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Growth Options and Related Stock Market Anomalies: Profitability, Distress, Lotteryness, and Volatility

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Abstract

We provide new evidence about the economic role of growth options behind the profitability, distress, lotteryness, and volatility anomalies. We use idiosyncratic skewness to measure growth options and estimate expected idiosyncratic skewness capturing investors' expectation about the firm's mix of growth options versus assets-in-place. We find that investors require a positive premium to hold stocks of inflexible firms with low growth options and negative expected skewness, and that a newly proposed skewness factor based on growth options explains the aforementioned anomalies. Thus, the new measure of expected idiosyncratic skewness may serve to reduce the number of anomalies in the literature.

I Introduction

Several stock market anomalies seem to be related to growth options. For example, firms with high profitability tend to have a higher portion of the firm's resources committed as cash-generating assets-in-place involving higher operating leverage and adjustment costs (e.g., Novy-Marx (2011), (2013)) and less in future growth options. Idiosyncratic volatility is a key driver of growth options (Cao, Simin, and Zhao (2008)) and of real options in general, and volatility changes can cause shifts in the firm's mix between growth options and assets-in-place. Lotteryness may also be seen to involve a more extreme form of out-of-the money growth options. Distress has also been attributed to lottery behavior (Conrad, Kapadia, and Xing (2014)) as many small, lottery-type stocks involve firms that may simultaneously be high-growth and distressed.

Contrary to commonly held belief, recent literature suggests that growth options and flexibility reflected in real options are generally less risky or reduce risk exposure (e.g., see Zhang (2005) or Ai and Kiku (2013)), and hence they may create the appearance of anomalous returns. A basic characteristic of growth options, and real options in general, is the discretionary nature of their exercise which results in asymmetric payoff outcomes, thus potentially influencing stock returns via the channel of idiosyncratic skewness (an analogous but distinct channel from that of idiosyncratic volatility). It is well known that option payoffs are convex transformations of the value of the underlying asset. Van Zwet (1964) shows that convex transformations increase the skewness of the distribution. This motivates us to use idiosyncratic skewness as a novel measure of growth options. To capture the asymmetric effects arising from the presence (or absence) of growth options and firm (in)flexibility or rigidity with the aim of identifying this causal mechanism, it is imperative to isolate expected idiosyncratic skewness that is specifically attributed to growth options rather than other variables that may be associated with these anomalies. As we discuss later, growth-options-driven expected idiosyncratic skewness is a powerful variable that measures the extent of growth option intensity and thus reflects investors' expectation about the firm's effectiveness in managing its mix of future growth options vs. committed assets-in-place (e.g., Berk, Green, and Naik (1999)).

The paper thereby investigates whether there is a link between the cross-sectional relations found among profitability, distress risk, lotteryness, and idiosyncratic volatility, representing a set of unresolved "puzzles" in the empirical asset pricing literature, and investors' expectation of idiosyncratic skewness arising from growth options or firm inflexibility (due to the absence of growth options). It thus represents the first empirical study to use idiosyncratic skewness as a measure of growth options and explore the inter-linkages among various stock market "anomalies" related to growth options, attributing this linkage to expected idiosyncratic skewness arising from growth options or firm inflexibility. We show that growth options, by increasing idiosyncratic skewness and reducing risk exposure, lay behind the profitability, distress, lotteryness, and volatility anomalies. There is an extensive literature on these anomalies studied as separate phenomena: the profitability anomaly (e.g., Haugen and Baker (1996), Fama and French (2006, 2015), Novy-Marx (2013), Hou, Xue, and Zhang (2015)), the distress risk puzzle (Dichev (1998), Campbell, Hilscher, and Szilagyi (2008)), demand for lottery-type stocks

(Kumar (2009), Bali, Cakici, and Whitelaw (2011)), and the idiosyncratic volatility effect (Ang, Hodrick, Xing, and Zhang (2006)). There are also separate literatures on growth options (Cao et al. (2008)), and on the skewness effect (Harvey and Siddique (2000), Boyer, Mitton, and Vorkink (2010)). Other related works include Gomes, Kogan, and Zhang (2003), Zhang (2005), and Cooper (2006). Yet no previous study has linked the above anomalous phenomena to growth options, the implications of their asymmetric nature on stock returns, and the economics of the relationship between growth options and risk exposure driving negative risk premia.

We posit that profitability, distress, lotteryness, and idiosyncratic volatility involve real options that impact the idiosyncratic skewness and volatility of the distribution of the firm's equity returns. If investors prefer stocks with embedded real options and dislike riskiness arising from firm inflexibility leading to more losses during bad states of the economy or during periods of high market volatility, then low or negative idiosyncratic skewness characterizing inflexible firms without such options may induce investors to require higher expected returns compared to flexible firms with real options that help reduce risk exposure.

We subsequently demonstrate that our newly proposed measure of growth options reflecting the mix of the firm's growth options vs. assets-in-place via the expectation of idiosyncratic skewness arising from growth options (or the lack of them) is priced in stock returns and can explain the aforementioned stock market anomalies. Our novel measure of growth options using idiosyncratic skewness plays a central role in investors' valuation as it captures investors' expectation of the mix of assets-in-place vs. growth options and hence the relative presence (or absence) of future growth options and how these induce return asymmetry in volatile environments. Standard measures such as profitability, investment, or asset growth merely reflect past or exercised growth opportunities indicating higher resource commitment. Low idiosyncratic skewness associated with growth indicates firm rigidity or operating inflexibility and hence higher risk exposure to bad economic states and market volatility. Low or negative idiosyncratic skewness is indicative of a greater proportion of assets-in-place (vs. growth options) which involve heavier capital commitment, higher fixed costs and costs of adjustment in down-scaling, and hence higher operating leverage and greater risk exposure to economic shocks since the return of these stocks will covary more with economic downturns. Our argument based on growth-options-induced idiosyncratic skewness (ISKEW) complements related arguments on operating inflexibility or operating leverage found in Anderson, Banker, and Janakiraman (2003), Zhang (2005), and Novy-Marx (2011). Zhang (2005) examines the cyclical properties of the expected value premium in an investment-based asset pricing framework. He shows that due to costly reversibility (that makes it costlier for firms to scale down or abandon than to expand productive capital) and the countercyclical price of risk, value firms are less flexible than growth firms in scaling down. The cash flows of value firms are consequently more adversely affected by worsening economic conditions than those of growth firms. The countercyclical price of risk worsens this effect. Thus, value firms (invested heavily in assets-in-place) are riskier than firms with growth options in bad economic times when the price of risk is high.

