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MISVALUATION AND CORPORATE INVENTIVENESS

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ABSTRACT

We test how market overvaluation affects corporate innovation. Estimated stock overvaluation is very strongly associated with measures of innovative inventiveness (novelty, originality, and scope), as well as R&D and innovative output (patent and citation counts). Misvaluation affects R&D more via a non-equity channel than via equity issuance. The sensitivity of innovative inventiveness to misvaluation is increasing with share turnover and overvaluation. The frequency of exceptionally high innovative inputs/outputs increases with overvaluation. This evidence suggests that market overvaluation may generate social value by increasing innovative output and by encouraging firms to engage in highly inventive innovation.

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1. Introduction

Both efficient and inefficient market theories imply that higher stock prices will be associated with higher corporate investment. This includes both the creation of tangible assets through capital expenditures, and the creation of intangible assets through research and development (R&D). Under the Q-theory of investment (Tobin 1969), higher stock price accurately reflects stronger growth opportunities, so high valuation firms invest more to exploit better opportunities. If the incremental investment of a high-valuation firm is for innovative purposes, as reflected in R&D expenditures, the firm should achieve greater innovative output, in the form of new discoveries, techniques, or products.

Similar effects arise when markets are inefficient and investors misvalue different firms differently. Under what we call the *misvaluation hypothesis of innovation*, firms respond to market overvaluation by engaging in more innovative activities, resulting in more risky and creative forms of innovation, and higher innovative investment and future innovative output.

With regard to the ambitiousness of firms' innovative activities, the management of an overvalued firm may have greater freedom to engage in more ambitious projects with radical solutions to problems, breakthrough technology, and major scope for improving the welfare of customers. Overvaluation can relax financing constraints on such projects, and can allow an ambitiously innovating firm to maintain a high stock price. Overvaluation can therefore help offset the limiting effect of managerial risk aversion on the riskiest forms of innovation. Indeed, since innovative activities tend to create positive externalities, overvaluation may sometimes be welfare-improving, as suggested by Keynes (1931), Gross (2009) and Shleifer (2000).

To test for such effects, we measure both the amount of innovative output—number of patents or patent citations—and the nature of the innovative activity. To evaluate the effects of misvaluation on the nature of innovation, we test whether overvaluation is associated with three aspects of innovativeness defined in previous literature. *Innovative novelty* is the number of citations per patent (Seru 2014). *Innovative originality* is defined as the extent to which a patent cites previous patents spanning a wide range of technology classes; *innovative scope* is the extent to which a patent is cited by future patents spanning a wide range of technology classes (Trajtenberg, Henderson, and Jaffe 1997).[1] We use the term *inventiveness* to refer collectively to these three aspects of innovation; we consider projects with very high expected inventiveness to be moon shots. We illustrate in Section 2 the co-occurrence of overvaluation and innovative activity with the case examples of Tesla, SpaceX, and NetApp.

Overvaluation can also potentially increase the level of investment---both in general, and in innovative activity. For example, overvaluation can encourage the firm to raise more equity capital (Stein 1996; Baker, Stein, and Wurgler 2003; Gilchrist, Himmelberg, and Huberman 2005) to exploit new shareholders.[2] If firms are inclined to invest the additional funds, overvaluation encourages investment. For example, if the market overvalues a firm's new investment opportunities, the firm may commit to additional investment in order to obtain favorable terms for new equity (or risky debt) financing.

There are pathways other than the financing channel by which overvaluation can affect innovation. For example, managers of an overvalued firm may feel insulated from board or takeover discipline, and therefore may be more willing to undertake risky innovative activity—a governance channel. Managers who desire publicity may also be attracted to ambitious,

[1] For a given total citation count, greater novelty suggests that a firm's patents are important rather than being 'least publishable units;' see Seru (2014). Regarding originality, a patent that draws upon knowledge from a wide range of technology areas is indicative of an innovation that deviates more from current technological trajectories. Drawing upon diverse technologies may also reflect the firm's ability to recombine technologies in an original way. Previous literature refers to what we call "scope" as "innovative generality." For applications of innovative originality and scope, see also Hall, Jaffe, and Trajtenberg (2001), Lerner, Sørensen, and Strömberg (2011), Custodio, Ferreira, and Matos (2013), and Hirshleifer, Hsu and Li (2018). Section 2 discusses in more depth the motivation for and estimation of the three dimensions of innovation inventiveness.

[2] Since equity is more sensitive than debt to firm valuations, equity is a more attractive vehicle for exploiting misvaluation. Several authors provide evidence suggesting that firms time new equity issues to exploit market misvaluation, or manage earnings to incite such misvaluation—see, e.g., Ritter (1991), Loughran and Ritter (1995), Teoh, Welch, and Wong (1998a, 1998b), Teoh, Wong, and Rao (1998), Baker and Wurgler (2000), Henderson, Jegadeesh, and Weisbach (2006) and Dong, Hirshleifer, and Teoh (2012). There is also evidence that overvaluation is associated with greater use of equity as a means of payment in takeovers (Dong et al. 2006), as predicted by the behavioral model of Shleifer and Vishny (2003).

glamorous and attention-grabbing projects.

There is also a possible catering channel. Managers who prefer high current stock prices may spend heavily, even at the expense of long-term value, to cater to short-term investor optimism about those investment opportunities that investors find appealing (Stein 1996; Jensen 2005; Polk and Sapienza 2009). Also, managers may be motivated to maintain high stock prices (Jensen 2005), possibly in part because high prices serve as a reference point for investor perceptions (Baker, Pan, and Wurgler 2012; Li and Yu 2012; George, Hwang, and Li 2018).

Crucially, even if investor optimism is transient, in the catering theory it affects current levels of 'long-term' investment such as capital expenditures, because managers desire credit for generating long-term value.[3] We expect such incentives to be especially strong for innovative spending, as innovative activities are exciting to investors and especially hard for the market to value. Subsection 3.2 documents that there are long-run effects of overvaluation on innovation.

Two other behavioral mechanisms can also induce an association between misvaluation and innovative activity. Managers themselves may share in the positive sentiment of investors that is the source of overvaluation. If, for example, managers overestimate innovative growth opportunities, the firm will undertake more such activity. Second, managers may be rationally cognizant of overvaluation, but the positive sentiment of consumers, suppliers or potential employees may improve the firm's opportunities in factor and product markets, making innovative activity more profitable. This positive feedback effect is modeled, for example, in Hirshleifer, Subrahmanyam, and Titman (2006). We refer to these two mechanisms as shared sentiment effects.

[3] Several empirical papers document investor sensitivity to 52-week highs, and some also provide evidence that this influences managerial behavior (Baker, Pan, and Wurgler (2012), Li and Yu (2012), Birru (2015), and George, Hwang, and Li (2018)).

These considerations motivate testing whether misvaluation predicts innovative input, in the form of R&D expenditures, and innovative output, in the form of patents and patent citations. Understanding how misvaluation affects R&D and resulting innovative output is important, since R&D is a key source of technological innovation (Hall, Jaffe, and Trajtenberg 2005), and is a major component of aggregate corporate investment (higher than capital expenditures since 1997 in our sample).

A key challenge for estimating the relationship between inventiveness, and innovative inputs and outputs to misvaluation is that valuation is endogenous; in an efficient market, firms with strong opportunities for innovative investment will rationally have high prices. In consequence, high valuation measures should predict high innovative investment, and subsequently, high innovative output. In other words, there is possible reverse causality. We address this issue by using a measure of misvaluation that is designed to exclude, as much as possible, this rational component of valuation.

Our misvaluation measure, *MFFlow,* uses mutual fund hypothetical sales of stocks as a function of investor outflows, following Edmans, Goldstein, and Jiang (2012) (building on Coval and Stafford (2007)). These papers find that mutual fund outflows (excluding sector funds) lead to selling pressure on stocks held in the funds, thereby temporarily depressing the prices of fund stock holdings for non-fundamental reasons. Because *MFFlow* is not based on market price, it is especially helpful for addressing the abovementioned endogeneity problem, that high price reflects opportunities for innovative investment. Firms with high *MFFlow* are on average undervalued relative to other firms, and firms with low *MFFlow* are on average overvalued relative to other firms (see also the discussion in Subsection 2.3).

Although our misvaluation proxy is designed to exclude the contaminating effects of growth prospects that are unrelated to misvaluation, we include several controls for such opportunities in all our tests, as well as performing robustness checks based on conservative filtering of the *MFFlow* variable.[4] If market participants tend to overvalue firms with good growth prospects, the inclusion of growth controls in our regressions will eliminate some of the misvaluation effect we seek to measure. Nevertheless, the effects of misvaluation that we document are strong.

MFFlow exerts a downward *shock* to misvaluation that is greater for some firms than others, but this does not mean that all firms with an *MFFlow* shock are undervalued. *MFFlow* shifts the distribution of misvaluation across firms by making overvalued firms less overvalued, and making undervalued firms more undervalued. So letting x be the level of overvaluation (possibly negative), firms with low *MFFlow* will have a higher distribution of x (in the sense of First Order Stochastic Dominance) than firms with high *MFFlow*. So crucially, the measure captures variation in misvaluation even within the deep *over*valuation range, not just in the undervaluation range.

Moreover, our *MFFlow* measure is immune to the criticism of the original Edmans, Goldstein, and Jiang (2012) measure of a possible mechanical correlation with contemporaneous returns (Wardlaw 2018); see Appendix A for details.[5] Wardlaw (2018) also suggests that the fund flow measure may be influenced by share turnover. It is unclear whether this is a drawback or a strength of this measure, since past studies have provided evidence that share turnover is associated with misvaluation (e.g., Lee and Swaminathan 2000; Baker and Stein 2004), which is what the flow measure is intended to capture. Nonetheless, to investigate whether the effects we identify are incremental to share turnover effects, we perform tests using *residual MFFlow*, or fund flow that is orthogonal to turnover. These tests, reported in the

[4] Our results are similar using industry-adjusted or R&D-adjusted *MFFlow* (see the Internet Appendix, Tables IA-8 and IA-9), or *MFFlow* filtered by growth-related return factors (the residual from the regression of *MFFlow* on the Fama-French high-minus-low book-to-market factor or a high-minus-low R&D factor).

[5] Outflows are multiplied by market values at the end of the quarter, not the beginning of the quarter as in the original Edman et al (2012) measure, and then scaled by volume at the end of the quarter. Because the market values and volume are measured at the end of the quarter, there is no mechanical contemporaneous return embedded in the measure. Other studies also use a similar fund flow-based price pressure measure that is free of contemporaneous returns; see Section 2.

Internet Appendix, confirm that our findings are robust to controlling for turnover.

As a further robustness check, we perform tests using an alternative misvaluation proxy, *VP*, defined as the ratio of 'intrinsic value' (*V*) to market price *P* (also reported in the Internet Appendix). *V* is a forward-looking measure of fundamental value derived from the residual income model of Ohlson (1995) using analyst forecasts of future earnings.[6] Notably, we obtain very similar results using a misvaluation proxy that is motivated and constructed very differently from *MFFlow*.

We perform four types of tests. First, we examine how misvaluation affects innovative investment in the form of R&D, and innovative output and inventiveness using patent-related measures. Second, we estimate whether the relation between misvaluation and innovative spending operates more through equity issuance versus other mechanisms, such as shared sentiment or direct catering to investor misperceptions. Third, we examine how the sensitivity of innovative activities to misvaluation varies with share turnover, which as we indicated above is a proxy for catering incentives; and with misvaluation itself. Fourth, we perform quantile regressions to test whether misvaluation affects the propensity toward extremes of high innovation.

We find that overvaluation has a very strong and robust association with higher intangible investments and resulting outputs (R&D, patents, and patent citations). For example, the sensitivity of R&D to misvaluation (variables scaled by their standard deviations) is much larger than the sensitivity to book-to-price, and is larger or comparable to the sensitivity to growth in sales and cash flow. Furthermore, the sensitivity of R&D to misvaluation is about 5 times greater than the sensitivity of capital expenditures to misvaluation.[7]

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[6] This measure has been used as a proxy for misvaluation in several studies (D'Mello and Shroff 2000; Dong et al. 2006; Dong, Hirshleifer, and Teoh 2012; Ma, forthcoming). A key advantage of *V* as a measure of fundamental value as compared, for example, to book value, is that *V* incorporates earnings growth prospects. As such, it filters such prospects from market price, except insofar as such prospects are associated with misvaluation rather than just growth.

[7]A previous literature examines the effects of misvaluation on equity issuance and on capital expenditures. With

With regard to inventiveness, we find that overvaluation is strongly associated with greater innovative novelty, originality, and scope. The patents of overvalued firms are heavily cited, draw from a wider range of technology classes, and are cited by patents in a greater range of technology classes. So misvaluation affects the qualitative nature, as well as the quantity, of innovative activity.

Second, to assess the relative importance of equity and debt financing versus other channels through which misvaluation can affect innovation, we conduct a path analysis of the R&D response to misvaluation; see Badertscher, Shanthikumar and Teoh (2019). We find over two thirds of the total effect of misvaluation on R&D spending derives from the non-financing channel. The remaining misvaluation effect operates mostly through equity issuance, with risky debt financing the least important channel in influencing innovation.

The evidence that overvaluation induces firms to raise cheap equity capital to finance intangible investment is consistent with the models of Stein (1996) and Baker, Stein, and Wurgler (2003). The evidence that misvaluation effects operate outside the equity channel is consistent with both the catering theory of Jensen (2005) and Polk and Sapienza (2009), and with the shared sentiment effects discussed above. The larger magnitudes of the non-financing channel suggest that catering and/or shared sentiment effects of misvaluation may be particularly strong.

With regard to the third issue, we dig more deeply into the misvaluation effect by testing whether catering incentive and overvaluation itself affect the sensitivities of innovative spending and outcomes to misvaluation. We first interact our misvaluation measure with an indicator for firms in the highest quintile for equity catering pressure as proxied by share turnover. We find that the three types of innovative inventiveness, as well as R&D spending

respect to R&D, Polk and Sapienza (2009) use the firm characteristic of high versus low R&D as a conditioning variable in some of their tests of the relation between misvaluation and capital expenditures. Baker, Stein, and Wurgler (2003) examine several measures of investment, one of which is the sum of capital expenditures and R&D, but they do not specifically examine whether misvaluation affects R&D.

and innovative output measures, are more sensitive to overvaluation among high turnover firms. This evidence is consistent with the idea that the effects of misvaluation on innovation activity and inventiveness are especially important among firms with higher catering incentives (Polk and Sapienza 2009).

Furthermore, our results suggest that the relations of misvaluation with innovative inputs, outputs, and inventiveness measures are convex. We find that overvaluation promotes innovation more strongly than undervaluation reduces innovation, which suggests that the ex ante prospect of strong misvaluation may on average increase social welfare.

Finally, we provide further verification of our findings by running quantile regressions, which are less sensitive to influences of outliers and distributional assumptions. The results are robust, and further indicate that variation in misvaluation has an especially strong effect in increasing the frequency of unusually high innovative outcomes. Collectively, these findings indicate that overvaluation encourages firms to engage in 'moon shot' projects in the sense of very high inventiveness and expected innovative output.[8]

The potentially positive effect of overvaluation on innovation contrasts with the adverse effects of overvaluation in inducing questionable capital expenditures (Polk and Sapienza 2009) and acquisitions (Dong et al. 2006). Our findings do not speak to whether the benefits of higher innovation are worth the cost. However, these findings do reinforce other evidence that behavioral biases, such as managerial overconfidence, sometimes promote innovation (Hirshleifer, Low, and Teoh 2012).

A previous literature tests whether market valuations, or proxies for misvaluation, affect investment by examining whether these have incremental predictive power after controlling for proxies for the quality of growth opportunities.[9] Most of these studies are focused on capital

[8] In discussing what he viewed as a period of overvaluateion by many firms, Keynes (1931) wrote that "[w]hile some part of the investment which was going on … was doubtless ill judged and unfruitful, there can, I think, be no doubt that the world was enormously enriched by the constructions of the quinquennium from 1925 to 1929..."

[9] See Barro (1990), Blanchard, Rhee, and Summers (1993) Morck, Shleifer, and Vishny (1990), Welch and

expenditures rather than innovative activity, and earlier tests do not distinguish the Q-theory of investment from the misvaluation hypothesis. Our approach differs from these papers in focusing on misvaluation effects on *innovation*, including *innovative outcomes*; and in our measures of misvaluation. We compare our misvaluation proxies to others used in previous literature in Section 2. Finally, a large literature investigates the economic factors that drive innovation (see, e.g., Acharya and Xu (2017) and references therein). Building on this research, our paper additionally describes how market misvaluation affects innovation.

2. Data, Empirical Measures and Test Design

Our sample includes U.S. firms listed on NYSE, AMEX, or NASDAQ that are covered by CRSP and COMPUSTAT and are subject to the following restrictions. We require firms to have mutual fund flows measure (*MFFlow*) from CDA/Spectrum and CRSP. Consequently, our sample starts from 1981 CDA/Spectrum reporting begins. Finally, we exclude financial firms (firms with one-digit SIC of 6) and utility firms (two-digit SIC of 49). Our final sample has 63,488 total firm-year observations with non-missing *MFFlow* measure from 1981 to 2012.

We examine the relation between firm innovation (innovative input as measured by R&D, and innovative output and inventiveness variables described below) and the misvaluation level of the firm's equity. We relate a firm's innovation activity during each fiscal year to the firm's misvaluation measure calculated at the end of the preceding fiscal year. For example, for a firm with December fiscal year end, the misvaluation measure is calculated at the end of December 2010 and the innovation activity is measured for the fiscal year ending in December 2011. Our sample includes firms with different fiscal year-ends.

