among large and liquid stocks, indicating that the NOA anomaly is not a mere small-firm phenomenon.

The NOA strategy does not require prompt trading at the time of target price releases nor frequent rebalancing. The magnitude of the NOA premium hardly diminishes and remains significant up to at least one year, yielding an average cumulative one-year excess return of 10.00% (t-statistic = 8.44). In addition, the profit is mostly generated from the long leg. Indeed, the short leg has a positive return and reduces the return of the long-short portfolio. Considering the attenuation of equity return anomalies following the decimalization in the U.S. stock exchanges in 2001 (Chordia et al., 2014; Green et al., 2017), it is also noticeable that the NOA profit is obtained during the recent period from 1999 to 2020.

The difference between our findings and earlier findings can be reconciled by the following factors. First, NOA has a different meaning from previously used measures. NOA compares target prices with the current price, whereas target price revision, used in many studies reporting significant positive market reactions, for instance, Brav and Lehavy (2003) and Bradshaw et al. (2013), compares target prices to their previous values. As analysts tend to revise target prices when the target-to-market price ratio diverges from its long-run value (Brav and Lehavy, 2003), target price revision does not always reflect analysts' view on the future price movement. When we test alternative measures based on target price revisions, we also find a positive relation between long-term stock returns and the measures, which is consistent with earlier findings.

Da and Schaumburg (2011) compare target prices with the current price and find a significant positive relation between the target price implied return and future stock returns within industry and no significant relation across all stocks. A crucial difference between their target price implied return and NOA is that their measure uses as the base price the price at the end of the portfolio formation month, whereas NOA uses the price at the beginning of the month. Therefore, their measure will have the opposite sign to NOA when the short-term reaction moves the price beyond the target price before the end of the formation month.

Different sample periods can also explain the contrasting results to some extent. The sample periods of prior studies are usually short and end before or during the early 2000's, and have little overlap with our sample period, 1999 to 2020, which spans the financial crisis and post-crisis period.

Finally, the negative predictability is not entirely new but is in line with So (2013). So (2013), albeit using earnings forecasts instead of target prices, finds that investors overweight analysts' earnings forecasts and ignore predictable analyst biases, which leads to predictably negative returns when analysts are optimistic, and vice versa.

We consider two hypotheses to explain the NOA anomaly: 1) (discount rate shift) the market perceives target prices as a risk indicator; or 2) (mispricing) the market reacts to target prices regardless of its forecasting accuracy and corrects itself as the true value of the firm is gradually revealed.

If investors perceive a lower target price as a signal of higher risk, the discount rate will be increased, which will cause an initial price drop that is followed by a higher return in the future. Even when investors interpret target prices mainly as cash flow news, return reversal can be observed if target prices turn out to be incorrect, and the price is adjusted gradually to the true value. If analysts are believed to be better informed and a target price is an outcome of thorough analyses of a firm, investors will consider it the best available estimate of the future price and trade accordingly, and then correct their positions later as they obtain more information.

Empirical evidence suggests that the NOA anomaly is attributable to both hypotheses rather than just one. First, the long-lasting anomalous return implies that the stocks with low NOA values have higher expected returns, which supports the discount rate shift hypothesis.

We adopt La Porta et al.'s (1997) approach to examine the possibility of mispricing. Consistent with earlier studies, for instance, Bradshaw et al. (2006), Lou and Shu (2017), and Engelberg et al. (2018), the NOA premium is more pronounced around earnings announcement days. This supports the second hypothesis that the return reversal is a result of mispricing correction.

When we divide the sample universe into two subsamples, stocks with or without an earnings announcement during the portfolio formation month, the risk-adjusted return of the NOA strategy becomes insignificant in the first subsample, whereas it remains significant in the second subsample. This result appears to support the mispricing correction hypothesis as earnings announcements in the formation month would mitigate mispricing. However, if we look at a longer horizon, it turns out that the return from the first subsample is higher in months 3, 6, 9, and 12 (earnings announcement months) and lower for the rest of the year, yielding a one-year cumulative return comparable to that of the second subsample. Furthermore, the returns of both Low and High NOA portfolios increase in earnings announcement months. This result suggests that earnings announcements enhance short-term returns by reducing uncertainty, but hardly affect the long-term profitability of NOA, which is more in line with the discount rate hypothesis. An additional analysis suggests that post-earnings announcement drift is responsible for the low returns in months following earnings announcements.

Finally, if the return reversal is purely due to a discount rate shift, we would observe a zero cumulative return spread between the Low and High NOA portfolios in the long run when the initial shock is included.[1] However, the cumulative return spread from the portfolio formation month changes from negative to positive in a few months and remains significantly positive, which can only be explained by the lack of analysts' forecasting power and mispricing correction. Therefore, we cannot rule out the second hypothesis.

Overall, we conclude that the NOA anomaly is caused by both a discount rate shift and mispricing correction.

We test alternative hypotheses that have been successfully employed to explain anomalies,

[1]A price shock caused by a discount rate change will eventually be offset by the long-run price change (Fama and French, 1988; Cochrane, 1991).

but none of them delivers a satisfactory explanation for the NOA anomaly. Limits-to-arbitrage is considered a robust explanation for the profitability of many anomalies. We find, however, that the NOA premium is more significant among stocks that are larger and more liquid, and insignificant otherwise, which contradicts the limits-to-arbitrage hypothesis. This unique characteristic of the NOA anomaly originates from the definition of NOA that depends on the number of analysts. As large and liquid firms receive more attention from analysts, these firms are more likely to be allocated to the extreme quantiles that comprise the long-short portfolio.

We also find that NOA is positively correlated with the stock return in the portfolio formation month, implying that the NOA strategy tends to buy recent losers and sell recent winners. Therefore, we test whether the NOA anomaly is a mere rediscovery of the short-term return reversal. Contrary to Avramov et al.'s (2006) finding that the profit of the reversal strategy is mainly derived from small, high turnover, and illiquid stocks, the stocks that constitute the NOA strategy are mostly large and liquid stocks. In addition, a long-short portfolio strategy based on the short-term reversal fails to generate a significant return in our sample. These results confirm that we are not rediscovering the short-term reversal through NOA.

We contribute to the literature in multiple aspects. First, we provide new evidence on the informativeness of target prices. Secondly, we develop a new measure, NOA, to capture the impact of target price releases on the market. NOA accounts for investors' confidence in target prices and is robust to potential analysts' bias. We use NOA for target prices, but it can be applied to any economic forecast that could affect investors' decisions. Thirdly, we add a new anomaly to the factor zoo. The NOA anomaly is unique in that it is derived from large and liquid stocks, lasts long, and survives the 2001 decimalization. Lastly, by focusing on investors' perception of target prices rather than their information contents, we offer a new insight into the mechanism of target price releases and long-term price reaction. We apply NOA to target prices but applying it to earnings forecasts or other firm-specific news would be an interesting future research investigation. With the scraping tools that allow us to easily collect news contents from the web, it can be employed to examine investors' sentiment changes to the news and consequent price reactions.

This paper is organized as follows. In Section 2, we establish hypotheses on the target price release and its long-term effect on the stock price. We also develop NOA and compare it with alternative measures. In Section 3, we explore the predictive power of NOA through a comprehensive set of analyses. In Section 4, we provide a potential explanation for the NOA premium and test alternative hypotheses. We conclude in Section 5.

2. Information of target prices

In this section, we establish a hypothesis on the target price release and its long-term impact on the stock price and develop a measure to predict the impact.

2.1. *Target price release and its long-term effect*

The relation between the current price and the future price of a stock can be derived from Campbell and Shiller (1988) present value identity:

$$p_t = \sum_{j=1}^{\infty} \rho^{j-1}(1-\rho)d_{t+j} - \sum_{j=1}^{\infty} \rho^{j-1} r_{t+j} \tag{1}$$

$$= \sum_{j=1}^{J} \rho^{j-1}(1-\rho)d_{t+j} - \sum_{j=1}^{J} \rho^{j-1} r_{t+j} + \rho^J p_{t+J}, \tag{2}$$

where $p_t = \log P_t$ denotes the logarithm of the stock price at the end of t, $d_t = \log D_t$ denotes the logarithm of the dividend paid during t, $r_t = \log \frac{P_t+D_t}{P_{t-1}}$ denotes the stock return during t, and $\rho \approx 0.96$ is a constant. As the identity holds for any information set, we can also write:

$$p_t = \sum_{j=1}^{J} \rho^{j-1}(1-\rho)E_t[d_{t+j}] - \sum_{j=1}^{J} \rho^{j-1} E_t[r_{t+j}] + \rho^J E_t[p_{t+J}]. \tag{3}$$

Equation (3) implies that a change in the expectation of a future price will lead to a corresponding change in the current price. This means that if investors adjust their expectation on the one-year ahead price following analysts' target price releases, the current price will react accordingly.

The long-term effect of target price releases on the stock price depends on the information content of the target price. Viewing the target price as the expected future price by an analyst, the target price can be decomposed into two parts; cash flow and discount rates:

$$\log TP_t^k = \sum_{j=1}^{\infty} \rho^{j-1}(1-\rho) E_t \left[d_{t+1+j} | I_t^k \right] - \sum_{j=1}^{\infty} \rho^{j-1} E_t \left[r_{t+1+j} | I_t^k \right], \tag{4}$$

where TP_t^k denotes the target price released by analyst k, and I_t^k denotes her information set. If the target price carried information only on cash flow, it would be reflected in the current price but not in the future returns. In contrast, if the target price carried information on discount rates, it would affect both the current price and future returns. For instance, if an analyst released a low price target in anticipation of elevated risk, the price would drop initially but rebound as investors require a higher return as compensation for the increased risk, resulting in a reversal of return. Indeed, there is abundant evidence that target prices provide information beyond earnings forecasts (Brav and Lehavy, 2003; Asquith et al., 2005; Bradshaw et al., 2013).

If the market reacts to target prices, but they turn out to have negligible or even negative predictive power, the return will also be reversed as the true value of the firm is gradually revealed and the market corrects the price. If analysts are believed to be better informed and a target price is an outcome of thorough analyses of a firm, investors will consider it the best available estimate of the future price and trade accordingly.

Figure 1 illustrates the long-term price movement scenarios described above. The dotted lines in the first graph represent the case when the target price implies only a cash flow revision, whereas the solid lines represent the case when the target price implies a discount rate revision. The second graph presents the case when the return reversal results from mispricing correction. Except for the cash flow revision scenario, a return reversal is expected to occur and, in such a case, a strategy that goes long on stocks with low target prices and goes short on stocks with high target prices is likely to make a profit when implemented after the initial price shock.

[FIGURE 1 here]

2.2. *Measure of target price impact*

To investigate whether there exists a return reversal following target price releases, we develop a measure of the impact of target prices on the market. If a return reversal occurs for any of the reasons described in Subsection 2.1, the long-term price change will be inversely proportional to the initial price shock, and this measure will exhibit negative cross-sectional predictability of the long-term returns.

Following the discussion in the previous section, we assume that the price shock following a target price release is proportional to the revision of the one-year ahead expected return:

$$\hat{R} = \hat{\mu} - \mu_0, \tag{5}$$

where $\hat{\mu} = \frac{\mathrm{E}[P_{t+1}|TP_t^k]-P_t}{P_t}$ denotes the one-year ahead expected return conditional on the target price TP_t^k, and $\mu_0 = \frac{\mathrm{E}[P_{t+1}|P_t]-P_t}{P_t}$ denotes the prior one-year ahead expected return based on the current information.

The current expected return μ_0 is assumed to be an unbiased estimate of the true expected return, $\mu = \frac{\mathrm{E}[P_{t+1}]-P_t}{P_t}$:

$$\mu_0 = \mu + e_0, \qquad e_0 \sim \mathcal{N}(0, \sigma_0^2). \tag{6}$$

We also assume that a target price is an unbiased estimate of the one-year ahead price and therefore its implied return is also an unbiased estimate of μ:

$$\mu_k = \frac{TP_t^k - P_t}{P_t} = \mu + e_k, \qquad e_k \sim \mathcal{N}(0, \sigma_k^2). \tag{7}$$

Whenever a new target price arrives, the market will update its expectation on the one-year ahead price, and if there are K target price releases within a short period of time, the expected return will have the posterior distribution given in Proposition 1.

Proposition 1. *When there are K target price releases, the posterior distribution of μ is a normal distribution with the hyperparameters defined as:*

$$\hat{\mu} = \frac{\mathrm{E}[P_{t+1} | TP_t^1, \ldots, TP_t^K] - P_t}{P_t} = \frac{\sigma_0^2 \bar{\mu}_K + \bar{\sigma}_K^2 \mu_0}{\sigma_0^2 + \bar{\sigma}_K^2}, \tag{8}$$

$$\sigma_{\hat{\mu}}^2 = \mathrm{Var}[\hat{\mu}] = \frac{\sigma_0^2 \bar{\sigma}_K^2}{\sigma_0^2 + \bar{\sigma}_K^2}, \tag{9}$$

where

$$\bar{\mu}_k = \frac{\bar{\sigma}_{k-1}^2 \mu_k + \sigma_k^2 \bar{\mu}_{k-1}}{\bar{\sigma}_{k-1}^2 + \sigma_k^2} \quad \textit{for } k = 2, \ldots, K, \quad \textit{and} \quad \bar{\mu}_1 = \mu_1, \tag{10}$$

$$\bar{\sigma}_k^2 = \frac{\bar{\sigma}_{k-1}^2 \sigma_k^2}{\bar{\sigma}_{k-1}^2 + \sigma_k^2} \quad \textit{for } k = 2, \ldots, K, \quad \textit{and} \quad \bar{\sigma}_1^2 = \sigma_1^2. \tag{11}$$

Proof: See the Appendix.

As it is difficult to distinguish analysts' forecasting power, we further assume that their forecasting errors have the same variance. Corollary 1 derives the posterior in such case.

Corollary 1. *If $\sigma_1^2 = \cdots = \sigma_K^2 \equiv \sigma_{TP}^2$,*

$$\hat{\mu} = \frac{K\sigma_0^2 \mu_{TP} + \sigma_{TP}^2 \mu_0}{K\sigma_0^2 + \sigma_{TP}^2}, \tag{12}$$

$$\sigma_{\hat{\mu}}^2 = \frac{\sigma_0^2 \sigma_{TP}^2}{K\sigma_0^2 + \sigma_{TP}^2}, \tag{13}$$

where $\mu_{TP} = \dfrac{1}{K}\sum_{k=1}^{K}\mu_k = \dfrac{\frac{1}{K}\sum_{k=1}^{K} TP_t^k - P_t}{P_t}$ *is the return implied by the average target price.*

The posterior mean $\hat{\mu}$ is a weighted average of μ_0 and μ_{TP} with weights proportional to the reciprocal of their variances, σ_0^2 and σ_{TP}^2/K. Letting $\tau = \sigma_{TP}/\sigma_0$, $\hat{\mu}$ can be rewritten as:

$$\hat{\mu} = \frac{K\mu_{TP} + \tau\mu_0}{K + \tau^2}. \tag{14}$$

The revision $\hat{R}$ is then given by:

$$\hat{R} = \hat{\mu} - \mu_0 = \frac{K(\mu_{TP} - \mu_0)}{K + \tau^2}. \tag{15}$$

Note that $\hat{R}$ increases not only with the average target price but also with the number of analysts, K. This is plausible as more target prices will increase investors' confidence in their average.