Our argument also complements Ai and Kiku (2013) who explicate the macroeconomic hedging benefits of growth options to justify why growth options are less risky than assets-in-place and hence carry a low risk premium relative to value stocks. Viewing the firm as a portfolio of assets-in-place and growth options (effectively seen as options on the assets), they highlight that the endogenously determined cost of growth option exercise (measured by the marginal cost of capital goods) is time-varying and procyclical: it is lower in bad economic states and higher in good states when demand for capital goods and costs rise, and thereby acts as a hedge against macroeconomic risk to assets-in-place. Firms with growth options expedite their exercise in good economic states (also when volatility is low), collectively driving up the cost of capital goods. The cost of exercising a growth option is lower in bad economic states when macroeconomic conditions are unfavorable (the higher uncertainty in bad states favors waiting). The procyclical dynamics of the equilibrium price of capital goods thus partially offsets the cyclical fluctuations in assets-in-place, which follow the state of the economy. An analogous effect runs through volatility: in bad economic states, volatility is higher justifying growth option delay, with the reverse occurring in good states. The above makes growth options less vulnerable to aggregate risks than assets-in-place. As a result, growth options are less risky and investors demand lower returns.

Motivated by the above discussion on the central role of growth options as a potential driver of asymmetric or skewed returns in relation to the above anomalies and the economics of the negative relation between growth options (and hence the idiosyncratic skewness associated with them) and risk exposure, we estimate expected idiosyncratic skewness related to the existence or absence of growth options (GO), henceforth denoted by $\text{E[ISKEW]}_{\text{GO}}$. We confirm that low or negative expected idiosyncratic skewness (from absence of growth options and prevalence of committed assets-in-place) represents higher risk exposure as stocks with negative $\text{E[ISKEW]}_{\text{GO}}$ have significantly positive alpha. Our results are driven by outperformance of stocks with negative $\text{E[ISKEW]}_{\text{GO}}$, which are riskier. Further, stocks with low idiosyncratic skewness have a negative volatility exposure (β^{VXO}), consistent with the intertemporal capital asset pricing model (ICAPM) of Merton (1973), Campbell (1993), and Bali and Engle (2010). As market volatility (VXO) increases in bad states of the economy, the return on stocks with a negative exposure to changes in VXO declines, so investors demand higher expected return to hold stocks with negative β^{VXO} and negative $\text{E[ISKEW]}_{\text{GO}}$. This is further supported by our finding that the negative skewness premium is higher during bad states of the economy or periods characterized by high market volatility.

Although the literature on the above anomalies is rich and extensive in its own right, the inter-linkage between idiosyncratic skewness linked to growth options and their asymmetric impact on returns via idiosyncratic skewness, and the profitability, distress, lotteryness, and idiosyncratic volatility phenomena remains essentially unexplored. We find that the positive cross-sectional relation between profitability and subsequent returns and the negative relations between distress risk, lotteryness, and idiosyncratic volatility with future stock returns documented in prior studies are linked to the skewed return distribution of firms having or lacking growth options, particularly when operating in more volatile environments. A novel skewness risk factor based on differentials in expected idiosyncratic skewness driven by the presence or absence of future growth options and firm inflexibility lies behind the above anomalies. It is noteworthy that the proposed skewness factor explains the profitability factors of Fama and French (2015) and Hou et al. (2015), but not vice versa. We emphasize that it is growth options (or their absence) via the channel of expected idiosyncratic skewness that lie behind these anomalies. Other key variables related to profitability, distress, lotteryness, and idiosyncratic volatility do not show the same effectiveness in explaining the mentioned anomalies via the channel of expected idiosyncratic skewness. Our study differs from previous work in using the channel of expected idiosyncratic skewness rather than idiosyncratic volatility or investigating these variables directly. We show that firms' exposure to the idiosyncratic skewness factor related to future growth options helps explain and contributes to our understanding of these anomalies, beyond other known factors. None of these other factor models explains the return spread on the proposed skewness factor.

Uncovering the economics of the relationship between growth options, their impact on idiosyncratic skewness and risk exposure is fundamental in acquiring a deeper understanding of anomalous returns behind various market anomalies. The measure of expected idiosyncratic skewness that we introduce is intuitive and may serve to reduce the number of anomalies in the literature.

The paper is organized as follows: Section II discusses the concept of idiosyncratic skewness arising from growth options and provides a literature review discussing why these anomalies are related to growth options. Section III describes our variables. Section IV discusses our empirical results presenting evidence on how these various anomalies can be explained by the idiosyncratic skewness factor from growth options and provides various robustness checks. Section V concludes.

II Growth Options and Idiosyncratic Skewness

A unique defining characteristic of growth options and real options in general (besides being more valuable in more volatile environments) is their discretionary asymmetric nature: they are rights but not obligations whose exercise provides valuable firm flexibility leading to equity value convexity and stock return asymmetry. It is thus important to consider growth options and real options generally as drivers of idiosyncratic skewness, besides being driven by idiosyncratic volatility, and recognize their indirect impact on stock returns via the separate channel of idiosyncratic skewness.