2.1 Measures of Innovative Output and Inventiveness

Wessels (2000), Baker, Stein, and Wurgler (2003), Gilchrist, Himmelberg, and Huberman (2005), Polk and Sapienza (2009), Hau and Lai (2013), Parise (2013), Alti and Tetlock (2014), and Warusawitharana and Whited (2015).

Patent and citation data are constructed from the November 2011 edition of the patent database of Kogan, Papanikolaou, Seru, and Stoffman (see Kogan et al. 2017). This database covers U.S. patent grants and patent citations up to 2010. On average, there is a two-year lag between patent application and patent grant. Since the latest year in the database is 2010, we end our observations of patents and citations in 2008 to reduce measurement bias caused by the application-grant period lag.

Following the innovation literature, we use two measures of innovative output. The first and simplest measure is the number of patents applied for in a fiscal year (*Pat*) that are ultimately successful (even if the grant occurs subsequent to the application fiscal year). However, simple patent counts imperfectly capture innovation success as patent innovations vary widely in their technological and economic importance. Following Hall, Jaffe, and Trajtenberg (2001, 2005)), we measure the importance of patents by their citation counts *Cites*, measured as the sum of raw citation counts ultimately received by patents applied for each year (even if those citations are obtained subsequent to the patent application year), scaled by the average citation counts of all patents applied in the same year and technology class. In our regression tests, we use log transformed values of *Pat* and *Cites* to limit the effects of outliers.

We use three measures of innovative inventiveness based on patent and citation outcomes. Following Seru (2014), *Novelty* is the average (technological class and year adjusted) citations per patent that are received over time (including subsequent years). It is a natural way to capture the importance of the innovations generated by the firm.

Following Trajtenberg, Henderson, and Jaffe (1997), we define *Originality* of a patent as one minus the Herfindahl concentration index for the fraction of citations made by the patent to patents in other technological classes. If a patent cites previous patents that span a wide (narrow) set of technologies, the originality score will be high (low). This is based on the idea that innovation is a process of recombinant search (e.g., Schumpeter 1934; Basalla 1988;

Romer 1990; Weitzman 1998; Singh and Fleming 2010). Under this view, useful new ideas come from combining existing ones in novel ways. An example is the discovery of the double helix structure of DNA by James Watson and Francis Crick. Crick's knowledge of X-ray crystallography helped Watson understand the famous X-ray diffraction image of DNA as a double helix structure.

Also following Trajtenberg, Henderson, and Jaffe (1997), *Scope* of a patent is defined as one minus the Herfindahl index across technological classes of future citations of the patent. This reflects the extent to which a patent has a wide influence. It is a natural way of measuring the extent to which an innovation is broad in scope, making it is useful in a wide range of different technological applications. Each of the three inventiveness measures is firm-level average over the patents' respective inventiveness scores. The innovative output (*Pat* and *Cites*) and inventiveness (*Novelty*, *Originality*, and *Generality*) measures are for a given patent application year and so include the grant and citations received subsequent to the application year. This allows for the lags between patent application, patent granting, and patent citations.

Tesla and SpaceX, founded by celebrity entrepreneur Elon Musk, are two current examples (outside our sample period) of possible irrational investor enthusiasm promoting moon shot innovation.[10] Tesla aims to disrupt the automobile industry with electric vehicles affordable to the average consumer. Cornell and Damodoran (2014) and Cornell (2016) perform case valuation analyses of the approximately 7-fold run-up in Tesla during a period of under a year during 2013-14, and conclude that this is hard to justify as a rational response to news.

SpaceX, although not literally in the business of moon shots, comes close, as its purpose is to monetize space travel, with a long-term goal of colonization of Mars. SpaceX is a private

[10] NetApp, a multinational storage and data management company, is an example within our sample. Just prior to fiscal year 2000, NetApp had a very low *VP*, and other indications of overvaluation such as heavy recent equity issuance. In fiscal 2000, it ranked in the top quintile in our sample for R&D, patents, patent citations, and in the patent-based measures of inventiveness that we examine.

firm valued at $21 billion as of 10/16/17 (Sorkin 2017). Gornall and Strebulaev (2017) point out that the valuations of many unicorns such as SpaceX are grossly inflated owing to valuations being based upon recently-issued shares with special cash flow rights.[11]

2.2 Investment and Control Variables

We measure firms' investment activities using the research and development (XRD) and capital expenditure (CAPX) items from the COMPUSTAT annual files. Our investment variables, *RD* and *CAPX*, are scaled by previous year total assets (item AT). All ratio variables, include the ones described below, are winsorized at the 1st and 99th percentile to mitigate the influence of outliers.

We need equity issuance and debt issuance to examine the financing channels of the effect of misvaluation on innovative investment. Following Baker and Wurgler (2002), equity issuance (*EI*) is calculated as [ΔBook Equity (COMPUSTAT item CEQ) + ΔDeferred Taxes (item TXDB) − ΔRetained Earnings (item RE)] scaled by lagged assets, and debt issuance (DI) is the change in assets minus the change in book equity [Δ total assets (item AT) – Δ book equity (item CEQ) – Δ deferred taxes (item TXDB)] scaled by lagged assets. These are net issuance variables.

In the multivariate tests, we control for other investment determinants. These control variables include growth rate in sales in the past three years (*GS*), book equity to price ratio (*BP*), cash flow [item IB + item DP + item XRD] scaled by lagged assets [missing XRD is set to zero to conserve non-missing cash flow observations], to control for the ability of the firm to generate cash from operations to fund investment. We include leverage (*Leverage*) defined

[11] Since these 'valuations' are not based on market prices for common shares, such 'overvaluation' need not imply any investor misperception. However, it almost surely does. It is common for managers and other employees in innovative start-ups to receive option compensation for their efforts, and these investors typically lack the financial sophistication needed to adjust reported firm valuations for subtle biases. Indeed, according to Strebulaev, "These financial structures and their valuation implications can be confusing and are grossly misunderstood not just by outsiders, but even by sophisticated insiders." Strebulaev also points out that "SpaceX's value actually fell in 2008" during a period when its reported valuation increased (Sorkin 2017).

as (item DLTT + item DLC)/(item DLTT + item DLC + item SEQ). Finally, we control for firm age and size (logarithm of lagged total assets) per DeAngelo, DeAngelo, and Stulz's (2010) finding that mature firms are less likely to issue new equity. Following DeAngelo, DeAngelo, and Stulz (2010), we define *Age* as the number of years between the listing date and the beginning of the fiscal year, truncated at 50 (results are not sensitive to this truncation).

Polk and Sapienza (2009) provide and test a catering theory in which the investment sensitivity to misvaluation is higher when there is a higher fraction of short-term investors. They document that the sensitivity of capital expenditures to misvaluation is higher for stocks with high share turnover. We measure turnover using monthly trading volume as a percentage of total number of shares outstanding.[12]

Table 1 reports summary statistics of these control variables, while Table 2 reports yearly descriptive information for our sample during 1981-2012. Capital expenditures are relatively stable over time, but there is a marked decrease after 2001, suggesting that companies generally cut capital spending after the collapse of the stock market bubble. This decrease in *CAPX* is coupled with a drastic drop in cash flow in 2002 (untabulated). R&D activities, on the other hand, have wider fluctuations but generally increase over time, and decline slightly after 2001. As mentioned in the Introduction, after 1996, *RD* overtakes *CAPX* as the larger component of corporate investment, growing much larger toward the end of the sample period. These facts highlight the importance of studying R&D activity.

2.3 Mispricing Proxy

Our primary proxy for equity misvaluation is the mutual fund outflow price pressure measure, *MFFlow.* We summarize estimation procedures here concisely; further details, which are drawn from previous literature, are provided in Appendix A. To verify the robustness of

[12] As is standard, to ensure comparability we divide the NASDAQ trading volume by 2 (LaPlante and Muscarella 1997).

our conclusions, we also use several alternative measures described below.

The misvaluation measure, *MFFlow*, is derived from mutual fund outflows (Coval and Stafford 2007; Edmans, Goldstein, and Jiang 2012). The motivation for this measure is that outflows put immediate pressure on fund managers to sell the underlying fund holdings to meet redemptions, causing temporary downward price pressure on the stocks held within the fund. To ensure that the outflow measure is unrelated to fund manager's private information about the underlying securities, Edmans, Goldstein, and Jiang (2012) refine the measure of Coval and Stafford (2007) by focusing on the *hypothetical* trades made by a fund assuming it sells in equal proportion to its current holdings.

In validation of their proxy, Edmans, Goldstein, and Jiang (2012) find that stocks with large mutual fund outflows have lower contemporaneous stock returns, and that these low returns are later reversed. The effects are substantial, as discussed below. So a larger outflow indicates greater undervaluation of stocks held by the fund. Inflows are more likely than outflows to reflect private information if fund managers wait to allocate inflows to stocks that they believe have better prospects.[13] We therefore follow Edmans, Goldstein, and Jiang (2012) and include outflows only.[14]

As argued in Edmans, Goldstein, and Jiang (2012), the *MFFlow* measure likely reflects an exogenous source of mispricing that is unrelated to firm characteristics such as extent of innovative activity. It is possible in general that fund flows are correlated with news that relates to firms' innovative investment strategies. Edmans, Goldstein, and Jiang use hypothetical fund flows to address this potential concern. For example, a firm might have strong growth

[13] Several studies, such as Jeng, Metrick, and Zeckhauser (2003) and Lakonishok and Lee (2001) find that insider buying reflects private information but insider selling does not, and even recent work that does identify some information in insider selling (Ali and Hirshleifer 2017) finds that buying is much more informative. Furthermore, individual investors are more likely to buy attention-grabbing stocks than sell such stocks (Barber and Odean 2008), consistent with the tendency of buying triggered by viewpoint-changing events.

[14] Several other papers employ mutual fund price pressure measure in studying the relationship between misvaluation and investment (e.g., Hau and Lai 2013; Parise 2013; Camanho 2015; Lou and Wang 2018; Dessaint et al. forthcoming;). Li (2019) also finds evidence supporting the idea that fund flows induce mispricing.

opportunities, but this does not explain why the funds that hold this firm would receive unusually high inflows. Similarly, an entire industry might have strong investment opportunities, but, following Edmans, Goldstein, and Jiang (2012), we exclude funds that specialize in a given industry, and in robustness tests, we also subtract industry *MFFlow* or R&D-matched *MFFlow* to further remove any possible industry effects. Furthermore, in regression tests we also include *BP*, sales growth, or analyst long-term earnings growth forecasts as additional controls for growth.

MFFlow observations are set to be positive reflecting outflows, so the variable is decreasing with overvaluation. So a high value of *MFFlow* indicates undervaluation. When mutual funds have zero or close to zero holdings of a stock, *MFFlow* is mechanically equal to zero. We set *MFFlow* to missing in this case as it has little ability to distinguish degrees of misvaluation among such stocks. Consequently, our measure of *MFFlow* has a considerably stronger price pressure effect than documented in Edmans, Goldstein, and Jiang (2012). For example, the highest-*MFFlow* decile experiences a market-adjusted return of roughly −12% about two quarters after the *MFFlow* measurement. In contrast, Edmans, Goldstein, and Jiang (2012) document a peak price pressure of about −6.5% market-adjusted return for the decile with the highest outflows.

As discussed in the Introduction, our measure of *MFFlow* is not subject to a concern raised by Wardlaw (2018) of a possible mechanical relation with contemporaneous returns in the flow measure of Edmans et al. (2018). Our modification, which removes any such mechanical effect, is similar to the fund flow misvaluation measures of Lou and Wang (2018), Li (2019), and Dessaint et al. (forthcoming). For further verification that our *MFFlow* effects are not just picking up effects of turnover, we also perform tests using the residual of the annual regression of *MFFlow* on turnover instead of *MFFlow.*

As a further robustness check, we perform tests using an alternative misvaluation proxy that involves the estimation of fundamental value of equity, based on the residual income model (Ohlson 1995). The residual income value *V* is estimated as the sum of book value of equity and the stream of discounted analyst forecasted earnings in excess of the firm's cost of equity capital, where the discount rate is the firm's cost of equity.

The residual income value has several advantages over book value as a fundamental measure. It is designed to be invariant to accounting treatments (to the extent that the 'clean surplus' accounting identity obtains; see Ohlson (1995). Unlike the book-to-price ratio (*BP*), *VP* does not have a mechanical relation with R&D.[15] Furthermore, since *V*, like market price and unlike book value, reflects future growth prospects, the *VP* ratio filters out growth effects contained in *BP* that are unrelated to mispricing. If market participants overvalue firms with good growth prospects, *VP* is designed to capture that misvaluation, and therefore can be correlated with growth prospects. However, unlike *BP*, *VP* is not mechanically increased by the sheer fact that a firm is growing. In our sample, the correlation of *BP* with *VP* is fairly low, 0.22. The Internet Appendix shows results are robust to using either *VP* or residual *MFFlow* as an alternative mispricing proxy.

Some misvaluation proxies used in past studies include discretionary accruals (Polk and Sapienza 2009) and dispersion in analyst forecasts of earnings (Gilchrist, Himmelberg, and Huberman 2005).[16] The intuitions for these variables are appealing. However, it is also useful to test for misvaluation effects using *MFFlow*, which arguably captures an exogenous shock to

[15] Accounting rules require expensing R&D, which reduces book values, but the market capitalizes the R&D so that high R&D firms tend to have low *BP*. In contrast, since *V* incorporates analyst forecasts of future earnings, *V* reflects the future-profit-creation side of R&D expenditures, not just the expense side.

[16] Morck, Shleifer and Vishny (1990) use CAPM alpha as their misvaluation proxy and find that it is unrelated to capital expenditures. Gilchrist, Himmelberg, and Huberman (2005) use dispersion in analyst forecasts of earnings as their misvaluation proxy in testing for a relation with aggregate capital expenditures. Two studies use mutual fund fire sales as proxies for undervaluation, and find that it is associated with cuts in capital expenditures (Hau and Lai 2013) or R&D (Parise 2013). Baker, Stein, and Wurgler (2003) examine the relation between financial constraints and valuations in determining capital expenditures. Several studies use structural methods to identify misvaluation effects on capital expenditures, with mixed conclusions (Chirinko and Schaller (2001, 2012), Campello and Graham (2013), Alti and Tetlock (2014), Warusawitharana and Whited (2015)).

misvaluation.[17] More importantly, our paper differs from this previous work in focusing on the effects on innovative inputs, outputs, and inventiveness.

2.4 Relation between R&D, Misvaluation, and Future Returns

Past research has explored whether R&D predicts future abnormal returns. The results are somewhat mixed, with some studies findings positive return predictive power and some finding no significant effect. It might seem that such tests provide insight into whether overvaluation encourages innovation. However, the misvaluation hypothesis does not have a clear-cut prediction about whether R&D positively or negatively predicts returns, so such tests do not get at the issues explored in our study.

Specifically, even if, as hypothesized, misvaluation affects R&D, we expect much variation in R&D to derive from other sources, notably including rational managerial responses to growth opportunities. Existing theories suggest that such variation can induce misvaluation. As suggested by Lev and Sougiannis (1996) and formally modelled in (Hirshleifer and Teoh 2003; Hirshleifer, Lim, and Teoh 2011), high R&D firms will be undervalued, if investors form expectations based upon earnings without adjusting for the fact that R&D, an economic investment which generates future cash flows, is expensed. In contrast, as we suggest here, high R&D may derive from overvaluation, and therefore be associated with overvaluation. A general sample will include both sources of variation in R&D, making the prediction for future returns ambiguous. So whether R&D predicts returns is not a test of whether misvaluation induces innovative activity.

3. Results

Our tests are based upon *MFFlow* as the misvaluation measure; results using *VP* as an

[17] Alternatively, it can be informative to use a more inclusive measure of misvaluation such as *VP*, as in our robustness checks, as *VP* is designed to measure the overall misvaluation of the firm's equity rather than the components of misvaluation that derive from earnings management or disagreement.

alternative proxy for misvaluation reinforce our conclusions (see the Internet Appendix).

3.1 The Relation between Misvaluation and Innovation Measures

We report the regression test results in Table 3 for the relation between year $t + 1$ innovative inputs and outputs, with year t misvaluation. The dependent variables are the measures of R&D expenditures (*RD*), patents (*Log(1+Pat)*), citations (*Log(1+Cites)*), and inventiveness (*Novelty*, *Originality*, and *Scope*). The independent variable of primary interest is misvaluation (beginning-of-year *MFFlow*). The control variables include proxies for growth opportunities (either *BP* or 3 year sales growth *GS*), cash flow (*CF*) measured as net income before depreciation and R&D expense scaled by lagged assets, leverage (*Leverage*), the firm age truncated at 50 (*Age*), and log of lagged assets. All independent variables (except for the indicator variables) are standardized to have a mean of zero and standard deviation of one. Following the innovation literature (e.g., Phillips and Zhdanov 2013; Seru 2014; Tian and Wang 2014; Acharya and Xu 2017), we control for year and industry fixed effects using the 2-digit SIC industry classification of Moskowitz and Grinblatt (1999). All standard errors in the regressions are simultaneously clustered by both firm and year.