If there are sufficiently many analysts for a stock (so large K) and their forecast errors are small compared to the error in μ_0 (so small τ), that is, $\tau \ll K$, $\hat{R}$ could be approximated to $(\mu_{TP} - \mu_0)$ and would no longer depend on K. However, none of these assumptions is realistic as there are only a few target price releases per stock each month, and the poor forecasting power of target prices is well documented in the literature.

Given the small number of analysts and their substantial forecasting errors, $\tau \gg K$ is a more plausible assumption, in which case, $\hat{R} \approx \frac{K}{\tau^2}(\mu_{TP} - \mu_0)$. As τ is constant across stocks, it can be omitted without loss of generality, and the impact of target prices can be predicted using the measure:

$$\hat{R}_s = K(\mu_{TP} - \mu_0) = \sum_{k=1}^{K}(\mu_k - \mu_0). \tag{16}$$

Defining the measure as in (16) is convenient as it avoids nontrivial estimations of σ_0 and σ_{TP}^2. Nonetheless, due to $\hat{R}_s$'s sensitivity to μ_k, the correlation between $\hat{R}_s$ and the true $R = \mu - \mu_0$ can be considerably low if target prices are subject to bias. It is well-known that analysts tend to overestimate the future price (*e.g.*, Bradshaw et al., 2013). Therefore, we propose another measure that is more robust in the presence of bias:

$$\hat{R}_n = \sum_{k=1}^{K} \text{sgn}(\mu_k - \mu_0), \tag{17}$$

where sgn(x) is a sign function that returns 1 if $x > 0$, -1 if $x < 0$, and 0 otherwise. The robustness of $\hat{R}_n$ can be established following the approach of Chiang et al. (2019), who develop a robust measure of earnings surprises. Relevant assumptions and key results are in the Appendix.

2.2.1. *Net number of optimistic analysts*

The calculation of $\hat{R}_n$ requires the unobservable μ_0, the expected return implied in the current price. Instead of estimating μ_0, we set $\mu_0 = 0$ to obtain a parameter-free measure, the net number of optimistic analysts (NOA):

$$NOA = \sum_{k=1}^{K} \text{sgn}(\mu_k). \tag{18}$$

Setting $\mu_0 = 0$ is not merely for convenience. Since investors cannot observe μ_0, they may draw sentiment simply by comparing the target price with the current price, which is equivalent to setting $\mu_0 = 0$. We calculate NOA every month using the target prices released within the month and the stock price at the end of the previous month.[2]

Another way of viewing NOA is as the difference between the number of optimistic analysts and the number of pessimistic analysts (hence the name):

$$NOA = NO - NP, \tag{19}$$

where NO is the number of analysts with an optimistic outlook ($TP_t^k > P_t$), and NP is the number of analysts with a pessimistic outlook ($TP_t^k < P_t$). If five analysts release target

[2] In an unreported analysis, we also define NOA using the prices two days prior to target price releases and find both definitions render qualitatively similar results.

prices for a stock, of which three are higher than the current price and two are lower, NOA would have a value of $3 - 2 = 1$. In this regard, NOA reflects analysts' overall sentiment on a firm with a positive (negative) value implying an optimistic (pessimistic) view.

Apart from it being robust to forecast bias, there are other reasons why we prefer NOA as the primary predictor of the future expected return. First, NOA is expected to more efficiently detect the information associated with the future expected return. A target price substantially different from the current price is likely to reflect a fundamental change of the firm's value and its future cash flow rather than the discount rate. Unlike a measure proportional to the distance between the target price and the current price, the sign-based NOA is not affected by the distance and therefore is less sensitive to large, cash flow-based target price revisions. Second, a long-short portfolio strategy based on NOA will contain more large and liquid stocks making its implementation more feasible. By the definition of NOA, stocks with the highest/lowest NOA values (therefore included in the long-short portfolio) are likely to be those with the largest number of target prices. Since large firms attract more analysts, these are usually large stocks. The empirical analysis in Section 3 confirms this is the case. Finally, by using the number of analysts rather than their fraction, NOA accounts for investors' confidence in target prices.

2.2.2. *Alternative Measures*

- **Sum of target price implied returns (STPR).** STPR is an implementable version of $\hat{R}_s$ and is defined as:

$$STPR = \sum_{k=1}^{K} \mu_k. \tag{20}$$

  In the absence of bias in target prices, STPR would be a better predictor than NOA.

- **Mean of target price implied returns (MTPR).** MTPR is defined as:

$$MTPR = \frac{1}{K} \sum_{k=1}^{K} \mu_k. \tag{21}$$

MTPR is the most commonly used consensus measure and would be appropriate if there are a sufficient number of analysts, and their forecasting errors are relatively small. Contrary to STPR, MTPR does not account for investors' confidence in target prices.

- **Median.** While it is robust to outliers, it does not appear to be a proper measure for our problem where target prices are released discretely over time: it is difficult to argue that investors will wait for a certain period and choose the median target price before they make investment decisions.

- **Fraction of optimistic analysts.** Another sign-based measure worth considering is the fraction of optimistic analysts (FOA), defined as:[3]

$$FOA = \frac{NO - NP}{K} = \frac{NOA}{K}. \tag{22}$$

While NOA measures the net number of optimistic analysts, FOA measures their fraction, and their relationship is equivalent to that of STPR and MTPR. With the poor forecasting power of target prices, NOA is believed to be a better measure as it accounts for investors' confidence. We highlight the difference between the two measures in the following example and provide further reasons why NOA is considered a better predictor for our purpose.

Suppose analysts release target prices for three stocks as below.

	NO	NP	NOA	FOA
Stock A	3	0	3	1
Stock B	6	0	6	1
Stock C	9	6	3	1/5

[3]FOA is similar to the robust earnings surprise measure of Chiang et al. (2019), the fraction of misses on the same side (FOM), which is defined as $FOM = \frac{K-M}{N}$, where N is the number of forecasts, K is the number of forecasts smaller than the actual announced earnings, and M is the number of forecasts greater than the actual earnings.

Comparing Stock A with Stock B, investors would consider the view on Stock B more optimistic as it has more optimistic target prices. In this case, NOA appears to be a more appropriate measure as it prioritizes the stock with more analysts. Meanwhile, FOA seems to be a better measure when we compare Stock A with Stock C as it assigns a lower value to Stock C, on which analysts' opinions are divided.

While both measures have their own advantages in different circumstances, our sample reveals that analysts tend to share their opinion (all optimistic or all pessimistic) as in the case of Stock A and Stock B, making NOA preferable to FOA: FOA does not distinguish stocks with different numbers of analysts if all analysts of a stock have the same opinion. The wider range of the value is another advantage of NOA as it facilitates sorting stocks and constructing quantile portfolios. Sorting on FOA is problematic as a large portion of stocks has FOA equal to 1 or -1.

Similar measures can be defined based on target price revisions by replacing P_t with the previous target price, TP_0^k:

- **Revision-based NOA (RNOA).**

$$RNOA = \sum_{k=1}^{K} \operatorname{sgn}\left(\frac{TP_t^k - TP_0^k}{TP_0^k}\right). \tag{23}$$

- **Revision-based STPR (RSTPR).**

$$RSTPR = \sum_{k=1}^{K} \left(\frac{TP_t^k - TP_0^k}{TP_0^k}\right). \tag{24}$$

In the empirical analysis, the previous target price is defined as the latest target price from the same brokerage within the past six months. NOA and the alternative measures are compared in the Appendix.

3. Profitability of NOA

In this section, we carry out a battery of portfolio and regression analyses to assess NOA's cross-sectional predictive power for future stock returns. We start with one-dimensional portfolio sorts to examine the profitability of a NOA-based long-short portfolio strategy and identify the connection between NOA and other firm characteristics. Employing five asset pricing models, we test whether the return of the NOA strategy can be explained by risk factors. We also conduct two-dimensional portfolio sorts to examine the viability of the NOA strategy after controlling for well-known firm characteristics and risk factors. We further investigate the interaction between NOA and other variables using firm-level cross-sectional regressions. Firm-level characteristics used throughout the paper are described in the Appendix.

3.1. *Data sample*

The sample consists of common stocks that are traded in the NYSE, AMEX, and Nasdaq exchanges and have analysts' target prices. The sample period is from February 1999 to December 2020, during which I/B/E/S provides individual analysts' target price data. Daily and monthly return data are collected from CRSP, and accounting variables are obtained from the merged CRSP-Compustat database. Following standard data cleansing procedures, we exclude monthly stock observations with any of the following information missing: book-to-market ratio, closing price on the last day of the previous month, shares outstanding, and return for the previous month. Stocks with a price below 5 dollars or an average target price implied return above 200% or below -99% are also excluded from the sample. After data-cleansing, there are 347,224 stock-month observations, 262 months, average 1,325 stocks per month, and average 4.86 analysts per stock-month in the sample.

3.2. *One-dimensional sorts*

By sorting individual stocks on NOA, we form equal-weighted decile portfolios at the end of each month during the sample period so that the first decile (Low) contains stocks with the lowest NOA and the tenth decile (High) contains stocks with the highest NOA. For each decile portfolio and the Low-minus-High (L-H) portfolio, future monthly excess returns are calculated up to one year as presented in Table 1. Panel A reports the average excess return of each portfolio in the portfolio formation month (RET0), in the next month (RET1), and over the next year (RET[1, 12]). The past one-month (RET-1) and one-year (RET[-12, -1]) returns prior to portfolio formation are also reported for comparison. Panel B reports average monthly excess returns of the long-short portfolio up to one year after portfolio formation. The *t*-statistics in the tables are Newey and West (1987) adjusted *t*-statistics.

[TABLE 1 here]

Consistent with studies that document a significant price reaction around target price releases, the return in the formation month increases with NOA. To ensure this pattern is not driven by the price movement before target price releases, we also calculate average five-day (DRET[-2, 2]) and eight-day (DRET[-2, 5]) excess returns surrounding target price releases. These returns are highly correlated with the formation month return (the correlation coefficients are 0.66 and 0.70, respectively), confirming that the cross-sectional variation of the formation month return is mainly associated with target price releases.

If the short-term market reaction implies a shift in future discount rates, low (high) NOA portfolios will have higher (lower) expected returns in the subsequent months. The average one-month ahead excess return (RET1) supports this view. The Low NOA portfolio earns on average an excess return of -1.61% in the formation month and 1.35% in the next month, whereas the High NOA portfolio earns an excess return of 4.26% in the formation month and 0.60% in the next month. The average return spread between the Low and High portfolios drops to -5.87% (t-statistic = -8.53) in the formation month but rebounds to 0.75% (t-statistic = 3.87) in the following month.

The NOA strategy continues to earn positive returns over longer holding periods, achieving an impressive 10.00% (t-statistic = 8.44) average one-year cumulative excess return without rebalancing. The average monthly excess return of the NOA strategy hardly diminishes over time (see Panel B), suggesting that the return is not concentrated in a few months but rather accumulated gradually throughout the year. It is remarkable that the NOA strategy consistently generates significant returns over a year that are nearly 0.7% per month. This is clearly visualized in the first two graphs of Figure 2. The top-left graph shows the reversal of returns following the initial shock in the formation month.

[FIGURE 2 here]

As shown in the graph at the bottom of Figure 2, an annually-rebalanced NOA strategy earns a higher return than a monthly-rebalanced strategy even before accounting for transaction costs.[4] The long-term profitability of the NOA strategy is particularly attractive and important to practitioners as it allows them to maximize net return by reducing turnover. As Novy-Marx and Velikov (2015) document, transaction costs severely reduce anomalies' profitability and significance. The results in Table 1 suggest that the NOA strategy has the potential to generate abnormal returns over a long horizon without the necessity of frequent portfolio rebalancing.

The persistence of the NOA premium supports our view that it is derived from a discount rate shift. While overreaction is another plausible explanation behind the phenomenon, the correction would occur more rapidly if it is the case. Moreover, the magnitude of the initial shock following a target price release is considerably smaller than the magnitude of the return implied by the target price (compare DRET[-2, 5] in Table 1 with MTPR in Table 3), which indicates that, if anything, the market underreacts to target price releases. Underreaction is

[4]When stocks are value-weighted, the two cumulative returns become comparable.

more likely as investors must recognize the large estimation errors of target prices.[5]

Comparing the Low and High NOA portfolios, we can see that the profit of the NOA strategy originates mostly from the long leg: the average one-month ahead excess return of the Low NOA portfolio is 1.35% and significant (t-statistic = 3.95), whereas that of the High NOA portfolio is 0.60% and insignificant (t-statistic = 1.64). This result is remarkable as most anomaly portfolio strategies earn their profits from the short leg. The high profitability of the long leg indicates that the NOA strategy can earn significant profits even when short-sale is restricted. It also implies that the abnormal return of the NOA strategy cannot be explained by limits-to-arbitrage, which ascribes the premium of an anomaly-based trading strategy to short-sale constraints and overpriced short-lag stocks. This topic is further discussed in Subsection 4.3.1.

Apparently, the NOA strategy is similar to the short-term reversal strategy as both buy losers and sell winners. Nevertheless, the NOA strategy mainly involves large, liquid stocks and does not share the typical characteristics of the short-term reversal strategy. In Subsection 4.3.2, we compare two strategies and confirm that NOA is not subsumed by the short-term reversal.

Table 2 reports the results from value-weighted portfolios. Remarkably, the return of the value-weighted NOA strategy is comparable to that of the equal-weighted strategy. The average one-month ahead excess return is 0.94% (t-statistic = 4.37), and the average one-year cumulative excess return is 9.10% (t-statistic = 5.98), suggesting that the profitability of the NOA strategy is not a mere small firm phenomenon. Overall, the results from the value-weighted portfolios are similar to those from the equal-weighted portfolios.

[TABLE 2 here]

We conduct one-dimensional sorts using alternative measures and report the results in the Appendix. The measure that takes into account the magnitude of the target price

[5] Underreaction in our context does not mean the price should drift in the same direction with the initial shock. With a change in discount rates, return reversal can occur even when the market underreacts.

implied return (STPR) exhibits slightly higher returns than NOA but they are less significant. The results also show that accounting for the number of target price releases enhances the performance of the long-short strategy. When STPR and NOA are compared with MTPR and FOA, respectively, which are similarly defined to STPR and NOA but without taking the number of target price releases into account, the former measures result in more significant long-short portfolio returns. Another interesting point to note is that when revision-based measures are employed, returns do not reverse direction but drift in the direction implied by target price revisions, which is consistent with the findings of Brav and Lehavy (2003). This leads to a negative long-short portfolio return, which is, however, insignificant.