Consider an actively managed firm dynamically managing a portfolio of committed cash-generating assets-in-place (with current discounted firm asset value V) and a set of expansion or growth options (calls) and, possibly, down-scale options (puts). This active firm is contrasted with a passive firm without such real options that is fully committed to cash-generating assets-in-place. The passive, inflexible firm is symmetrically exposed to market expansion or contraction, producing cost efficiently in good times but suffering more losses due to higher fixed costs and costs of down-scale adjustment in bad economic times. The active, flexible firm has a call option to either expand, enjoying economies of scale when demand or profits grow and firm asset value exceeds an upper threshold, or contract, reducing fixed operating costs when firm asset value drops below a low threshold, its scale. The growth option preserves and enhances upside value potential, while the protective down-scale put option reduces downside risk in bad economic states. It is known that option payoffs are convex transformations of the value of the underlying asset, which is also apparent from the payoff functions of call and put options. A general theorem of Van Zwet (1964) implies that convex transformations increase the skewness of the distribution. This motivates the paper to use idiosyncratic skewness to measure the asymmetric effect of growth options.

Other measures of growth options used in prior studies include book-to-market value of equity (BM), book value of assets to market value of assets (e.g., Berk et al. (1999), Carlson, Fisher, and Giammarino (2004), Cao et al. (2008)), Tobin's Q, and the ratio of market value of assets to their replacement cost (e.g., Erickson and Whited (2000)). These measures rely on market values but do not necessarily reflect the asymmetric nature of growth options as they are contaminated by potential market mispricing. They may also reflect other aspects, such as distress. Tobin's Q in particular has been used to proxy for other firm characteristics in many different contexts. Our expected idiosyncratic skewness from growth measure better reflects the asymmetric or convex payoff structure of growth options and filters out potential mispricing bias via equation (4).[1]

As discussed previously, the better ability of a flexible firm to take advantage of growth opportunities in good times and down-scale or otherwise reposition itself to avoid high fixed costs or high adjustment costs in bad economic times naturally leads to lower

[1] Asset growth, measured as percent change in total assets (e.g., Cooper, Gulen, and Schill (2008), Chen, Novy-Marx, and Zhang (2011)) and expected 1-year ahead change in investment-to-assets (Hou, Mo, Xue, and Zhang (2018)) are credible alternative measures but mostly reflect the exercise of growth options, rather than the creation of new, yet-unexercised future growth options.

risk exposure (see also the related arguments of Zhang (2005) and Ai and Kiku (2013)). By contrast, the higher rigidity, operating inflexibility or operating leverage of the passive firm (without growth or real options) will lead to higher losses in bad economic times (and potentially higher opportunity cost in good times), leading to higher risk exposure.

As noted, growth options are directly or indirectly related to each of the above 4 anomalies and due to their asymmetric nature they also affect returns via the channel of idiosyncratic skewness (besides that of idiosyncratic volatility, or directly). It is already well documented in the literature that growth options (Anderson and Garcia-Feijóo (2006), Cao et al. (2008)) and return skewness (e.g., Harvey and Siddique (2000), Boyer et al. (2010)) besides idiosyncratic volatility (Ang et al. (2006), Bali and Cakici (2008)) help predict the cross-sectional variation in stock returns. It is further known that profitability (Fama and French (2006, 2015), Novy-Marx (2013), Hou et al. (2015)), lottery features (Kumar (2009), Kumar, Page, and Spalt (2011), Bali et al. (2011), Bali, Brown, Murray, and Tang (2017)), and distress risk (e.g., Dichev (1998), Campbell et al. (2008), Chava and Purnanandam (2010), Garlappi and Yan (2011)) may also help explain part of the cross section of equity returns. The lottery feature, whereby retail (individual) investors exhibiting lottery demand are willing to accept lower returns in exchange for a small chance to receive a big payoff, has also been identified to be behind the distress anomaly (Conrad et al. (2014)). Most of the aforementioned studies, except for profitability, document a negative relation between stock returns and growth options, skewness and idiosyncratic volatility, lotteryness and distress risk (each separately).

Prior studies mostly focus on explaining these anomalous relations as stand-alone, unrelated phenomena. Regarding the negative growth-returns relation, Anderson and Garcia-Feijóo (2006) suggest that the return predictability associated with growth options is also responsible for the explanatory power of the size and book-to-market factors in cross-sectional stock returns (Fama and French (1992, 1993)). Grullon, Lyandres, and Alexei (2012) find a stronger volatility-return relation for growth firms and that the sensitivity of firm value to changes in volatility declines after firms exercise their growth options. Trigeorgis and Lambertides (2014) show that growth options are priced in the cross-section and help explain stock returns, while Del Viva, Kasanen, and Trigeorgis (2017) show a link between real options, idiosyncratic skewness and diversification.

A related puzzle is the positive risk-adjusted return of high-profitability firms documented by Haugen and Baker (1996), Novy-Marx (2013), Fama and French (2006, 2015), Hou et al. (2015), and Ball, Gerakos, Linnainmaa, and Nikolaev (2016).

The profitability anomaly gained more prominence recently as several influential authors (Fama and French (2015), Hou et al. (2015)) have suggested using the high-minus-low profitability factor in addition to the standard size (SMB) and value (HML) factors of Fama and French (1993). We argue that behind the profitability factor there is a skewness factor related to the presence or absence of growth options and firm (in)flexibility or rigidity. Although including the profitability factor in long-established factor models helps explain various other anomalies, the risk-based explanation or driving force of the profitability effect and the economic mechanism behind it remain unclear. We show that our skewness factor attributed to growth options helps explain the profitability factor, but the reverse does not hold.