As a reminder, the timing of our variable definitions is important for interpreting these tests. A patent or citation attributed to year $t + 1$ is associated with a patent that was *applied for* in year $t + 1$, but the relevant patent grant or citation could be, and often is, received in a later year. We are therefore measuring long-term innovation over an extended period associated with patent applications in year $t + 1$.

We report two regression specifications for each dependent variable. Model (1) uses the book-to-price ratio (*BP*) as the control for growth opportunities, while model (2) uses the 3-year sales growth rate (*GS*). The use of *BP* as a growth control is likely conservative as it contains information about misvaluation. In subsequent tests, we report results using only *GS* as the growth control; results are also robust using *BP*.

3.1.1 Innovative Input

The first set of columns describes the relationship of misvaluation with R&D. Column 1 shows a highly significant negative coefficient of −1.47 (t = −7.72). Since high *MFFLow* indicates equity undervaluation, this finding indicates that greater overvaluation (or less undervaluation) is strongly associated with higher innovative expenditures. A one standard deviation increase in overvaluation is associated with an increase in R&D of 16.3% relative to the R&D sample mean (9%). Column 2, which uses *GS* as the control for growth opportunities, indicates a similar sensitivity of R&D to *MFFlow*; the R&D coefficient is −1.51 (t = −7.77). The effect of misvaluation on R&D is roughly comparable to the effect of a one standard deviation increase in growth prospects (proxied by *BP* or *GS*), and far stronger than the effect of a one standard deviation increase in cash flow.

A general possible concern for tests of whether how misvaluation affects innovative activities such as R&D is reverse causality—investors may overvalue firms with high innovation activity. Two considerations help alleviate this concern. First, *MFFlow* is a shock that is arguably exogenous to the firm's innovative project opportunities. It is based on investor outflows from mutual funds, and is not based on whether a mutual fund is specifically selling the given firm. (As a reminder, *MFFlow* is based on the hypothetical selling of a given firm that a fund *would* engage in if it were to sell its current holdings in proportion to current weights in the firm's portfolio.)

Second, there is no evidence in the literature that suggests investors systematically overvalue R&D. To the contrary, since R&D is expensed, it has been argued that investors who are fixated on earnings tend to undervalue firms with high R&D (e.g., Lev and Sougiannis 1996). Furthermore, the evidence that R&D predicts abnormal returns is mixed, and it is, if anything, a *positive* return predictor (e.g., Chan, Lakonishok, and Sougiannis 2001; Eberhart, Maxwell, and Siddique 2004).

3.1.2 Innovative Output Measures

We next examine innovative output measures. *Log(1+Pat)* measures the firm's success in obtaining patents; *Log(1+Cites)* indirectly reflects the number and importance of the patents. The regressions again indicate significant misvaluation effects on innovative output and with alternative controls for growth prospects, suggesting an increase in innovative output that is commensurate with the increased innovative input that is associated with stock overvaluation. From Column 2, a one standard deviation increase in overvaluation (measured by *MFFlow*) leads to a 0.08 increase of *Log(1+Pat)*, which would boost the patent count by 1.15, to 13.93, for a firm with a patent count at the sample mean. This is 9% of the sample mean number of patents, or a more than 20% increase over the sample median patent count of 5 for firms with a positive patent count.[18] A similar calculation suggests that for a firm with the mean *Cites* (11.59), a one standard deviation increase in overvaluation leads to an increase in the year and technology class adjusted citation count of 0.51, which is 4.4% of the sample mean.

Turning to innovative inventiveness, we observe that greater overvaluation is also associated with all three proxies for inventiveness. A one standard deviation increase in overvaluation leads to an increase of 9.8%, 7.8%, and 9.6% in *Novelty, Originality,* and *Scope*, respectively, relative to the sample mean values. This suggests that overvalued firms are more prone to engage in 'moon shot' projects.

3.1.3 Robustness

The tests in Table 3 are designed to remove the effects of growth opportunities as much as possible to focus sharply on misvaluation effects. Our measure of misvaluation (*MFFlow*) is designed to be exogenous to growth opportunities, but our results are robust to including

[18] For a firm with the mean patent count (12.78), a one standard deviation decrease in *MFFlow* leads to a new *Pat* value *N*, where log(1+*N*) – log(1+12.78) = 0.08. Solving for *N* yields the new patent count of 13.93, which is an increase of 9% relative to the sample mean.

additional growth controls such as *BP, GS,* or analyst long-term earnings growth rate forecast (*LTG*; results using *LTG* as a control are unreported for brevity). Also, as mentioned in footnote 3, we use an industry adjusted *MFFlow* measure to remove any possible remaining industry growth effects from *MFFlow*; and, alternatively, we filter growth-related return factors from *MFFlow* by using the residual from regressing *MFFlow* on the Fama-French high-minus-low (book-to-market) factor or a high-minus-low R&D factor. Finally, to address the concern that firms acquire innovation through takeovers, we remove all firms involved in acquisition activities in the prior three years; again all of our results remain robust.

The sample for the regressions using R&D is smaller, because R&D is missing in Compustat for many firms. Some studies retain observations with missing R&D and set its value in those cases to zero. In unreported tests, we find that our findings are robust to setting missing R&D values to zero (*MFFlow* still significantly affects R&D, though the effects are slightly weaker) or to restricting the sample to non-zero R&D observations (where the misvaluation effects on R&D and innovative output are even stronger).

There are also perceptible differences between the earlier and later periods of our sample. In the earlier years there is a lower level of R&D relative to total assets and higher inflation. In more recent years, many firms hold much higher levels of cash, which could affect the scaling of capital and R&D expenditures. In addition, in later years of the sample, there is a more severe truncation bias in the measurement of citations and inventiveness. In unreported tests, we split the sample into two roughly equal periods (before and after December 1994). Most of the misvaluation effects on R&D, innovative output, and inventiveness are significant in the earlier time period, and all are highly significant in the later period. The strength of the effects in the later period is more than double that in the earlier period. The stronger misvaluation effects on innovation may be related to greater importance of corporate innovation, increased use of equity financing, increased catering incentives of managers, or heightened shared sentiment effects, in more recent times.[19]

3.2 Long-Term Effects of Overvaluation on Innovation

It may take some time for the investment in innovation to generate any output, especially relatively fundamental innovations such as moon shot projects. On the other hand, equity overvaluation tends to be transient (e.g., on the order of a few years), and managers may want to take advantage of overvaluation in a timely manner. So it is interesting to look at the long-term effects of overvaluation on innovation.

We therefore examine the long-term overvaluation effects by regressing innovation variables on lagged misvaluation. This repeats the tests in Table 3 using lagged misvaluation (*MFFlow*) by one, two, or three years (hereafter, we use *GS* as a growth control; using *BP* produces similar results). Table 4 reports the results when we lag misvaluation by three years; results using shorter lags follow a similar pattern. While the misvaluation effect on *RD* moderately decreases moving from the immediate next year to three years after, misvaluation significantly predicts future innovative output (*Pat* and *Cites*) and inventiveness (*Novelty*, *Originality* and *Scope*) up to three years ahead, with even a slightly higher strength (for most output and inventiveness measures) than the immediate effect—possibly because of lags in the effect of misvaluation on innovative output. Therefore, the misvaluation effect on innovation is persistent.

The finding that misvaluation affects long-term investment in innovation is consistent with the catering theory, which is about how transient variations in stock prices motivate managers who care about the short-term prices to take action that affect long-term value. It is also consistent with other corporate finance studies that find enduring effects of misvaluation

[19] The stronger effects of misvaluation on innovation is not mainly driven by the technology boom of the late 1990s, as the effects are quite similar between the late 1990s and the period after 2000. Also, our results are not driven by truncation of patent data near the end of the sample period as the results remain strong even if we end the sample in 2000.

on corporate policy (e.g., Baker and Wurgler (2002) on valuation and capital structure). In addition, the financing channel is influenced by transient mispricing, because, as is well-documented in the corporate finance literature, short-term financial constraints influence long-term investment. Indeed, financing constraints are especially important for R&D activities (Li 2011).

It could be argued that for misvaluation to affect innovation, it must persist long enough for firms to react to it. We provide some evidence in the Internet Appendix to suggest that misvaluation is not too transient for firms to use it in making innovation decisions.[20] To see whether the effect of *MFFlow* on innovation is stronger when the *MFFlow* is more persistent, we conduct tests for subsamples sorted by *MFFlow* autocorrelation. Specifically, we create an indicator for a firm being in the top autocorrelation quintile and interact it with 3-year lagged *MFFlow* in the long-run innovation regression. Table 5 shows that this interaction variable has a significant and negative coefficient in most of the innovative output and inventiveness regressions, suggesting that *MFFlow* has a stronger long-run effect on innovation when the misvaluation is more persistent. Interestingly, the interaction variable is insignificant when the dependent variable is innovative input (R&D). One possible interpretation of these results is that overvaluation promotes R&D spending regardless of whether mispricing is persistent; but when mispricing is persistent, firms tend to engage in more productive and inventive innovation.

3.3 Financing versus Non-Financing Channels

Misvaluation can affect investment in general, either through equity issuance, risky debt

[20] *MFFlow*—which is measured by summing quarterly outflows in the previous four quarters—has a mean autocorrelation of 0.254, indicating some persistence. Table IA-12 suggests evidence that misvaluation is sufficiently slow moving to affect firm innovative investment. It reports how *MFFlow* evolves over time for the top and bottom *MFFlow* quintiles, i.e., the mean *MFFlow* values for firms currently ranked in the top and bottom *MFFlow* quintile over the past five years. Firms in the top quintile have higher *MFFlow* in the past five years than firms in the bottom quintile.

issuance, or via catering or shared sentiment (Stein 1996; Baker, Stein, and Wurgler 2003; Gilchrist, Himmelberg, and Huberman 2005; Jensen 2005; Polk and Sapienza 2009; Badertscher, Shanthikumar and Teoh, 2019). To estimate the extent to which misvaluation affects investment via the equity and debt channels, we perform a path analysis following Badertscher, Shanthikumar, and Teoh (2019). Path analysis is a method of comparing an independent variable's direct effect on the dependent variable to the indirect effects that operate via intermediate variables. Of course, the ability to disentangle paths of effects relies on a test variable such as *MFFlow* to identify causation. We estimate the following regressions:

$$RD_{it} = a_1 + b_1\, MFFlow_{it} + c_1 EI_{it} + d_1 DI_{it} + \theta_1\, \boldsymbol{X}_{1it} + u_{1it}$$

$$EI_{it} = a_2 + b_2\, MFFlow_{it} + \theta_2\, \boldsymbol{X}_{2it} + u_{2it},$$

$$DI_{it} = a_3 + b_3\, MFFlow_{it} + \theta_3\, \boldsymbol{X}_{2it} + u_{3it},$$

where *i* indexes firms and *t* denotes years. All regressions include year and 2-digit SIC industry fixed effects in addition to the control variables in the vectors $\boldsymbol{X}_1$ and $\boldsymbol{X}_2$ (such as *GS, CF* or *ROA, Leverage, Age,* and *Size*), with standard errors clustered by firm and year.

Panels A and B of Table 6 indicate the control variables for each regression. The estimated value of b_1 captures the non-financing effect of *MFFlow* on investment, and the estimated value of $b_2 \times c_1$ captures the effect of *MFFlow* through the equity issuance channel. Similarly, the estimated value of $b_3 \times d_1$ captures the effect of *MFFlow* through the debt issuance channel. We interpret the non-financing effect as likely coming from either catering or shared sentiment.

Intuitively, if the relation of equity issuance to investment is similar regardless of whether this issuance was induced by *MFFlow*, the effect of *MFFlow* operating through the equity channel is captured by the corresponding coefficient in the first equation, with the direct effect captured by the *MFFlow* coefficient. The second equation gives the coefficient needed to rescale the *EI* coefficient in the first equation to reflect the sensitivity of the financing variable to *MFFlow*. A similar remark applies to debt issuance.

Firm overvaluation (as measured by equity overvaluation) can lead to a reduction in both the cost of equity financing and cost of debt financing. There are, however, some reasons to expect the effect on debt financing to be relatively weak. As documented in Dong, Hirshleifer, and Teoh (2012), debt issuance is not nearly as sensitive as equity issuance to equity misvaluation. On the one hand, the factors that drive high equity valuation may similarly also drive high debt valuation, which reduces the cost of debt and therefore increase the incentive to issue debt. On the other hand, there is a substitution effect between equity and debt financing, and since equity is more sensitive to equity valuation than debt, an increased level of equity financing may lead to a reduction of debt financing. So the net effect of equity misvaluation on debt issuance should be weak or perhaps even reversed.

Table 6 reports key coefficient estimates from the regressions. The percentages at the bottom of Panel C summarize the portion of the total effect of *MFFlow* that is through the equity issuance, debt issuance, and the non-financing channels. The preponderance of the total effect of *MFFlow* on R&D, 72.12%, comes from the non-financing channel. The equity channel contributes 27.06%, with debt issuance contributing the remaining 0.82%. Additional tests (reported in Internet Appendix Table IA-4) confirm that, using *VP* instead of *MFFlow* to measure mispricing, we obtain the same conclusion that non-financing is the primary channel through which stock misvaluation affects R&D spending.

According to the pecking order theory, debt issuance is supposed to be preferred to equity financing. Our finding that equity issuance is more important than debt financing in innovative investment is therefore inconsistent with the pecking order. Other research also finds evidence inconsistent with the pecking order. For example, Graham and Harvey (2001, p. 222) find that "asymmetric information does not seem to cause the importance of these [pecking-order] factors, as it should if the pecking-order model is the true model of capital structure choice." One interpretation of our finding is that the existence of equity overvaluation in effect reduces the cost of equity, which consists of the main form of external financing associated with innovation. We should expect this reduction to be especially important for firms that engage in R&D activity, since equity is the main form of external financing for firms that engage in R&D. This is also consistent with the evidence from Huang and Ritter (2019) that debt financing is associated with short-term cash needs while equity financing is associated with long-term R&D investment.

We also perform a path analysis for subsamples sorted by yearly aggregate misvaluation (measured by the mean *MFFlow* of the sample firms) and catering incentive (proxied by share turnover). Tables IA-13 and IA-14 show that the total *MFFlow* effect on R&D, as well as the effect through each individual channel, is much higher in high valuation years (i.e,, below-median aggregate *MFFlow*) than in low valuation markets. In fact, the direct effect accounts for a larger portion of the total effect in high valuation markets (77.3%) than in low valuation markets (71.1%). Likewise, Tables IA-15 and IA-16 confirm that the total effect, as well as component effects, of *MFFlow* on R&D is much higher among high turnover firms. However, the equity channel effect is also stronger among high turnover firms, so that overall, the portion of effect through the direct channel is slightly lower for high turnover firms (73.9%) that among low turnover firms (74.7%).

3.4 Effect of Turnover

Table 7 tests for interaction effects of overvaluation and catering incentives on innovative investments and output. We test the hypothesis that misvaluation has a stronger marginal effect on innovation among high turnover firms by including an interaction between *MFFlow* and an indicator for a firm being in the top turnover quintile.

Consistent with the hypothesis that misvaluation effects on innovation are stronger when firms have a strong catering incentive, the sensitivity of R&D expenditure to *MFFlow* is much stronger among high turnover firms, with an interaction coefficient of −1.43 ($t = -2.73$), which is larger than the baseline coefficient of −1.25 ($t = -7.44$). An even stronger pattern holds for innovative output and inventiveness. In the top turnover quintile, the effect of overvaluation on innovative output (*Pat* and *Cites*) is 3.9-5.2 times greater, and the effect on inventiveness (*Novelty*, *Originality*, and *Scope*) is 3.4-3.8 times greater, than the baseline effect.

In the full sample, a one standard deviation increase in overvaluation as measured by *MFFlow* leads to an increase of 16.8% in R&D, 9% in patent count, 4.4% in citations, 9.8% in novelty, 7.8% in originality, and 9.6% in scope relative to the sample mean values. However, the effects are much stronger in the top turnover quintile. According to the coefficient estimates in Table 6, among the top turnover quintile, a one standard deviation boosts *RD, Pat, Cites, Novelty, Originality,* and *Scope* by 29.8%, 39.2%, 15.1%, 27.4%, 21.2%, and 28.1% relative to the sample mean, respectively. The results confirm that the sensitivity of R&D, patents and citations to overvaluation is greater in the top turnover quintile. Furthermore, the sensitivity of innovative novelty, originality and scope to overvaluation is also much stronger among high turnover firms, consistent with catering taking the form of undertaking moon shot projects.[21]

3.5 Convexity of Overvaluation Effects

Are the misvaluation effects on innovation stronger among overvalued or undervalued firms? On the one hand, it is easier to cut than to increase innovation, which implies stronger effects when firms are undervalued. However, there are also several economic reasons to believe that the misvaluation effect on innovation is stronger among overvalued than among

[21] In unreported tests we find that the effects of *MFFlow* on innovation are generally stronger among firms with the least financial constraints (i.e., with the lowest Kaplan-Zingales (1997) index), confirming that *MFFlow* does affect innovation through the non-financing channel.

undervalued firms. First, when there are fixed costs of issuing equity, overvalued firms should be more likely to issue than undervalued firms. Second, when there are positive complementarities in innovation, overvaluation will tend to have a nonlinear increasing effect on innovation. Third, overvaluation can insulate managers from career concerns if such overvaluation is associated with favorable assessment of managerial skill. Such overvaluation can therefore encourage undertaking risky innovative projects. Therefore, the direction of nonlinearity is an empirical question.

