WORKING PAPER

STOCK PRICE ANCHORING

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Abstract

We provide evidence on a new anomaly in the stock market. We show that stock prices are very robustly correlated to firm value in a cross-sectional framework. We interpret this result as evidence that investors' valuations are biased by a specific version of the availability heuristic, by which investors wrongly interpret the easily available information about the stock price as a piece of relevant cross-sectional information about true firm value. In this way firm value is "anchored" to the stock price, confirming the existence of anchoring effects in financial markets beyond the boundaries of the experimental lab. Interestingly, firms with a high nominal share price at the end of the year, tend to have lower returns in the subsequent year. After controlling for common risk factors, this underperformance amounts to 1.77 basis points per day, or 4.56% per annum.

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JEL Codes: G02, G11, G14

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1 Introduction

In most economic settings free prices are determined by the intersection of an upward-sloping supply function, that captures marginal cost, and a downward-sloping demand function, that captures marginal utility, in this way coordinating an efficient market equilibrium. In the last decades, however, evidence is accumulating that the valuation of goods by consumers may not be independent of the price of these goods and thus that the slope of demand curves may not be continuously negative, giving rise to the possibility of multiple market equilibria. To understand the relation between the price of a good and the consumers' valuation of that good we need to understand how consumers' beliefs and expectations shape their decision-making process and post-cognitive satisfaction. One possibility is that consumers, when faced with valuation uncertainty about the product's intrinsic characteristics, rely on extrinsic cues of the product, such as the price or the brand name, to assess the value of the good.

Consumers frequently make judgments based on incomplete information or limited knowledge, relying on heuristics and prior beliefs instead. We focus on the price-quality heuristic, which refers to the case where consumers interpret a product's price as a signal of its quality. The positive relationship between price and perceived quality is well-documented in the consumer behavior literature (see e.g., Johnson and Kellaris, 1988; Obermiller, 1988; Rao and Monroe, 1989). This price driven inference about product quality may also influence consumers' individual choice behavior as documented in Cronley et al. (2005). Shiv et al. (2005) show that the efficacy of energy drinks to produce behavioral effects depends on their apparent price. The authors find that energy drinks improve performance in a puzzle-solving task if the participants believe these energy drinks are more expensive. This is consistent with the view that the experienced valuation system is subject to uncertain perturbations and therefore resorts to external cues (in this case prices) to facilitate inference and subsequent decision-making. The neurobiological basis of this anomaly has been documented by Plassmann et al. (2008), who demonstrate a positive correlation between neural responses in medial orbitofrontal cortex and experienced pleasantness for wine tasting subjects if they believe the same wine was more expensive. Of particular interest is their finding that price not only moderates consumers' pleasure claims, but also their actual experiences.[1]

Since wine prices per bottle (and other commodity prices per fixed quantity) are comparable in their levels, one could still argue that consumers interpret a higher stated price as a signal of revealed higher valuation by other consumers. The observed correlation between price and experienced valuation in the presence of asymmetric information about the product's quality can then be interpreted as rationally taking into account the valuations of others in one's individual valuation. Compared to wine (or any other commodity) prices, however, stock price levels cannot be directly interpreted as a measure of value of the underlying firm in the eyes of other investors, since the number of outstanding shares is subject to managerial discretion. This essential difference should render comparisons between stock price levels as a measure of firm quality/value meaningless in a cross-sectional universe.

In efficient and frictionless markets, the nominal stock price can be considered as random and therefore should have no influence on the valuation of the underlying firm. Suppose an investor holds a position of $1 million in a company. Whether she buys 100 thousand shares at $10 or 10 thousand shares at $100 dollar, her stake in the firm should be identical since the total market value of the firm should be a reflection of the underlying firm fundamentals only. Since the stock price is irrelevant to firm value in standard finance theory, the relationship between stock price and firm value has not been subject to empirical scrutiny. Yet, research in consumer psychology has found that consumer judgment is often influenced by irrelevant anchors. In the classical wheel of fortune experiment, Tversky and Kahneman (1974) show that the numbers obtained by spinning a wheel of fortune influenced subjects' predictions regarding the number of African countries that are member of the United Nations. Ariely et al. (2003) found that an arbitrary anchor in the form of the last two digits of the subject' Social Security number strongly affects the willingness to pay for a variety of consumption

[1] Related to these findings is that of Mussweiler and Strack (1999) who show that anchoring effects are mediated by selectively increased accessibility of anchor-consistent knowledge. In other words, they show that participants generate evidence that is consistent with the notion that an object's value is equal to the value of the anchor.

goods.

Despite the fact that the level of the stock price should be irrelevant for the valuation of the underlying firm, several papers emphasize that nominal stock prices do influence investor behavior. Gompers and Metrick (2001) for example show that institutional ownership is positively related to the stock price, while Kumar and Lee (2006) find that retail investors are more attracted by low-priced stocks. Related to these findings, Schultz (2000) documents that a stock split increases the number of small shareholders. Green and Hwang (2009) show that asset returns have a higher degree of co-movement with low-priced stocks following a stock split and argue that this is a result of price-based stock categorization. Furthermore, it has been observed that individual investors exhibit a stronger preference for low-priced stocks because of their lottery-like distribution of returns, in particular the large upside potential (Kumar, 2009; Bali et al., 2011; Birru and Wang, 2016). Firms, in turn, appear to take note of the behavioral effects of nominal prices and often try to manage the level of their stock price. Theories offered to rationalize stock price management include efforts to customize the stock price in accordance with the market norm (Weld et al., 2009), matching time-varying preferences of investors to maximize firm value (Baker et al., 2009; Dyl and Elliott, 2006), and stock splits to signal inside information (Brennan and Copeland, 1988; Ikenberry et al., 1996).

While anchoring effects have been studied comprehensively in individual choice experiments, their applicability to real market settings, including the stock market, has been largely neglected (Furnham and Boo, 2011). In this paper, we fill this gap by examining the relationship between a firm's stock price and value. For a cross-sectional universe of US stocks between 1990 and 2014, we consistently show that the valuation of firms is surprisingly arbitrary. After controlling for persistence and mechanical effects, firm value appears to be significantly and positively related to the nominal stock price (i.e., the anchor). First, this study shows that firms with higher stock prices have higher valuations, as measured by their market-to-book ratio. These results hold when we control for firm-specific characteristics that account for growth opportunities, intangible asset structures, equity risk, corporate governance and market risk. These results are robust to alternative measures of firm valuation such as Tobin's Q, as well as variations in the set of control variables or the estimation method. Next, we also examine the association between stock prices and firm valuation by matching firms with similar characteristics but different price levels using nearest-neighbor matching first proposed by Rubin (1973, 1977). Results show that firms in the top price quintile are valued more than 20% higher than otherwise comparable firms with a more moderate share price. Although the nominal stock price should be irrelevant for firm value, it is the most visible figure that investors are subjected to. Our results therefore suggest that for a considerable proportion of investors their mental representation of a stock's value is shaped by the stock's price. These findings confirm previous observations in experimental designs where valuation was found to be manipulated by irrelevant cues or 'anchors' (e.g., Kahneman and Knetsch, 1992; Ariely et al., 2003). We confirm the relevance of these anchors even beyond experimental settings. Our findings are also in line with Plassmann et al. (2008) as investors attach more value to a company if the company is traded at a higher stock price.