3.3. *Average characteristics*

Table 3 presents the average characteristics of the equal-weighted decile portfolios formed on NOA. NOA varies from -4.47 (Low) to 13.37 (High), which means on average four more analysts issue pessimistic forecasts in the Low NOA portfolio and thirteen more analysts issue optimistic forecasts in the High NOA portfolio. The greater magnitude of NOA in the High NOA portfolio reflects analysts' tendency to issue more optimistic forecasts. The number of analysts ($NALST$) is U-shaped (with a larger value on H) and is comparable to the magnitude of NOA: for instance, $NALST$ of the Low and High NOA portfolios are respectively 5.88 and 14.98. This implies that analysts usually issue target prices in the same direction.

[TABLE 3 here]

The market capitalization ($MCAP$) is also U-shaped as large firms attract more analysts. The average market capitalizations of the Low and High NOA portfolios are respectively \$10.49 billion and \$23.40 billion, much greater than that of the entire sample, \$10.18 billion, and the CRSP universe, \$3.19 billion. Involving mostly large-cap stocks, the NOA strategy is easier to implement than other strategies that often involve small-cap stocks. The turnover

($TURN$) is also pronounced in the extreme deciles, suggesting that the stocks in these portfolios are more actively traded during the formation month.

Among the characteristics correlated with NOA are the market beta ($BETA$), short-term reversal ($MOM1M$), dispersion of opinion ($DISP$), mispricing ($MISP$), and profitability measures. The correlation with these variables suggests an implicit connection between the NOA anomaly and well-known anomalies. The market beta increases with NOA, suggesting that the NOA anomaly is consistent with the low-beta anomaly (Frazzini and Pedersen, 2014). The short-term reversal increases with NOA, suggesting that the NOA anomaly is consistent with the short-term reversal effect (Jegadeesh and Titman, 1993). The positive correlation between the dispersion of opinion and NOA is consistent with the findings of Diether et al. (2002). NOA's negative correlation with profitability conforms to the capital budgeting perspective of Cochrane (1991) that a firm with higher profitability has a higher discount rate, namely higher expected return.

The mispricing score ($MISP$) of Stambaugh and Yuan (2016) increases with NOA, which implies that low NOA stocks are underpriced and high NOA stocks are overpriced. The High NOA portfolio's high return (4.26%) in the formation month supports that the stocks in this portfolio are overpriced. This finding is also consistent with the high dispersion of opinion of the High NOA portfolio: analysts tend to issue more optimistic earnings forecasts when earnings are uncertain (Scherbina, 2004). In an unreported analysis, we examine the time variation of the mispricing score over the next twelve months and find that the mispricing gap between the Low NOA portfolio and the High NOA portfolio decreases over time from 2.90 to 2.21. This result implies that mispricing is evident in the portfolio formation month and it is reduced over time, which is consistent with the mispricing hypothesis.

The average recommendation ($RECOM$) decreases with NOA, implying that analysts' recommendations are consistent with target prices.[6]

[6] The scale of recommendation is: 1. Strong Buy, 2. Buy, 3. Hold, 4. Underperform, 5. Sell.

3.4. *Factor model regressions*

We next employ the following asset pricing models to examine whether the NOA premium can be explained by risk factors: Fama and French (1993) three-factor, Carhart (1997) four-factor, Fama and French (2015) five-factor, Hou et al. (2015) four-factor, and Stambaugh and Yuan (2016) four-factor models. Table 4 reports the time series regression results of the equal-weighted portfolios.[7] The risk-adjusted return (α) from the Fama and French three-factor model decreases from 0.41% to -0.33% as we move from the lowest to highest NOA quantile, resulting in an economically and statistically significant α of the L-H portfolio, which is 0.74% per month with t-statistic = 3.79. The magnitude of the risk-adjusted return tends to diminish as more factors are added, but it remains significant in all models. The results in Table 4 suggest that market, size, book-to-market, momentum, profitability, investment, and mispricing cannot explain the return spread between the Low and High NOA stocks. Considering that the sample is comprised mainly of large and liquid stocks, this result is particularly impressive.

[TABLE 4 here]

The loading on the market portfolio is smaller for the low NOA portfolio, which can be used to argue against the discount rate hypothesis. However, the loadings on all the other risk factors are higher for the low NOA portfolio and many of the factor loadings on the L-H portfolio are significant: for instance, HML and MOM in the Carhart four-factor model and SMB and ROE in the Hou-Xue-Zhang four-factor model are significant. This finding is in line with the discount rate hypothesis. The factor regression result, although weak, appears to support the discount rate hypothesis.

The same time series regression analysis is repeated using value-weighted portfolios.[8] Consistent with the results from one-dimensional sorts, the risk-adjusted returns of the

[7] Due to data availability, the sample period for the Stambaugh and Yuan (2016) four-factor model ends in December 2016.

[8] The results are omitted to save the space.

value-weighted portfolios are comparable to those of the equal-weighted portfolios. Recently discovered factors help explain the return spread, but cannot eliminate it completely. The large and significant risk-adjusted returns of the value-weighted portfolios confirm that the NOA premium does not stem from small-cap stocks.

The factor regressions reassure the previous finding that the profit of the NOA strategy is derived primarily from the long leg. When stocks are equal-weighted, the α of the Low NOA portfolio is significantly positive regardless of the factor model (t-statistic ranging from 2.11 to 4.04), whereas the α of the High NOA portfolio is insignificant in all factor models. The results are similar when stocks are value-weighted. These results confirm that the significantly positive α of the L-H portfolio originates primarily from the superior performance of the Low NOA portfolio.

3.5. *Two-dimensional sorts*

The viability of the NOA anomaly is further investigated using two-dimensional independent sorts. We construct 5×5 portfolios formed on NOA and one of the following control variables: the market beta ($BETA$), size ($SIZE$), book-to-market ratio (BM), momentum ($MOM12M$), short-term reversal ($MOM1M$), idiosyncratic volatility ($IVOL$), illiquidity ($ILLQ$), turnover ($TURN$), dispersion of opinion ($DISP$), profitability (ROE, GMA, OP), investment (IA), and institutional ownership ($INST$, RI).

Table 5 reports the average one-month ahead excess returns of these portfolios. The return spread between the Low and High NOA portfolios is significantly positive in most beta groups (except for group 2), implying that the market beta cannot explain the NOA anomaly. The return spread is also economically and statistically significant within most groups of size and book-to-market ratio except for the smallest size and the highest book-to-market ratio groups. The wide return variation across NOA groups within each of these groups indicates that NOA is not merely capturing the size or value effect.

[TABLE 5 here]

From the two-dimensional sorts on NOA and momentum, and NOA and short-term reversal, we observe significantly positive return spreads between the Low and High NOA portfolios across all groups, which suggests that the cross-sectional predictive power of NOA cannot be explained by these factors. The return spread also remains significant in most groups of idiosyncratic volatility, illiquidity, and turnover. The significance of the return spread becomes weaker within each group of dispersion of opinion. However, it is largely due to the imbalanced distribution of stocks across $DISP$: for many stocks, there is only one target price release, resulting in a zero $DISP$ of these stocks and overall a narrow range of $DISP$.

The return spread remains significant in most profitability and investment groups indicating that the NOA premium cannot be explained by the capital budgeting perspective. Institutional ownership cannot explain the NOA premium, either. Overall, the NOA premium is not subsumed by any of the control variables considered here.

3.6. *Firm-level cross-sectional regression*

A portfolio-level analysis is nonparametric and does not require a functional form specifying the relationship between NOA and future returns, but it cannot test NOA controlling for multiple characteristics simultaneously due to the reduced sample size. We next investigate the informativeness of NOA using a firm-level monthly Fama and MacBeth (1973) cross-sectional regression of the form:

$$r_{i,t+m} = \lambda_{0,t} + \lambda_{1,t} NOA_{i,t} + \boldsymbol{\lambda}_{2,t}^T \boldsymbol{X}_{i,t} + \epsilon_{i,t+1}, \tag{25}$$

where $r_{i,t+m}$ is the m-month ahead realized excess return on stock i, $NOA_{i,t}$ is the net number of optimistic analysts of stock i in month t, and $\boldsymbol{X}_{i,t}$ is a collection of firm-specific control variables for stock i observed at the end of t. $\boldsymbol{X}_{i,t}$ includes the market beta ($BETA$), size ($SIZE$), book-to-market ratio (BM), momentum ($MOM12M$), short-term reversal

($MOM1M$), idiosyncratic volatility ($IVOL$), Amihud's (2002) illiquidity measure ($ILLQ$), analyst coverage ($CVRG$), dispersion of opinion ($DISP$), return-on-equity (ROE), Novy-Marx's (2013) profitability (GMA), operating profit (OP), and investment (IA).

Table 6 reports the time series averages of the coefficients on NOA and the control variables for one-month ahead return (Panel A), and the average coefficient on NOA for two- to twelve-month returns controlling for all the firm characteristics (Panel B). The simple regression result in the first column confirms the negative and statistically significant relation between NOA and the one-month ahead return, with an average coefficient of -0.00046 (t-statistic = -3.24). The economic significance of this value can be inferred from the NOA values of the decile portfolios in Table 3. The average NOA of the Low NOA portfolio is -4.47, whereas that of the High NOA portfolio is 13.37. The average coefficient implies that the future return will decrease on average by 0.82% ($= -0.00046 \times (13.37 - (-4.47))$) per month when a stock moves from the lowest to highest decile.

[TABLE 6 here]

The second column of Table 6 reports the coefficient on NOA after controlling for the market beta, size, book-to-market ratio, momentum, and short-term reversal. The coefficient on NOA remains negative and significant; -0.00034 with t-statistic = -3.85, whereas the coefficients on the control variables are insignificant except for size, which is negatively correlated with the one-month ahead return.

We repeat the regression analysis after adding to the above control variables one of the following variables: idiosyncratic volatility, illiquidity, analyst coverage, dispersion of opinion, investment, or profitability. We find that none of these variables is significant. The coefficient on NOA hardly changes after controlling for these variables. The result is similar even after adding all control variables (column (11)).

The weak explanatory power of the control variables is partially attributable to two aspects of the sample: the size of the firms and the sample period. The sample contains only the stocks with analysts' target prices, which inevitably restricts the sample to relatively large and liquid stocks, and to a recent period. As Green et al. (2017) document, most firm characteristics known to have predictive power lose their power among non-micro firms since 2003. In contrast, NOA survives and remains significant in this sample.

Panel B reports the average coefficient on NOA for two- to twelve-month returns after controlling for all the firm characteristics. Remarkably, the average coefficient on NOA remains negative and significant for all future returns. The long-lasting NOA premium supports our view that there is a shift in discount rates when target prices are released.

3.7. *Determinants of NOA*

We next investigate the determinants of NOA using firm-level cross-sectional regressions. We regress NOA on lagged firm-level characteristics and risk factors and report the time series averages of the coefficients in Table 7.[9] The results in the first two columns are from simple regressions and the other two columns are from a multiple regression involving all variables.

[TABLE 7 here]

The first row of the simple regression results shows that NOA is significantly positively related to the lagged market beta (t-statistic = 7.67), implying that analysts consider systemic risk in their forecasts and assign higher target prices to riskier stocks, which is consistent with the traditional risk-based framework. On the other hand, no significant relationship is found between NOA and the lagged total or idiosyncratic volatility, suggesting that analysts are less concerned about idiosyncratic risk.

The coefficient on the size is positive and significant (t-statistic = 7.41), and the coefficient on Amihud's (2002) illiquidity measure is negative and significant (t-statistic = -7.19), implying that analysts give a more favorable forecast to large and liquid firms. The positive

[9] Exceptions are the analyst coverage and dispersion of opinion whose calculations are based on the target prices of the same month.

and significant relationship between NOA and the lagged turnover (t-statistic = 5.34) also supports this view. Both the price momentum (t-statistic = -2.77) and short-term reversal (t-statistic = -4.91) factors are negatively correlated with NOA, suggesting that analysts behave like a contrarian.

NOA is positively correlated with the analysts' coverage, implying that analysts tend to issue a more optimistic target price. The coefficient on the dispersion of opinion is also positive and extremely significant (t-statistic = 18.97), suggesting that analysts are inclined to issue an optimistic target price when the future value of a stock is uncertain. This result is in line with Scherbina's (2004) finding that analysts issue more optimistic earnings forecasts when earnings are uncertain and explains to some extent the low return of high NOA stocks. Analysts also appear to allocate a low target price to the firms that are profitable and invest less as evidenced from the negative coefficients on ROE, GMA, and OP, and the positive coefficient on IA.

When all variables are considered together, some coefficients change their sign and significance implying that their marginal effects are different. In particular, the coefficients on the lagged illiquidity and turnover change their sign while remaining significant. Overall, stocks with low target prices tend to have characteristics that are known to be associated with high future returns, for instance, low beta, small size, and high momentum. While it is unclear whether analysts actually consider these factors in their forecasting process, the inverse relationship between NOA and these variables appears to contribute to the return reversal and strengthen the NOA premium.

4. Potential sources of profit

As described in Section 2, there are two possible explanations for the profitability of the NOA strategy:

1. (Discount rate shift) The market perceives target prices as a risk indicator.

2. (Mispricing) The market reacts to target prices regardless of its forecasting accuracy and corrects itself as the true value of the firm is gradually revealed.

In this section, we examine these hypotheses via a set of analyses. As detailed below, the evidence suggests that the NOA premium is attributable to both hypotheses.

4.1. *NOA premium around earnings announcements*

If the NOA profit is due to mispricing and subsequent correction, it would become more pronounced when new information on cash flow arrives in the market. To test this, we adopt La Porta et al.'s (1997) approach, which hypothesizes that an anomaly associated with mispricing is more pronounced during earnings announcement periods as earnings news helps correct mispricing. This hypothesis is advocated by many studies that report higher anomaly returns around earnings announcement days, for instance, La Porta et al. (1997), Bradshaw et al. (2006), and Lou and Shu (2017). More recently, Engelberg et al. (2018), using a sample of 97 stock return anomalies, find that anomaly returns are six times higher for earnings announcement periods.

We select stocks with an earnings announcement in the first month following portfolio formation and compute the abnormal return over the three-day window [-1, 1] around the announcement day and the rest of the month by subtracting the value-weighted CRSP return from the stock return. This procedure is repeated every month in the sample period to obtain the time series averages of the abnormal returns reported in Table 8. Consistent with earlier studies, the NOA premium is more pronounced around earnings announcement days: the average return spread between the Low and High NOA portfolios is 0.55% (3.64% per month, t-statistic = 2.65) around earnings announcement days, whereas it is 1.19% (1.40% per month, t-statistic = 3.54) for non-announcement days. The difference is also statistically significant (t-statistic = 2.45). This result supports the mispricing hypothesis.

[TABLE 8 here]

4.2. *Earnings announcements in the formation month*

If the return reversal were caused by mispricing correction, it would be attenuated when there is an earnings announcement in the formation month as it would help forecast cash flow more precisely. To test this, we separate the sample universe into two subsamples: stocks with or without an earnings announcement during the portfolio formation month. We then calculate the NOA premium from each subsample.