Table 8 tests for nonlinear effects of overvaluation on innovative investments and output. We test the nonlinear effect of misvaluation by including an interaction between *MFFlow* and an indicator for a firm being in the bottom *MFFlow* (top overvaluation) quintile. Consistent with the hypothesis that misvaluation effects on innovation are convex, the sensitivity of R&D expenditure to *MFFlow* is much stronger among overvalued firms, with a large interaction coefficient of −5.39 ($t = -9.42$), which is nearly 5 times larger than the baseline coefficient of −1.18 ($t = -7.78$). A similar conclusion holds for innovative output and inventiveness using either of the misvaluation proxies. In the most overvalued quintile, the effect of overvaluation on innovative output (*Pat* and *Cites*) is 6.7-8.7 times greater, and the effect on inventiveness (*Novelty*, *Originality*, and *Scope*) is 4.4-6.3 times greater, than the baseline effect.

This nonlinear effect of misvaluation continues to hold when we use *VP* to measure misvaluation (Table IA-10). When we repeat the test using turnover-orthogonalized fund flow (*MFF_r*) to measure misvaluation, the convexity result does not hold (Tables IA-11 and IA-12). However, *MFF_r* is overly restrictive as we describe in the introduction because it removes all effects of turnover, a valid source of misvaluation, from the *MFFlow* measure. So, we infer overall, that the misvaluation effect on innovation is convex.

3.6 Effect of Misvaluation on Likelihood of Being an Innovator

Since the majority of firms do not have positive patent and citation counts (Table 1), we also examine whether overvaluation increases the probability that a firm has a positive number of patents, or the likelihood of being an innovator. Logistic regressions (unreported) indicate that overvaluation increases the probability that the firm has a positive patent count. The interaction between overvaluation and turnover is also positively associated with the probability that the firm has a positive patent count, consistent with overvaluation increasing the likelihood of being an innovator. Since most firms have zero patents, getting a positive patent count is an indicator of going for a big win.

3.7 Quantile Regressions

Our results so far are based on the least squares regressions. We run quantile regressions, which are more robust to influences of outliers and distributional assumptions of the error process than linear regressions, to provide further robustness of our findings.[22] Our purpose is to explore whether overvaluation has an especially strong effect in promoting *unusually* high innovative input, output and inventiveness. For *RD*, we run quantile regressions for the 0.2, 0.4, 0.6, and 0.8 quantiles of the dependent variable. For *Pat*, *Cites*, *Novelty, Originality*, and *Scope*, since the median is zero, we choose quantile values of 0.65, 0.7, 0.75, and 0.8. If overvaluation promotes unusually high levels of innovative input, output or inventiveness, then we expect to see stronger overvaluation effects at higher quantiles.

The results are reported in Table 9. For brevity, we only report the coefficients of the misvaluation proxy (*MFFlow*). If overvaluation is especially important in driving the highest R&D outcomes and innovative outputs (moon shots), we ought to observe stronger *MFFlow*

[22] The quantile regression parameter estimates the change in a specified quantile (*Q*) of the response variable produced by a one unit change in the predictor variable. For example, quantile regressions for different *RD* quantiles allow us to compare how some percentiles of *RD* may be more affected by misvaluation than other percentiles using the change in coefficient estimates of misvaluation across the different quantiles.

effects for higher quantile cutoffs. This is indeed what we observe. For example, for R&D, although the quantile regressions show statistically significant effect of *MFFlow* at all quantiles, the effect of *MFFlow* increases from –0.103 at quantile 0.2 to –1.427 at quantile 0.8, with the difference in *MFFlow* coefficients highly significant.

In all cases, the effect of misvaluation increases monotonically from lower to higher quantiles, with the difference in misvaluation coefficient between the top and bottom quantiles highly significant. These results are therefore consistent with the conclusion that extreme overvaluation especially promotes moon shots in the sense of unusually high innovative investment, output, and inventiveness.

4. Conclusion

We test how market overvaluation affects corporate innovative inventiveness, spending, and success. We employ patents-based measures of innovative inventiveness (novelty, originality and scope) from previous literature to evaluate how misvaluation affects the propensity to engage in 'moon shot' projects, and the success of such efforts. We also use number of patents or patent citations as measures of innovative output, and R&D expenditures as a proxy for innovative spending.

We use a proxy for equity misvaluation that is designed to focus on variations in mispricing unrelated to the firm's growth prospects. This misvaluation measure uses hypothetical mutual fund outflows, like the fund flow measure of Edmans, Goldstein, and Jiang (2012), but is unrelated to contemporaneous returns. Extensive additional controls for growth opportunities are also included as a failsafe. We verify that our results are robust to using a very different proxy for misvaluation based on a price-to-fundamentals ratio, as well as a price pressure measure that is orthogonal to turnover.

The tests reveal a strong positive association between equity overvaluation and subsequent R&D spending, patent and patent citation production, and inventiveness.

Furthermore, quantile regression indicates that higher valuation (i.e., less undervaluation or greater overvaluation) has an especially strong effect on the frequency of extreme levels of innovative input, output, and inventiveness.

The effect of misvaluation operates partly via the association of misvaluation with equity issuance, and more strongly via the non-financing channel, which includes managerial catering to investor optimism about innovation, or alternatively overoptimism that is shared by managers, customers, suppliers, and/or employees as well as investors. The sensitivity of innovative inventiveness to misvaluation is greater among high turnover firms, consistent with catering or shared sentiment effects, especially in the form of taking more inventive projects. Furthermore, our evidence suggests that the effect of misvaluation on innovation is nonlinear, with stronger effects among the most overvalued firms.

In sum, we find that strong evidence that high overvaluation is associated with a greater propensity of firms to engage in inventive projects, and with greater innovative expenditures that are rewarded with high innovative output. Overvaluation, especially among the most catering-sensitive and perhaps the most overvalued firms, encourages moon shot activities.

Appendix A. Calculation of Mutual Fund Outflow Price Pressure (*MFFlow*)

We follow Edmans, Goldstein, and Jiang (2012) to calculate the hypothetical mutual fund outflow price pressure measure, with one modification (see below). Quarterly mutual fund holdings data are obtained from CDA Spectrum/Thomson and mutual fund returns are from CRSP.

First, in each quarter *t*, we estimate mutual fund flows for all U.S. funds that are not specialized in a given industry using CRSP mutual funds data as

$$Outflow_{j,t} = \frac{TA_{j,t-1}\left(1 + R_{j,t}\right) - TA_{j,t}}{TA_{j,t-1}},$$

where $TA_{j,t}$ is the total asset value of fund *j* (= 1, …, *m*) at the end of quarter *t* and $R_{j,t}$ is the return of fund *j* in quarter *t*, computed by compounding monthly fund returns. $Outflow_{j,t}$ is therefore the total outflow experienced by fund *j* in quarter *t* as a percentage of its asset value at the beginning of the quarter.

Second, we calculate the dollar holdings of stock *i* by fund *j* at the end of quarter *t* using data from CDA Spectrum/Thomson. CDA Spectrum/Thomson provides the number of stocks held by all US funds at the end of every quarter. The total dollar value of the participation held by fund *j* in stock *i* at the end of quarter *t* in year t is

$$Share_{i,j,t} \times PRC_{i,t},$$

where $Share_{i,j,t}$ is the number of stocks *i* held by fund *j* at the end of quarter *t*, and $PRC_{i,t}$ is the price of stock *i* at the end of quarter *t*.

Third, we compute the quarterly mutual fund flow

$$QMfflow_{i,t} = \sum_{j=1}^{m} \frac{Outflow_{j,t} \times Share_{i,j,t} \times PRC_{i,t}}{VOL_{i,t}},$$

where the summation is only over funds *j* for which $Outflow_{j,t} \geq 0.05$, and where $VOL_{i,t}$ is the total dollar trading volume of stock *i* in quarter *t*. This variable corresponds to the hypothetical selling pressure of stock *i* by all mutual funds subject to large outflows.

Finally, we calculate the annual *MFFlow* for stock *i* in quarter *t* by recursively summing up *QMFFlow* across the four quarters up to quarter *t*.

Importantly, Wardlaw (2018) noted that the original Edmans, Goldstein, and Jiang measure use $PRC_{i,t-1}$ in the above formula, which together with $VOL_{i,t}$ in the denominator, induces a mechanical correlation between *MFFlow* and contemporaneous returns. We use $PRC_{i,t}$ and $VOL_{i,t}$ measured in the same quarter, which removes the mechanical correlation, and so our *MFFlow* measure is immune to this critique.

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Table 1. Summary Statistics of Innovation Input and Outputs, Valuation, and Control Variables

The sample includes U.S. non-financial firms listed on NYSE, AMEX and NASDAQ with COMPUSTAT and CDA/Spectrum mutual fund flows data during 1981-2012. Patent and citation counts data (November 2011 version) is provided by Kogan et al. (2013); we end the patent and citation data in 2008 to reduce truncation biases caused by the delay in patent approval and citation counts. Innovation input is R&D expenditure scaled by lagged total assets (*RD*). Capital expenditures scaled by lagged total assets (*CAPX*) is also reported for comparison. Variables for the patents applied for in a fiscal year include: number of patents (*Pat*); number of citations adjusted for the effects of year and technological class (*Cites*); *Novelty* measured by number of citations per patent; *Originality* and *Scope* are patent-citation quality measures as defined by Hall, Jaffe, and Trajtenberg (2001). *MFFlow* is the mutual fund price pressure measure following Edmans, Goldstein, and Jiang (2012). *VP* is the residual-income-value to price ratio. *BP* is the book equity to price ratio. *CF* is cash flow (income before extraordinary items + depreciation + *RD*) over the fiscal year scaled by lagged assets (missing *RD* is set to zero in the *CF* calculation). *Leverage* is defined as (long-term debt + current liabilities)/(long-term debt + current liabilities + shareholders' equity). *Age* is the number of years between the beginning of the fiscal year and the listing date of the firm in CRSP, truncated at 50. *GS* is the growth rate of sales in the 3 years prior to each fiscal year. *LTG* is the long-term analyst earnings growth rate forecast. Equity issuance (*EI*) and debt issuance (*DI*) are equity and debt issuances during the fiscal year constructed from the balance sheet scaled by lagged assets. *Turnover* is monthly trading volume scaled by the number of shares outstanding. Except for the innovation input and output variables, and cash flow (*CF*), and equity issuance (*EI*), which are measured over each fiscal year, all other control variables, valuation variables, and valuation sensitivity variables are measured in the month preceding the beginning of each fiscal year. Total assets and sales figures are in 2012 dollars. All ratio variables are winsorized at the 1^{st} and 99^{th} percentiles.

	N	Mean	Std Dev	Median	P1	P99
Innovation Input and Output Variables						
RD (%)	40,111	9.00	14.08	4.09	0.00	71.97
CAPX (%)	62,893	7.07	8.40	4.54	0.11	43.30
Pat	53,629	12.78	88.11	0.00	0.00	247.00
Cites	52,315	11.59	78.32	0.00	0.00	225.25
Novelty	52,315	0.39	0.74	0.00	0.00	3.12
Originality	53,550	0.17	0.25	0.00	0.00	0.80
Scope	52,315	0.15	0.23	0.00	0.00	0.78
Valuation Variables						
MFFlow (%)	63,488	3.52	6.01	1.65	0.01	30.52
VP	48,352	0.59	0.53	0.55	-1.09	2.39
Control or Conditioning Variables for Innovation Regressions						
BP	63,187	0.65	0.69	0.46	-0.24	4.11
GS	57,401	0.80	2.28	0.31	-0.75	11.54
CF (%)	63,315	11.33	16.41	11.60	-45.80	56.68
Leverage	63,041	0.28	0.27	0.24	0.00	1.24
Age	63,488	16.25	13.46	12.25	1.25	50.00
Total Assets ($M)	63,435	3300.17	18072.30	395.31	12.16	49856.18
LTG	40,107	0.18	0.10	0.15	0.04	0.51
EI (%)	63,309	8.45	35.05	0.94	-14.64	163.35
DI (%)	63,435	6.51	23.49	2.16	-34.52	112.83
Turnover (%)	63,422	13.21	14.87	7.85	0.39	73.13

Table 2. Corporate Investment, Innovative Output, and Equity Valuations by Year

This table reports the time pattern of selected variables. The yearly mean values are reported, except for the valuation ratios (*BP* and *VP*) for which the medians are shown. The sample includes U.S. non-financial firms listed on NYSE, AMEX and NASDAQ with COMPUSTAT and CDA/Spectrum mutual fund flows data during 1981-2012. Patent and citation data is from Kogan et al. (2016) (November 2011 version); we end the patent and citation data in 2008 to reduce truncation biases.

Year	*N*	*RD* (%)	*CAPX* (%)	*Pat*	*Cites*	*Novelty*	*Originality*	*Scope*	*MFFlow* (%)
1981	295	3.98	13.91	38.16	36.15	0.56	0.23	0.25	1.31
1982	707	3.98	9.99	20.44	19.36	0.54	0.20	0.24	5.12
1983	689	4.25	8.43	19.65	18.65	0.50	0.20	0.24	4.36
1984	686	5.73	11.23	18.96	18.45	0.53	0.19	0.23	1.48
1985	1,186	6.00	10.06	12.32	12.36	0.47	0.17	0.21	4.16
1986	1,229	6.18	9.15	11.40	11.53	0.46	0.18	0.21	4.33
1987	1,333	6.26	8.34	11.17	11.13	0.48	0.18	0.21	4.51
1988	1,346	5.85	8.69	12.20	12.15	0.46	0.17	0.20	2.71
1989	1,300	6.07	8.58	13.47	13.45	0.45	0.18	0.21	1.98
1990	1,329	6.80	8.33	13.76	13.87	0.49	0.18	0.21	1.56
1991	1,781	6.38	7.16	10.75	10.96	0.39	0.16	0.18	10.18
1992	1,813	6.91	7.39	11.08	11.52	0.40	0.16	0.18	4.18
1993	1,926	7.73	7.93	11.15	11.51	0.40	0.16	0.18	3.53
1994	2,211	8.18	8.40	10.77	11.15	0.39	0.17	0.18	3.26
1995	2,563	9.23	8.87	11.39	11.55	0.40	0.17	0.18	1.96
1996	2,415	8.86	9.17	12.03	12.44	0.40	0.17	0.17	2.37
1997	2,358	9.65	8.93	14.54	15.13	0.46	0.19	0.19	2.08
1998	2,653	10.13	8.63	13.00	13.32	0.42	0.18	0.17	2.16
1999	2,929	10.97	7.79	12.67	12.80	0.40	0.17	0.16	4.17
2000	2,819	11.33	7.73	13.98	13.95	0.40	0.17	0.15	9.24
2001	2,664	9.20	6.02	15.62	14.93	0.42	0.19	0.14	4.74
2002	2,781	9.80	4.90	15.67	13.76	0.41	0.20	0.13	1.57
2003	2,810	10.39	4.87	15.03	11.84	0.40	0.20	0.10	2.70
2004	2,489	9.40	5.46	15.43	10.83	0.38	0.20	0.08	2.06
2005	2,493	9.55	5.71	14.21	8.30	0.33	0.18	0.06	2.11
2006	2,523	10.68	6.20	11.23	5.27	0.29	0.17	0.04	3.71
2007	2,403	10.12	6.35	7.58	2.85	0.22	0.14	0.02	2.93
2008	2,444	9.69	5.97	3.41	0.94	0.14	0.10	0.01	3.21
2009	2,497	9.64	3.99	-	-	-	-	-	4.21
2010	2,322	9.74	4.86	-	-	-	-	-	3.36
2011	2,265	9.38	5.52	-	-	-	-	-	2.85
2012	2,229	10.07	5.54	-	-	-	-	-	3.25
All	63,488	9.00	7.07	12.78	11.59	0.39	0.17	0.15	3.52

Table 3. Regressions of Investments and Innovative Output on Stock Misvaluation

The variables are defined in Table 1. All independent variables are standardized to have a mean of zero and standard deviation of one. All regressions include 2-digit SIC industry fixed effects and year fixed effects. *T*-statistics are reported in parentheses. Standard errors are clustered by firm and year. The sample includes U.S. non-financial, non-utility firms listed on NYSE, AMEX and NASDAQ with COMPUSTAT and CDA/Spectrum mutual fund flows data during 1981-2012. The patent and citation (*Pat* and *Cites*) data sample period is 1981-2008.