Next, we also investigate whether the higher valuation given to high-priced stocks has consequences for the firm's performance on the stock market. Motivated by psychological evidence on limited investor attention and anchoring, Li and Yu (2012) document reversal effects for firms that enjoyed a historically high share price. Lee and Piqueira (2017) show that this post-peak underperformance is related to short-selling behavior. These price patterns are also in line with Griffin and Tversky (1992), who argue that investors overreact to a long series of good news, and underreact to sporadic news confronting their beliefs. Using the approach of Liu and Strong (2008), we construct buy-and-hold portfolios based on the firm's nominal share price. After controlling for common risk factors from Carhart (1997), the results show that high-priced firms earn up to 4.88% less during the subsequent year. Hence, we show that price anchoring is an important channel to explain the presence of reversal effects.

This paper is organized as follows. Section 2 describes the data. In Section 3, we present our main empirical results analyzing the link between share price and firm value. Section 4 examines the relation between share prices and stock market performance. Finally, Section 5 provides a discussion and concluding remarks.

2 Data

2.1 Sample selection

We obtain data from Thomson Reuters on all companies trading at the US stock markets spanning from 1990 until 2014. We choose 1990 as the starting date for our sample to accommodate the availability of the control variables at the level of securities. The sample includes all stocks with available financial data from the Thomson Reuters Datastream database.[2] To disentangle the anchoring effect from market microstructure effects of small stocks, unless otherwise stated, we exclude observations with a stock price lower than 5 dollar. Next, the literature shows (see e.g. Grinblatt et al., 1984; Mcnichols and Dravid, 1990) that corporate actions such as stock splits influence return expectations and firm value. Therefore, we disregard firms in the years with a split ratio[3] smaller than 0.95 or larger than 1.05. To ensure that our results are not driven by inordinate observations, we winsorize all potentially unbounded variables at the 1% and 99% level. The final sample consists of 36,360 observations from 4,144 unique companies.

2.2 Variable Description

In line with previous studies (e.g., Core et al., 1999; Green and Jame, 2013), we use the market-to-book value (MTBV) as a measure of firm valuation, constructed as the market

[2] As a result, the sample excludes opaque firms.

[3] The number of new shares divided by the number of old shares due to corporate actions like stock splits, stock dividends or rights issuances.

value divided by the balance sheet value of the firms' equity at the end of its fiscal year. The market-to-book value approximates the market's estimation of the firm's net present value, and largely counters subjective accounting judgments. As an alternative, we use the Tobin's Q, which is calculated by dividing the firm's market value by the firm's asset replacement costs (e.g., Fang et al., 2009; Morck et al., 1988). While Tobin's Q is commonly used in finance research, our preference is tilted towards the market-to-book value ratio because the valuation of asset replacement costs in Tobin's Q suffers from difficulties in valuing intangible assets. The market-to-book value directly measures shareholder value creation, i.e., how shareholders perceive and value a firm, without suffering from potential accounting biases (Hillman and Keim, 2001). We use the end-of-day unadjusted stock price at the end of the firm's fiscal year to measure the nominal price level. This corresponds to the real trading price on that moment, without historical adjustments for stock splits, stock dividends or other rights issuances. Per year, we divide our sample into five groups based on their nominal share price. We use these groups to compare firms with the highest prices in the fifth price quintile to the rest of the sample.

For each firm-year we compute a series of control variables. For details on the construction of these control variables, we refer to Appendix A. Since growth perspectives are a crucial factor for a firm's valuation we incorporate sales growth, profitability, age, natural logarithm of size and growth estimates of professional analysts in our analysis. We control for the asset structure of the company by including the amount spend on research and development and the asset turnover. Both measures are associated with the intangible assets that are not taken into account in the book value, and thus lead to higher market-to-book value and Tobin's Q values. Because investors typically demand a compensation for risk, we include the firm's current ratio, leverage, stock volatility and market beta as proxies for equity risk. As the valuation of a company also relies on its corporate governance practices, we include the payout ratio, analyst coverage and the cash ratio of the firm. These proxies reflect managerial freedom to spend available cash, and thus control for agency problems.

Moreover, these ratios are correlated with business maturity and cash flow stability. To account for the market power of the company, we calculate the concentration within each sector (Herfindahl index), the firm's the market share, and the interaction of both measures. In addition, we construct a market power dummy that indicates when a company is active in a highly concentrated sector (highest quintile Herfindahl index) or has a high market share (highest quintile market share).

It is well established that market conditions differ over time and have an impact on the firm valuation and vary over time. For example, illiquidity can cause firms to trade at a discount, while momentum captures possible persistence effects in the market valuation. Therefore, we control for market risk by incorporating the Amihud (2002) measure of illiquidity, share turnover (liquidity) and momentum effects. Because index membership affects firm visibility, we also include NYSE and Nasdaq dummies as controls. Finally, we add sector fixed effects in the form of 41 sector dummies based on the Industry Classification Benchmark (ICB). Unless stated otherwise in Appendix A, the data correspond to the last day of the fiscal year.

3 Share Price and Firm Value

In this section, we investigate whether higher-priced stocks enjoy a higher valuation. Section 3.1 introduces the methodology to compare firm value across different nominal stock price levels. Section 3.2 reports the descriptive statistics, and Section 3.3 shows our main results. In Section 3.4, we present the results using a matching procedure.

3.1 Methodology

To investigate the impact of the nominal stock price on firm valuation, we regress our value measures, market-to-book value and Tobin's Q, on the stock price and several control variables. The baseline specification is defined as follows:

$$Value_{it} = \beta_0 + \beta_1 P_{it} + \beta_2 Value_{i,t-1} + \beta_3 \bigtriangleup P_{it} + \beta_4 X_{it} + \varepsilon_{it} \quad (1)$$

where $Value_{it}$ is the log market-to-book value or the log Tobin's Q measured at the end of the firm i's fiscal year t. The variable of interest P_{it} represents the nominal share price of a firm's market value of equity. X_{it} controls for an extensive battery of firm-specific characteristics. β is the the matrix of coefficient estimates, and ε_{it} is the model's error term. All specifications incorporate industry fixed effects. To account for non-linear price effects, the P_{it} variable enters Eq.(1) as a covariate categorized in quintiles rather than introducing it as a continuous covariate. We only report the coefficient estimates for top price quintiles, while prices ranked at or below the third quintile serve as the reference category.[4] Eq. 1 is devised in such a way that it captures persistence effects and accounts for the potential mechanical relationship[5] from increased prices to a higher valuation metric. A lagged dependent variable is included to absorb the persistence effects that are not explicitly captured by other control variables. One of the factors in the deviation of a firm's value is the market price of a firm's equity. Ideally, we want to isolate the informational content of the market price from the mechanical linkage between the price and firm value. Hence, the inclusion of both the lagged dependent variable and the price change during the corresponding year helps us to eliminate the part of the price that gives rise to the mechanical effect on firm value. By doing so, the coefficient β_1 is intended to capture the pure causal impact of the stock price level on firm value (see Furfine and Rosen (2011) for a similar approach). Rearranging Eq. 1 into the following form $\bigtriangleup Value_{it} = \beta_0 + \beta_1 P_{it} + \beta_3 \bigtriangleup P_{it} + \beta_4 X_{it} + \varepsilon_{it}$ makes our estimation strategy more intuitive. As explained in the introduction, standard finance theories predict that there should be no causal effect from the stock price to the valuation of the firm. If, however, β_1 is positive, this

[4] We proceed with this classification to maintain consistency with the matching procedure in Section 3.4. We reach the same conclusions in any other combinations of price quintiles, as well as if P_{it} is defined as a continuous variable. These results are available on request.