In Table 9, Panel A, B, and C report the average one-month ahead excess returns and risk-adjusted returns of the portfolios formed on NOA in each subsample, and Panel D and E report longer-term average excess returns. We find that the return spread between the Low and High NOA portfolios is considerably higher (0.80% per month, t-statistic = 4.80) in the first subsample (no earnings announcements) compared to the return spread (0.29% per month, t-statistic = 1.38) in the second subsample. Moreover, the risk-adjusted returns remain positive and significant under all asset pricing models in the first subsample, whereas they are often insignificant in the second subsample.

[TABLE 9 here]

The above results appear to support the view that the return reversal is due to mispricing correction. However, if we look at a longer horizon (Panels D and E), it turns out that the returns from the second subsample are higher in months 3, 6, 9, and 12 (earnings announcement months) and lower for the rest of the year, yielding a one-year cumulative return comparable to that of the first subsample. Furthermore, the returns of both the Low and High NOA portfolios increase in earnings announcement months. These results suggest that earnings announcements enhance short-term returns by reducing uncertainty, but hardly affect the long-term profitability of NOA, which is more in line with the first hypothesis. Overall, the empirical evidence suggests that the NOA anomaly is caused by both discount rate shifts and mispricing correction.

4.3. *Alternative hypotheses*

4.3.1. *Limits-to-arbitrage*

The theory of limits-to-arbitrage states that the profitability of an anomaly-based trading strategy is lower among the stocks priced more efficiently, such as large and liquid stocks, and those with high institutional ownership. Limits-to-arbitrage has been successfully employed to explain various anomalous profits, and recent studies show that anomalies often disappear when micro stocks are removed from the sample (Green et al., 2017; DeMiguel et al., 2020). In addition, consistent with the Miller's (1977) theorem, which suggests that heterogeneous beliefs and short-sale constraints lead to overpricing and subsequent low stock returns, most well-known anomaly-based trading strategies generate their profits from the short leg comprising overpriced stocks. Moreover, Stambaugh et al. (2012) investigate the presence of market-wide sentiment effects by combining Miller's (1977) argument and find that the short leg of each strategy is more profitable following periods of high sentiment. In contrast, the empirical analysis reveals that this is not the case for the NOA anomaly.

To examine limits-to-arbitrage, we revisit Table 5, which reports the one-month ahead excess returns of the double-sorted portfolios formed on NOA and one of the size ($SIZE$), illiquidity ($ILLQ$), and institutional ownership ($INST$, RI) factors. The average excess return of the long-short portfolio is 0.81% (t-statistic = 5.29) among the biggest stocks, whereas it is 0.36% (t-statistic = 1.08) among the smallest stocks. Sorting on the Amihud's illiquidity measure, we obtain a significantly positive return (0.79%, t-statistic = 4.67) among the most liquid stocks, but an insignificant return (0.08%, t-statistic = 0.26) among the least liquid stocks. Our finding is contrary to the intuition behind limits-to-arbitrage and inconsistent with Miller (1977) and Stambaugh et al. (2012).

The evidence from the institutional ownership strengthens our view. The return spread is significant in both the lowest and the highest institutional ownership stocks. The result is similar when we employ Nagel's (2005) residual institutional ownership: 0.83% (t-statistic

= 2.52) among the highest institutional ownership stocks and 0.90% (t-statistic = 2.69) among the lowest institutional ownership stocks. The higher return spread among higher institutional ownership stocks contradicts the notion of limits-to-arbitrage.

In Subsection 3.2, we find that the economically and statistically significant return of the NOA strategy stems from the superior performance of the long leg comprising low NOA stocks: to recall, the one-month ahead excess return on the Low NOA portfolio is 1.35% (t-statistic = 3.95), whereas the return on the High NOA portfolio is 0.60% (t-statistic = 1.64). The risk-adjusted returns in Table 4 also show similar results. Furthermore, the fact that the short leg of the NOA strategy usually earns a positive return rules out the possibility of overpricing of the stocks in the short leg. In conclusion, the models of Miller (1977) and Stambaugh et al. (2012) cannot explain the profit of the NOA strategy.

Chordia et al. (2014) find that the attenuation of equity return anomalies is contemporaneous with the increased stock market liquidity and arbitrage trading that resulted from the decimalization in 2001. The fact that the NOA profit is obtained during the period from 1999 to 2020 reaffirms that limits-to-arbitrage is not a likely cause for the NOA anomaly.

4.3.2. *Short-term reversal*

NOA is positively correlated with the stock return in the portfolio formation month, implying that the NOA strategy tends to buy recent losers and sell recent winners. Although there is an apparent connection between NOA and short-term reversal, the NOA strategy does not share the typical characteristics of the short-term reversal strategy.

The profit of the reversal strategy is mainly derived from small, high turnover, and illiquid stocks (Grossman and Miller, 1988; Campbell et al., 1993; Conrad et al., 1994; Avramov et al., 2006). In contrast, the stocks that constitute the NOA strategy are large and liquid as witnessed in Table 3. In addition, the two-dimensional sort results in Table 5 reveal that the NOA premium is insignificant among small or illiquid stocks. These results indicate that we are not rediscovering the short-term reversal through NOA. Furthermore, the firm-level cross-sectional regression results in Table 6 show that the short-term reversal does not carry a significant premium.

To confirm our claim, we construct equal-weighted decile portfolios using the short-term reversal factor and calculate average one-month ahead excess returns, both in our sample and in the entire CRSP universe excluding our sample. The results in Table 10 show that while the short-term reversal is observable from the CRSP universe during the same period, it disappears in our sample, which can be attributed to the relatively large and liquid stocks in our sample. The results confirm that NOA is irrelevant to the short-term reversal.

[TABLE 10 here]

5. Conclusion

We develop a robust measure, the net number of optimistic analysts (NOA), to capture the impact of target price releases on the market. We show that it has a strong negative cross-sectional predictive power for future stock returns as stock returns drift in the opposite direction to target prices after an initial price shock.

A long-short portfolio strategy based on NOA is highly profitable. It yields an economically and statistically significant one-month ahead return of 0.75% per month, and the risk-adjusted returns obtained from various asset pricing models remain significant. Two-dimensional sorts and firm-level cross-sectional regression results reveal that NOA is not subsumed by other firm characteristics or risk factors, such as the size, book-to-market ratio, and momentum.

The NOA anomaly is characterized by several favorable features that distinguish it from other anomalies and make the implementation of the long-short strategy easy. Remarkably, the long-short portfolio involves large, liquid, and high institutional ownership stocks, and its profit is more pronounced among larger and more liquid stocks. The profit mostly arises from the long leg and lasts for a long period, yielding an average cumulative one-year excess return of 10.00%.

Empirical evidence suggests that the NOA anomaly is caused by discount rate shifts as investors perceive target prices as a risk indicator and require a higher return when analysts issue low target prices. Mispricing correction also appears to contribute to the return reversal and enhance the NOA premium.

We contribute to the extant literature by providing new evidence on the informativeness of target prices that contradicts earlier findings. Furthermore, by focusing on investors' perception of target prices rather than their information content, we offer a new insight into the mechanism of target price releases and long-term price reaction. The framework of NOA can be applied to any economic forecasts that affect investors' decisions.

We apply NOA to target prices but applying it to earnings forecasts or other firm-specific news would be interesting future research. With the scraping tools available, it is possible to collect news articles or analyst reports and examine the investors' sentiment changes to them and consequent price reactions.

References

Ali, A., Hwang, L.S., Trombley, M.A., 2003. Arbitrage risk and the book-to-market anomaly. Journal of Financial Economics 69, 355–373.

Amihud, Y., 2002. Illiquidity and stock returns: cross-section and time-series effects. Journal of Financial Markets 5, 31–56.

Ang, A., Hodrick, R.J., Xing, Y., Zhang, X., 2006. The cross-section of volatility and expected returns. The Journal of Finance 61, 259–299.

Asquith, P., Mikhail, M.B., Au, A.S., 2005. Information content of equity analyst reports. Journal of Financial Economics 75, 245–282.

Avramov, D., Chordia, T., Goyal, A., 2006. Liquidity and autocorrelations in individual stock returns. The Journal of Finance 61, 2365–2394.

Bilinski, P., Lyssimachou, D., Walker, M., 2012. Target price accuracy: International evidence. The Accounting Review 88, 825–851.

Bonini, S., Zanetti, L., Bianchini, R., Salvi, A., 2010. Target price accuracy in equity research. Journal of Business Finance & Accounting 37, 1177–1217.

Bradshaw, M.T., Brown, L.D., Huang, K., 2013. Do sell-side analysts exhibit differential target price forecasting ability? Review of Accounting Studies 18, 930–955.

Bradshaw, M.T., Richardson, S.A., Sloan, R.G., 2006. The relation between corporate financing activities, analysts? forecasts and stock returns. Journal of Accounting and Economics 42, 53–85.

Brav, A., Lehavy, R., 2003. An empirical analysis of analysts' target prices: Short-term informativeness and long-term dynamics. The Journal of Finance 58, 1933–1967.

Campbell, J.Y., Grossman, S.J., Wang, J., 1993. Trading volume and serial correlation in stock returns. The Quarterly Journal of Economics 108, 905–939.

Campbell, J.Y., Shiller, R.J., 1988. The dividend-price ratio and expectations of future dividends and discount factors. The Review of Financial Studies 1, 195–228.

Carhart, M.M., 1997. On persistence in mutual fund performance. The Journal of Finance 52, 57–82.

Chen, L., Zhang, L., 2010. A better three-factor model that explains more anomalies. Journal of Finance 65, 563–595.

Chiang, C.h., Dai, W., Fan, J., Hong, H., Tu, J., 2019. Robust measures of earnings surprises. The Journal of Finance 74, 943–983.

Chordia, T., Subrahmanyam, A., Tong, Q., 2014. Have capital market anomalies attenuated in the recent era of high liquidity and trading activity? Journal of Accounting and Economics 58, 41–58.

Cochrane, J.H., 1991. Production-based asset pricing and the link between stock returns and economic fluctuations. The Journal of Finance 46, 209–237.

Conrad, J.S., Hameed, A., Niden, C., 1994. Volume and autocovariances in short-horizon individual security returns. The Journal of Finance 49, 1305–1329.

Da, Z., Hong, K.P., Lee, S., 2016. What drives target price forecasts and their investment value? Journal of Business Finance & Accounting 43, 487–510.

Da, Z., Schaumburg, E., 2011. Relative valuation and analyst target price forecasts. Journal of Financial Markets 14, 161–192.

DeMiguel, V., Martin-Utrera, A., Nogales, F.J., Uppal, R., 2020. A transaction-cost perspective on the multitude of firm characteristics. The Review of Financial Studies 33, 2180–2222.

Diether, K.B., Malloy, C.J., Scherbina, A., 2002. Differences of opinion and the cross section of stock returns. The Journal of Finance 57, 2113–2141.

Engelberg, J., McLean, R.D., Pontiff, J., 2018. Anomalies and news. The Journal of Finance 73, 1971–2001.

Fama, E.F., French, K.R., 1988. Dividend yields and expected stock returns. Journal of Financial Economics 22, 3–25.

Fama, E.F., French, K.R., 1993. Common risk factors in the returns on stocks and bonds. Journal of Financial Economics 33, 3–56.

Fama, E.F., French, K.R., 2015. A five-factor asset pricing model. Journal of Financial Economics 116, 1–22.

Fama, E.F., MacBeth, J.D., 1973. Risk, return, and equilibrium: Empirical tests. Journal of Political Economy 81, 607–636.

Frazzini, A., Pedersen, L.H., 2014. Betting against beta. Journal of Financial Economics 111, 1–25.

Green, J., Hand, J.R., Zhang, X.F., 2017. The characteristics that provide independent information about average us monthly stock returns. The Review of Financial Studies 30, 4389–4436.

Grossman, S.J., Miller, M.H., 1988. Liquidity and market structure. the Journal of Finance 43, 617–633.

Hou, K., Xue, C., Zhang, L., 2015. Digesting anomalies: An investment approach. The Review of Financial Studies 28, 650–705.

Jegadeesh, N., Titman, S., 1993. Returns to buying winners and selling losers: Implications for stock market efficiency. The Journal of Finance 48, 65–91.

La Porta, R., Lakonishok, J., Shleifer, A., Vishny, R., 1997. Good news for value stocks: Further evidence on market efficiency. The Journal of Finance 52, 859–874.

Lou, X., Shu, T., 2017. Price impact or trading volume: Why is the amihud (2002) measure priced? The Review of Financial Studies 30, 4481–4520.

Miller, E.M., 1977. Risk, uncertainty, and divergence of opinion. The Journal of Finance 32, 1151–1168.

Nagel, S., 2005. Short sales, institutional investors and the cross-section of stock returns. Journal of Financial Economics 78, 277–309.

Newey, W.K., West, K.D., 1987. A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. Econometrica 55, 703–708.

Novy-Marx, R., 2013. The other side of value: The gross profitability premium. Journal of Financial Economics 108, 1–28.

Novy-Marx, R., Velikov, M., 2015. A taxonomy of anomalies and their trading costs. The Review of Financial Studies 29, 104–147.

Scherbina, A., 2004. Analyst disagreement, forecast bias and stock returns. Working paper .

So, E.C., 2013. A new approach to predicting analyst forecast errors: Do investors overweight analyst forecasts? Journal of Financial Economics 108, 615–640.

Stambaugh, R.F., Yu, J., Yuan, Y., 2012. The short of it: Investor sentiment and anomalies. Journal of Financial Economics 104, 288–302.

Stambaugh, R.F., Yuan, Y., 2016. Mispricing factors. The Review of Financial Studies 30, 1270–1315.