III Measurement of Variables

A Idiosyncratic Skewness and Volatility

This section describes the construction of the key variable, idiosyncratic skewness, and the affiliated variable related to idiosyncratic volatility. We calculate idiosyncratic skewness and idiosyncratic volatility based on daily returns for non-financial firms in the CRSP/Compustat merged file from January 1983 to December 2015. Idiosyncratic skewness (ISKEW) and idiosyncratic volatility (IVOL) are calculated each month as scaled measures of the third and second central moments of the residuals ($u_{i,t}$) obtained by fitting a variant of the market model to daily stock returns. Following Boyer et al. (2010), we first calculate the residuals of the following time-series regression using 5 years of daily observations:

(1) $$R_{i,t} - R_{f,t} = \alpha + \beta_{i,t}^{\mathrm{mkt}}(R_{m,t} - R_{f,t}) + \beta_{i,t}^{\mathrm{cosk}}(R_{m,t} - R_{f,t})^2 + u_{i,t},$$

where $(R_{i,t} - R_{f,t})$ and $(R_{m,t} - R_{f,t})$ are the daily excess return of stock i and the daily excess market return at time t, respectively. $\beta_{i,t}^{\mathrm{mkt}}$ captures stock i's return sensitivity to changes in the market return at time t, while $\beta_{i,t}^{\mathrm{cosk}}$ captures the return sensitivity to changes in market volatility or co-skewnesss (see Harvey and Siddique (2000)). By focusing on the residuals after controlling for co-skewness, we better isolate the pure idiosyncratic return component. Although we do not claim that flexibility and its exercise are unrelated to market exposure, we control for common market exposures to avoid capturing the effect of other firm characteristics (besides flexibility) that may also be related to equity return and its moments, such as leverage, profitability, and distress.[2] For each stock we calculate the daily idiosyncratic skewness (ISKEW_t) and daily idiosyncratic volatility (IVOL_t) for each month t as the realized idiosyncratic skewness and volatility using daily returns from the first day of month t through end of month $t + T$.[3]

For the asset pricing tests we use an estimate of expected idiosyncratic skewness generated from future growth options (GO), after controlling for other well-known determinants of skewness. We use this estimate of expected idiosyncratic skewness (rather than realized skewness) to infer the impact on skewness due to GO. Our estimation of expected idiosyncratic skewness is feasible in that it only uses information available to investors at the time the expectation is formed so there is no look-ahead bias. To account for the real options and other known drivers of idiosyncratic skewness (before we extract the impact of GO), we estimate the following cross-sectional regressions:

[2]Related to this, Ai and Kiku (2016) find that while exposure to idiosyncratic volatility does convey information regarding future growth options, exposure to aggregate market volatility is not informative on future growth as it is contaminated by other variables. A similar logic might apply to the third moment as well. Since nonsynchronous trading may introduce an errors-in-variables problem, for robustness we also estimate the model as in Scholes and Williams (1977). Results are analogous and are available from the authors.

[3]Results are reported for $T = 60$ months. For robustness, we repeat the analysis using different horizons varying from 12 to 60 months. Results are similar and available from the authors.

$$
\begin{aligned}
\text{(2)} \quad \text{ISKEW}_t \;=\; & \alpha + \beta_{\text{ISKEW}}\text{ISKEW}_{t\text{-}(T+1)} + \beta_{\text{GO}}\text{GO}_{t\text{-}1} + \beta_{\text{ROE}}\text{ROE}_{t\text{-}1} + \beta_{\text{DR}}\text{DR}_{t\text{-}1} + \beta_{\text{MAX}}\text{MAX}_{t\text{-}1} \\
& + \beta_{\text{IVOL}}\text{IVOL}_{t\text{-}(T+1)} + \beta_{\text{AG}}\text{AG}_{t\text{-}1} + \beta_{\text{AGIV}}(\text{AG} \times\text{IVOL})_{t\text{-}(T+1)} + \beta_{\text{BM}}\text{BM}_{t\text{-}1} + \beta_{\text{TURN}}\text{TURN}_{t\text{-}1} \\
& + \beta_{\text{LEV}}\text{LEV}_{t\text{-}1} + \beta_{\text{SMALL}}\text{SMALL} + \beta_{\text{BIG}}\text{BIG} + \text{INDU} + \text{EXCH} + \epsilon_t.
\end{aligned}
$$

In equation (2) above, the dependent variable ISKEW_t is an M×1 vector of M firms' cross-sectional idiosyncratic skewness calculated from month t to month $t+T$. Besides past idiosyncratic skewness ($\text{ISKEW}_{t-(T+1)}$), among the main explanatory variables GO_{t-1} is an M×1 vector of cross-sectional growth option (GO) values in month $t-1$. Growth option (GO) intensity is calculated as in equation (3) in the next section. ROE_{t-1} is calculated as the ratio of operating cash flow to shareholders' equity. Distress risk (DR) in month $t-1$ is the Merton's (1974) negative distance-to-default ($-d_2$). MAX_{t-1} is the maximum daily return observed in month $t-1$. $\text{IVOL}_{t-(T+1)}$ is lagged idiosyncratic volatility. Control variables (in the last 2 lines of equation (2)) include lagged i) asset growth (AG_{t-1}) calculated as the percent change in firm total book assets; ii) $(\text{AG} \times\text{IVOL})_{t-(T+1)}$ capturing the interaction between AG_{t-1} and lagged idiosyncratic volatility $\text{IVOL}_{t-(T+1)}$; iii) the book-to-market ratio (BM_{t-1}); iv) turnover (TURN_{t-1}), calculated as the ratio of trading volume to shares outstanding in month $t-1$; v) leverage (LEV_{t-1}), calculated as the ratio of book value of debt and market value of the firm; vi) as in Boyer et al. (2010), we also allow for a nonlinear size-skewness relationship by modeling size as 2 binary dummies for SMALL (bottom 30%) and BIG (top 30%) firms built on market capitalization observed in the previous month; vii) INDU and EXCH are controls for the 10 industries of Fama and French (1997) and for the NASDAQ exchange, respectively. equation (2) is cross-sectionally estimated for each month t. As a robustness check, we also estimate equation (2) without ROE, DR, MAX, and IVOL in the estimation of idiosyncratic skewness. Main results are qualitatively similar when these variables are excluded (they are available from the authors).