[5] Section 4 includes a performance analysis demonstrating the potential benefits for investors, eliminating possible concerns on a mechanical relation.

would provide support for anchoring effects, as it would suggest that higher nominal share prices result in higher firm valuation. The focus of this study is to test for cross-sectional differences in firm valuation. Therefore, we use the Fama and MacBeth (1973) two-step procedure to estimate our model. In the first step, we perform a cross-sectional regression for each single time period (i.e., each year). In the second step, the final coefficient estimates are obtained by taking the average of the first step coefficient estimates. We use the Newey and West (1987) standard errors with a lag length of 4 years to correct for heteroskedasticity and serial autocorrelation.

3.2 Descriptive Statistics

Table 1 provides the summary statistics of the valuation metrics, the nominal share price, and all control variables. The left-hand side of Table 1 reports the statistics for the full sample, while the right-hand sides focuses on the 20% shares with the highest share price, i.e., firms in price quintile 5. For the full sample, the average share price is 28.63 US dollar. In the group of the 20% highest priced firms, this amounts to 63.15 US dollar. On average, higher priced firms enjoy a higher valuation. Higher-priced firms also tend to have a higher sales growth, profitability, age and size, while the average analyst growth estimates tend to be lower. The average amount spend on R&D and asset turnover is lower for firms in the fifth price quintile. We notice that the current ratio, volatility and market beta are slightly lower for high-priced firms. Interestingly, the average leverage ratio is lower for these companies. Highly priced firms also tend to have more market power, while the payout ratio, analyst coverage and firm's cash position suggest that this coincides with better corporate governance. Moreover, these firms enjoy a higher liquidity and momentum.

3.3 Empirical Results

Table 2 reports our main empirical results. The coefficient of the price level variable is positive and significant at the 1% level. When we use the market-to-book value as the measure for firm performance, the upper quantile coefficient estimate indicates that shares in the highest price quantile have a valuation reward of 12.9% compared to stock prices ranked at or below the third quintile. Our results remain qualitively similar when we consider the alternative valuation metric, i.e., the Tobin's Q. The highest-priced stocks are granted a valuation premium of 11.8%. These results support our main hypothesis that higher share prices are correlated with higher firm value, while controlling for a variety of firm characteristics.

To strengthen our hypothesis, we conduct a series of robustness tests using alternative sample selections, model specifications, and price variables. In the interest of brevity, Table 3 only reports the coefficient estimates of the fifth share price quintile. Model 1 corresponds to the baseline model from Table 2. To start, rows 2 to 7 show the results using different sample selection procedures. In model 2, we repeat our analysis but exclude all financial companies from our sample. In particular because some firm characteristics can be very different for these firms. For example, the levels of leverage that are common in the financial industry would indicate very high levels of stress in other industries. Both coefficient estimates and standard errors share the magnitude of the baseline model, which demonstrates that the results are not driven by financial firms. Model 3 includes the firm-year observations with a share price below 5 US dollar. The results are very similar to model 1, indicating that the impact of low priced penny stocks is limited. In model 4 and 5, we split our sample in two subperiods: from 1990 until 2001 and from 2002 until 2014. Estimates are slightly higher for the latter period, suggesting that the effect did not mitigate over time. In model 6 and 7, we repeat our analysis using firms that had respectively negative or positive stock returns over the past three years. The main motivation for this approach was to check whether stocks who experienced bad returns, but still have high prices, lose their value reward. The estimates in model 6 are still positive, indicating that having a negative return over the past three years does not erase the positive relation between stock prices and firm value. We refer to Section 4 for a more elaborate analysis on the share prices and returns.

Next, rows 8 to 13 of Table 3 show the results using different model specifications. For model 8, we do not winsorize our variables. Again, results are in line with previous findings. Model 9 presents the estimates obtained by including quintile dummies of all control variables. By doing so, we allow for non-linear effects of these control variables on the dependent variable. The results confirm the findings of our baseline specification. Next, model 10 addresses the concern that our valuation measures is correlated with the firm's size, momentum and profitability. Therefore, we adjust the firm's valuation by subtracting the average value of similar firms in a reference group. Each year, we divide all stocks in five size groups. Subsequently, within each size group, we sort the firms based on momentum creating 25 groups. To end, in every one of the 25 groups, we sort the firms in five groups based on profitability. Consequently, we constructed 125 portfolios based on size, momentum and profitability. Within each portfolio, we calculate the mean market-to-book value and Tobin's Q. This mean valuation serves as a benchmark for each company that belongs to that portfolio. Next, we subtract the mean value of the benchmark portfolio from the value of the firm. Finally, we rerun our model with the adjusted valuation serving as dependent variable. The results of model 8 show that our findings remain intact. The coefficients and t-statistics even increase, lending further support to our hypothesis. Model 11 and 12 report the results using a pooled OLS model respectively without and with standard errors clustered on the firm level. T-statistics are considerably higher compared to our baseline results, showing the importance of using the Fama and MacBeth (1973) two-step procedure to produce reliable estimates of the cross-sectional variation in our model. Model 13 uses the between-estimator which can be seen as a cross-section regression on the mean data for each stock. Hence, the between-estimator mitigates problems because of short-term fluctuations in firm characteristics, outliers and serial correlation of the error term. The between-estimator results reveal that coefficient estimates of the upper price quintile for both valuation measures are lower in magnitude compared to the pooled OLS estimates. This is not surprising as the between-estimator puts the focus on the cross-sectional heterogeneity, excluding the impact of intertemporal variation on the estimation results.

Finally, we construct new price quintiles using respectively the average, lowest, and highest price during the fiscal year in model 14, 15 and 16. Coefficient estimates are lower, but interestingly, we still find a significant impact of the nominal stock price on the valuation of a firm. The robustness tests above all confirm our main finding. High share prices coincide with a higher valuation.