	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
	RD		*Log(1+Pat)*		*Log(1+Cites)*		*Novelty*		*Originality*		*Scope*	
MFFlow	-1.47	-1.51	-0.07	-0.08	-0.03	-0.04	-3.53	-3.82	-1.19	-1.33	-1.37	-1.44
	(-7.72)	(-7.77)	(-7.13)	(-7.10)	(-7.80)	(-7.88)	(-7.09)	(-7.49)	(-6.30)	(-6.69)	(-7.30)	(-7.67)
BP	-1.61		-0.08		-0.04		-4.88		-1.78		-1.28	
	(-6.86)		(-5.95)		(-6.42)		(-6.66)		(-6.20)		(-5.05)	
GS		1.15		0.02		0.02		3.14		0.74		0.67
		(6.43)		(3.43)		(4.35)		(5.40)		(4.67)		(4.64)
CF	0.28	1.07	0.09	0.13	0.04	0.06	3.89	5.53	1.02	1.76	1.29	1.83
	(1.04)	(4.11)	(6.43)	(8.73)	(6.80)	(9.23)	(5.11)	(7.14)	(3.91)	(7.32)	(4.49)	(6.21)
Leverage	-1.22	-0.97	-0.18	-0.17	-0.08	-0.07	-7.22	-6.55	-2.76	-2.50	-2.65	-2.48
	(-7.96)	(-6.51)	(-12.63)	(-11.65)	(-12.80)	(-11.79)	(-11.23)	(-10.10)	(-11.33)	(-10.39)	(-10.14)	(-9.82)
Log(Age)	-1.60	-1.64	0.12	0.15	0.04	0.05	-0.03	0.45	1.24	1.54	1.15	1.43
	(-9.92)	(-8.07)	(5.41)	(5.26)	(4.28)	(4.48)	(-0.03)	(0.46)	(3.31)	(3.53)	(3.20)	(3.67)
Log(Assets)	-3.96	-3.36	0.63	0.65	0.23	0.23	12.27	12.80	5.51	5.69	4.50	4.61
	(-14.43)	(-13.03)	(18.06)	(18.16)	(18.73)	(18.92)	(14.72)	(15.32)	(19.04)	(19.53)	(10.25)	(10.06)
Intercept	8.21	8.05	-0.16	-0.18	-0.09	-0.09	-2.03	-0.67	1.89	2.21	-4.62	-4.73
	(56.94)	(54.22)	(-9.16)	(-8.20)	(-11.79)	(-9.73)	(-3.07)	(-0.76)	(7.90)	(7.33)	(-9.11)	(-8.31)
N	39,773	35,911	53,150	47,986	51,853	46,802	51,853	46,802	53,072	47,917	51,853	46,802
R^2	0.3024	0.2838	0.3747	0.3850	0.3438	0.3552	0.1228	0.1252	0.1777	0.1808	0.2158	0.2260

Table 4. Long-Term Misvaluation Effects: Regressions of Innovative Input, Output and Inventiveness on 3-Year Lagged Stock Misvaluation

The misvaluation measure (*MFFlow*) is lagged by 3 years. The variables are defined in Table 1. All independent variables are standardized to have a mean of zero and standard deviation of one. *Novelty, Originality*, and *Scope* are in percentage. All regressions include 2-digit SIC industry fixed effects and year fixed effects. *T*-statistics are reported in parentheses. Standard errors are clustered by firm and year. The sample includes U.S. non-financial, non-utility firms listed on NYSE, AMEX and NASDAQ with COMPUSTAT and CDA/Spectrum mutual fund flows data during 1981-2012. The patent and citation data (*Pat, Cites, Novelty, Originality,* and *Scope*) sample period is 1981-2008.

	RD	*Log(1+Pat)*	*Log(1+Cites)*	*Novelty*	*Originality*	*Scope*
MFFflow	-1.42	-0.09	-0.04	-4.27	-1.53	-1.23
	(-7.08)	(-6.17)	(-6.61)	(-6.25)	(-7.08)	(-4.85)
GS	1.83	-0.01	0.00	2.03	0.56	0.39
	(5.78)	(-0.85)	(0.27)	(1.85)	(1.82)	(1.36)
CF	1.01	0.16	0.07	6.29	2.21	2.20
	(3.32)	(7.62)	(7.92)	(6.17)	(6.56)	(5.44)
Leverage	-0.80	-0.17	-0.07	-5.86	-2.21	-2.13
	(-4.77)	(-10.08)	(-9.93)	(-8.00)	(-8.22)	(-7.92)
Log(Age)	-1.93	0.17	0.05	-0.85	1.44	1.15
	(-8.67)	(4.49)	(3.62)	(-0.69)	(2.57)	(2.33)
Log(Assets)	-3.28	0.68	0.24	13.08	5.89	4.52
	(-12.07)	(17.20)	(17.94)	(15.23)	(18.52)	(9.31)
Intercept	8.51	-0.29	-0.13	-1.21	1.78	-5.17
	(48.02)	(-8.95)	(-9.58)	(-1.21)	(4.57)	(-7.11)
N	28,147	36,089	35,058	35,058	36,034	35,058
R^2	0.2831	0.4009	0.3762	0.1385	0.1909	0.2517

Table 5. Persistence of Misvaluation and Long-Term Misvaluaton Effects on Innovation

The 3-year lagged misvaluation measure (*MFFlow*) is interacted with an indicator for the highest quintile of *MFFlow* autocorrelation, *HighAuto*. The other variables are defined in Table 1. All independent variables are standardized to have a mean of zero and standard deviation of one. *Novelty, Originality*, and *Scope* are in percentage. All regressions include 2-digit SIC industry fixed effects and year fixed effects. *T*-statistics are reported in parentheses. Standard errors are clustered by firm and year. The sample includes U.S. non-financial, non-utility firms listed on NYSE, AMEX and NASDAQ with COMPUSTAT and CDA/Spectrum mutual fund flows data during 1981-2012. The patent and citation data (*Pat, Cites, Novelty, Originality,* and *Scope*) sample period is 1976-2008.

	RD	*Log(1+Pat)*	*Log(1+Cites)*	*Novelty*	*Originality*	*Scope*
MFFlow	-1.40	-0.08	-0.04	-3.94	-1.30	-1.14
	(-7.13)	(-5.89)	(-6.48)	(-6.06)	(-6.67)	(-5.00)
*MFFlow*HighAuto*	-0.18	-0.09	-0.03	-2.62	-1.75	-0.71
	(-0.70)	(-2.61)	(-2.63)	(-1.95)	(-2.57)	(-1.30)
GS	1.83	-0.01	0.00	2.04	0.56	0.39
	(5.78)	(-0.85)	(0.28)	(1.86)	(1.82)	(1.36)
CF	1.01	0.16	0.07	6.27	2.19	2.19
	(3.32)	(7.57)	(7.88)	(6.14)	(6.50)	(5.43)
Leverage	-0.80	-0.17	-0.07	-5.84	-2.20	-2.13
	(-4.77)	(-10.05)	(-9.90)	(-7.98)	(-8.18)	(-7.93)
Log(Age)	-1.92	0.17	0.05	-0.81	1.46	1.16
	(-8.66)	(4.53)	(3.66)	(-0.66)	(2.62)	(2.36)
Log(Assets)	-3.28	0.68	0.24	13.08	5.89	4.52
	(-12.07)	(17.20)	(17.93)	(15.24)	(18.57)	(9.31)
Intercept	8.51	-0.29	-0.13	-1.28	1.74	-5.19
	(47.73)	(-9.01)	(-9.63)	(-1.27)	(4.45)	(-7.08)
N	28,147	36,089	35,058	35,058	36,034	35,058
R^2	0.2831	0.4013	0.3766	0.1386	0.1914	0.2518

Table 6. Path Analysis of the Effects of Misvaluation on R&D: Allowing Debt Issuance

This analysis is based on a sample during 1981-2012. The variables in Panel A are defined in Table 1. In Panel B, *ROA* is operating income before depreciation and R&D expenses scaled by total assets for the prior fiscal year, and *ΔCR* is change in the current ratio (total current assets divided by total current liabilities). All variables are not standardized. All regressions include industry and year fixed effects. *T*-statistics are reported in parentheses. Standard errors are clustered by firm and year. We break the total effect of *MFFlow* on R&D into three parts: the direct catering effect, and the indirect effects through the equity issuance and debt issuance channels.

Panel A. *RD* Regression

	RD
MFFlow	-18.4757
	(-6.30)
EI	0.1498
	(16.12)
DI	0.0240
	(3.55)
GS	0.2926
	(4.57)
CF	0.1085
	(9.13)
Leverage	-4.1511
	(-8.06)
Log(Age)	-1.2128
	(-7.48)
Size	-1.2091
	(-11.32)
Intercept	16.3468
	(21.60)
N	35,876
R^2	0.4476

Panel B. Equity Issuance (*EI*) and Debt Issuance (*DI*) Regressions

	EI	*DI*
MFFlow	-46.2833	-8.7069
	(-9.91)	(-5.54)
GS	1.0165	0.5847
	(7.56)	(6.94)
ROA	-0.3178	0.0487
	(-9.61)	(5.20)
ΔCR	3.8549	-1.6203
	(5.03)	(-8.58)
Leverage	-0.3374	-4.3868
	(-0.23)	(-5.66)
Log(Age)	-2.0671	-1.1200
	(-6.30)	(-5.64)
Size	-2.6969	0.1615
	(-13.15)	(1.58)
Intercept	34.5739	8.3476
	(15.15)	(14.12)
N	55,320	55,405
R^2	0.1488	0.0428

Panel C. Path analysis results for the effects of *MFFlow* on *RD*

	Coefficient	*T*-stat
(1) Direct Effect of *MFFlow* on *RD*		
MFFlow → *RD*	-18.4757	(-6.30)
(2) Indirect Effect of *MFFlow* on RD via Equity Channel		
MFFlow → *EI*	-46.2833	(-9.91)
EI → *RD*	0.1498	(16.12)
Equity Path Effect	-6.9332	
(3) Indirect Effect of *MFFlow* on RD via Debt Channel		
MFFlow → *DI*	-8.7069	(-5.54)
DI → *RD*	0.0240	(3.55)
Debt Path Effect	-0.20897	
(4) Total *MFFlow* Effect on *RD*	-25.6179	
% Direct Path	72.12%	
% Equity Path	27.06%	
% Debt Path	0.82%	

Table 7. Regressions of Innovative Input, Output and Inventiveness on Stock Misvaluation: Interaction with Turnover

The misvaluation measure (*MFFlow*) is interacted with an overvaluation indicator. *HighTurn*) is an indicator variable for the highest *Turnover* quintile. The variables are defined in Table 1. All independent variables are standardized to have a mean of zero and standard deviation of one. *Novelty, Originality*, and *Scope* are in percentage. All regressions include 2-digit SIC industry fixed effects and year fixed effects. *T*-statistics are reported in parentheses. Standard errors are clustered by firm and year. The sample includes U.S. non-financial, non-utility firms listed on NYSE, AMEX and NASDAQ with COMPUSTAT and CDA/Spectrum mutual fund flows data during 1981-2012. The patent and citation data (*Pat, Cites, Novelty, Originality,* and *Scope*) sample period is 1976-2008.

	RD	*Log(1+Pat)*	*Log(1+Cites)*	*Novelty*	*Originality*	*Scope*
MFFlow	-1.25	-0.06	-0.03	-2.79	-1.07	-1.15
	(-7.44)	(-6.52)	(-7.39)	(-6.39)	(-6.23)	(-7.30)
*MFFlow*HiTurnover*	-1.43	-0.25	-0.10	-7.88	-2.53	-3.06
	(-2.73)	(-5.21)	(-4.91)	(-4.45)	(-4.60)	(-3.98)
GS	1.03	0.02	0.01	2.56	0.61	0.53
	(5.90)	(2.35)	(3.29)	(4.72)	(3.90)	(3.82)
CF	1.01	0.13	0.06	5.26	1.70	1.77
	(4.07)	(8.90)	(9.39)	(7.02)	(7.18)	(6.32)
Leverage	-0.94	-0.17	-0.07	-6.34	-2.45	-2.42
	(-6.89)	(-11.60)	(-11.84)	(-10.37)	(-10.67)	(-10.11)
Log(Age)	-1.39	0.16	0.06	1.22	1.71	1.61
	(-6.61)	(5.67)	(5.00)	(1.23)	(3.88)	(4.11)
Log(Assets)	-3.79	0.63	0.22	11.33	5.36	4.28
	(-13.43)	(18.07)	(18.64)	(12.25)	(16.71)	(9.78)
Turnover	1.05	0.03	0.02	3.99	0.84	0.80
	(4.14)	(1.06)	(1.88)	(3.84)	(2.35)	(2.18)
Intercept	7.59	-0.22	-0.12	-5.14	1.24	-5.70
	(43.23)	(-5.75)	(-7.18)	(-3.46)	(2.32)	(-7.06)
N	35,911	47,986	46,802	46,802	47,917	46,802
R^2	0.2919	0.3878	0.3589	0.1293	0.1828	0.2286

Table 8. Regressions of Innovative Input, Output and Inventiveness on Stock Misvaluation: Interaction with High Valuation Indicator (*LowFlow*)

The misvaluation measure (*MFFlow*) is interacted with an overvaluation indicator. *LowFlow* is an indicator variable for the lowest *MFFlow* quintile. The variables are defined in Table 1. All independent variables are standardized to have a mean of zero and standard deviation of one. *Novelty, Originality*, and *Scope* are in percentage. All regressions include 2-digit SIC industry fixed effects and year fixed effects. *T*-statistics are reported in parentheses. Standard errors are clustered by firm and year. The sample includes U.S. non-financial, non-utility firms listed on NYSE, AMEX and NASDAQ with COMPUSTAT and CDA/Spectrum mutual fund flows data during 1981-2012. The patent and citation data (*Pat, Cites, Novelty, Originality,* and *Scope*) sample period is 1976-2008.

	RD	*Log(1+Pat)*	*Log(1+Cites)*	*Novelty*	*Originality*	*Scope*
MFFlow	-1.18	-0.06	-0.03	-3.09	-1.11	-1.11
	(-7.78)	(-7.15)	(-8.05)	(-6.65)	(-6.75)	(-8.11)
*MFFlow*LowFlow*	-5.39	-0.46	-0.17	-12.71	-3.82	-5.83
	(-9.42)	(-7.09)	(-7.44)	(-4.42)	(-3.89)	(-7.59)
GS	1.10	0.02	0.01	3.00	0.70	0.61
	(6.22)	(2.90)	(4.01)	(5.36)	(4.53)	(4.31)
CF	1.17	0.14	0.06	5.71	1.82	1.92
	(4.58)	(9.67)	(9.99)	(7.45)	(7.71)	(6.64)
Leverage	-1.01	-0.17	-0.07	-6.63	-2.53	-2.51
	(-6.87)	(-11.73)	(-11.91)	(-10.14)	(-10.38)	(-10.02)
Log(Age)	-1.60	0.15	0.05	0.54	1.56	1.47
	(-7.80)	(5.45)	(4.65)	(0.54)	(3.59)	(3.81)
Log(Assets)	-3.07	0.67	0.24	13.37	5.87	4.88
	(-13.15)	(18.89)	(19.99)	(16.21)	(19.77)	(10.94)
Intercept	7.72	-0.20	-0.10	-1.30	2.02	-5.03
	(46.22)	(-9.35)	(-10.85)	(-1.46)	(6.46)	(-8.79)
N	35,911	47,986	46,802	46,802	47,917	46,802
R^2	0.2909	0.3892	0.3586	0.1263	0.1817	0.2283

Table 9. Quantile Regressions

We perform quantile regressions of R&D, innovative output (*Pat* and *Cites*) and inventiveness variables (*Novelty, Originality* and *Scope*) on misvaluation (measured by *MFFlow*) and control variables with industry and year fixed effects. We choose quantile values of Q to be 0.2, 0.4, 0.6, and 0.8 for *RD*; and quantile values of 0.65, 0.7, 0.75, and 0.8 for innovative output and inventive measures because these variables have a median value of zero. We report only the coefficient on *MFFlow*. *T*-statistics of the *MFFlow* coefficient of the quantile regressions are reported in parentheses, with *p*-values of the *F*-test for the difference in the coefficients between the top or bottom quantiles shown in square brackets.

	Q(0.2)	Q(0.4)	Q(0.6)	Q(0.8)	Q(0.8)-Q(0.2) [*p*-value]
RD	-0.103	-0.497	-0.923	-1.427	-1.324
	(-11.74)	(-20.61)	(-22.08)	(-19.70)	[0.000]

	Q(0.65)	Q(0.7)	Q(0.75)	Q(0.8)	Q(0.8)-Q(0.65) [*p*-value]
Pat	-0.067	-0.078	-0.089	-0.100	-0.032
	(-10.98)	(-9.26)	(-9.89)	(-9.81)	[0.000]
Cites	-0.033	-0.037	-0.041	-0.051	-0.018
	(-11.59)	(-10.26)	(-11.30)	(-12.31)	[0.000]
Novelty	-1.509	-2.146	-3.202	-4.278	-2.769
	(-8.36)	(-7.62)	(-7.70)	(-7.49)	[0.000]
Originality	-0.113	-0.605	-1.469	-2.089	-1.976
	(-6.89)	(-6.48)	(-6.47)	(-7.15)	[0.000]
Scope	-0.676	-1.290	-2.018	-2.345	-1.669
	(-11.11)	(-12.32)	(-14.54)	(-15.52)	[0.000]

Internet Appendix of "Stock Market Overvaluation, Moon Shots, and Corporate Innovation"

In this Appendix, we provide regression results using two alternative misvaluation measures: the residual income value-to-price ratio (*VP*) and residual *MFFlow* (*MFF_r*). The estimation procedures for *VP* is provided at the end of this appendix. *MFF_r* is defined as the residual from the annual regression of *MFFlow* on *Turnover*. *VP* observations start 1976, while *MFF_r* observations start 1981. Both variables end 2012. In Table IA-8 we report results using industry-adjusted *MFFlow* as the misvaluatino proxy.

IA-A. Test Results on Sample with Non-Missing *VP* Observations

Table IA-1. Regressions of Investments and Innovative Output on Stock Misvaluation

The variables are defined in Table 1. All independent variables are standardized to have a mean of zero and standard deviation of one. All regressions include 2-digit SIC industry fixed effects and year fixed effects. *T*-statistics are reported in parentheses. Standard errors are clustered by firm and year. The sample includes U.S. non-financial, non-utility firms listed on NYSE, AMEX and NASDAQ with COMPUSTAT and I/B/E/S coverage during 1976-2012. The patent and citation (*Pat* and *Cites*) data sample period is 1976-2008.