B Growth Options, Lotteryness, Distress, and Profitability

We now describe the construction of the other main variables in our study: growth options, lotteryness, distress, and profitability. In line with a view of the firm managing a mix of assets-in-place and growth options (e.g., Berk et al. (1999)), we use a set of growth measures that capture both the impact of past (exercised) growth via asset growth (AG) and of future growth potential (GO), which in extreme form might be manifested as lotteryness as proxied by the maximum daily return (MAX) during the previous month. This dual complementary role of past vs. future growth components (with a potentially mixed effect) is well accepted in the literature (e.g., Cao et al. (2008), Grullon et al. (2012), Trigeorgis and Lambertides (2014)). In line with the close link between growth options and volatility (Grullon et al. (2012)) and the interaction between asset growth and idiosyncratic volatility documented in Lipson, Mortal, and Schill (2011), we include an interaction term given by the product of asset growth AG (measured using Compustat data item #6) and idiosyncratic volatility IVOL (AG $\times$IVOL).

Our growth option (GO) measure represents the residual future-oriented firm growth potential. This future (yet-to-be exercised) growth option measure (GO) is calculated as the % of a firm's market value (V) arising from future-oriented growth opportunities (PVGO/V). It is inferred by subtracting from the current market value of the firm (V) the perpetual discounted stream of expected operating cash flows under a no-further growth policy (see, e.g., Kester (1984), Cao et al. (2008)):

$$\text{(3)} \qquad \mathrm{V}_{i,t} = \frac{\mathrm{CF}_{i,t}}{\mathrm{k}_i} + \mathrm{PVGO}_{i,t} \qquad \text{or} \qquad \mathrm{GO}_{i,t} \equiv \frac{\mathrm{PVGO}_{i,t}}{\mathrm{V}_{i,t}} = 1 - \frac{(\mathrm{CF}_{i,t}/\mathrm{V}_{i,t})}{\mathrm{k}_i}.$$

In equation (3), $\mathrm{V}_{i,t}$ is the market value of firm i at time t, $\mathrm{CF}_{i,t}$ is the expected operating cash flow of firm i at time t, and k_i is firm i's weighted average cost of capital (WACC).[4] CF is measured as the free operating cash flow under a no-further-growth policy where capital expenditures equal depreciation. To estimate cost of equity in WACC, we use the market model with beta equal to 1 and we add to the risk-free return a 6% market risk premium for all firms. This simple setup avoids our results relying on the empirical validity of the CAPM. We estimate a firm's cost of debt to be 4% less than its cost of equity. Effective tax rates are income taxes (#370) divided by pretax income (#365).

Asset growth and growth option effects are distinct from each other when idiosyncratic volatility is high. This set of growth variables is expected to have an impact on idiosyncratic skewness and on the way investors form their expectations regarding the firm's future growth. We posit that investors form their expectations about future

[4]Expected operating cash flow at time t is estimated as the fitted value of an AR(4) model that is run separately on the cash flows of each firm using observations of the preceding 5-year period.

idiosyncratic skewness by considering the firm's past asset growth (in interaction with idiosyncratic volatility) as well as its residual future growth potential as implied by the market. The latter growth option (GO) variable is incremental in our regressions after controlling for asset growth and its interaction with volatility. GO is thus capturing residual future growth that increases idiosyncratic skewness, while the direct asset growth (AG) impact from exercising past growth options may be insignificant or potentially reduce skewness.

An extreme variant of future growth options involving a small chance of a high payoff is lotteryness. We measure a stock's lotteryness using the maximum daily return over the previous month (MAX) as in Bali et al. (2011). While lottery stocks are associated with lower subsequent returns, the drivers of lotteryness have not yet been adequately investigated. We adopt the lottery definition (MAX) of Bali et al. (2011) to avoid potential measurement overlap with skewness-related or other growth option measures. Lotteryness here may represent growth options in more extreme (rare-event) form as well as increased risk reflecting gambling-type behavior, both of which might increase the value of future growth options. Given that lotteryness has been linked to distress (Conrad et al. (2014)), we explicitly control for distress risk (DR), measured as the negative of Merton's distance to default ($-d_2$) estimated as in Bharath and Shumway (2008).[5]

[5] Alternative measures of Merton's distance-to-default ($-d_2$), including Moody's KMV, are used by Vassalou and Xing (2004), Campbell et al. (2008), Garlappi, Shu, and Yan (2008), Chava and Purnanandam (2010), and George and Hwang (2010). Our result is robust to using an alternative measure of distress risk based on Ohlson (1980).

Following Cao et al. (2008), we estimate return on equity (ROE) as operating cash flow (CF) in year t divided by shareholders' equity at end of year $t-1$:

$$\mathrm{ROE}_t = \frac{\mathrm{CF}_t}{\mathrm{SHEQUITY}_{t-1}}$$

Operating cash flow (CF) is the net cash flow from operating activities (Compustat item #308) plus interest and related expenses (#15) minus depreciation and amortization (#125).[6] Shareholders' equity value follows Davis, Fama, and French (2000). Using income before extraordinary items (Hou et al. (2015)) produces analogous results.

C Expected Idiosyncratic Skewness from Growth and Returns

In this subsection we discuss the construction of expected idiosyncratic skewness from growth options and its relation to future stock returns. After we estimate equation (2), we next determine the expected idiosyncratic skewness, $\mathrm{E[ISKEW]_{GO}}$, attributed to growth options (GO), as follows:

$$\mathrm{E}_t[\mathrm{ISKEW}_{t+T}]_{\mathrm{GO}} = \hat{\alpha} + \hat{\beta}_{\mathrm{ISKEW}}\mathrm{ISKEW}_t + \hat{\beta}_{\mathrm{GO}}\mathrm{GO}_t. \tag{4}$$

Expected idiosyncratic skewness estimated from $t+1$ to $t+T$ as in equation (4) isolates the expected idiosyncratic skewness effect attributed solely to growth options (GO) in line

[6]For years prior to 1988, we follow Xie (2001) in estimating CF as funds from operations (#110) − change in current assets (#4) + change in cash and cash equivalents (#1) + change in current liabilities (#5) − change in short-term debt (#34).