3.4 Matching

In this section we test the validity of our main hypothesis by comparing the valuations of otherwise similar firms with different price levels. We follow a matching procedure first introduced by Rubin (1973, 1977) to pair firms. In line with Section 3.1, the goal is to compare firms in the quintile with the 20% highest share prices within one year, the treatment group, to firms in share price quintile 1 to 3, the control group. We start by matching each firm in the treatment group with one[6] firm in the control group that is most similar. To execute this matching, we need a set of characteristics to determine the similarity between firms. To counter industry fixed effects, we impose that firms are matched within the same industry. Additionally, firms are matched based on their size, momentum, profitability, analyst coverage, sales growth, R&D, market beta and cash ratio.[7] We use the Nearest-neighbor matching (NNM) procedure to pair each firm in the treatment group to the firm in the control group that is most similar. This is accomplished by calculating the Mahalanobis distance.[8] The matching is done with replacement, meaning that firms in the control group can be matched with multiple high-priced firms. As a result, firms are always matched with the most identical pair, which improves the matching accuracy and avoids the concern that the initial ordering of the treatment observations matters (Smith and Todd, 2005). Because

[6]Table 5 shows that our results are robust to a changing number of matched firms.

[7]We choose these covariates based on the highest correlations with our valuation measures. Alternative groups of control variables are tested, confirming our results below.

[8]The Mahalanobis distance is based on a Pythagorean theorem adapted to handle the fact that covariates may be correlated and measured on different scales.

we match firms based on more than one continuous control variable, we correct for a possible large-sample bias as suggested by Abadie and Imbens (2006, 2008). This procedure leads to a final sample of 7237 observations with a high price, paired to 3908 firms from our control sample. Finally, we compute the average treatment effects on the treated (ATET) by taking the average of the valuation differences between the pairs of treated and control firms.

We start our empirical analysis by comparing the summary statistics of the most important control variables. Table 4 presents the group averages of the firm's size, momentum, profitability, analyst coverage, sales growth, R&D, market beta and cash ratio. The left-hand panel describes the high-priced treatment group. The middle part reports on the full sample of firms in price quintiles one to three, while the right-hand side panel describes the statistics of the control firms matched with our firms in the treatment group. To start, we calculate the percentage standardized differences of the sample means by dividing the difference in means between the treatment and control group by the square root of the average standard deviation in both groups. The column 'Bias full' refers to the difference between the full sample and the treatment group, while column 'Bias matched' compares the control group with the treatment group. The column '% change in bias' reports how much this bias changed after the full sample was limited to the matched companies in the control group. It shows that for seven out of eight control variables, the bias reduces by 72% to 98%. Second, the t-statistics in Table 4 reveal that the differences between the control group and the treatment group are smaller and less significant after our matching procedure. Figure 1 presents the decrease in standardized differences graphically. Although some of the covariates are still significantly different, Figure 2 clearly shows that the distribution of the firm characteristics of high-priced firms are very similar to the distribution in our control group.

Table 5 reports the average treatment effect on the treated for both the market-to-book value and Tobin's Q. The baseline model in row 1 shows that firms with a share price in the top quintile enjoy a significantly higher valuation. The average value reward is 24% for the market-to-book value and 11% for Tobin's Q. Similar to our analysis in Section 3.3, model 2 until 9 of Table 5 show that our results are robust to different sample selections and model specifications. Again, we adjust our sample by excluding financials, incorporating stocks under 5 US dollar, and splitting the sample in two shorter periods. In addition, we impose in model 6 that firms are matched within the same year, or allow high-priced firms to be paired with more than one control firm in model 7, 8 and 9. Coefficient estimates and t-statistics are in line with our baseline model, confirming the previous findings. Although there is no initial reason to believe that a 100 dollar share with identical characteristics to a 10 dollar stock should be valued higher, our results indicate that stock prices are associated with firm valuation, validating our main hypothesis.

4 Share Price and Future Returns

If our estimation strategy and the battery of robustness checks still do not fully eliminate concerns about the mechanical effects between the nominal stock price and firm value, the reader should bear in mind that, given our findings, it should not be possible to devise a trading strategy that systematically outperforms the market. In this section, we investigate whether having a high share price, and the accompanying higher valuation, has implications for the firm's performance on the stock market. Given the price effects on valuation, high stock prices will be appealing to investors. Conversely, lower stock prices will be unappealing to investors. Since high price stocks are overvalued, we examine whether these stocks have, on average, low subsequent returns as compared to lower price stocks.

In line with Section 3, we compare two portfolios based on the firm's share price level. Using daily return series, we construct buy-and-hold portfolios as suggested by Liu and Strong (2008). At the end of every year, we sort the firms based on their share price and form two portfolios, one with stocks from the highest price quintile and one with stocks from the first three price quintiles. We invest the same dollar amount in every stock in the two portfolios. Stocks are kept in portfolio for 1 year, reflecting a feasible and realistic trading strategy for investors. By using this approach, we avoid high transaction costs due to the need of frequent portfolio rebalancing and address the concern that our trading strategy would suffer from statistical inferences (Liu and Strong, 2008). In addition, working with daily return series but yearly rebalancing is in line with Section 3, where we sorted companies based on the end-of-year[9] share prices using yearly data.

Table 6, Panel A, shows the raw portfolio returns. Row 1 of Panel A reports the returns of the portfolio with firms from the top price quintile at the end of the previous year. The second line of the table shows the portfolio returns of the control group with shares from the lowest three quintiles at the end of the previous year. Most interestingly, the third line shows the difference of both portfolios, which mimics a long/short portfolio that is long in high-priced stocks and short in the control group. On average, high-priced firms earn 1.61 basis points per day, or 4.14% per annum, less during the subsequent year in an equally weighted portfolio. For a value-weighted portfolio, this return difference equals 1.28 basis points per day, or 3.28% per annum. This suggests that high-priced firms are overvalued, causing them to underperform on the stock market. Next, we investigate whether this return difference can be explained by common risk factors. Panel B of Table 6 reports the results of regressing our buy-and-hold portfolios on the risk factors of the Carhart (1997) four-factor model and the Fama and French (2016) five-factor model with momentum. The equally weighted long/short portfolio using the Carhart (1997) model generates a significant negative alpha of 1.77 basis points per day, corresponding to a loss in return of 4.56% per annum. When using the five-factor model, our long/short strategy generates an annual profit of 3.54%. The results for value-weighted portfolios show that the long/short strategy is slightly less profitable, with an annual return difference of 3.12%. Both in term of size and significance, the return difference is lower for value-weighted portfolios. Even after controlling for a possible size effect in the factor models, the results remain equivalent. This means that the effect is smaller for firms with a higher market capitalization, in which

[9] In Section 3, fiscal year-end data are used to be consistent with control variables based on accounting data. Here, we use share prices of December 31 to have one portfolio rebalancing moment per year.

ownership is typically dominated by institutional investors. Not surprisingly, small stocks are more prone to the effects of stock price anchoring, as retail investors make a larger part of their investor base. This finding is also in line with Baker and Wurgler (2006) showing that smaller, harder to arbitrage, firms are more likely to differ more from their true value. Furthermore, equally weighted returns are more reflective of the performance of the typical firm, hence representing the price response of many stocks rather than the response of a few large stocks.

Our results show that the underperformance of highly priced firms can not be fully attributed to common risk factors, suggesting that the overvaluation of firms based on their nominal share price is not fully priced into the market.