	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	RD				*Log(1+Pat)*				*Log(1+Cites)*			
VP	-2.57	-2.46			-0.09	-0.10			-0.09	-0.10		
	(-14.86)	(-12.74)			(-5.53)	(-4.95)			(-6.27)	(-5.45)		
MFF_r			-0.98	-1.04			-0.06	-0.06			-0.06	-0.06
			(-5.25)	(-5.50)			(-5.76)	(-5.84)			(-5.74)	(-5.85)
BP	-0.48		-1.73		-0.06		-0.08		-0.06		-0.08	
	(-2.75)		(-6.91)		(-4.02)		(-6.11)		(-4.41)		(-6.43)	
GS		0.92		1.20		0.03		0.03		0.04		0.04
		(5.49)		(6.63)		(4.39)		(3.83)		(5.50)		(4.53)
CF	1.51	2.14	0.26	1.08	0.13	0.19	0.09	0.13	0.14	0.19	0.09	0.13
	(5.50)	(8.62)	(0.96)	(4.11)	(9.49)	(11.67)	(6.37)	(8.75)	(9.16)	(10.71)	(6.33)	(8.23)
Leverage	-1.69	-1.35	-1.26	-0.99	-0.20	-0.21	-0.18	-0.17	-0.20	-0.21	-0.18	-0.17
	(-13.18)	(-10.78)	(-8.05)	(-6.49)	(-11.58)	(-11.41)	(-12.72)	(-11.71)	(-11.79)	(-11.43)	(-12.27)	(-11.33)
Log(Age)	-0.83	-0.81	-1.69	-1.74	0.09	0.18	0.11	0.15	0.08	0.17	0.10	0.13
	(-7.03)	(-5.17)	(-10.31)	(-8.45)	(5.94)	(6.94)	(5.22)	(5.09)	(4.95)	(6.49)	(4.59)	(4.70)
Log(Assets)	-3.00	-2.48	-3.83	-3.21	0.69	0.72	0.63	0.65	0.67	0.69	0.60	0.62
	(-11.33)	(-10.38)	(-13.93)	(-12.57)	(19.10)	(19.61)	(18.17)	(18.32)	(17.35)	(17.50)	(15.58)	(15.55)
Intercept	7.42	7.09	8.21	8.07	-0.27	-0.35	-0.16	-0.18	-0.39	-0.47	-0.25	-0.27
	(41.70)	(56.57)	(58.31)	(58.39)	(-12.26)	(-14.32)	(-8.88)	(-7.84)	(-17.40)	(-18.34)	(-12.96)	(-11.23)
N	40,206	34,658	39,773	35,911	55,048	47,295	53,150	47,986	53,935	46,296	51,853	46,802
R^2	0.3271	0.3233	0.2975	0.2778	0.3909	0.4103	0.3737	0.3838	0.3735	0.3956	0.3562	0.3676

Table IA-2. Regressions of Innovative Inventiveness on Stock Misvaluation

The variables are defined in Table 1. All independent variables are standardized to have a mean of zero and standard deviation of one. *Novelty, Originality*, and *Scope* are in percentage. All regressions include 2-digit SIC industry fixed effects and year fixed effects. *T*-statistics are reported in parentheses. Standard errors are clustered by firm and year. The sample includes U.S. non-financial, non-utility firms listed on NYSE, AMEX and NASDAQ with COMPUSTAT, I/B/E/S, and patent-citation data coverage during 1976-2008.

	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	Novelty				*Originality*				*Scope*			
VP	-6.13	-5.98			-2.06	-2.12			-1.88	-1.77		
	(-9.54)	(-7.64)			(-7.27)	(-6.21)			(-8.96)	(-6.93)		
MFF_r			-2.18	-2.48			-0.87	-1.00			-0.92	-1.01
			(-5.15)	(-5.52)			(-5.26)	(-5.78)			(-5.64)	(-6.04)
BP	-2.04		-5.15		-0.68		-1.86		-0.38		-1.37	
	(-2.64)		(-6.78)		(-2.11)		(-6.28)		(-1.41)		(-5.21)	
GS		3.35		3.27		0.59		0.78		0.66		0.72
		(5.73)		(5.61)		(3.25)		(4.90)		(3.92)		(4.98)
CF	6.29	8.07	3.85	5.57	1.90	2.54	1.01	1.78	2.05	2.58	1.27	1.85
	(7.87)	(10.41)	(5.02)	(7.17)	(7.51)	(10.44)	(3.86)	(7.35)	(6.89)	(8.06)	(4.41)	(6.23)
Leverage	-8.34	-7.54	-7.30	-6.61	-2.94	-2.79	-2.79	-2.52	-3.07	-2.95	-2.68	-2.50
	(-11.80)	(-10.95)	(-11.25)	(-10.13)	(-11.22)	(-10.55)	(-11.33)	(-10.38)	(-11.91)	(-11.13)	(-10.14)	(-9.81)
Log(Age)	1.19	3.38	-0.23	0.23	1.57	2.56	1.18	1.47	1.36	2.42	1.08	1.36
	(1.50)	(3.33)	(-0.26)	(0.24)	(5.98)	(6.55)	(3.15)	(3.38)	(4.91)	(6.34)	(2.97)	(3.46)
Log(Assets)	13.34	13.44	12.55	13.12	5.53	5.50	5.59	5.79	5.09	5.00	4.60	4.73
	(14.67)	(14.04)	(14.99)	(15.83)	(17.26)	(16.20)	(19.27)	(19.88)	(12.14)	(11.40)	(10.33)	(10.19)
Intercept	-6.07	-6.10	-1.99	-0.53	1.32	1.09	1.91	2.26	-6.50	-7.31	-4.59	-4.68
	(-9.00)	(-7.93)	(-2.81)	(-0.56)	(4.43)	(3.67)	(7.77)	(7.19)	(-14.11)	(-13.57)	(-8.85)	(-8.04)
N	53,935	46,296	51,853	46,802	54,968	47,228	53,072	47,917	53,935	46,296	51,853	46,802
R^2	0.1328	0.1432	0.1217	0.1240	0.1904	0.1963	0.1770	0.1799	0.2220	0.2368	0.2144	0.2245

Table IA-3. Long-Term Misvaluation Effects: Regressions of Innovative Input, Output and Inventiveness on 3-Year Lagged Stock Misvaluation

The misvaluation measure (*VP* or *MFF_r*) is lagged by 3 years. The variables are defined in Table 1. All independent variables are standardized to have a mean of zero and standard deviation of one. *Novelty, Originality*, and *Scope* are in percentage. All regressions include 2-digit SIC industry fixed effects and year fixed effects. *T*-statistics are reported in parentheses. Standard errors are clustered by firm and year. The sample includes U.S. non-financial, non-utility firms listed on NYSE, AMEX and NASDAQ with COMPUSTAT and I/B/E/S coverage during 1976-2012. The patent and citation data (*Pat, Cites, Novelty, Originality,* and *Scope*) sample period is 1976-2008.

	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
	RD		*Log(1+Pat)*		*Log(1+Cites)*		*Novelty*		*Originality*		*Scope*	
VP	-2.45		-0.10		-0.09		-5.27		-2.00		-1.27	
	(-11.81)		(-5.12)		(-5.53)		(-6.70)		(-5.84)		(-5.63)	
MFF_r		-0.95		-0.06		-0.06		-2.85		-1.03		-0.78
		(-5.17)		(-4.93)		(-5.04)		(-5.02)		(-5.63)		(-3.92)
GS	1.49	1.91	-0.03	-0.01	-0.02	0.00	2.18	2.17	0.53	0.62	0.40	0.42
	(5.05)	(6.30)	(-2.04)	(-0.69)	(-1.17)	(0.02)	(2.14)	(1.92)	(1.84)	(1.92)	(1.70)	(1.44)
CF	1.79	1.00	0.20	0.16	0.20	0.17	7.33	6.28	2.61	2.21	2.57	2.19
	(7.39)	(3.27)	(9.79)	(7.57)	(8.97)	(6.96)	(7.59)	(6.12)	(8.00)	(6.49)	(6.36)	(5.40)
Leverage	-0.63	-0.83	-0.17	-0.17	-0.17	-0.17	-6.05	-5.95	-2.19	-2.24	-2.55	-2.16
	(-4.05)	(-4.89)	(-9.52)	(-10.17)	(-9.61)	(-9.79)	(-7.77)	(-8.05)	(-7.59)	(-8.21)	(-9.69)	(-8.02)
Log(Age)	-0.93	-2.05	0.19	0.16	0.16	0.14	1.89	-1.19	2.60	1.31	2.10	1.04
	(-4.71)	(-9.15)	(5.51)	(4.24)	(4.88)	(3.78)	(1.72)	(-0.96)	(5.49)	(2.34)	(4.58)	(2.10)
Log(Assets)	-2.86	-3.13	0.73	0.69	0.70	0.65	13.22	13.45	5.41	6.02	4.76	4.63
	(-9.82)	(-11.57)	(18.75)	(17.34)	(16.54)	(14.21)	(12.76)	(15.67)	(15.02)	(19.12)	(10.37)	(9.40)
Intercept	7.69	8.36	-0.42	-0.27	-0.53	-0.36	-5.59	-0.25	1.33	2.13	-7.21	-4.90
	(51.86)	(47.60)	(-16.07)	(-7.84)	(-17.85)	(-9.84)	(-6.80)	(-0.23)	(4.27)	(5.21)	(-10.99)	(-6.64)
N	28,852	28,113	38,367	36,068	37,497	35,040	37,497	35,040	38,313	36,013	37,497	35,040
R^2	0.3135	0.2776	0.4111	0.3992	0.3981	0.3860	0.1429	0.1370	0.1957	0.1896	0.2462	0.2505

Table IA-4. Path Analysis of the Effects of Misvaluation (*VP*) on R&D

This analysis is based on a sample during 1976-2012, using *VP* instead of *MFFlow* to measure misvaluation. The variables in Panel A are defined in Table 1. In Panel B, *ROA* is operating income before depreciation and R&D expenses scaled by total assets for the prior fiscal year, and *ΔCR* is change in the current ratio (total current assets divided by total current liabilities). All variables are not standardized. All regressions include industry and year fixed effects. *T*-statistics are reported in parentheses. Standard errors are clustered by firm and year. We break the total effect of *MFFlow* on R&D into three parts: the direct catering effect, and the indirect effects through the equity issuance and debt issuance channels.

Panel A. *RD* Regression

	RD
MFFlow	-15.3534
	(-5.10)
EI	0.1512
	(16.47)
DI	0.0242
	(3.56)
GS	0.3041
	(4.74)
CF	0.1095
	(9.16)
Leverage	-4.2067
	(-8.10)
Log(Age)	-1.2682
	(-7.81)
Size	-1.1582
	(-11.01)
Intercept	15.5408
	(21.12)
N	35,876
R^2	0.4458

Panel B. Equity Issuance (*EI*) and Debt Issuance (*DI*) Regressions

	EI	*DI*
MFFlow	-28.9719	-4.4143
	(-8.73)	(-3.15)
GS	1.0648	0.5948
	(7.51)	(7.01)
ROA	-0.3165	0.0489
	(-9.42)	(5.24)
ΔCR	3.8641	-1.6183
	(4.99)	(-8.53)
Leverage	-0.4384	-4.4071
	(-0.29)	(-5.65)
Log(Age)	-2.2359	-1.1561
	(-6.19)	(-5.78)
Size	-2.5526	0.1917
	(-12.83)	(1.89)
Intercept	32.5107	7.9510
	(14.71)	(13.75)
N	55,320	55,405
R^2	0.1444	0.0424

Panel C. Path analysis results for the effects of *MFFlow* on *RD*

	Coefficient	*T*-stat
(1) Direct Effect of *MFFlow* on *RD*		
MFFlow → *RD*	-15.3534	(-5.10)
(2) Indirect Effect of *MFFlow* on RD via Equity Channel		
MFFlow → *EI*	-28.9719	(-8.73)
EI → *RD*	0.1512	(16.47)
Equity Path Effect	-4.3806	
(3) Indirect Effect of *MFFlow* on RD via Debt Channel		
MFFlow → *DI*	-4.4143	(-3.15)
DI → *RD*	0.0242	(3.56)
Debt Path Effect	-0.10683	
(4) Total *MFFlow* Effect on *RD*	-19.8408	
% Direct Path	77.38%	
% Equity Path	22.08%	
% Debt Path	0.54%	

Table IA-5. Path Analysis of the Effects of Misvaluation (*MFF_r*) on R&D

This analysis is based on a sample during 1981-2012. The variables in Panel A are defined in Table 1. In Panel B, *ROA* is operating income before depreciation and R&D expenses scaled by total assets for the prior fiscal year, and *ΔCR* is change in the current ratio (total current assets divided by total current liabilities). All variables are not standardized. All regressions include industry and year fixed effects. *T*-statistics are reported in parentheses. Standard errors are clustered by firm and year. We break the total effect of *MFFlow* on R&D into three parts: the direct catering effect, and the indirect effects through the equity issuance and debt issuance channels.

Panel A. *RD* Regression

	RD
MFF_r	-3.5020
	(-11.49)
EI	0.1302
	(11.44)
DI	0.0185
	(2.73)
GS	0.2331
	(3.47)
CF	0.1235
	(10.39)
Leverage	-5.3987
	(-10.73)
Log(Age)	-0.6293
	(-4.83)
Size	-0.9512
	(-8.58)
Intercept	14.5921
	(17.77)
N	34,626
R^2	0.4360

Panel B. Equity Issuance (*EI*) and Debt Issuance (*DI*) Regressions

	EI	*DI*
MFF_r	-5.4387	-0.3437
	(-6.78)	(-0.89)
GS	1.0296	0.6159
	(9.38)	(7.79)
ROA	-0.1611	0.0669
	(-6.01)	(6.10)
ΔCR	3.3297	-1.6798
	(4.11)	(-7.85)
Leverage	-3.0156	-3.1460
	(-2.49)	(-4.48)
Log(Age)	-1.2193	-1.0151
	(-4.14)	(-6.15)
Size	-1.9367	0.0151
	(-11.78)	(0.18)
Intercept	27.0351	8.2442
	(13.28)	(11.65)
N	53,524	53,598
R^2	0.1232	0.0445

Panel C. Path analysis results for the effects of *MFF_r* on *RD*

	Coefficient	*T*-stat
(1) Direct Effect of *MFF_r* on *RD*		
MFF_r → *RD*	-3.5020	(-11.49)
(2) Indirect Effect of *MFF_r* on RD via Equity Channel		
MFF_r → *EI*	-5.4387	(-6.78)
EI → *RD*	0.1302	(11.44)
Equity Path Effect	-0.7081	
(3) Indirect Effect of *MFF_r* on RD via Debt Channel		
MFF_r → *DI*	-0.3437	(-0.89)
DI → *RD*	0.0185	(2.73)
Debt Path Effect	-0.0064	
(4) Total *MFF_r* Effect on *RD*	-4.2165	
% Direct Path	83.06%	
% Equity Path	16.79%	
% Debt Path	0.15%	

Table IA-6. Regressions of Investments and Innovative Output on Stock Misvaluation: Interaction with Growth or Turnover

The misvaluation measure (*VP* or *MFF_r*) is interacted with share turnover (*Turnover*). *HighTurn* is an indicator variable for the highest *Turnover* quintile. The variables are defined in Table 1. *Novelty, Originality*, and *Scope* are in percentage. All independent variables are standardized to have a mean of zero and standard deviation of one. All regressions include 2-digit SIC industry fixed effects and year fixed effects. *T*-statistics are reported in parentheses. Standard errors are clustered by firm and year. The sample includes U.S. non-financial, non-utility firms listed on NYSE, AMEX and NASDAQ with COMPUSTAT and I/B/E/S coverage during 1976-2012. The patent and citation (*Pat* and *Cites*) data sample period is 1976-2008.