with the central role of growth options lying behind or related to the studied anomalies. equation (4) is needed to capture the specific measure of expected idiosyncratic skewness that is attributed to growth options rather than to other variables. We do not use the full set of variables in equation (2) since our main argument requires us to focus on the pure growth-option driven idiosyncratic skewness effect rather than on that of other variables. equation (2) controls for a multitude of potential idiosyncratic skewness determinants while the intention of equation (4) is specifically to isolate the impact of GO and past ISKEW.[7] As discussed later, a measure of expected skewness built by replacing the specification of equation (4) with all variables contained in equation (2), $E[ISKEW]_{ALL}$, is not able to explain the above 4 anomalies (see Supplementary Material Table A.2 Panel B). For the above reason, Panel B of subsequent Table 4 acquires added importance in showing that expected skewness factors based on other variables related to these anomalies (e.g., ROE, DR, MAX, or IVOL) cannot explain the anomalous returns.[8]

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[7]The measure of expected growth-option skewness given by equation (4) is a linear function of firm lagged skewness and firm growth options (GO). In order to understand how much variation in expected growth-option skewness is driven by each variable, lagged skewness vs. GO, we perform some additional tests. Table A.1 in the Supplementary Material shows the percentage of stocks classified into skewness quintiles based on expected skewness calculated as per equation (4) vs. expected skewness obtained only from GO (Panel A); and compared to simply using GO directly (Panel B). Table A.1, Panels A and B show that the highest overlap that occurs in the high-skewness quintile (% of stocks) among the alternative measures is 72%, meaning that these measures do not lead to the same exact classification of firms.

[8]Unlike Harvey and Siddique (2000), who focus on the pricing of co-skewness (the second term in equation (1)), we here focus on the impact of idiosyncratic skewness (the residual of equation (1)) resulting from future growth options (GO). The main reason we focus on idiosyncratic skewness is the firm-specific

We subsequently study the relation between expected idiosyncratic skewness attributed to growth options ($\text{E[ISKEW]}_{\text{GO}}$ as per equation (4)) and future stock returns, after controlling for a number of cross-sectional predictors at the firm and portfolio levels. At the firm-level, we control for market beta (BETA), firm size (SIZE), book-to-market (BM), and momentum (MOM). We further control for profitability, measured by return on equity (ROE), and asset growth (AG) proxying for the exercise of past growth options to focus on the incremental role of future growth options (GO).

Following Fama and French (1992), market risk (BETA) is estimated over the previous 36 months using the Sharpe-Lintner (CAPM) model: $\text{E}[R_{i,t}] = R_{f,t} + \beta_{i,t}(R_{m,t} - R_{f,t})$, where $R_{i,t}$ is the stock return of firm i in month t, $R_{m,t}$ is the market return in month t (a value-weighted portfolio of NYSE/AMEX/NASDAQ stock returns), $R_{f,t}$ is the 1-month U.S. T-bill rate in month t, and $\beta_{i,t}$ is the BETA of firm i in month t. SIZE is the market value of equity (ME), estimated as $\log$ [price per share (#199) $\times$ number of shares outstanding (#25)]. Book-to-market (BM) is book value of common equity (#60) divided by fiscal year-end market value of equity (ME). Momentum (MOM) is the past 1-year (11-month) cumulative return skipping the most recent month. Return on equity (ROE) is operating cash flow divided by shareholders' equity. Controlling for past asset growth (AG) helps isolate the impact that future un-exercised growth options (GO), captured in the growth-options-driven expected

nature of firm growth options lying behind the studied anomalies that enhances idiosyncratic skewness. This differentiates our approach from standard co-skewness arguments.

skewness measure, have on equity returns. Expected idiosyncratic skewness arising from growth options, $E[ISKEW]_{GO}$, is measured based on equations (2) and (4).

IV Empirical Results

A Summary Statistics

Our sample consists of 12,709 U.S. listed firms during the 1983-2015 period with data available in the CRSP/Compustat merged database (excluding financials and utility firms with 4-digit Standard Industrial Classification (SIC) codes between 6000 and 6999 and between 4900 and 4999). We estimate cross-sectional regressions as per equation (2) and obtain expected idiosyncratic skewness estimates based on equation (4) for each month from February 1988 to December 2015.[9]

[9]There are several reasons why we focus on the post-1983 period. First, many growth stocks are traded on NASDAQ. Second, market volatility and growth option value have been higher since 1983. Xu and Malkiel (2003) show that idiosyncratic risk has become more important over time as stocks listed on NASDAQ increased in number and importance. The start of S&P 500 index futures trading in 1983 and related computerized program trading activities increased market volatility and the value of growth options. A potential growth options factor would be more significant in the presence of volatility and enhanced growth opportunities, which are more pronounced since 1983. For robustness, we test the predictive power of $E[ISKEW]_{GO}$ for the extended period 1962–2015 and find that the effect of yet-unexercised growth options (GO) on stock returns is significant but economically smaller than the corresponding effect found for the recent and more volatile period (1983–2015). Section I of the Supplementary Material also presents two pieces of supporting empirical evidence. First, the average idiosyncratic skewness in the post-1980

Table 1, Panel A reports summary statistics for all variables in our empirical analyses. To limit the influence of outliers, we remove the extreme 1% in both tails of estimated expected idiosyncratic skewness. Market beta (BETA) is close to 1. Mean book-to-market (BM) is 0.65, within the range found in earlier studies (e.g., Cooper et al. (2008), Anderson and Garcia-Feijóo (2006)). The mean monthly return (R) is 0.93%. The time-series average of the cross sectional expected skewness ($\mathrm{E[ISKEW]_{GO}}$) is 0.12 with a standard deviation of 0.19. Panel B of Table 1 reports Pearson correlation coefficients among the key variables. Expected idiosyncratic skewness ($\mathrm{E[ISKEW]_{GO}}$) is negatively correlated with SIZE, ROE and LEV. It has a low positive correlation with other variables (e.g., BETA, BM, AG, MOM, DR, MAX, and IVOL).