5 Conclusions

This paper shows that higher stock prices coincide with higher valuations, as measured by the market-to-book value or Tobin's Q. This result is robust under a very wide set of model specifications, control variables, time periods and subsamples. As a result, this paper provides evidence on a new and surprising anomaly in the stock market, namely the cross-sectional correlation between the level of the stock price and the firm value. Two otherwise identical firms with only a difference in their stock price should not be valued any different by the market, as their stock prices can be freely set by choosing the number of shares. Our results, however, suggest the opposite. We argue that the underlying mechanism for this anomaly originates from investors suffering from a behavioral bias that causes a positive correlation between stock prices and the perceived value. Specifically, since investors may have incomplete information about the value of the firm or may lack the necessary competences to process that information, their valuation may be biased by a version of the availability heuristic, by which investors wrongly interpret the easily available stock price as a piece of relevant cross-sectional information about true firm value (Tversky and Kahneman, 1974). In this way the firm value may become "anchored" to the stock price.

Interestingly, the results also show that, after enjoying a higher valuation, high-priced firms subsequently underperform. Results show that the yearly underperformance of 4.14% per annum can not be fully attributed to common risk factors, suggesting that the overvaluation of firms based on their nominal share price is not fully priced into the market. In addition, our results show that the effect of stock price anchoring is larger for smaller firms.

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Table 1: Summary statistics

	Full sample			Price quintile 5		
	Mean	Median	Stdev	Mean	Median	Stdev
Nominal share price	28.63	22.61	22.04	63.15	56.99	20.63
MTBV	3.07	2.13	3.32	4.20	3.04	3.90
Tobin 's Q	3.59	2.59	4.23	4.73	3.46	4.66
Growth perspectives						
Sales growth	12.24	8.49	21.34	13.30	9.54	18.04
Profitability	0.33	0.29	0.48	0.46	0.37	0.46
Age	18.25	16.78	10.37	21.11	20.06	10.61
Size	5.26	0.74	21.22	14.06	3.05	40.83
Analyst growth estimates	5.89	0.00	67.02	-5.48	0.00	23.24
(In)Tangible assets						
Research & development	7.58	0.00	40.80	4.35	0.22	25.93
Asset turnover	113.03	0.96	83.19	101.18	88.00	72.48
Equity risk						
Current ratio	2.64	1.98	2.40	2.18	1.63	2.04
Leverage	28.96	28.01	23.28	31.62	31.74	21.32
Volatility	32.50	30.97	11.83	25.80	23.87	9.07
Market beta	0.94	0.91	0.57	0.92	0.90	0.46
Corporate governance						
Payout ratio	18.00	0.00	24.92	24.80	20.92	24.12
Analyst coverage	356.92	170.00	467.29	540.62	393.00	574.31
Cash	30.81	24.14	25.78	28.90	22.53	23.55
Herfindahl index	14.48	0.10	12.48	15.75	10.44	13.42
Market share	3.99	0.01	9.56	8.76	3.09	14.29
Market power	103.06	0.00	549.64	244.33	33.24	807.73
Market risk						
Illiquidity	4.30	0.00	37.56	0.73	0.01	23.67
Turnover shares	1.92	1.21	7.70	2.40	1.34	16.55
Momentum 3 year	13.07	10.38	25.42	20.43	16.85	21.02

Table 1 reports the summary statistics for the main variables used in our sample period spanning from 1990 until 2014. The sample includes stocks with available financial data from the Thomson Reuters Datastream database. This results in 36,360 observations for 4,144 companies. Per year, we divide our sample into 5 groups based on their nominal share price. The left-hand side of the table shows the summary statistics for the whole sample, while the right-hand side reports the summary statistics of the firms with the 20% highest prices, price quintile 5. All potentially unbounded variables are winsorized at the 1% and 99% level. More detailed information on the construction of our variables is available in Appendix A. Unless otherwise stated in Appendix A, data correspond to the firms' fiscal year.

Table 2: Nominal share price and firm value

	MTBV		Tobin's Q	
Nominal share price				
Quintile 4	0.079***	(5.38)	0.060***	(9.53)
Quintile 5	0.129***	(5.08)	0.118***	(8.88)
Control variables				
$\text{Valuation}_{t\text{-}1}$	0.770***	(34.65)	0.677***	(48.38)
Momentum 1 year	0.351***	(7.65)	0.224***	(10.17)
Growth perspectives				
Sales growth	-0.000***	(-2.91)	-0.000**	(-2.50)
Profitability	0.042**	(2.73)	0.063***	(4.24)
Age	-0.000***	(-3.01)	-0.001***	(-3.95)
Size	-0.041***	(-6.20)	-0.048***	(-9.32)
Analyst growth estimates	-0.075**	(-2.63)	-0.053**	(-2.65)
(In)Tangible assets				
Research & development	0.054***	(3.97)	0.111**	(2.20)
Asset turnover	0.035***	(9.24)	0.028***	(9.14)
Equity risk				
Current ratio	-0.015***	(-6.11)	-0.015***	(-4.54)
Leverage	0.001***	(6.14)	0.005***	(14.29)
Volatility	-0.001*	(-1.73)	-0.002***	(-4.70)
Market beta	0.033***	(6.16)	0.036***	(4.14)
Corporate governance				
Payout ratio	0.000***	(7.29)	0.000***	(6.97)
Analyst coverage	0.000***	(8.10)	0.000***	(6.96)
Cash	0.001***	(3.97)	0.000***	(4.51)
Herfindahl index	0.000	(1.23)	0.000**	(2.37)
Market share	0.002***	(2.97)	0.004***	(3.58)
Market power	-0.004**	(-2.59)	-0.005**	(-2.56)
Market power dummy	0.009***	(3.05)	0.010*	(1.94)
Market risk				
Illiquidity	-0.081***	(-5.16)	-0.109***	(-4.18)
Turnover shares	-0.004**	(-2.42)	-0.003*	(-1.92)
Momentum 3 year	0.001***	(5.38)	0.001***	(4.99)
NYSE	0.041***	(4.22)	0.043***	(5.20)
S&P 500	0.005	(0.68)	-0.001	(-0.14)
Constant	0.493***	(6.59)	0.687***	(9.27)
Industry fixed effects	Yes		Yes	
R^2	84.2		78.4	
N	36,360		31,966	

Table 2 shows the results of Fama and MacBeth (1973) two-step panel regressions of firm value on the stock price and firm characteristics. Column 2 and 3 show the results using the natural logarithm of the market-to-book value (MTBV), while column 4 and 5 report on the results using the Tobin's Q. The price variables dummies for quintile 4 and quintile 5 compare high-priced stocks to stocks trading at a low to moderate price. The lag of the natural log of market-to-book value captures persistence effects, and the one-year momentum accounts for a possible mechanical relation between stock prices and firm value. Firms with a stock price lower than 5 US Dollar are excluded to mitigate market microstructure effects of small stocks. The R-square corresponds to the average value of the R-squares from the cross-sectional regressions in the first step of the Fama-MacBeth procedure. Newey and West (1987) standard errors with a lag length of 4 years are used to calculate *t*-statistics, reported in parentheses. *, **, *** indicate the statistical significance at the 10%, 5% and 1% levels.