	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
	RD		*Log(1+Pat)*		*Log(1+Cites)*		*Novelty*		*Originality*		*Scope*	
VP	-2.47		-0.08		-0.08		-4.93		-1.89		-1.58	
	(-12.94)		(-4.66)		(-4.99)		(-6.30)		(-5.48)		(-6.08)	
*VP*HighTurn*	0.14		-0.06		-0.06		-3.18		-0.98		-0.80	
	(0.51)		(-2.11)		(-1.96)		(-2.77)		(-2.92)		(-2.27)	
MFF_r		-1.25		-0.06		-0.06		-2.79		-1.07		-1.21
		(-7.44)		(-6.52)		(-6.60)		(-6.39)		(-6.23)		(-7.98)
*MFF_r*HighTurn*		-1.43		-0.25		-0.26		-7.88		-2.53		-4.12
		(-2.73)		(-5.21)		(-5.13)		(-4.45)		(-4.60)		(-4.36)
GS	0.83	1.03	0.03	0.02	0.04	0.03	2.83	2.56	0.50	0.61	0.63	0.60
	(5.00)	(5.90)	(3.70)	(2.35)	(4.66)	(3.08)	(5.22)	(4.72)	(2.96)	(3.90)	(3.83)	(4.28)
CF	2.09	1.01	0.18	0.13	0.19	0.13	7.64	5.26	2.48	1.70	2.57	1.81
	(8.77)	(4.07)	(11.97)	(8.90)	(11.11)	(8.42)	(10.04)	(7.02)	(10.10)	(7.18)	(8.23)	(6.32)
Leverage	-1.36	-0.94	-0.21	-0.17	-0.21	-0.17	-7.61	-6.34	-2.82	-2.45	-2.99	-2.44
	(-10.88)	(-6.89)	(-11.16)	(-11.60)	(-11.17)	(-11.29)	(-11.25)	(-10.37)	(-10.72)	(-10.67)	(-11.03)	(-9.78)
Log(Age)	-0.80	-1.39	0.18	0.16	0.16	0.14	3.63	1.22	2.60	1.71	2.36	1.50
	(-5.23)	(-6.61)	(6.99)	(5.67)	(6.66)	(5.43)	(3.50)	(1.23)	(6.38)	(3.88)	(6.15)	(3.90)
Log(Assets)	-2.70	-3.79	0.72	0.63	0.69	0.59	12.57	11.33	5.37	5.36	4.97	4.50
	(-10.42)	(-13.43)	(18.90)	(18.07)	(17.07)	(15.60)	(12.06)	(12.25)	(14.59)	(16.71)	(11.39)	(10.34)
Turnover	0.65	1.05	0.03	0.03	0.04	0.03	3.54	3.99	0.56	0.84	0.09	-0.00
	(3.48)	(4.14)	(1.06)	(1.06)	(1.50)	(1.22)	(3.89)	(3.84)	(1.58)	(2.35)	(0.44)	(-0.02)
Intercept	6.85	7.59	-0.39	-0.22	-0.52	-0.32	-10.24	-5.14	0.42	1.24	-7.35	-4.93
	(51.43)	(43.23)	(-9.53)	(-5.75)	(-11.93)	(-7.87)	(-7.30)	(-3.46)	(0.80)	(2.32)	(-10.43)	(-6.92)
N	33,945	35,911	46,152	47,986	45,155	46,802	45,155	46,802	46,085	47,917	45,155	46,802
R^2	0.3276	0.2919	0.4131	0.3878	0.3992	0.3726	0.1468	0.1293	0.1974	0.1828	0.2392	0.2277

Table IA-7. Quantile Regressions

We perform quantile regressions of R&D, and innovative output (*Pat* and *Cites*) and inventiveness variables (*Novelty, Originality* and *Scope*) on misvaluation (measured by *VP* as in Panel A, or by *MFF_r* as in Panel B) and control variables with industry and year fixed effects. We choose quantile values of Q to be 0.2, 0.4, 0.6, and 0.8 for *RD*; and quantile values of 0.65, 0.7, 0.75, and 0.8 for innovative output and inventive measures because these variables have a median value of zero. We report only the coefficient on *VP* (Panel A) or *MFF_r* (Panel B). *T*-statistics of the *VP* or *MFF_r* coefficient of the quantile regressions are reported in parentheses, with *p*-values of the *F*-test for the difference in the coefficients between the top or bottom quantiles shown in square brackets.

Panel A. Misvaluation measured by *VP*.

	Q(0.2)	*Q*(0.4)	*Q*(0.6)	*Q*(0.8)	*Q*(0.8)-*Q*(0.2) [*p*-value]
RD	-0.414	-1.105	-1.637	-2.038	-1.624
	(-33.11)	(-43.04)	(-39.66)	(-29.53)	[0.000]

	Q(0.65)	*Q*(0.7)	*Q*(0.75)	*Q*(0.8)	*Q*(0.8)-*Q*(0.65) [*p*-value]
Pat	-0.079	-0.098	-0.121	-0.134	-0.055
	(-10.71)	(-11.68)	(-12.03)	(-12.82)	[0.000]
Cites	-0.039	-0.050	-0.061	-0.069	-0.030
	(-11.85)	(-14.40)	(-14.52)	(-17.65)	[0.000]
Novelty	-2.147	-3.604	-5.805	-7.781	-5.634
	(-9.23)	(-11.96)	(-12.81)	(-12.59)	[0.000]
Originality	-0.427	-1.477	-2.799	-3.760	-3.333
	(-10.00)	(-10.76)	(-11.60)	(-13.36)	[0.000]
Scope	-0.893	-1.936	-2.963	-3.300	-2.407
	(-9.44)	(-15.15)	(-18.57)	(-20.26)	[0.000]

Panel B. Misvaluation measured by *MFF_r*.

	Q(0.2)	*Q*(0.4)	*Q*(0.6)	*Q*(0.8)	*Q*(0.8)-*Q*(0.2) [*p*-value]
RD	-0.065	-0.339	-0.692	-1.119	-1.054
	(-7.00)	(-14.15)	(-18.16)	(-17.47)	[0.000]

	Q(0.65)	*Q*(0.7)	*Q*(0.75)	*Q*(0.8)	*Q*(0.8)-*Q*(0.65) [*p*-value]
Pat	-0.054	-0.063	-0.074	-0.080	-0.025
	(-9.34)	(-8.31)	(-8.75)	(-8.81)	[0.000]
Cites	-0.026	-0.028	-0.034	-0.038	-0.012
	(-9.36)	(-9.73)	(-10.02)	(-11.05)	[0.000]
Novelty	-1.141	-1.649	-2.467	-3.355	-2.214
	(-7.21)	(-6.73)	(-6.72)	(-6.83)	[0.000]
Originality	-0.085	-0.496	-1.225	-1.817	-1.732
	(-6.49)	(-5.76)	(-6.44)	(-7.74)	[0.000]
Scope	-0.511	-1.006	-1.543	-1.827	-1.316
	(-9.28)	(-11.23)	(-11.80)	(-14.10)	[0.000]

Table IA-8. Regressions of Investments and Innovative Output on Stock Misvaluation

MFFlow_I is the industry-adjusted mutual fund flow based misvaluation measure (raw *MFFlow* minus 2-digit-SIC industry mean *MFFlow*). The variables are defined in Table 1. All independent variables are standardized to have a mean of zero and standard deviation of one. *Novelty, Originality*, and *Scope* are in percentage. All regressions include industry and year fixed effects. *T*-statistics are reported in parentheses. Standard errors are clustered by firm and year. The sample includes U.S. non-financial, non-utility firms listed on NYSE, AMEX and NASDAQ with COMPUSTAT and I/B/E/S coverage during 1976-2012. The patent and citation data (*Pat, Cites, Novelty, Originality,* and *Scope*) sample period is 1996-2008.

	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
	RD		*Log(1+Pat)*		*Log(1+Cites)*		*Novelty*		*Originality*		*Scope*	
MFFlow_I	-1.31	-1.24	-0.07	-0.07	-0.03	-0.03	-3.71	-3.43	-1.22	-1.20	-1.34	-1.27
	(-6.85)	(-6.53)	(-5.60)	(-5.51)	(-6.23)	(-6.18)	(-5.92)	(-5.98)	(-4.21)	(-4.35)	(-5.91)	(-5.94)
BP	-0.72		-0.05		-0.02		-2.82		-1.03		-0.54	
	(-3.74)		(-3.37)		(-3.26)		(-3.52)		(-2.84)		(-1.66)	
GS		1.04		0.03		0.02		3.72		0.77		0.76
		(5.51)		(3.39)		(4.43)		(5.81)		(3.89)		(4.20)
CF	1.28	1.87	0.13	0.18	0.06	0.08	6.11	7.63	1.62	2.27	1.87	2.34
	(4.88)	(6.92)	(7.78)	(9.93)	(7.86)	(9.91)	(6.88)	(8.82)	(5.37)	(8.31)	(5.45)	(6.67)
Leverage	-1.62	-1.39	-0.22	-0.21	-0.09	-0.08	-7.85	-7.20	-3.01	-2.78	-2.89	-2.67
	(-11.95)	(-10.39)	(-11.35)	(-10.86)	(-11.87)	(-11.29)	(-10.95)	(-10.07)	(-10.57)	(-9.88)	(-10.36)	(-10.15)
Log(Age)	-1.45	-1.27	0.10	0.15	0.04	0.06	-0.03	1.48	1.57	2.20	1.37	1.92
	(-9.33)	(-6.69)	(4.37)	(4.95)	(3.79)	(4.68)	(-0.03)	(1.29)	(3.83)	(4.53)	(3.47)	(4.43)
Log(Assets)	-3.32	-2.88	0.70	0.72	0.24	0.25	12.33	12.70	5.22	5.28	4.46	4.49
	(-12.06)	(-11.16)	(17.39)	(17.54)	(18.23)	(18.45)	(12.54)	(12.73)	(14.32)	(14.31)	(9.64)	(9.39)
Intercept	7.49	7.28	-0.16	-0.19	-0.08	-0.10	-0.00	0.54	3.06	3.04	-4.64	-5.06
	(47.39)	(49.43)	(-7.01)	(-7.53)	(-9.49)	(-9.12)	(-0.00)	(0.51)	(10.63)	(8.89)	(-8.53)	(-8.27)
N	31,084	27,982	40,692	36,598	39,714	35,701	39,714	35,701	40,633	36,544	39,714	35,701
R^2	0.3131	0.3095	0.3980	0.4112	0.3651	0.3803	0.1355	0.1428	0.1899	0.1954	0.2325	0.2459

Table IA-9. Regressions of Investments and Innovative Output on Stock Misvaluation: R&D-Adjusted *MFFlow*

MFFlow_RD is the R&D-adjusted mutual fund flow measure Specifically, we sort firms into R&D quintiles, with the bottom quintile having zero R&D, and the top quintile being the highest R&D quartile of positive R&D firms. *MFFlow_RD* is the difference between *MFFlow* and the mean *MFFlow* of the firm's R&D quintile. The variables are defined in Table 1. All independent variables are standardized to have a mean of zero and standard deviation of one. *Novelty, Originality*, and *Scope* are in percentage. All regressions include industry and year fixed effects. *T*-statistics are reported in parentheses. Standard errors are clustered by firm and year. The sample includes U.S. non-financial, non-utility firms listed on NYSE, AMEX and NASDAQ with COMPUSTAT and I/B/E/S coverage during 1976-2012. The patent and citation data (*Pat, Cites, Novelty, Originality,* and *Scope*) sample period is 1996-2008.

	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
	RD		*Log(1+Pat)*		*Log(1+Cites)*		*Novelty*		*Originality*		*Scope*	
MFFlow_RD	-0.49	-0.63	-0.05	-0.06	-0.02	-0.03	-1.77	-2.39	-0.43	-0.67	-0.78	-0.98
	(-4.01)	(-5.39)	(-4.49)	(-5.27)	(-5.11)	(-5.91)	(-3.16)	(-4.03)	(-2.45)	(-3.46)	(-4.55)	(-5.17)
BP	-1.78		-0.12		-0.05		-6.91		-2.19		-1.75	
	(-7.32)		(-6.71)		(-6.94)		(-6.65)		(-5.87)		(-4.75)	
GS		1.22		0.04		0.02		3.80		0.90		0.77
		(6.67)		(4.68)		(5.12)		(5.79)		(4.82)		(4.42)
CF	0.22	1.07	0.05	0.10	0.03	0.05	3.25	4.81	0.72	1.43	0.97	1.50
	(0.79)	(4.02)	(3.97)	(6.46)	(4.95)	(7.46)	(3.99)	(5.44)	(2.80)	(5.44)	(3.51)	(4.96)
Leverage	-1.29	-1.00	-0.18	-0.17	-0.07	-0.07	-6.83	-5.88	-2.29	-1.92	-2.56	-2.32
	(-8.30)	(-6.49)	(-9.80)	(-8.85)	(-9.56)	(-8.52)	(-7.26)	(-6.17)	(-7.05)	(-5.98)	(-8.23)	(-7.78)
Log(Age)	-1.73	-1.76	0.15	0.19	0.05	0.06	-1.48	-1.38	1.16	1.35	1.15	1.30
	(-10.44)	(-8.40)	(5.58)	(5.40)	(4.06)	(4.18)	(-1.28)	(-1.08)	(2.50)	(2.48)	(2.56)	(2.62)
Log(Assets)	-3.87	-3.27	0.84	0.86	0.30	0.30	14.73	15.22	6.44	6.57	5.17	5.24
	(-13.36)	(-12.06)	(20.59)	(20.74)	(21.62)	(21.95)	(14.51)	(14.93)	(19.47)	(19.17)	(10.52)	(10.37)
Intercept	8.26	8.10	-0.02	-0.04	-0.04	-0.04	3.76	6.55	5.69	6.32	-4.35	-4.23
	(57.97)	(55.40)	(-0.94)	(-1.29)	(-4.02)	(-3.31)	(3.50)	(4.83)	(12.62)	(11.62)	(-7.38)	(-6.71)
N	39,271	35,493	33,356	30,014	32,276	29,039	32,276	29,039	33,292	29,959	32,276	29,039
R^2	0.2951	0.2737	0.4499	0.4607	0.3938	0.4064	0.1003	0.1016	0.1507	0.1533	0.2345	0.2477

Table IA-10. Regressions of Innovative Input, Output and Inventiveness on Stock Misvaluation: Interaction with High Valuation Indicator (*LowVP*)

The misvaluation measure (*VP*) is interacted with an overvaluation indicator. *LowVP* is an indicator variable for the lowest *VP* quintile. The variables are defined in Table 1. All independent variables are standardized to have a mean of zero and standard deviation of one. *Novelty, Originality*, and *Scope* are in percentage. All regressions include 2-digit SIC industry fixed effects and year fixed effects. *T*-statistics are reported in parentheses. Standard errors are clustered by firm and year. The sample includes U.S. non-financial, non-utility firms listed on NYSE, AMEX and NASDAQ with COMPUSTAT and I/B/E/S coverage during 1976-2012. The patent and citation data (*Pat, Cites, Novelty, Originality,* and *Scope*) sample period is 1976-2008.

	RD	*Log(1+Pat)*	*Log(1+Cites)*	*Novelty*	*Originality*	*Scope*
VP	-0.19	-0.04	-0.02	-3.09	-1.08	-0.93
	(-0.98)	(-1.96)	(-2.86)	(-4.04)	(-3.56)	(-3.70)
*VP*LowVP*	-6.53	-0.19	-0.07	-9.23	-3.33	-2.67
	(-13.45)	(-7.38)	(-6.89)	(-7.00)	(-7.38)	(-5.74)
GS	0.78	0.03	0.02	3.00	0.50	0.58
	(5.36)	(3.86)	(4.81)	(5.46)	(2.90)	(3.61)
CF	2.56	0.19	0.08	8.13	2.59	2.58
	(11.97)	(12.61)	(12.54)	(11.21)	(11.59)	(8.50)
Leverage	-1.23	-0.19	-0.08	-6.81	-2.51	-2.65
	(-11.31)	(-11.66)	(-12.28)	(-11.19)	(-10.78)	(-11.27)
Log(Age)	-0.63	0.20	0.08	3.82	2.77	2.60
	(-4.28)	(7.30)	(7.17)	(3.66)	(6.96)	(6.64)
Log(Assets)	-1.92	0.70	0.25	13.39	5.45	4.94
	(-9.74)	(19.98)	(21.15)	(14.77)	(16.80)	(11.70)
Intercept	5.42	-0.22	-0.12	-3.46	2.05	-6.37
	(30.98)	(-10.25)	(-14.29)	(-3.94)	(6.61)	(-12.51)
N	34,658	47,295	46,296	46,296	47,228	46,296
R^2	0.3690	0.4127	0.3819	0.1454	0.1987	0.2384

Table IA-11. Regressions of Innovative Input, Output and Inventiveness on Stock Misvaluation: Interaction with Low *MFF_r* Indicator

The misvaluation measure (*MFF_r*) is interacted with an overvaluation indicator. *LowMFF_r* is an indicator variable for the lowest *MFF_r* quintile. The variables are defined in Table 1. All independent variables are standardized to have a mean of zero and standard deviation of one. *Novelty, Originality*, and *Scope* are in percentage. All regressions include 2-digit SIC industry fixed effects and year fixed effects. *T*-statistics are reported in parentheses. Standard errors are clustered by firm and year. The sample includes U.S. non-financial, non-utility firms listed on NYSE, AMEX and NASDAQ with COMPUSTAT and CDA/Spectrum mutual fund flows data during 1981-2012. The patent and citation data (*Pat, Cites, Novelty, Originality,* and *Scope*) sample period is 1976-2008.

	RD	*Log(1+Pat)*	*Log(1+Cites)*	*Novelty*	*Originality*	*Scope*
MFF_r	-1.20	-0.05	-0.03	-2.97	-1.22	-1.13
	(-8.85)	(-4.24)	(-5.69)	(-6.19)	(-6.19)	(-7.60)
*MFF_r*LowMFF_r*	0.89	-0.06	-0.00	2.96	1.34	0.74
	(1.58)	(-1.48)	(-0.30)	(2.54)	(3.08)	(1.60)
GS	1.20	0.03	0.02	3.25	0.77	0.72
	(6.63)	(3.96)	(4.79)	(5.60)	(4.87)	(4.95)
CF	1.07	0.13	0.06	5.53	1.76	1.84
	(4.09)	(8.86)	(9.29)	(7.14)	(7.25)	(6.22)
Leverage	-0.98	-0.17	-0.07	-6.59	-2.51	-2.49
	(-6.49)	(-11.74)	(-11.88)	(-10.12)	(-10.37)	(-9.80)
Log(Age)	-1.71	0.14	0.05	0.28	1.50	1.37
	(-8.46)	(5.05)	(4.29)	(0.29)	(3.43)	(3.48)
Log(Assets)	-3.27	0.65	0.24	12.98	5.72	4.69
	(-12.43)	(18.63)	(19.40)	(15.31)	(19.52)	(10.16)
Intercept	8.17	-0.18	-0.09	-0.29	2.37	-4.62
	(50.80)	(-8.26)	(-9.52)	(-0.31)	(7.51)	(-8.02)
N	35,911	47,986	46,802	46,802	47,917	46,802
R^2	0.2782	0.3840	0.3536	0.1241	0.1801	0.2245

Table IA-12. The Evolution of MFFlow Over a Five-Year Period for Top and Bottom *MFFlow* Quintiles

This table reports the mean value of *MFFlow* or lagged *MFFlow* (each lag is 1-year long) for the current-year top and bottom quintiles of *MFFlow*. The sample mean *MFFlow* is 3.52% (as reported in Table 1).