[Table 1 around here]

B Cross-Sectional Skewness Drivers and Fama–MacBeth Return Regressions

To corroborate the impact of our main variables on idiosyncratic skewness, we first run a series of firm-level cross-sectional regressions based on equation (2). Table 2 shows the time-series averages of the cross-sectional slopes using the above skewness determinants. Growth options (GO), distress (DR), lotteryness (MAX), and idiosyncratic volatility (IVOL) are statistically significant positive drivers of idiosyncratic skewness, both alone (models 1, 3, 4 and 5) and after controlling for a number of relevant covariates

period has been higher than in the pre-1980 period, and second the average ISKEW has increased over time in the later part of our sample compared to the earlier sample period.

(models 6 and 7). Higher values of GO, DR, MAX, and IVOL are associated with higher future idiosyncratic skewness, in line with the idiosyncratic-skewness-enhancing impact of growth options and related lotteryness and distress options. High profitability (ROE) is associated with significantly lower future idiosyncratic skewness (model 2).[10]

[Table 2 around here]

We then examine the cross-sectional relation between $\mathrm{E}[\mathrm{ISKEW}]_{\mathrm{GO}}$ and future returns at the stock-level using Fama and MacBeth (1973) regressions. We report the time-series averages of the slope coefficients from the regressions of 1-month-ahead stock returns ($R_{i,t+1}$) on $\mathrm{E}_t[\mathrm{ISKEW}]_{\mathrm{GO}}$ with various control variables. For ease of comparison, all explanatory variables are cross-sectionally standardized. Monthly cross-sectional regressions are run for the following econometric specification and nested versions thereof:

$$R_{i,t+1} = \alpha + \beta\,\mathrm{E}_t[\mathrm{ISKEW}]_{\mathrm{GO}} + \gamma\,X_{i,t} + \epsilon_{i,t+1}, \tag{5}$$

where $R_{i,t+1}$ is 1-month-ahead excess return on stock i in month $t+1$, $\mathrm{E}_t[\mathrm{ISKEW}]_{\mathrm{GO}}$ is growth-options driven expected idiosyncratic skewness of stock i in month t, and $X_{i,t}$ is a set of firm-specific control variables observable at time t for stock i, namely market BETA, market capitalization (SIZE), book-to-market ratio (BM), momentum (MOM), profitability

[10] Asset growth (AG) is also negatively related with skewness (models 6 and 7). This is expected because when past growth options are exercised and turned into cash-generating assets-in-place, they reduce the asymmetry of the return distribution. In terms of other controls in equation (2) shown in models 6 and 7, book-to-market (BM), leverage (LEV), and past idiosyncratic skewness (ISKEW) are significant positive determinants. Turnover (TURN) has a significant negative impact.

(ROE), and asset growth (AG).[11] We use Newey and West (1987) adjusted t-statistics with 6 lags to determine the statistical significance of the average slope coefficients from Fama–MacBeth regressions.

Results reported in the first row of Panel A in Table 3 are consistent with earlier studies, confirming the findings of Fama and French (1992), (1993) and Jegadeesh and Titman (1993) concerning beta, size, value and momentum effects. The second row in Panel A of Table 3 confirms that profitability measured by return on equity (ROE) predicts high future return, while asset growth (AG) exhibits a significantly negative relation with subsequent stock returns. The third row in Panel A of Table 3 extends the above analyses by additionally considering future growth-options driven expected idiosyncratic skewness, $E[ISKEW]_{GO}$, beyond the standard control variables. The results confirm that expected skewness driven by future growth options ($E[ISKEW]_{GO}$) is significantly negatively related to future stock returns, beyond all other variables, including ROE and AG. Controlling for everything else, a 1-standard-deviation increase in expected

[11]To ensure that the accounting and growth option variables are known before the returns they are used to explain, we match the accounting data for fiscal year end in calendar year $t-1$ (1983–2015) with the returns from July of year t to June of year $t+1$. We use a firm's market equity at the end of December of year $t-1$ to compute its book-to-market ratio for $t-1$. To be included in the return tests for July of year t, a firm must have CRSP/Compustat data for December of year $t-1$ and June of year t. It must also have monthly returns for at least 24 of the 36 months preceding July of year t in order to calculate the option-based variables (such as the firms' volatility, DR and skewness) and the firm's beta. Considering the sensitivity of our results to extreme observations, we perform the analysis winsorizing the top and bottom 1% of observations for each independent variable except size (setting them at the 1st and the 99th percentiles, respectively). These lead to a final sample of 707,261 firm-month observations.

idiosyncratic skewness arising from growth options implies a 0.34% per month (4.06% per annum) lower average return. The negative impact of expected skewness on future stock returns is broadly consistent with evidence from prior studies (e.g., Harvey and Siddique (2000), Boyer et al. (2010)). Here, however, we differentiate from co-skewness and focus specifically on idiosyncratic skewness driven by growth options. The significantly negative impact of expected idiosyncratic skewness associated with growth options on stock returns is consistent with a rational incorporation of growth option values in stock prices, which justifies lower expected stock returns. The above is in line with the argument that investors are willing to accept lower returns in exchange for the positively skewed upside potential and macroeconomic hedging benefits associated with corporate growth options. Conversely, investors demand a risk premium in the form of higher returns for the higher volatility risk and downside risk exposure in bad economic states for inflexible firms lacking such growth options and characterized by low or negative idiosyncratic skewness.