Appendix

A. Proofs

A.1. *Proof of Proposition 1*

Assume that investors update one-year ahead expected return using Bayes' theorem whenever a target price is released. Given the conjugate prior, $\mathcal{N}(\mu_0, \sigma_0^2)$, the posterior distribution when the first target price TP_t^1 arrives becomes a normal distribution with the hyperparameters:

$$\hat{\mu} = \frac{\sigma_0^2\mu_1 + \sigma_1^2\mu_0}{\sigma_0^2 + \sigma_1^2} = \frac{\sigma_0^2\bar{\mu}_1 + \bar{\sigma}_1^2\mu_0}{\sigma_0^2 + \bar{\sigma}_1^2}, \tag{A.1}$$

$$\sigma_{\hat{\mu}}^2 = \frac{\sigma_0^2\sigma_1^2}{\sigma_0^2 + \sigma_1^2} = \frac{\sigma_0^2\bar{\sigma}_1^2}{\sigma_0^2 + \bar{\sigma}_1^2}. \tag{A.2}$$

When the second target price TP_t^2 arrives, the posterior distribution of the expected return is given by

$$\begin{aligned}\hat{\mu} := \frac{\sigma_{\hat{\mu}}^2\mu_2 + \sigma_2^2\hat{\mu}}{\sigma_{\hat{\mu}}^2 + \sigma_2^2} &= \frac{\dfrac{\sigma_0^2\bar{\sigma}_1^2}{\sigma_0^2 + \bar{\sigma}_1^2}\mu_2 + \sigma_2^2\dfrac{\sigma_0^2\bar{\mu}_1 + \bar{\sigma}_1^2\mu_0}{\sigma_0^2 + \bar{\sigma}_1^2}}{\dfrac{\sigma_0^2\bar{\sigma}_1^2}{\sigma_0^2 + \bar{\sigma}_1^2} + \sigma_2^2} \\ &= \frac{\sigma_0^2\dfrac{\bar{\sigma}_1^2\mu_2 + \sigma_2^2\bar{\mu}_1}{\bar{\sigma}_1^2 + \sigma_2^2} + \dfrac{\bar{\sigma}_1^2\sigma_2^2}{\bar{\sigma}_1^2 + \sigma_2^2}\mu_0}{\sigma_0^2 + \dfrac{\bar{\sigma}_1^2\sigma_2^2}{\bar{\sigma}_1^2 + \sigma_2^2}} = \frac{\sigma_0^2\bar{\mu}_2 + \bar{\sigma}_2^2\mu_0}{\sigma_0^2 + \bar{\sigma}_2^2},\end{aligned} \tag{A.3}$$

$$\sigma_{\hat{\mu}}^2 := \frac{\sigma_{\hat{\mu}}^2\sigma_2^2}{\sigma_{\hat{\mu}}^2 + \sigma_2^2} = \frac{\dfrac{\sigma_0^2\bar{\sigma}_1^2}{\sigma_0^2 + \bar{\sigma}_1^2}\sigma_2^2}{\dfrac{\sigma_0^2\bar{\sigma}_1^2}{\sigma_0^2 + \bar{\sigma}_1^2} + \sigma_2^2} = \frac{\sigma_0^2\dfrac{\bar{\sigma}_1^2\sigma_2^2}{\bar{\sigma}_1^2 + \sigma_2^2}}{\sigma_0^2 + \dfrac{\bar{\sigma}_1^2\sigma_2^2}{\bar{\sigma}_1^2 + \sigma_2^2}} = \frac{\sigma_0^2\bar{\sigma}_2^2}{\sigma_0^2 + \bar{\sigma}_2^2}. \tag{A.4}$$

Applying (A.3) and (A.4) recursively, the posterior distribution after K target price releases is given by:

$$\hat{\mu} = \frac{\sigma_0^2\bar{\mu}_K + \bar{\sigma}_k^2\mu_0}{\sigma_0^2 + \bar{\sigma}_k^2}, \qquad \sigma_{\hat{\mu}}^2 = \frac{\sigma_0^2\bar{\sigma}_K^2}{\sigma_0^2 + \bar{\sigma}_K^2}. \tag{A.5}$$

■

A.2. *Proof of Corollary 1*

It is trivial to show that when $\sigma_1^2 = \cdots = \sigma_K^2 \equiv \sigma_{TP}^2$,

$$\bar{\mu}_K = \frac{1}{K}\sum_{k=1}^{K}\mu_k = \mu_{TP}, \qquad \bar{\sigma}_K^2 = \frac{1}{K}\sigma_{TP}^2. \tag{A.6}$$

Substituting $\bar{\mu}_K$ and $\bar{\sigma}_K^2$ in (A.6) into (A.5), we obtain:

$$\hat{\mu} = \frac{K\sigma_0^2\mu_{TP} + \sigma_{TP}^2\mu_0}{K\sigma_0^2 + \sigma_{TP}^2}, \qquad \sigma_{\hat{\mu}}^2 = \frac{\sigma_0^2\sigma_{TP}^2}{K\sigma_0^2 + \sigma_{TP}^2}. \tag{A.7}$$

■

B. Robustness of NOA

Following Chiang et al. (2019), we assume that a target price is often biased and its implied return can be written as:

$$\mu_k = \mu + y_k, \tag{B.1}$$

where:

$$y_k \sim \begin{cases} \mathcal{N}(0, \sigma_{TP}^2) & \text{with probability } w_0 \\ \mathcal{N}(b_k, \sigma_{TP}^2) & \text{with probability } w_1 = 1 - w_0. \end{cases} \tag{B.2}$$

The bias b_k follows $\mathcal{N}(B, \sigma_b^2)$, where B represents the aggregate bias level, which also varies over time following $\mathcal{N}(\mu_B, \sigma_B^2)$.

Recall that:

$$R = \mu - \mu_0 = -e_0, \tag{B.3}$$

$$\hat{R}_s = \sum_{k=1}^{K} \mu_k - \mu_0 = \sum_{k=1}^{K} (y_k - e_0), \tag{B.4}$$

$$\hat{R}_n = \sum_{k=1}^{K} \text{sgn}(\mu_k - \mu_0) = \sum_{k=1}^{K} \text{sgn}(y_k - e_0). \tag{B.5}$$

The specifications of $\hat{R}_s$ and $\hat{R}_n$ are similar to those of the consensus error (CE) and the fraction of miss (FOM) defined in Chiang et al. (2019) except CE and FOM are defined as averages rather than sums. Since $\text{Cor}[R, \hat{R}_s] = \text{Cor}[R, \hat{R}_s/K]$ and $\text{Cor}[R, \hat{R}_n] = \text{Cor}[R, \hat{R}_n/K]$ for a given number of analysts K, we can follow Chiang et al. (2019) to show that:

$$\text{Cor}[R, \hat{R}_s] = \frac{\sigma_0}{\sqrt{\frac{1}{K}(\sigma_{TP}^2 + w_1\sigma_b^2 + w_0 w_1 \sigma_B^2 + w_0 w_1 \mu_B^2) + \sigma_0^2 + w_1^2 \sigma_B^2}}, \tag{B.6}$$

$$\text{Cor}[R, \hat{R}_n] \geq \frac{2w_0}{\sqrt{2\pi(1 + \sigma_{TP}^2/\sigma_0^2)}}, \tag{B.7}$$

and

$$\text{Cor}[R, \hat{R}_n] - \text{Cor}[R, \hat{R}_s] \geq \frac{2w_0}{\sqrt{2\pi(1 + \sigma_{TP}^2/\sigma_0^2)}} - \frac{\sigma_0}{\sqrt{\sigma_0^2 + w_1^2 \sigma_B^2}}. \tag{B.8}$$

For proofs, the reader is referred to Lemma 1 and Lemma 2 of Chiang et al. (2019).

Note that both large μ_B and σ_B will bring $\text{Cor}[R, \hat{R}_s]$ close to 0, whereas the lower bound of $\text{Cor}[R, \hat{R}_n]$ is independent of B and positive as long as $w_0 > 0$. Therefore, $\hat{R}_n$ is expected to outperform $\hat{R}_s$ in the presence of substantial bias. More specifically, from (B.8), $\text{Cor}[R, \hat{R}_n] \geq \text{Cor}[R, \hat{R}_s]$ when $\sigma_B^2 \geq \frac{\pi(\sigma_0^2 + \sigma_{TP}^2) - 2w_0^2\sigma_0^2}{2w_0^2 w_1}$, that is, the larger σ_B^2 or the smaller σ_{TP}^2, the more likely $\hat{R}_n$ will outperform $\hat{R}_s$.

More comprehensive analysis of the robust measure can be found in Chiang et al. (2019).

C. Other predictors

This section provides the definitions of other firm-specific variables used throughout the paper. Following Fama and MacBeth (1973), the market beta (BETA) of a stock is estimated from weekly rolling regressions of excess stock returns on the equal-weighted market returns for three years ending at the end of month $t-1$ with at least 52 weeks of returns. The size of a firm (SIZE) is defined as the natural logarithm of the product of the price per share and the number of shares outstanding. The book-to-market equity ratio (BM) is computed as the book value of stockholder equity plus deferred taxes and investment tax credit (if available) minus the book value of preferred stock at the end of the previous fiscal year, divided by the market value of equity at the end of the fiscal year.

Following Jegadeesh and Titman (1993), the price momentum (MOM12M) is defined as the cumulative return of a stock over a period of eleven months ending one month prior to the portfolio formation month, and the short-term reversal (MOM1M) is defined as the stock return for the formation month. The volatility (TVOL) is defined as the standard deviation of daily stock returns in month $t-1$ following Ang et al. (2006), and the idiosyncratic volatility (IVOL) is defined, following Ali et al. (2003), as the standard deviation of the residuals from the regression of the weekly returns on weekly equal-weighted market returns for three years prior to the end of the formation month.

The analyst coverage (CVRG) is defined as the natural logarithm of one plus the number of analysts. Following Amihud (2002), illiquidity (ILLQ) is defined as the ratio of the daily absolute stock return to the daily dollar trading volume, averaged over the formation month. A stock is required to have at least fifteen daily return observations in the month. The turnover (TURN) is the trading volume divided by the number of shares outstanding. The dispersion of analysts' opinion (DISP) is defined as the standard deviation of target price implied returns. Institutional ownership (INST) is defined as the number of shares held by institutional owners divided by the number of shares outstanding. Nagel (2005)'s residual institutional ownership (RI) is obtained as the residual in a cross-sectional regression of logit(INST) on the logarithm of the size and the square of it.

Three different methods are used to measure the profitability of a firm. Novy-Marx (2013) profitability measure (GMA) is defined as revenue minus cost of goods sold divided by lagged total assets. Following Fama and French (2015), the operating profit (OP) is defined as revenue minus cost of goods sold minus SG&A expense minus interest expense, divided by lagged common shareholders' equity. As in Hou et al. (2015), the return-on-equity (ROE) is computed as earnings before extraordinary items divided by lagged common shareholders' equity. Finally, following Chen and Zhang (2010), the investment (IA) of a firm is defined as the annual change in gross property, plant, and equipment plus annual change in inventories, divided by lagged total assets.

D. Comparison of target price impact measures

In this subsection, we compare different measures of target prices' impact based on their cross-sectional predictive power. The following measures defined in Subsection 2.2.2 are considered: the sum of target price implied returns (STPR), the mean of target price implied returns (MTPR), the fraction of optimistic analysts (FOA), the revision-based NOA (RNOA), and the revision-based STPR (RSTPR).

D.1. *Correlation between the measures*

We first examine the similarity of the measures using correlation as reported in Table D.1. The correlation between NOA and non-robust measures, MTPR and STPR, is rather low (0.37 and 0.23, respectively) considering they aim to measure the same property. Meanwhile, a summation measure and its average counterpart are highly correlated: 0.50 between NOA and FOA and 0.58 between STPR and MTPR. In contrast, the revision-based measures, RNOA and RSTPR, have an extremely low or even negative correlation with the other measures implying that the information content of a revision-based measure is significantly different from that of an implied-return-based measure. As shown in the next section, these two measures sort stocks in a completely different fashion compared to the other measures.

Table D.1: Correlations between target price impact measures

This table reports the correlation coefficients between the target price impact measures defined in Section 2.2: the net number of optimistic analysts (NOA), sum of target price implied returns (STPR), mean of target price implied returns (MTPR), fraction of optimistic analysts (FOA), target price revision-based NOA (RNOA), and target price revision-based STPR (RSTPR).

	NOA	STPR	MTPR	FOA	RNOA	RSTPR
NOA	1.00	0.23	0.37	0.50	0.20	0.01
STPR	0.23	1.00	0.58	0.42	0.00	0.06
MTPR	0.37	0.58	1.00	0.71	-0.00	0.02
FOA	0.50	0.42	0.71	1.00	0.07	0.03
RNOA	0.20	0.00	-0.00	0.07	1.00	0.13
RSTPR	0.01	0.06	0.02	0.03	0.13	1.00

D.2. *One-Dimensional sorts on the alternative measures*

Table D.2 reports the average one-month and one-year ahead excess returns of decile portfolios obtained from the alternative measures. Some of FOA-based decile portfolios are missing since FOA has only a small number of discrete values.

As expected, robust measures generate more significant results. When stocks are sorted on STPR, both the average one-month ahead excess return and one-year cumulative excess return of the long-short portfolio are higher but less significant than those from NOA: 0.86% (t-statistic = 3.31) vs. 0.75% (t-statistic = 3.87) and 13.43% (t-statistic = 7.45) vs. 10.00% (t-statistic = 8.44), respectively. Similarly, when stocks are sorted on MTPR, the returns are higher but less significant than those from FOA: 0.65% (t-statistic = 1.81) vs. 0.55% (t-statistic = 2.97) and 14.00% (t-statistic = 4.93) vs. 8.72% (t-statistic = 5.76), respectively. Although the robust measures yield lower returns by ignoring the magnitude of the difference between the target price and current price, they appear to find a good balance between predictive power and robustness.

The effect of the number of analysts can be assessed by comparing the summation mea-

Table D.2: One-dimensional sorts on alternative measures

This table reports the average one-month ahead excess returns (RET1) and one-year ahead excess returns (RET[1,12]) of equal-weighted portfolios formed on the alternative measures of target price impact defined in Section 2.2: the net number of optimistic analysts (NOA), sum of target price implied returns (STPR), mean of target price implied returns (MTPR), fraction of optimistic analysts (FOA), target price revision-based NOA (RNOA), and target price revision-based STPR (RSTPR). The portfolios are constructed at the end of each month during the sample period from February 1999 to December 2020. Newey-West adjusted t-statistics are given in parentheses.

	Low	2	3	4	5	6	7	8	9	High	L-H
STPR											
RET1	1.57	1.14	1.02	0.84	0.82	0.84	0.89	0.90	0.77	0.70	0.86
	(4.59)	(3.04)	(3.00)	(2.56)	(2.56)	(2.59)	(2.62)	(2.37)	(1.93)	(1.56)	(3.31)
RET[1,12]	16.58	12.25	10.05	7.64	6.62	6.38	6.36	6.34	5.46	3.15	13.43
	(4.82)	(3.50)	(3.00)	(2.42)	(2.03)	(1.95)	(1.81)	(1.71)	(1.41)	(0.76)	(7.45)
MTPR											
RET1	1.74	0.95	1.04	0.64	0.80	0.83	0.73	0.73	0.94	1.09	0.65
	(4.83)	(2.74)	(2.84)	(2.12)	(2.60)	(2.62)	(2.13)	(1.97)	(2.23)	(2.13)	(1.81)
RET[1,12]	19.12	10.55	8.98	6.66	6.81	6.50	5.95	5.74	5.32	5.12	14.00
	(5.34)	(3.02)	(2.71)	(2.09)	(2.20)	(2.02)	(1.79)	(1.58)	(1.32)	(1.12)	(4.93)
FOA											
RET1	1.37	1.34	0.79	0.58	1.10	0.44				0.83	0.55
	(4.01)	(3.38)	(2.15)	(1.37)	(1.36)	(0.29)				(2.34)	(2.97)
RET[1,12]	14.79	7.38	5.98	4.97	11.88	12.65				6.07	8.72
	(4.46)	(1.72)	(1.57)	(1.24)	(2.49)	(2.70)				(1.75)	(5.76)
RNOA											
RET1	0.58	0.77	0.44	0.63	0.57	0.46	1.61	1.40	1.20	1.08	-0.50
	(1.31)	(1.88)	(0.81)	(1.67)	(1.10)	(0.71)	(3.71)	(3.93)	(4.05)	(3.34)	(-1.91)
RET[1,12]	6.01	6.56	5.66	6.43	6.16	6.89	10.66	9.54	9.01	9.00	-2.99
	(1.40)	(1.65)	(1.36)	(1.96)	(1.51)	(1.68)	(2.90)	(2.77)	(3.00)	(2.78)	(-1.30)
RSTPR											
RET1	0.45	0.45	0.77	0.93	1.07	0.93	1.01	1.04	1.19	1.46	-1.02
	(0.98)	(1.13)	(1.94)	(2.51)	(3.33)	(2.78)	(2.97)	(3.23)	(3.58)	(3.65)	(-2.91)
RET[1,12]	5.58	6.01	7.11	7.98	8.01	8.85	8.83	8.77	9.01	9.48	-3.90
	(1.23)	(1.56)	(2.00)	(2.36)	(2.42)	(2.69)	(2.77)	(2.69)	(2.65)	(2.44)	(-1.67)

sures with their average counterparts. The long-short portfolio return of NOA is higher and more significant than that of FOA for both one-month and one-year periods, and the return of STPR is higher and more significant than that of MTPR for one-month period and lower but more significant for one-year period. This result supports our view that investors take the forecast error into account and their reaction can be better estimated accounting for the number of target price releases.