No. of Lags of *MFFlow*	0 (Current Year)	1	2	3	4	5
			Top *MFFlow* Quintile			
Mean *MFFlow* (%)	10.95	7.60	6.61	6.14	5.58	5.36
N	12,692	10,993	9,845	8,906	7,997	7,267
			Bottom *MFFlow* Quintile			
Mean *MFFlow* (%)	0.26	1.39	1.89	2.15	2.36	2.60
N	12,683	9,500	8,069	7,033	6,011	5,081

Table IA-13. Path Analysis of the Effects of Misvaluation on R&D: High Valuation (Low-*MFFlow*) Years

High valuation years are years in which the aggregate *MFFlow* is below median. The variables in Panel A are defined in Table 1. In Panel B, *ROA* is income before depreciation and R&D expenses scaled by total assets for the prior fiscal year, and *ΔCR* is change in the current ratio (total current assets divided by total current liabilities). All variables are not standardized. All regressions operating include industry and year fixed effects. *T*-statistics are reported in parentheses. Standard errors are clustered by firm and year. We break the total effect of *MFFlow* on R&D into three parts: the direct catering effect, and the indirect effects through the equity issuance and debt issuance channels.

Panel A. *RD* Regression

	RD
MFFlow	-37.4851
	(-9.04)
EI	0.1585
	(15.96)
DI	0.0262
	(2.75)
GS	0.2446
	(2.88)
CF	0.1189
	(7.94)
Leverage	-4.5273
	(-7.06)
Log(Age)	-1.3253
	(-6.55)
Size	-1.2009
	(-11.55)
Intercept	14.0421
	(16.01)
N	18,604
R^2	0.4403

Panel B. Equity Issuance (*EI*) and Debt Issuance (*DI*) Regressions

	EI	*DI*
MFFlow	-67.9207	-8.4301
	(-10.09)	(-2.15)
GS	0.7987	0.6301
	(7.85)	(4.77)
ROA	-0.3198	0.0601
	(-7.96)	(4.88)
ΔCR	2.7009	-1.8991
	(5.74)	(-10.68)
Leverage	0.9307	-3.1727
	(0.84)	(-3.40)
Log(Age)	-1.5571	-1.2526
	(-4.68)	(-4.05)
Size	-2.7523	0.1420
	(-10.71)	(0.88)
Intercept	34.3344	9.6497
	(11.69)	(11.07)
N	28,322	28,362
R^2	0.1322	0.0434

Panel C. Path analysis results for the effects of *MFFlow* on *RD*

	Coefficient	*T*-stat
(1) Direct Effect of *MFFlow* on *RD*		
MFFlow → *RD*	-37.4851	(-9.04)
(2) Indirect Effect of *MFFlow* on RD via Equity Channel		
MFFlow → *EI*	-67.9207	(-10.09)
EI → *RD*	0.1585	(15.96)
Equity Path Effect	-10.7654	
(2) Indirect Effect of *MFFlow* on RD via Debt Channel		
MFFlow → *DI*	-8.4301	(-2.15)
DI → *RD*	0.0262	(2.75)
Debt Path Effect	-0.22087	
(3) Total *MFFlow* Effect on *RD*	-48.4714	
% Direct Path	77.33%	
% Equity Path	22.21%	
% Debt Path	0.46%	

Table IA-14. Path Analysis of the Effects of Misvaluation on R&D: Low Valuation (High-*MFFlow*) Years

Low valuation years are years in which the aggregate *MFFlow* is above median. The variables in Panel A are defined in Table 1. In Panel B, *ROA* is income before depreciation and R&D expenses scaled by total assets for the prior fiscal year, and *ΔCR* is change in the current ratio (total current assets divided by total current liabilities). All variables are not standardized. All regressions operating include industry and year fixed effects. *T*-statistics are reported in parentheses. Standard errors are clustered by firm and year. We break the total effect of *MFFlow* on R&D into three parts: the direct catering effect, and the indirect effects through the equity issuance and debt issuance channels.

Panel A. *RD* Regression

	RD
MFFlow	-14.9968
	(-6.28)
EI	0.1439
	(12.18)
DI	0.0216
	(2.18)
GS	0.3467
	(4.53)
CF	0.0999
	(6.99)
Leverage	-3.8498
	(-7.11)
Log(Age)	-1.0365
	(-6.43)
Size	-1.2163
	(-7.74)
Intercept	16.0622
	(16.77)
N	17,272
R^2	0.4612

Panel B. Equity Issuance (*EI*) and Debt Issuance (*DI*) Regressions

	EI	*DI*
MFFlow	-40.9575	-8.7515
	(-7.87)	(-5.30)
GS	1.3192	0.5248
	(6.82)	(6.85)
ROA	-0.3201	0.0352
	(-6.16)	(3.66)
ΔCR	4.9278	-1.3616
	(3.92)	(-4.85)
Leverage	-1.7706	-5.6692
	(-0.71)	(-5.30)
Log(Age)	-2.5355	-0.9967
	(-5.09)	(-5.01)
Size	-2.6443	0.1836
	(-9.55)	(1.54)
Intercept	35.2025	8.2708
	(9.80)	(11.14)
N	26,998	27,043
R^2	0.1702	0.0429

Panel C. Path analysis results for the effects of *MFFlow* on *RD*

	Coefficient	*T*-stat
(1) Direct Effect of *MFFlow* on *RD*		
MFFlow → *RD*	-14.9968	(-6.28)
(2) Indirect Effect of *MFFlow* on RD via Equity Channel		
MFFlow → *EI*	-40.9575	(-7.87)
EI → *RD*	0.1439	(12.18)
Equity Path Effect	-5.8938	
(2) Indirect Effect of *MFFlow* on RD via Debt Channel		
MFFlow → *DI*	-8.7515	(-5.30)
DI → *RD*	0.0216	(2.18)
Debt Path Effect	-0.18903	
(3) Total *MFFlow* Effect on *RD*	-21.0796	
% Direct Path	71.14%	
% Equity Path	27.96%	
% Debt Path	0.90%	

Table IA-15. Path Analysis of the Effects of Misvaluation on R&D: High Turnover Firms

High turnover firms are firms in the highest turnover quintile. The variables in Panel A are defined in Table 1. In Panel B, *ROA* is income before depreciation and R&D expenses scaled by total assets for the prior fiscal year, and *ΔCR* is change in the current ratio (total current assets divided by total current liabilities). All variables are not standardized. All regressions operating include industry and year fixed effects. *T*-statistics are reported in parentheses. Standard errors are clustered by firm and year. We break the total effect of *MFFlow* on R&D into three parts: the direct catering effect, and the indirect effects through the equity issuance and debt issuance channels.

Panel A. *RD* Regression

	RD
MFFlow	-36.4972
	(-4.47)
EI	0.1273
	(13.54)
DI	0.0295
	(2.28)
GS	0.1392
	(1.46)
CF	0.0983
	(6.78)
Leverage	-3.7961
	(-4.20)
Log(Age)	-0.6717
	(-2.43)
Size	-1.3361
	(-5.93)
Intercept	16.1902
	(11.59)
N	9,041
R^2	0.4723

Panel B. Equity Issuance (*EI*) and Debt Issuance (*DI*) Regressions

	EI	*DI*
MFFlow	-99.9084	-6.9753
	(-5.59)	(-0.74)
GS	0.6984	0.6771
	(4.49)	(3.47)
ROA	-0.3571	0.0175
	(-7.07)	(0.77)
ΔCR	5.0419	-0.7221
	(3.39)	(-2.11)
Leverage	-1.4215	-3.4616
	(-0.98)	(-2.45)
Log(Age)	-1.1582	-1.0606
	(-2.30)	(-2.55)
Size	-5.1579	-0.0031
	(-8.38)	(-0.01)
Intercept	55.2219	11.5630
	(9.67)	(9.17)
N	12,927	12,960
R^2	0.2029	0.0376

Panel C. Path analysis results for the effects of *MFFlow* on *RD*

	Coefficient	*T*-stat
(1) Direct Effect of *MFFlow* on *RD*		
MFFlow → *RD*	-36.4972	(-4.47)
(2) Indirect Effect of *MFFlow* on RD via Equity Channel		
MFFlow → *EI*	-99.9084	(-5.59)
EI → *RD*	0.1273	(13.54)
Equity Path Effect	-12.7183	
(2) Indirect Effect of *MFFlow* on RD via Debt Channel		
MFFlow → *DI*	-6.9753	(-0.74)
DI → *RD*	0.0295	(2.28)
Debt Path Effect	-0.20577	
(3) Total *MFFlow* Effect on *RD*	-49.4213	
% Direct Path	73.85%	
% Equity Path	25.73%	
% Debt Path	0.42%	

Table IA-16. Path Analysis of the Effects of Misvaluation on R&D: Low Turnover Firms

Low turnover firms are firms in the lowest turnover quintile. The variables in Panel A are defined in Table 1. In Panel B, *ROA* is income before depreciation and R&D expenses scaled by total assets for the prior fiscal year, and *ΔCR* is change in the current ratio (total current assets divided by total current liabilities). All variables are not standardized. All regressions operating include industry and year fixed effects. *T*-statistics are reported in parentheses. Standard errors are clustered by firm and year. We break the total effect of *MFFlow* on R&D into three parts: the direct catering effect, and the indirect effects through the equity issuance and debt issuance channels.

Panel A. *RD* Regression

	RD
MFFlow	-4.9980
	(-2.59)
EI	0.1688
	(6.97)
DI	0.0352
	(1.75)
GS	0.3531
	(2.72)
CF	0.1120
	(4.69)
Leverage	-5.2145
	(-7.19)
Log(Age)	-1.8096
	(-5.75)
Size	-1.6820
	(-8.29)
Intercept	18.1928
	(12.02)
N	4,505
R^2	0.4137

Panel B. Equity Issuance (*EI*) and Debt Issuance (*DI*) Regressions

	EI	*DI*
MFFlow	-9.3129	-3.5698
	(-3.63)	(-1.65)
GS	0.7558	0.5061
	(2.77)	(2.80)
ROA	-0.3154	0.0287
	(-5.74)	(1.23)
ΔCR	1.7689	-2.1210
	(4.02)	(-9.78)
Leverage	3.0968	-3.0514
	(2.09)	(-2.52)
Log(Age)	-1.2663	-1.3952
	(-3.73)	(-4.10)
Size	-2.5058	-0.4086
	(-5.72)	(-1.64)
Intercept	23.7588	11.1757
	(8.62)	(8.50)
N	7,872	7,872
R^2	0.1105	0.0512

Panel C. Path analysis results for the effects of *MFFlow* on *RD*

	Coefficient	*T*-stat
(1) Direct Effect of *MFFlow* on *RD*		
MFFlow → *RD*	-4.9980	(-2.59)
(2) Indirect Effect of *MFFlow* on RD via Equity Channel		
MFFlow → *EI*	-9.3129	(-3.63)
EI → *RD*	0.1688	(6.97)
Equity Path Effect	-1.5720	
(2) Indirect Effect of *MFFlow* on RD via Debt Channel		
MFFlow → *DI*	-3.5698	(-1.65)
DI → *RD*	0.0352	(1.75)
Debt Path Effect	-0.12566	
(3) Total *MFFlow* Effect on *RD*	-6.6957	
% Direct Path	74.65%	
% Equity Path	23.48%	
% Debt Path	1.88%	

Appendix IA-B. Calculation of Residual Income Value-to-Price (*VP*)

Our estimation procedure for *VP* is similar to that of Lee, Myers, and Swaminathan (1999). For each stock in month *t*, we estimate the residual income model (RIM) price, denoted by $V(t)$. *VP* is the ratio of $V(t)$ to the stock price at the end of month *t*. With the assumption of 'clean surplus' accounting, which states that the change in book value of equity equals earnings minus dividends, the intrinsic value of firm stock can be written as the book value plus the discounted value of an infinite sum of expected residual incomes (see Ohlson (1995)),

$$V(t) = B(t) + \sum_{t=1}^{\infty} \frac{E_t[\{ROE(t+i) - r_e\,(t+i-1)\}B(t+i-1)]}{[1+\ r_e(t)]^i},$$

where Et is the expectations operator, $B(t)$ is the book value of equity at time *t* (negative $B(t)$ observations are deleted), $ROE(t+i)$ is the return on equity for period $t+i$, and $re(t)$ is the firm's annualized cost of equity capital.

For practical purposes, the above infinite sum needs to be replaced by a finite series of $T-1$ periods, plus an estimate of the terminal value beyond period *T*. This terminal value is estimated by viewing the period *T* residual income as a perpetuity. Lee, Myers, and Swaminathan (1999) report that the quality of their $V(t)$ estimates was not sensitive to the choice of the forecast horizon beyond three years. Of course, residual income $V(t)$ cannot perfectly capture growth, so our misvaluation proxy *VP* does not perfectly filter out growth effects. However, since *V* reflects forward-looking earnings forecasts, a large portion of the growth effects contained in *BP* should be filtered out of *VP*.

We use a three-period forecast horizon:

$$V(t) = \frac{[f^{ROE}\,(t+1) - r_e(t)]B(t)}{1+\,r_e(t)} + \frac{[f^{ROE}\,(t+2) - r_e(t)]B(t+1)}{[1+\,r_e(t)]^2} + \frac{[f^{ROE}\,(t+3) - r_e(t)]B(t+2)}{[1+\,r_e(t)]^2 r_e(t)},$$

where $f^{ROE}(t+i)$ is the forecasted return on equity for period $t+i$, the length of a period is one year, and where the last term discounts the period $t+3$ residual income as a perpetuity.[1]

Forecasted ROE's are computed as

$$f^{ROE}\,(t+i) = \frac{f^{EPS}\,(t+i)}{\bar{B}(t+i-1)},$$

where $\bar{B}(t+i-1)$ is defined as the average of $B(t+i-1)$ and $B(t+i-2)$, and where $f^{EPS}(t+i)$ is the forecasted EPS for period $t+i$. If the EPS forecast for any horizon is not available, it is substituted by the EPS forecast for the previous horizon and compounded at the long-term growth rate (as provided by I/B/E/S). If the long-term growth rate is not available from I/B/E/S, the EPS forecast for the first preceding available horizon is used as a surrogate for $f^{EPS}(t+i)$. We require that each of these f^{ROE}'s be less than 1.

Future book values of equity are computed as

$$B(t+i) = B(t+i-1) + (1-k)f^{EPS}(t+i),$$

[1] In unreported robustness tests we estimate *V* using a 5-year rather than 3-year forecast period. Many firms have missing EPS forecasts beyond forecast year 3; to preserve sample size, when the 4-year and 5-year EPS forecasts are missing, we use the 3-year EPS forecast multiplied by the long-run growth forecast rate as a proxy. Our results are highly robust, with only slightly reduced magnitude of the effects.

where k is the dividend payout ratio determined by

$$k = \frac{D(t)}{EPS(t)},$$

and *D*(*t*) and *EPS*(*t*) are respectively the dividend and EPS for period t. Following Lee, Myers, and Swaminathan (1999), if $k < 0$ (owing to negative EPS), we divide dividends by (0.06 × total assets) to derive an estimate of the payout ratio, i.e., we assume that earnings are on average 6% of total assets. Observations in which the computed k is greater than 1 are deleted from the study.

The annualized cost of equity, *re*(*t*), is determined as a firm-specific rate using the CAPM, where the time-*t* beta is estimated using the trailing five years (or, if there is not enough data, at least two years) of monthly return data. The market risk premium assumed in the CAPM is the average annual premium over the risk-free rate for the CRSP value-weighted index over the preceding 30 years. Any estimate of the CAPM cost of capital that is outside the range of 5%-20% is winsorized to lie at the border of the range. The literature shows that the inferences from *V* estimates are not sensitive to the choice of forecast horizon (such as three years) and cost of capital models (Lee, Myers, and Swaminathan 1999), and to whether the discount rate is allowed to vary across firms (D'Mello and Shroff 2000).

There is strong support for *VP* as an indicator of mispricing. It is a stronger return predictor than *BP* (Lee, Myers, and Swaminathan 1999, Frankel and Lee 1998, Ali, Hwang, and Trombley 2003).

The benchmark for fair valuation for *BP* and *VP* is not equal to 1. Book is an historical value that does not reflect growth, and residual income model valuations have been found to be too low on average. We retain negative *V* values caused by low earnings forecasts relative to the cost of equity capital, because such cases should also be informative about overvaluation; negative and low values of *VP* indicate overvaluation and large values of *VP* indicate undervaluation. Similarly, to avoid problems with low or zero book value, and for consistency, we also use a *BP* variable rather than *P/B*. Removing negative *VP* observations (about 6% of the sample) tends to reduce statistical significance levels in our tests without materially altering the results.