Table 3: Nominal share price and firm value: robustness checks

	MTBV			Tobin's Q		
	Quintile 5	R^2	N	Quintile 5	R^2	N
01 Baseline results	0.129***(5.08)	0.84	36360	0.118***(8.88)	0.78	31966
Sample selection						
02 Without financials	0.135***(5.08)	0.84	34412	0.127***(8.93)	0.78	30057
03 With penny stocks	0.128***(5.78)	0.81	46026	0.148***(7.89)	0.74	37861
04 Subsample: 1990-2001	0.114** (2.55)	0.87	12306	0.112***(4.82)	0.79	11022
05 Subsample: 2002-2014	0.145***(12.95)	0.82	24054	0.125***(12.85)	0.78	20944
06 Negative momentum	0.096***(3.07)	0.87	10423	0.054* (1.71)	0.84	8363
07 Positive momentum	0.120***(5.12)	0.85	25937	0.110***(6.58)	0.79	23603
Model specifications						
08 No winsorizing	0.133***(5.23)	0.84	36352	0.123***(8.15)	0.78	33037
09 Quintiles of all controls	0.121***(6.01)	0.78	36360	0.123***(4.57)	0.72	36190
10 SMP adjusted valuation	0.188***(6.92)	0.66	35161	0.169***(6.92)	0.66	35161
11 Pooled OLS	0.193***(17.93)	0.79	36360	0.156***(20.39)	0.74	33044
12 Pooled OLS clustered SE	0.193***(16.43)	0.79	36360	0.156***(16.71)	0.74	33044
13 Between estimator	0.162***(8.34)	0.87	36360	0.144***(6.55)	0.82	33044
Price variable						
14 Year-average	0.077***(6.84)	0.84	36360	0.076***(10.18)	0.78	33044
15 Year-low	0.087***(4.95)	0.84	36360	0.080***(8.65)	0.78	33044
16 Year-high	0.063***(7.78)	0.84	36360	0.070***(8.00)	0.78	33044

Table 3 presents the results of variations in sample selection, model specifications and price variables compared to the baseline models in table 2. Because the main objective is to test the robustness of the stock price variable, we only report the coefficient of the fifth price quintile. The first row shows the results of the Fama and MacBeth (1973) two-step panel regressions model that serves as a benchmark model. Rows 2 to 7 show the results using a different sample selection procedure. Model 2 excludes firm from the financial industry and model 3 includes the excluded penny stocks under 5 US Dollar. Row 4 and 5 show the results based on the subsamples 1990-2001 and 2002-2014. In model 6 and 7, we split our sample based on the firm's returns over the past three years. Model 6 reports the results of firms with negative momentum, model 7 for firms with positive momentum. Rows 8 to 13 show the results of alternative model specifications. Row 8 reports the results without winsorising our variables. To allow for nonlinear effects, model 9 shows the results when regressing the value measures on quintile dummies of all control variables. Row 10 shows the results when using 125 portfolios sorted on size, momentum and profitability (SMP), and subsequently adjust the value measure market-to-book value or Tobin's Q by subtracting from a firms' value the mean value in the reference group. Row 11, 12 and 13 shows the results using respectively a standard pooled OLS model, a pooled OLS model with standard erros clustered on the firm level, and the between estimator to focus on the cross sectional differences. Instead of using the price at the end of the fiscal year to contruct our quintile dummies, the year-average, year-low, and year-high are used in model 14, 15 and 16, respectively. The R-square corresponds to the average value of the R-squares from the cross-sectional regressions in the first step of the Fama-MacBeth procedure. Newey and West (1987) standard errors are used to calculate *t*-statistics, reported in parentheses. *, **, *** indicate the statistical significance at the 10%, 5% and 1% levels.

Table 4: Nearest-neighbor matching diagnostics

	Treatment group		Full sample					Control group						
Holding Period	N	Mean	N	Mean	Diff.	t-stat	Bias full	N	Mean	Diff.	t-stat	Bias matched	% change in bias	t-stat
Size	7237	14.98	27677	13.00	1.98	−14.73	1.09	3908	14.33	0.65	−7.10	0.11	−90.24	−15.77
Momentum	7237	20.43	27677	8.54	11.89	−14.14	0.49	3908	18.30	2.14	−4.19	0.14	−72.50	−16.29
Cash	7237	28.90	27677	31.96	−3.06	2.09	−0.12	3908	29.67	−0.77	0.89	0.03	−75.78	−2.16
Profitability	7237	0.46	27677	0.28	0.18	−7.58	0.36	3908	0.40	0.06	−4.26	0.11	−68.23	−7.14
Analyst coverage	7237	540.62	27677	273.64	266.99	−11.18	0.55	3908	426.18	114.45	−5.43	0.05	−90.21	−13.66
Sales growth	7237	13.30	27677	12.19	1.11	−1.80	0.05	3908	13.01	0.28	−0.63	0.10	86.52	1.54
R&D	7237	0.04	27677	0.09	−0.05	1.86	−0.13	3908	0.05	0.00	0.55	0.01	−90.92	−1.86
Market beta	7237	0.92	27677	0.92	0.00	−0.04	0.00	3908	0.94	−0.02	1.00	0.00	−97.76	−0.85

Table 4 reports the matching diagnostics for the main variables in the matching procedure. Companies are matched based on the nearest-neighbor procedure with replacement using the Mahalanobis distance. The left-hand panel shows the summary statistics of the companies in the highest price quintile. The middle part reports on the full sample of companies in the share price quintiles 1, 2 or 3. The right-hand panel focuses on the companies that were selected for the control group as nearest-neighbors for companies in the treatment group. The columns 'Bias full' and 'Bias matched' show the standardized percentage bias between the high-priced firms in the treatment group and respectively the companies in the full sample and control group. The column '% change in bias' shows how much the bias changed after the full sample was limited to the matched companies in the control group.

Table 5: Nominal share price and firm value: nearest-neighbor matching

	MTBV			Tobin's Q		
	ATET		N	ATET		N
01 Baseline results	0.241***	(20.88)	7237	0.113***	(10.97)	7061
Sample selection						
02 Without financials	0.247***	(20.48)	6855	0.120***	(11.07)	6681
03 With penny stocks	0.252***	(21.06)	7237	0.119***	(11.00)	7061
04 Subsample: 1990-2001	0.209***	(10.68)	2439	0.102***	(5.95)	2359
05 Subsample: 2002-2014	0.259***	(18.08)	4798	0.131***	(10.25)	4702
Model specifications						
06 Match within year	0.256***	(24.56)	7237	0.135***	(14.28)	7061
07 Multiple matches: 2	0.254***	(24.80)	7237	0.125***	(13.71)	7061
08 Multiple matches: 3	0.256***	(26.81)	7237	0.127***	(14.84)	7061
09 Multiple matches: 4	0.260***	(28.47)	7237	0.132***	(15.90)	7061