When stocks are sorted on revision-based measures, we no longer observe a return reversal: returns drift in the directions implied by target price revisions resulting in a negative return spread. The return spread is, however, small and insignificant. Brav and Lehavy (2003) also document stock returns' drifting in the direction of target price revision for a long term, which they ascribe to investors' underreaction.

Table 1: One-dimensional sorts on NOA: Equal-weighted

This table reports the average excess returns of equal-weighted decile portfolios formed on NOA. The portfolios are constructed at the end of each month during the sample period from February 1999 to December 2020. Panel A reports the average excess returns at various intervals: previous one-year (RET[-12,-1]), previous month (RET-1), five-days (DRET[-2, 2]) and eight-days (DRET[-2, 5]) around target price releases, portfolio formation month (RET0), next month (RET1), and next year (RET[1, 12]). Panel B reports the average monthly excess returns up to one year after portfolio formation. Newey-West adjusted t-statistics are given in parentheses.

Panel A: Average excess returns at various intervals

	Low	2	3	4	5	6	7	8	9	High	L-H
RET[-12,-1]	23.97	23.34	20.11	23.61	14.93	19.10	18.77	19.69	18.94	18.54	5.44
	(5.05)	(4.83)	(3.77)	(4.09)	(2.92)	(5.12)	(4.02)	(4.57)	(4.59)	(4.35)	(2.46)
RET-1	2.41	2.53	2.04	1.51	1.24	1.29	1.55	1.23	1.28	1.19	1.22
	(5.99)	(6.38)	(3.76)	(2.91)	(2.34)	(3.17)	(3.10)	(3.10)	(3.42)	(2.62)	(4.43)
DRET[-2,2]	-1.26	-1.15	0.58	0.36	0.92	1.08	1.40	1.39	1.59	1.89	-3.16
	(-3.90)	(-6.05)	(0.96)	(0.88)	(5.25)	(9.60)	(10.70)	(10.49)	(12.83)	(11.99)	(-8.80)
DRET[-2,5]	-1.14	-1.03	0.50	0.31	1.09	1.24	1.59	1.58	1.75	2.11	-3.25
	(-3.13)	(-4.32)	(0.83)	(0.60)	(4.56)	(7.20)	(9.48)	(9.37)	(11.47)	(11.22)	(-8.49)
RET0	-1.61	-1.81	0.76	0.96	1.62	2.08	3.23	3.00	3.54	4.26	-5.87
	(-2.20)	(-3.41)	(0.88)	(0.79)	(3.04)	(4.54)	(8.31)	(8.09)	(9.23)	(10.34)	(-8.53)
RET1	1.35	1.22	0.84	0.49	1.90	0.57	1.26	0.88	0.67	0.60	0.75
	(3.95)	(3.19)	(2.79)	(0.90)	(4.57)	(1.22)	(3.61)	(2.44)	(1.95)	(1.64)	(3.87)
RET[1,12]	13.91	12.98	10.00	12.50	9.56	5.58	9.04	6.30	5.59	3.90	10.00
	(4.07)	(3.84)	(3.03)	(3.58)	(2.26)	(1.69)	(2.71)	(1.78)	(1.59)	(1.10)	(8.44)

Panel B: Average monthly excess returns over a year

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12
Low	1.35	1.27	1.44	1.26	1.08	1.47	1.21	1.15	1.32	1.09	0.99	1.26
	(3.95)	(3.67)	(4.17)	(3.83)	(3.23)	(4.15)	(3.57)	(3.45)	(3.96)	(3.24)	(2.45)	(3.58)
High	0.60	0.31	0.54	0.39	0.37	0.52	0.34	0.39	0.59	0.58	0.48	0.52
	(1.64)	(0.82)	(1.44)	(0.99)	(0.94)	(1.35)	(0.90)	(0.97)	(1.61)	(1.54)	(1.25)	(1.33)
L-H	0.75	0.96	0.90	0.88	0.72	0.95	0.86	0.75	0.73	0.51	0.51	0.74
	(3.87)	(4.06)	(4.15)	(4.96)	(4.16)	(4.95)	(6.63)	(4.34)	(5.42)	(4.23)	(2.70)	(5.67)

Table 2: One-dimensional sorts on NOA: Value-weighted

This table reports the average excess returns of value-weighted decile portfolios formed on NOA. The portfolios are constructed at the end of each month during the sample period from February 1999 to December 2020. Panel A reports the average excess returns at various intervals: previous one-year (RET[-12,-1]), previous month (RET-1), five-days (DRET[-2, 2]) and eight-days (DRET[-2, 5]) around target price releases, portfolio formation month (RET0), next month (RET1), and next year (RET[1, 12]). Panel B reports the average monthly excess returns up to one year after portfolio formation. Newey-West adjusted t-statistics are given in parentheses.

Panel A: Average excess returns at various intervals

	Low	2	3	4	5	6	7	8	9	High	L-H
RET[-12,-1]	26.14	21.18	17.20	25.24	14.72	15.84	15.49	15.50	13.81	17.19	8.95
	(5.78)	(4.69)	(3.92)	(3.07)	(3.98)	(5.34)	(5.14)	(5.18)	(4.66)	(4.27)	(3.33)
RET-1	2.48	1.91	1.64	0.94	0.88	1.08	1.25	0.98	0.89	1.20	1.28
	(7.20)	(6.32)	(4.22)	(2.34)	(2.71)	(3.24)	(4.11)	(3.88)	(3.10)	(3.20)	(5.14)
DRET[-2,2]	-0.44	-0.37	0.11	0.46	0.24	0.38	0.52	0.48	0.66	0.97	-0.89
	(-2.06)	(-2.90)	(0.43)	(2.62)	(2.33)	(3.21)	(6.87)	(5.23)	(7.53)	(8.08)	(-5.55)
DRET[-2,5]	-0.32	-0.28	0.17	0.31	0.39	0.39	0.68	0.53	0.73	1.16	-0.92
	(-1.29)	(-1.70)	(0.49)	(1.28)	(3.54)	(2.65)	(7.04)	(3.94)	(5.64)	(8.00)	(-4.89)
RET0	-0.39	-0.65	0.77	1.00	0.93	0.69	1.55	1.35	1.60	2.60	-1.85
	(-0.72)	(-1.73)	(0.78)	(2.16)	(2.75)	(1.78)	(7.01)	(5.19)	(5.56)	(8.04)	(-4.69)
RET1	1.22	0.84	1.05	0.34	1.60	0.47	0.77	0.65	0.38	0.28	0.94
	(3.72)	(2.27)	(2.55)	(0.79)	(4.75)	(1.07)	(3.08)	(2.27)	(1.26)	(0.78)	(4.37)
RET[1,12]	13.04	10.37	9.11	7.14	10.42	4.79	8.48	5.48	4.28	3.94	9.10
	(4.00)	(3.43)	(2.41)	(2.13)	(3.07)	(1.44)	(3.26)	(1.69)	(1.39)	(1.18)	(5.98)

Panel B: Average monthly excess returns over a year

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12
Low	1.22	1.24	1.04	1.25	1.01	1.27	1.20	1.05	1.16	1.09	0.87	1.17
	(3.72)	(3.10)	(2.82)	(3.76)	(2.72)	(4.27)	(3.43)	(2.74)	(3.29)	(3.05)	(2.15)	(3.24)
High	0.28	0.26	0.40	0.27	0.30	0.47	0.39	0.31	0.55	0.47	0.43	0.46
	(0.78)	(0.78)	(1.25)	(0.69)	(0.91)	(1.26)	(1.04)	(0.82)	(1.70)	(1.43)	(1.28)	(1.32)
L-H	0.94	0.97	0.64	0.98	0.70	0.80	0.81	0.74	0.61	0.61	0.44	0.70
	(4.37)	(4.24)	(3.23)	(4.33)	(3.83)	(3.69)	(3.97)	(4.74)	(3.08)	(3.65)	(1.98)	(3.80)

Table 3: Average characteristics of the portfolios formed on NOA

This table reports the average characteristics of equal-weighted portfolios formed on NOA. The portfolios are constructed at the end of each month during the sample period from February 1999 to December 2020. NOA is the net number of optimistic analysts, MTPR average target price implied return, NALST number of analysts, BETA market beta, PRC stock price, MCAP market capitalization in billion dollars, BM book-to-market ratio, MOM12M price momentum, MOM1M short-term reversal, IVOL idiosyncratic volatility, TURN turnover, DISP dispersion of opinion, ROE return-on-equity, GMA Novy-Marx's (2013) profitability, OP operating profit, IA investment, MISP mispricing, and RECOM recommendation (1: strong buy, 5: sell). These variables are defined in the Appendix. The t-statistics are Newey-West adjusted t-statistics.

	Low	2	3	4	5	6	7	8	9	High	L-H	t-stat
NOA	-4.47	-1.72	0.20	0.50	1.17	1.65	2.66	3.51	5.55	13.37	-17.84	-32.97
MTPR	-14.58	-6.43	8.05	13.53	23.96	26.53	25.08	26.46	26.98	30.65	-45.23	-16.04
NALST	5.88	2.80	2.65	2.39	1.68	2.22	3.41	4.28	6.54	14.98	-8.09	-9.03
BETA	1.04	1.07	1.09	1.16	1.18	1.17	1.20	1.20	1.19	1.19	-0.15	-7.03
PRC	47.74	60.27	55.36	144.75	185.19	93.27	67.37	57.96	50.43	53.11	-5.38	-1.68
MCAP	10.49	7.19	6.22	5.62	6.17	6.55	9.08	10.44	14.00	23.40	-12.91	-5.78
BM	0.45	0.48	0.47	0.52	0.51	0.49	0.49	0.47	0.46	0.46	-0.01	-1.08
MOM12M	20.63	19.90	17.90	17.27	12.83	18.39	15.79	18.41	17.91	17.10	3.53	2.45
MOM1M	-2.14	-1.98	-2.26	-0.35	2.17	2.24	3.14	2.98	3.61	4.29	-6.44	-10.69
IVOL	4.73	4.88	5.21	5.22	5.01	5.43	5.01	5.27	5.17	4.99	-0.26	-3.30
TURN	2.79	2.25	2.35	2.06	2.01	2.04	2.32	3.40	2.61	2.97	-0.18	-1.77
DISP	5.96	5.67	7.57	6.96	2.90	4.24	7.08	8.26	10.17	12.84	-6.88	-14.75
ROE	0.03	0.02	0.03	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.01	4.31
GMA	0.36	0.36	0.36	0.33	0.33	0.34	0.32	0.33	0.33	0.32	0.05	7.44
OP	0.83	0.81	0.83	0.77	0.76	0.78	0.75	0.78	0.78	0.76	0.07	5.14
IA	0.07	0.06	0.07	0.05	0.05	0.06	0.05	0.06	0.07	0.08	-0.01	-3.54
MISP	47.83	48.27	48.88	49.62	50.26	50.55	50.57	50.82	50.84	50.66	-2.90	-14.60
RECOM	2.66	2.60	2.42	2.21	2.20	2.21	2.19	2.17	2.17	2.15	0.51	57.48

Table 4: Factor regressions of the portfolios formed on NOA: Equal-weighted

This table reports the time series regression results of equal-weighted portfolios formed on NOA. Five factor models are employed: Fama and French (1993) three-factor, Carhart (1997) four-factor, Fama and French (2015) five-factor, Hou et al. (2015) four-factor, and Stambaugh and Yuan (2016) four-factor models. The sample period is from February 1999 to December 2020 except for the Stambaugh and Yuan model, for which the period ends in December 2016 due to data availability. The columns under Estimates are the coefficient estimates and those under t-stat are the corresponding Newey-West adjusted t-statistics.