Table 5 reports the average treatment effects on the treated (ATET) on market-to-book value and Tobin's Q of matched firms with a high price compared to the control firms with a low to medium price. Companies are matched based on the nearest-neighbor procedure with replacement using the Mahalanobis distance. Row 1 shows the results of the benchmark model, in which high-priced companies are matched based on the firms' size, momentum, profitability, analyst coverage, sales growth, R&D, market beta and cash position with a company in the control group within the same industry. Row 2 until 10 report the results of using variations of the sample selection and model specification. Model 2 excludes firm from the financial industry and model 3 allows penny stocks under 5 US Dollar to be in the control group. Row 4 and 5 show the results based on the subsamples 1990-2001 and 2002-2014. Row 6 shows the results when firms are matched within the same year instead of the same level 3 ICB sector. Instead of matching with 1 nearest neighbor, model 7, 8 and 9 match the high-priced firms with respectively 2, 3 and 4 control firms. The results are corrected for a possible large-sample bias that exists when matching on more than one continuous covariates using the method suggested by Abadie and Imbens (2006, 2008). Newey and West (1987) standard errors are used to calculate t-statistics, reported in parentheses. N refers to the number of high-priced firms that are matched. Coefficients marked with ***, **, and * indicate significance at the 1, 5, and 10 percent level, respectively.

Table 6: Nominal share price and firm returns

	Equally weighted		Value-weighted	
	Alpha (bp/day)	*t*-stat	Alpha (bp/day)	*t*-stat
Panel A: raw returns				
High price	5.49***	(3.82)	4.30***	(2.86)
Control group	7.10***	(4.84)	5.58***	(3.15)
Difference	-1.61***	(-2.68)	-1.28	(-1.51)
Panel B: long/short portfolio				
Raw returns	-1.61***	(-2.68)	-1.28	(-1.51)
Carhart model	-1.77***	(-3.95)	-1.22*	(-1.69)
FF5-momentum model	-1.38***	(-3.14)	-1.22*	(-1.71)

Table 6 reports the daily buy-and-hold returns of equally and value-weighted portfolios. Panel A reports the raw returns of the portfolio of high-priced firms, a portfolio of the firms in the lower three price quintiles (control group), and the difference between these two. Panel B shows the result of the raw difference portfolio returns, and this long/short portfolio returns regressed on the Carhart (1997) four-factor model and the Fama and French (2016) five-factor model with momentum. The sample includes all firms with available price and return data in Thomson Reuters Datastream, using 6484 unique firms. We have 6300 daily times series observations from 1990 until 2014, resulting in 16.868.432 firm-day observations. Portfolios are rebalanced yearly based on the end-of-December share price. Coefficients marked with ***, **, and * indicate significance at the 1, 5, and 10 percent level, respectively. *t*-statistics reported in parentheses.

Figure 1: Matching diagnostics: standardized differences

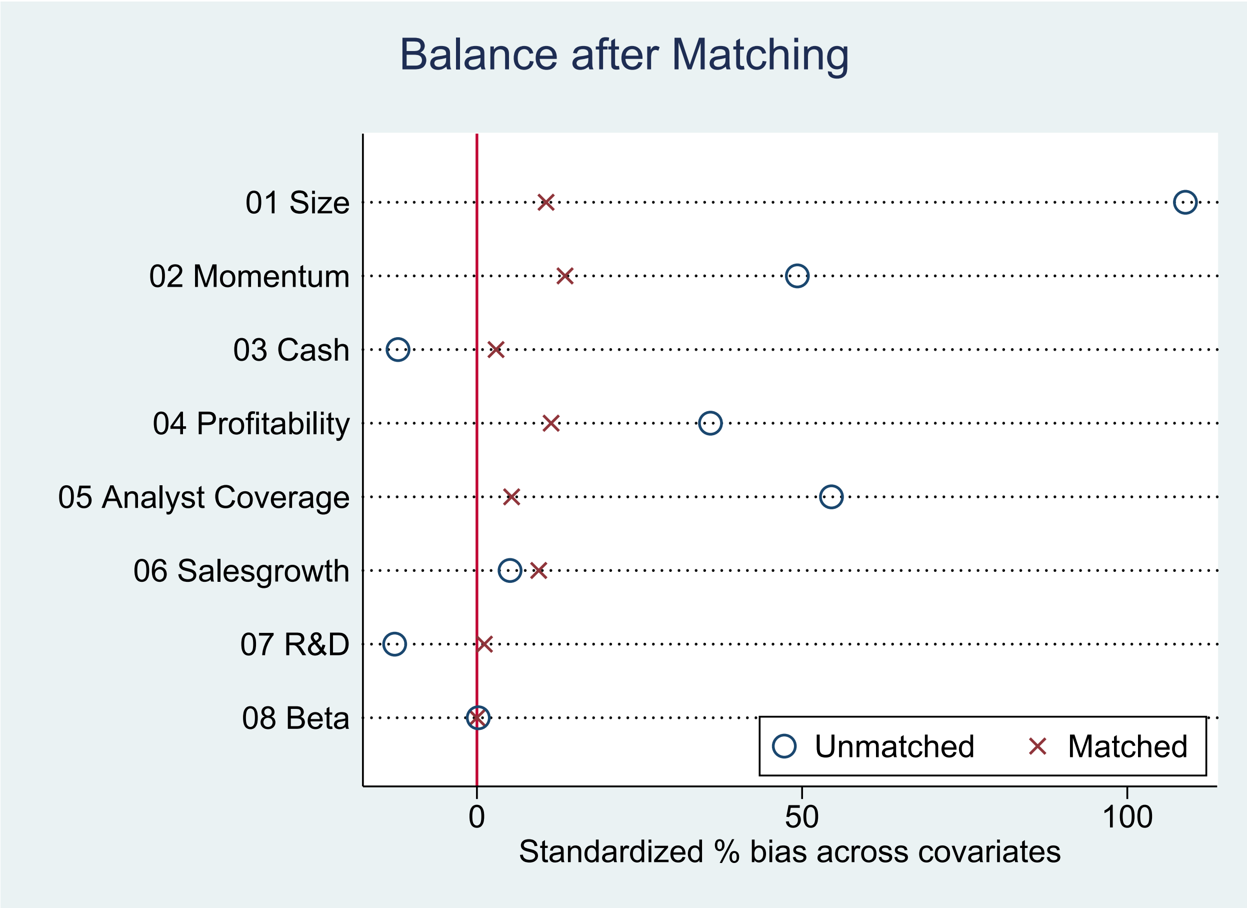

Figure 1 displays the percentage standardized differences of the sample means before and after matching for the eight control variables used in the baseline model 1 of Table 5. The percentage standardized differences are calculate by dividing the difference in mean between the treatment and control group by the square root of the average standard deviation in both groups.

Figure 2: Matching diagnostics: balance after matching

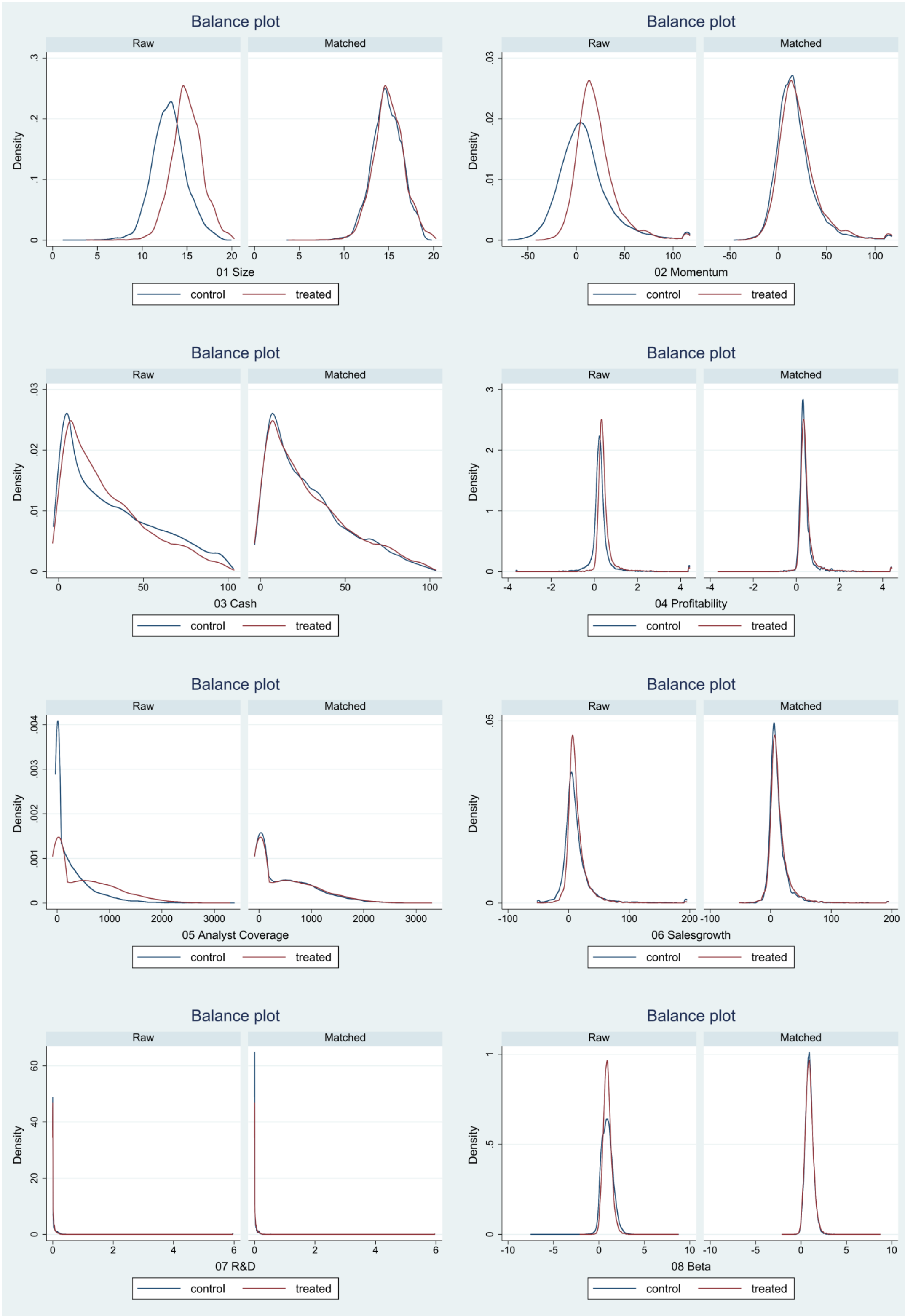

Figure 2 reports the distribution of the control variables described in Table 4 for both the full control sample before the matching procedure (raw), as well as for the control group after matching (matched).

Appendix A Variable Definitions

Variable	Definition
Value Metric	
MTBV	Market value of the ordinary (common) equity at the end of the fiscal year divided by the balance sheet value of the ordinary (common) equity in the company.
Tobin's Q	Enterprise value (market capitalization + preferred stock + minority interest + total debt minus cash) divided by the book value of the proportioned common equity in the company.
Price Variable	
End-of-year Price	Unadjusted price: the real price a stock was trading at. Not adjusted for corporate actions.
Year-average	Average unadjusted closing prices over the fiscal year.
Year-high	Highest unadjusted closing price over the fiscal year.
Year-low	Lowest unadjusted closing price over the fiscal year.
Growth Perspectives	
Sales growth	Current year's net sales or revenues divided by the net sales or revenues four years ago. Reduced to a compound annual rate.
Profitability	Earnings Before Interest, Taxes and Depreciation (EBITDA) divided by the book value.
Age	Number of years since Datastream holds information about the issue.
Size	Natural logarithm of net sales or revenues: represent gross sales and other operating revenue less discounts, returns and allowances (billion USD).
Analyst growth estimates	Average of 12 month price target by analysts, divided by the current stock price (%). Data starting from March 1999. If no target prices are available, we set this variable to zero.
(In)tangible Assets	
Research & Development	Research and Development expenditures divided by the net sales or revenues (%). We set missing values to zero.
Asset Turnover	Net sales or revenues divided by the total assets (%).
Equity Risk	
Current Ratio	Liquidity ratio: Current Assets-Total / Current Liabilities-Total.
Leverage	Total debt as a percentage of the total capital.

Variable	Definition
Equity Risk	
Volatility	A measure of a stock's average annual price movement to a high and low from a mean price for each fiscal year. For example, a stock's price volatility of 20% indicates that the stock's annual high and low price has shown a historical variation of +20% to -20% from its annual average price.
Market beta	The beta factor of the CAPM model. It expresses the relative movement of the price against the market, showing the likely relative change for a given market movement and whether the stock is prone to under- or overreact.
Corporate Governance	
Payout Ratio	Dividends per share over earnings per share, multiplied by 100.
Analyst Coverage	The total number of estimators covering the company for the fiscal period. We set missing values to zero.
Cash	Represents money available for use in the normal operations of the company. Cash and equivalents as a percentage of total current assets.
Herfindahl Index	Measure of sector concentration(%): sum of the squares of the market shares (sales) of the firms within the level 3 ICB industry.
Market Share	Share (%) in total sales within the level 3 ICB industry.
Market Power	Interaction term of sector concentration (Herfindahl index) and the company's market share.
Market Power Dummy	Dummy variable that indicates companies that are both in a highly concentrated sector (highest quintile Herfindahl index) and have a high market share (highest quintile).
Market Risk	
Illiquidity	Amihud (2002) illiquidity ratio: the absolute (percentage) price change per dollar of daily trading volume, averaged per year.
Turnover Shares	Turnover by volume scaled by shares outstanding.
Momentum 3 Year	Multiplied annual (3 years) total investment return reduced to a compound annual rate.
Index Inclusion	
S&P500	Dummy variable equal to one if the firm is a constituent of the S&P500.
NYSE	Dummy variable equal to one if the firm trades on the NYSE.
Industry	Dummy variables based on the level 3 ICB sectors (41 sectors).

Table A describes the construction of the dependent variables and the controls used in the regression analysis. All company-level variables are computed each year from 1990 to 2014, using the Thomson Reuters Datastream database.