Panel A: Fama-French Three-Factor

	Estimates				t-stat				R^2
	α	MKT	SMB	HML	α	MKT	SMB	HML	R^2
Low	0.41	1.09	0.60	0.35	2.23	42.93	7.30	5.58	0.80
2	0.34	1.05	0.59	0.36	1.58	21.24	5.68	5.18	0.92
3	0.12	1.18	0.64	0.10	1.26	35.60	6.43	1.44	0.94
4	-0.05	1.20	0.61	0.05	-0.65	26.33	7.29	0.69	0.94
High	-0.33	1.23	0.49	0.06	-2.25	20.83	4.42	0.59	0.88
L-H	0.74	-0.14	0.11	0.28	3.79	-2.65	2.25	2.82	0.21

Panel B: Carhart Four-Factor

	α	MKT	SMB	HML	MOM	α	MKT	SMB	HML	MOM	R^2
Low	0.44	1.05	0.62	0.31	-0.09	2.39	37.10	8.12	4.85	-2.54	0.80
2	0.37	1.02	0.60	0.33	-0.07	1.72	19.77	6.16	4.37	-1.78	0.93
3	0.22	1.08	0.69	0.02	-0.21	2.69	52.10	9.75	0.50	-7.07	0.96
4	0.04	1.10	0.65	-0.03	-0.21	0.56	42.21	11.38	-0.80	-8.80	0.96
High	-0.22	1.12	0.53	-0.04	-0.24	-1.54	28.81	6.54	-0.51	-6.95	0.91
L-H	0.65	-0.08	0.09	0.35	0.15	3.63	-2.15	1.86	3.81	2.85	0.29

Panel C: Fama-French Five-Factor

	α	MKT	SMB	HML	RMW	CMA	α	MKT	SMB	HML	RMW	CMA	R^2
Low	0.36	1.11	0.61	0.30	0.05	0.07	2.11	34.65	7.45	4.98	3.87	0.82	0.81
2	0.15	1.12	0.69	0.22	0.31	0.08	0.62	25.03	5.57	2.74	2.18	0.90	0.92
3	0.23	1.14	0.59	0.20	-0.15	-0.10	1.92	35.44	6.67	3.28	-1.40	-0.74	0.94
4	0.07	1.15	0.56	0.16	-0.17	-0.11	0.71	31.60	6.76	2.35	-1.69	-0.83	0.94
High	-0.23	1.19	0.47	0.17	-0.08	-0.20	-1.28	32.62	4.01	1.73	-0.63	-1.20	0.88
L-H	0.59	-0.09	0.14	0.13	0.13	0.27	2.80	-1.33	3.65	0.38	2.80	1.75	0.32

Panel D: Hou-Xue-Zhang Four-Factor

	α	MKT	SMB	IA	ROE	α	MKT	SMB	IA	ROE	R^2
Low	0.38	1.10	0.52	0.44	-0.12	2.27	23.27	5.39	4.36	-1.57	0.79
2	0.23	1.08	0.59	0.40	-0.01	1.05	15.15	4.25	3.37	-0.06	0.91
3	0.27	1.09	0.49	0.13	-0.35	2.14	20.97	4.05	1.26	-3.87	0.94
4	0.12	1.09	0.45	0.05	-0.37	1.06	29.64	4.25	0.45	-5.42	0.94
High	-0.15	1.12	0.34	-0.02	-0.37	-0.84	21.50	2.47	-0.12	-4.73	0.89
L-H	0.53	-0.02	0.19	0.46	0.25	2.68	-0.67	4.38	2.86	3.93	0.33

Panel E: Stambaugh-Yuan Four-Factor

	α	MKT	SMB	MGT	PFM	α	MKT	SMB	MGT	PFM	R^2
Low	0.61	0.98	0.67	0.26	-0.14	4.04	20.97	5.01	2.59	-2.82	0.75
2	0.49	1.07	0.65	0.31	-0.19	2.15	23.65	8.80	3.15	-4.11	0.90
3	0.41	1.04	0.63	-0.08	-0.23	2.85	25.69	8.50	-1.28	-6.32	0.94
4	0.32	1.05	0.60	-0.16	-0.24	2.41	25.38	9.80	-2.84	-6.73	0.95
High	0.18	1.04	0.45	-0.25	-0.24	0.81	23.69	4.01	-2.49	-5.70	0.89
L-H	0.43	-0.06	0.22	0.51	0.11	2.68	-0.95	3.87	5.99	1.48	0.44

Table 5: Two-dimensional sorts on NOA and other variables

This table reports the average one-month ahead excess returns of equal-weighted portfolios formed on NOA and one of the firm characteristics: market beta (BETA), size (SIZE), book-to-market ratio (BM), momentum (MOM12M), short-term reversal (MOM1M), idiosyncratic volatility (IVOL), Amihud's (2002) illiquidity measure (ILLQ), turnover (TURN), dispersion of opinion (DISP), return-on-equity (ROE), Novy-Marx's (2013) profitability (GMA), operating profit (OP), investment (IA), institutional ownership (INST), and Nagel's (2005) residual institutional ownership (RI). These variables are defined in the Appendix. The portfolios are constructed by sorting stocks independently on NOA and a firm characteristic at the end of each month during the sample period from February 1999 to December 2020. Newey-West adjusted t-statistics are given in parentheses.

	Low	2	3	4	High	Low	2	3	4	High	Low	2	3	4	High
	BETA					SIZE					BM				
Low	1.08	1.11	1.39	1.69	1.25	1.53	1.51	1.55	1.26	1.15	1.50	1.46	1.39	1.11	1.09
2	1.12	1.44	1.41	1.33	1.26	1.50	1.49	1.41	1.22	0.86	1.18	1.46	1.36	1.17	1.45
3	0.86	0.97	0.87	0.99	0.87	0.98	0.91	0.87	0.92	0.61	0.73	0.86	0.89	0.84	1.02
4	0.89	0.87	0.96	0.88	0.73	1.19	0.97	0.73	0.64	0.50	0.80	0.78	0.86	0.96	0.92
High	0.66	0.94	0.75	0.63	0.42	1.17	1.05	0.55	0.60	0.34	0.52	0.56	0.65	0.84	0.82
L-H	0.42	0.16	0.63	1.06	0.83	0.36	0.47	1.01	0.66	0.81	0.99	0.90	0.75	0.27	0.27
	(3.54)	(1.19)	(3.95)	(5.43)	(3.27)	(1.08)	(2.31)	(5.04)	(3.54)	(5.29)	(4.64)	(4.86)	(4.40)	(1.51)	(1.26)
	MOM12M					MOM1M					IVOL				
Low	1.31	1.01	1.25	1.30	1.57	1.28	1.39	1.34	1.31	1.23	1.09	1.11	1.20	1.84	1.58
2	1.39	1.20	1.27	1.10	1.66	1.29	1.28	1.39	1.37	1.38	1.00	1.31	1.23	1.48	1.70
3	0.88	1.03	0.81	0.88	1.18	0.90	0.96	1.01	0.78	0.77	0.91	0.91	0.80	1.14	0.75
4	0.78	0.75	0.85	1.00	1.21	0.90	0.85	0.89	0.78	0.87	0.76	0.87	0.88	0.90	0.89
High	0.29	0.65	0.70	0.81	0.91	0.33	0.72	0.74	0.70	0.72	0.73	0.65	0.70	0.83	0.41
L-H	1.02	0.35	0.56	0.49	0.66	0.95	0.67	0.60	0.60	0.50	0.36	0.46	0.50	1.01	1.17
	(4.04)	(2.18)	(4.04)	(3.70)	(3.50)	(4.21)	(3.79)	(4.02)	(3.71)	(2.12)	(3.65)	(3.41)	(2.81)	(4.82)	(4.16)
	ILLQ					TURN					DISP				
Low	1.18	1.32	1.55	1.60	1.24	0.94	1.07	1.27	1.41	1.69	1.30	1.19	1.47	1.53	1.11
2	0.95	1.34	1.39	1.54	1.25	0.98	1.26	1.12	1.79	1.73	0.94	0.79	1.28	0.69	1.15
3	0.63	0.91	0.89	0.96	0.91	0.88	0.96	0.73	1.02	0.73	0.71	1.15	0.58	0.96	1.06
4	0.47	0.65	0.83	0.99	1.10	0.89	0.99	0.98	0.66	0.68	0.51	0.84	1.15	1.11	1.18
High	0.39	0.57	0.62	0.90	1.16	0.88	0.76	0.79	0.55	0.53	0.52	1.23	0.71	0.72	0.88
L-H	0.79	0.75	0.94	0.70	0.08	0.06	0.31	0.48	0.86	1.16	0.78	-0.03	0.76	0.81	0.23
	(4.67)	(3.96)	(4.78)	(3.37)	(0.26)	(0.44)	(1.96)	(3.25)	(4.27)	(4.89)	(2.11)	(-0.13)	(3.66)	(5.72)	(1.00)
	ROE					GMA					OP				
Low	0.94	1.29	1.39	1.40	1.46	0.80	1.07	1.61	1.48	1.56	0.99	1.44	1.21	1.46	1.45
2	1.08	1.42	1.30	1.21	1.44	0.94	1.42	1.50	1.49	1.41	1.24	1.17	1.46	1.35	1.33
3	0.90	0.91	0.89	0.92	0.83	0.83	0.63	1.02	0.97	1.11	0.65	0.87	0.87	1.06	1.08
4	0.73	0.74	0.84	0.97	1.00	0.78	0.65	0.95	0.99	1.08	0.76	0.81	0.86	1.04	1.00
High	0.24	0.83	0.76	0.78	0.78	0.55	0.53	0.80	0.93	0.81	0.40	0.70	0.88	0.72	0.80
L-H	0.70	0.46	0.63	0.62	0.69	0.25	0.54	0.81	0.55	0.74	0.59	0.75	0.33	0.74	0.64
	(2.66)	(2.15)	(3.63)	(4.02)	(4.29)	(1.24)	(2.89)	(4.04)	(3.09)	(3.96)	(2.74)	(3.53)	(1.67)	(4.12)	(3.76)
	IA					INST					RI				
Low	0.92	1.05	1.45	1.63	1.54	2.08	1.52	1.40	1.57	1.50	1.57	1.92	1.48	1.65	1.56
2	1.42	1.21	1.21	1.47	1.35	1.05	1.61	1.24	1.65	1.47	1.50	1.97	1.78	1.35	1.21
3	1.01	0.87	1.12	0.85	0.80	1.10	1.28	1.10	1.20	0.99	0.81	1.03	1.14	1.14	1.30
4	1.02	0.88	0.91	0.97	0.60	1.04	1.37	0.93	1.20	0.96	0.79	1.25	1.20	1.25	1.11
High	0.75	1.03	0.73	0.74	0.28	0.77	1.09	0.97	0.82	0.50	0.66	0.91	1.39	0.97	0.73
L-H	0.17	0.02	0.72	0.89	1.26	1.30	0.42	0.43	0.74	1.00	0.90	1.00	0.09	0.69	0.83
	(0.94)	(0.13)	(3.87)	(4.64)	(6.30)	(3.18)	(1.64)	(1.97)	(2.38)	(2.61)	(2.69)	(2.82)	(0.75)	(2.30)	(2.52)

Table 6: Firm-level Fama-MacBeth regression of future stock returns

This table reports the time series averages of the coefficients obtained from firm-level cross-sectional regressions of future monthly stock returns on NOA and firm-specific control variables. The regression equation has the following econometric specification:

$$r_{i,t+m} = \lambda_{0,t} + \lambda_{1,t} NOA_{i,t} + \boldsymbol{\lambda}_{2,t}^{T} \boldsymbol{X}_{i,t} + \epsilon_{i,t+1},$$

where $r_{i,t+m}$ is the m-month ahead realized excess return on stock i, $NOA_{i,t}$ is NOA of stock i in month t, and $\boldsymbol{X}_{i,t}$ is a collection of firm-specific control variables for stock i observed at the end of month t. $\boldsymbol{X}_{i,t}$ includes the market beta (BETA), size (SIZE), book-to-market ratio (BM), momentum (MOM12M), short-term reversal (MOM1M), idiosyncratic volatility (IVOL), Amihud (2002)'s illiquidity (ILLQ), analyst coverage (CVRG), dispersion of opinion (DISP), return-on-equity (ROE), Novy-Marx (2013)'s profitability (GMA), operating profit (OP), and investment (IA). These variables are defined in the appendix. The sample period is from February 1999 to December 2020. Panel A reports the average coefficients from regressions of one-month ahead return, and Panel B reports the average coefficient on NOA from regressions of two- to twelve-month ahead returns controlling for all firm-specific variables. All coefficients are multiplied by 1,000. Newey-West adjusted t-statistics are given in parentheses.

Panel A: Regression of one-month ahead returns

	1	2	3	4	5	6	7	8	9	10	11
NOA	-0.46	-0.34	-0.33	-0.34	-0.29	-0.33	-0.34	-0.32	-0.34	-0.35	-0.30
	(-3.24)	(-3.85)	(-3.75)	(-3.84)	(-2.79)	(-3.67)	(-3.84)	(-3.70)	(-3.83)	(-3.72)	(-2.84)
BETA		-1.01	-0.70	-1.19	-0.99	-1.04	-0.84	-0.98	-1.09	-0.96	-0.93
		(-0.37)	(-0.32)	(-0.44)	(-0.37)	(-0.39)	(-0.31)	(-0.36)	(-0.41)	(-0.36)	(-0.42)
SIZE		-1.29	-1.36	-1.40	-1.25	-1.31	-1.34	-1.25	-1.29	-1.32	-1.37
		(-2.41)	(-2.40)	(-2.49)	(-2.24)	(-2.39)	(-2.48)	(-2.36)	(-2.42)	(-2.47)	(-2.21)
BM		-3.10	-3.26	-2.95	-3.10	-3.09	-3.04	-2.17	-3.10	-3.44	-2.53
		(-1.49)	(-1.59)	(-1.41)	(-1.49)	(-1.48)	(-1.45)	(-1.12)	(-1.49)	(-1.58)	(-1.28)
MOM12M		1.79	1.57	1.72	1.78	1.75	1.67	1.99	1.87	1.73	1.36
		(0.52)	(0.45)	(0.50)	(0.52)	(0.52)	(0.49)	(0.57)	(0.55)	(0.51)	(0.40)
MOM1M		-0.32	-0.36	0.47	0.57	0.57	0.58	-0.28	0.27	0.28	-0.50
		(-0.06)	(-0.07)	(0.09)	(0.11)	(0.11)	(0.11)	(-0.05)	(0.05)	(0.05)	(-0.10)
IVOL			17.25								-0.12
			(0.40)								(0.00)
ILLQ				-3.04							-2.59
				(-0.86)							(-0.73)
CVRG					0.40						-0.10
					(0.63)						(-0.15)
DISP						-4.66					-2.17
						(-1.13)					(-0.53)
ROE							5.01				4.28
							(1.81)				(1.63)
GMA								3.21			3.82
								(1.44)			(1.63)
OP									0.01		-0.47
									(0.03)		(-1.57)
IA										-7.06	-8.73
										(-1.93)	(-2.54)

Panel B: Regression of two- to twelve-month ahead returns

	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12
NOA	-0.33	-0.39	-0.40	-0.25	-0.36	-0.27	-0.27	-0.33	-0.21	-0.33	-0.29
	(-2.82)	(-3.59)	(-4.74)	(-3.02)	(-4.12)	(-3.72)	(-3.31)	(-3.19)	(-2.33)	(-2.77)	(-4.22)

Table 7: Determinants of NOA

This table reports the time series averages of the coefficients obtained from firm-level cross-sectional regressions of NOA on lagged firm-specific control variables. The regression equation has the following econometric specification:

$$NOA_{i,t} = \gamma_{0,t} + \boldsymbol{\gamma}_{1,t}^T \boldsymbol{X}_{i,t-1} + e_{i,t},$$

where $NOA_{i,t}$ is NOA of stock i in month t, and $\boldsymbol{X}_{i,t}$ is a collection of firm-specific variables: the market beta (BETA), size (SIZE), book-to-market ratio (BM), momentum (MOM12M), short-term reversal (MOM1M), total return volatility (TVOL), idiosyncratic volatility (IVOL), Amihud (2002)'s illiquidity (ILLQ), turnover (TURN), analyst coverage (CVRG), dispersion of opinion (DISP), return-on-equity (ROE), Novy-Marx (2013)'s profitability (GMA), operating profit (OP), and investment (IA). These variables are defined in the appendix. All control variables are measured at the end of month $t-1$ except for CVRG and DISP which are computed from the target price releases in month t. The sample period is from February 1999 to December 2020. The results under Simple Regression are the results obtained from individual simple regressions, and those under Multiple Regression are from a multiple regression involving all control variables. The t-statistics are Newey-West adjusted t-statistics.

	Simple Regression		Multiple Regression	
	estimate	t-stat	estimate	t-stat
BETA	0.59	7.67	0.36	4.30
SIZE	0.55	7.41	0.07	4.59
BM	0.06	0.64	0.28	5.26
MOM12M	-0.27	-2.77	-0.11	-1.75
MOM1M	-1.17	-4.92	-1.40	-11.04
TVOL	-2.99	-0.71	12.70	6.65
IVOL	0.05	0.02	9.19	5.85
ILLQ	-0.34	-7.19	0.11	3.50
TURN	0.12	5.34	-0.10	-8.44
CVRG	3.62	11.12	3.55	9.07
DISP	13.12	18.97	-0.29	-0.24
ROE	-0.61	-2.70	-0.30	-3.40
GMA	-0.87	-6.89	-0.55	-9.42
OP	-0.08	-6.08	0.02	1.29
IA	1.48	4.09	0.23	0.96

Table 8: NOA premium around earning announcements

This table reports the average abnormal returns of equal-weighted portfolios formed on NOA for the three-day window [-1, 1] around earnings announcements and the rest of the month following portfolio formation. Abnormal returns are computed from stocks with an earnings announcement in the first month by subtracting the value-weighted CRSP return. The sample period from February 1999 to December 2020. Twenty days per month is assumed for monthly conversion. Newey-West adjusted t-statistics are given in parentheses.

	Low	2	3	4	5	6	7	8	9	High	L-H
Announcement	0.51	0.17	0.28	0.57	0.49	0.29	-0.01	0.13	-0.15	-0.03	0.55
(monthly)	3.43	1.14	1.87	3.78	3.30	1.93	-0.09	0.87	-0.97	-0.21	3.64
	(2.96)	(0.85)	(1.52)	(2.46)	(1.60)	(1.96)	(-0.08)	(1.04)	(-0.78)	(-0.20)	(2.65)
No announcement	1.12	0.44	0.86	0.85	0.11	0.56	0.55	0.15	0.28	-0.07	1.19
(monthly)	1.32	0.51	1.02	1.00	0.13	0.66	0.65	0.18	0.33	-0.08	1.40
	(3.78)	(1.56)	(2.64)	(2.02)	(0.27)	(1.65)	(2.18)	(0.70)	(1.16)	(-0.24)	(3.54)
Difference (monthly)	2.11	0.63	0.85	2.78	3.17	1.27	-0.74	0.69	-1.30	-0.13	2.24
	(2.51)	(0.45)	(0.63)	(1.89)	(1.42)	(1.18)	(-0.71)	(0.86)	(-1.05)	(-0.13)	(2.45)

Table 9: Effects of earning announcements in the formation month

This table reports the performance of the NOA strategy when there are earnings announcements in the portfolio formation month and when there are not. Panel A (B) reports average one-month ahead excess returns and risk-adjusted returns of the equal-weighted portfolios formed on NOA from stocks without (with) an earnings announcement in the formation month, and Panel C reports the difference of the two. The risk-adjusted returns are obtained from the Fama and French (1993) three-factor (FF3), Carhart (1997) four-factor (Carhart), Fama and French (2015) five-factor (FF5), Hou et al. (2015) four-factor (HXZ), and Stambaugh and Yuan (2016) four-factor (SY) models. Panel D and E report average m-month ahead excess returns of the NOA strategy from each sample. The sample period is from February 1999 to December 2020 except for the Stambaugh and Yuan model, for which the period ends in December 2016 due to data availability. The t-statistics are Newey-West adjusted t-statistics.

Panel A: No earnings announcement in the formation month

	$\hat{\alpha}$						t-stat					
	Raw	FF3	Carhart	FF5	HXZ	SY	Raw	FF3	Carhart	FF5	HXZ	SY
Low	1.33	0.50	0.54	0.47	0.46	0.67	3.45	2.63	2.91	2.60	2.63	3.39
2	1.56	0.48	0.51	0.48	0.47	0.49	3.33	2.28	2.50	2.28	2.59	2.31
3	0.96	0.09	0.16	0.28	0.27	0.33	1.74	1.00	1.77	2.43	2.36	2.38
4	0.84	-0.15	-0.06	0.01	-0.01	0.15	2.04	-1.40	-0.68	0.06	-0.11	1.03
High	0.53	-0.37	-0.27	-0.16	-0.16	0.16	1.30	-2.49	-1.87	-0.95	-0.96	1.34
L-H	0.80	0.87	0.81	0.64	0.62	0.51	4.80	4.36	4.41	4.10	3.39	2.99

Panel B: Earnings announcement in the formation month

	Raw	FF3	Carhart	FF5	HXZ	SY	Raw	FF3	Carhart	FF5	HXZ	SY
Low	0.87	0.06	0.14	-0.13	0.07	0.23	2.21	0.29	0.67	-0.65	0.31	0.91
2	0.87	0.11	0.19	0.05	0.16	0.28	2.29	0.66	1.23	0.30	0.83	1.62
3	0.90	0.00	0.11	0.04	0.17	0.31	2.24	0.03	0.98	0.30	1.21	2.19
4	0.71	-0.10	0.03	0.00	0.11	0.36	1.68	-0.59	0.22	0.02	0.51	1.51
High	0.57	-0.22	-0.07	-0.16	0.04	0.21	1.36	-1.41	-0.55	-0.88	0.22	1.12
L-H	0.29	0.28	0.21	0.03	0.03	0.01	1.38	1.21	1.00	0.12	0.13	0.06

Panel C: Difference

	Raw	FF3	Carhart	FF5	HXZ	SY	Raw	FF3	Carhart	FF5	HXZ	SY
Low	0.46	0.44	0.40	0.60	0.39	0.44	2.38	3.25	2.78	4.96	2.61	2.91
2	0.70	0.38	0.32	0.43	0.32	0.21	0.96	1.01	0.95	1.25	0.85	0.67
3	0.07	0.09	0.04	0.24	0.10	0.03	0.15	0.34	0.58	1.08	0.61	-0.27
4	0.12	-0.05	-0.09	0.01	-0.12	-0.21	0.46	-0.52	-0.71	-0.20	-0.73	-1.26
High	-0.04	-0.15	-0.19	-0.01	-0.20	-0.05	-0.56	-0.49	-0.74	0.23	-0.53	0.31
L-H	0.50	0.59	0.60	0.61	0.59	0.49	2.62	2.80	2.72	2.89	2.54	2.21

Panel D: m-month ahead excess returns (no earnings announcement)

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R[1,12]
Low	1.33	1.18	1.13	1.19	1.17	1.14	1.27	1.15	1.17	1.30	1.07	0.78	13.79
	(3.45)	(3.18)	(2.91)	(3.23)	(3.22)	(2.95)	(3.36)	(3.10)	(2.86)	(3.37)	(-0.40)	(2.81)	(9.70)
High	0.40	0.60	0.41	0.29	0.52	0.49	0.17	0.55	0.51	0.32	0.65	0.45	4.13
	(0.94)	(1.40)	(0.96)	(0.69)	(1.23)	(1.12)	(0.36)	(1.26)	(1.17)	(0.72)	(0.64)	(1.48)	(2.76)
L-H	0.80	0.71	0.79	0.83	0.70	0.62	0.91	0.65	0.67	0.96	0.40	0.27	9.42
	(4.80)	(3.82)	(4.87)	(4.71)	(3.96)	(3.69)	(5.16)	(3.74)	(3.75)	(5.03)	(-1.83)	(2.28)	(14.72)

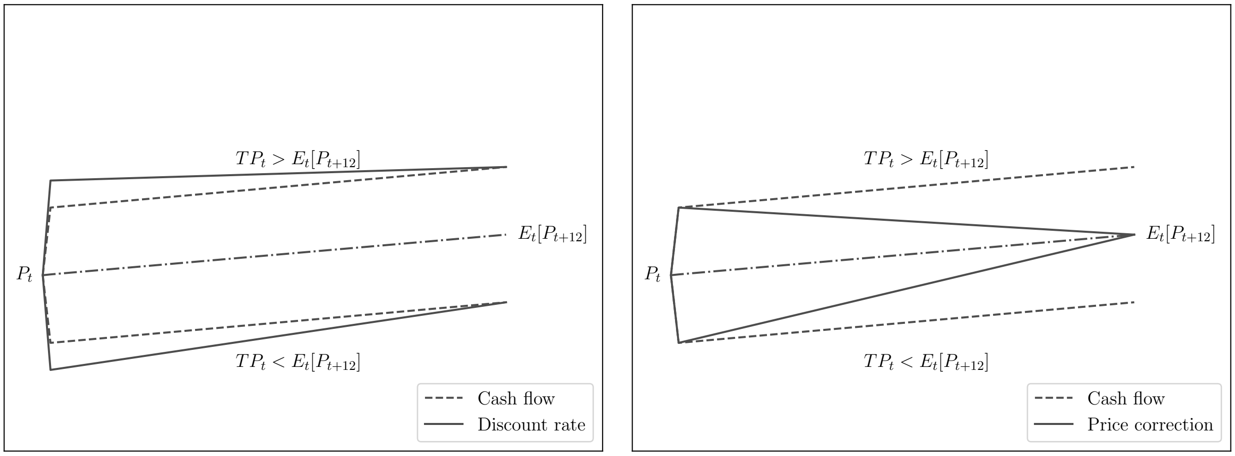
Panel E: m-month ahead excess returns (earnings announcement)

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R[1,12]
Low	0.87	0.93	1.55	1.08	0.90	1.42	0.76	0.70	1.47	0.89	0.71	1.75	14.23
	(2.21)	(2.29)	(3.93)	(2.84)	(2.19)	(3.49)	(1.95)	(1.75)	(3.54)	(2.08)	(0.19)	(1.77)	(9.01)
High	0.50	0.28	0.55	0.34	0.44	0.58	0.34	0.32	0.64	0.49	0.48	0.74	5.51
	(1.17)	(0.64)	(1.25)	(0.84)	(1.00)	(1.39)	(0.80)	(0.74)	(1.42)	(1.12)	(0.35)	(1.01)	(3.52)
L-H	0.29	0.67	1.07	0.73	0.54	0.81	0.39	0.41	0.91	0.39	0.33	1.11	9.17
	(1.38)	(3.18)	(4.55)	(3.47)	(2.76)	(3.70)	(1.96)	(2.06)	(3.44)	(2.07)	(2.14)	(1.80)	(10.98)

Table 10: One-dimensional sorts on short-term reversal

This table reports the average one-month ahead excess returns (RET1), market capitalizations (MCAP), and illiquidity values (ILLQ) of equal-weighted portfolios formed on the short-term reversal. The portfolios are constructed at the end of each month during the sample period from February 1999 to December 2020. The results in the first two rows are obtained from the entire CRSP universe excluding our sample, and those in the next two rows are obtained from our sample. The t-statistics are Newey-West adjusted t-statistics.

	Low	2	3	4	5	6	7	8	9	High	L-H	t-stat
CRSP excluding our sample												
RET1	1.17	1.14	1.03	0.95	0.87	0.87	0.72	0.58	0.44	0.05	1.12	4.54
MCAP	0.80	1.49	1.87	2.13	2.28	2.42	2.25	2.15	1.81	0.83	-0.04	-0.50
ILLQ	1.41	1.45	1.44	1.37	1.49	1.37	1.34	1.27	1.37	1.41	-0.00	-0.00
Our sample												
RET1	1.08	1.07	1.08	1.06	1.11	1.04	0.93	0.92	0.76	1.22	-0.14	-0.44
MCAP	4.43	9.19	11.19	13.19	13.08	13.55	12.57	11.85	9.37	4.46	-0.03	-0.11
ILLQ	0.06	0.07	0.08	0.05	0.05	0.05	0.06	0.05	0.05	0.05	0.01	0.88

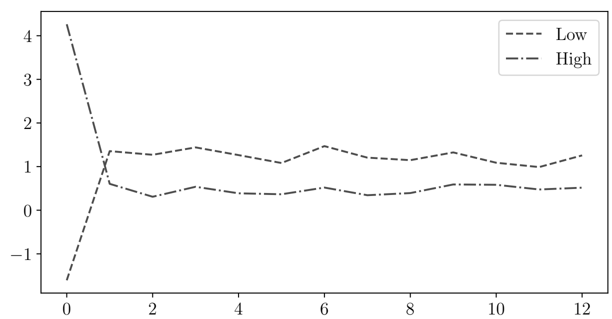


(a) Discount rate news

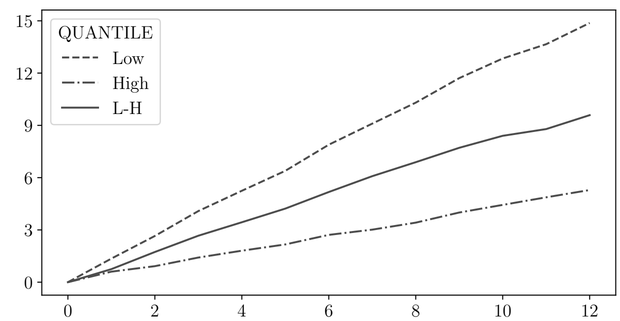
(b) Mispricing correction

Figure 1: Long-term effects of a target price release

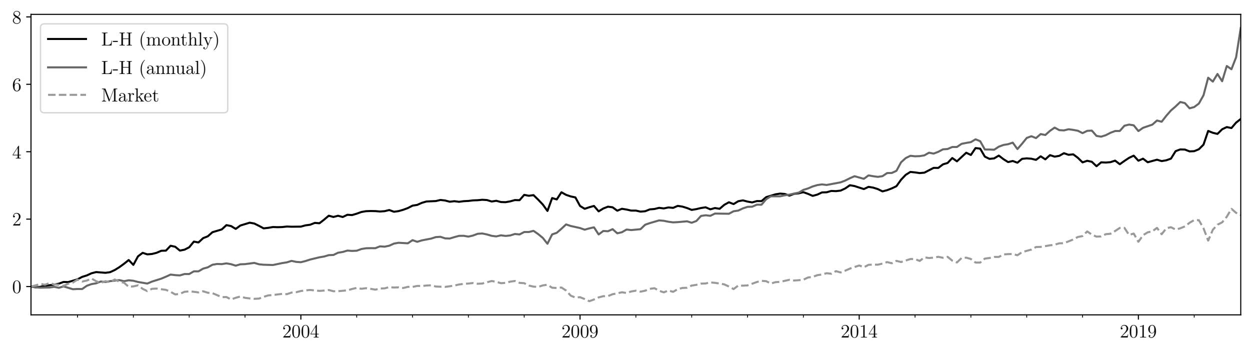
This figure presents different scenarios for the long-term price movement following target price releases. The dotted lines in the first graph represent the case when the target price carries only cash flow news, whereas the solid lines represent the case when it carries discount rate news. The second graph presents the case when the return reversal results from mispricing correction.



(a) Average monthly returns



(b) Average cumulative returns



(c) Cumulative returns (1999.03 - 2015.09)

Figure 2: Long-term performance of the NOA strategy

This figure presents the long-term performance of the NOA strategy. The top-left graph shows the average monthly excess returns of the Low and High NOA portfolios for twelve months following portfolio formation, and the top-right graph shows the average cumulative excess returns of the portfolios and their long-short portfolio. The bottom graph compares the cumulative excess returns of a monthly- and annually-rebalanced long-short portfolio and the CRSP market index for the sample period from February 1999 to December 2020.