[Table 3 around here]

In order to examine the robustness of our results, we additionally test whether our findings are driven by small stocks, illiquid firms, low-priced stocks or stocks traded beyond the NYSE. Panel B of Table 3 presents separate results for stock subsamples differing along these characteristics. Specifically, we re-run regression (3) in the last row of Panel A, for subsamples containing only big stocks, only liquid stocks, big and liquid stocks, excluding low-priced stocks, and for only firms trading on NYSE.[12] The results confirm that none of

[12] In Panel B of Table 3, "Big" refers to the subsample of firms in the top (66th) percentile on market equity (ME), "Liquid" refers to firms in the lowest (33th) percentile of bid–ask spread, "Big and Liquid"

these firm characteristics is driving our main findings. Overall, growth-driven expected skewness ($E[ISKEW]_{GO}$) remains significant at the 1% level in all subsamples of stocks, after accounting for all other standard controls. Further, the last 2 rows confirm that the $E[ISKEW]_{GO}$ effect is more pronounced for firms with high idiosyncratic volatility.[13]

In further robustness, Panel C of Table 3 confirms that $E[ISKEW]_{GO}$ remains significant after controlling for a larger battery of controls, including direct effects of DR, MAX, and IVOL, as well as stock exposure to market volatility (β^{VXO}) as in Ang et al. (2006) and analysts' forecast dispersion (DISP) as in Diether, Malloy, and Scherbina (2002). $E[ISKEW]_{GO}$, as well as DR, MAX, and DISP, are negative and significant at the 1% level. Idiosyncratic volatility (IVOL) becomes weaker after including $E[ISKEW]_{GO}$.[14]

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refers to a joint subsample of Big and Liquid firms, "Low Price excl." excludes firms with market price less than $1 per share, and "NYSE" refers to a subsample of firms traded only on the NYSE.

[13] "Low volatility" and "High volatility" in Table 3, Panel B, refer to stock samples that are generated based on the 33rd and the 66th percentiles of idiosyncratic volatility.

[14] In Table 2, we have shown that GO, ROE, DR, MAX, IVOL and other control variables have significant predictive power for ISKEW. So using all variables on the right-hand side of equation (2) to predict E[ISKEW] does not provide clear evidence for the significance of GO-driven E[ISKEW] because if E[ISKEW] is estimated using all variables (ALL), it would not be possible to disentangle the marginal contribution of GO vs. that of ROE, DR, MAX, IVOL or the other control variables. We would need to use 5 alternative specifications of equation (4) to identify the incremental predictive power of GO vs. that of ROE, DR, MAX, IVOL (or other controls). In subsequent robustness, we generate a new measure of $E[ISKEW]_{ALL}$ directly coming from all variables of equation (2) and replicate the firm-level cross-sectional regressions of Table 3. $E[ISKEW]_{ALL}$ is significantly negatively priced in the cross-section of equity returns. However, in disentangling their incremental contribution only GO can explain the above anomalies as

C Factor Analysis: Explaining Related Anomalies

We next examine whether a skewness factor based on firm idiosyncratic skewness differentials associated with the presence or absence of growth options alone can help explain the time-series variation in hedge-portfolio returns related to profitability (ROE), distress risk (DR), lottery demand (MAX), and the idiosyncratic volatility (IVOL) puzzle. For each month, we form univariate value-weighted decile portfolios by sorting individual stocks based on DR and MAX, where decile 1 contains stocks with the lowest characteristic during the past month and decile 10 comprisng stocks with the highest aforementioned characteristic. Similar portfolios built on operating profitability (ROE) and idiosyncratic volatility (IVOL) are collected directly from Kenneth French's online data library. Panel A of Table 4 presents the risk-adjusted return (alpha) for each decile and the monthly risk-adjusted return (alpha) difference between deciles 1 and 10. We report the 5-factor alpha controlling for the 5 standard factors (FFCPS model): the market, size and book-to-market (MKT, SMB, HML) factors of Fama and French (1993), the momentum (MOM) factor of Carhart (1997), and the liquidity risk (LIQ) factor of Pastor and Stambaugh (2003).

Panel A of Table 4 provides evidence that a long position in decile 10 coupled with a short position in decile 1 forming hedge portfolio positions built on ROE, DR, MAX, or IVOL produces a significant risk-adjusted return spread after controlling for all 5 factors (MKT, SMB, HML, MOM, LIQ). Specifically, the 5-factor FFCPS alpha spread is 0.59%

hypothesized (see Panel B of Table A.2 of the Supplementary Material), confirming the central role of growth options behind these anomalies.

per month (t-stat. = 2.91) for profitability (ROE), −0.51% (t-stat. = −2.02) for distress risk (DR), −0.85% (t-stat. = −2.46) for lottery demand (MAX), and −0.74% (t-stat. = −3.08) for idiosyncratic volatility (IVOL). These significant cross-sectional relations among profitability, distress, lotteryness, and idiosyncratic volatility with risk-adjusted returns are in line with Fama and French (2006), (2015), Dichev (1998), Campbell et al. (2008), Bali et al. (2011), and Ang et al. (2006), respectively.

[Table 4 around here]

To test the impact that expected idiosyncratic skewness arising from growth options, $\text{E[ISKEW]}_{\text{GO}}$, has in explaining the above anomalies, we augment the set of the above 5 standard factors (MKT, SMB, HML, MOM, LIQ) with an expected idiosyncratic skewness factor (FISKEW_{X}) constructed by forming zero-cost long-short portfolios of a relevant variable X associated with the 4 anomalies (one of GO, ROE, DR, MAX, or IVOL) based on our entire sample. Following Fama and French (1993), the expected skewness factor is formed using independent bivariate sorting based on 2 × 3 value-weighted portfolios (i.e., median SIZE (50%, 50%) and then 30%, 40%, 30% breakpoints for $\text{E[ISKEW]}_{\text{X}}$). We build our factor as the difference between the average low (bottom 30%) $\text{E[ISKEW]}_{\text{X}}$ portfolio return minus the average high (top 30%) $\text{E[ISKEW]}_{\text{X}}$ portfolio return.

The row ($\text{FFCPS+FISKEW}_{\text{GO}}$) in Panel A of Table 4 shows that including this newly proposed idiosyncratic skewness factor ($\text{FISKEW}_{\text{GO}}$) generated by growth options (GO) reduces the above alphas to insignificant levels, effectively removing the ROE, DR, MAX, and IVOL "anomalous" returns. After controlling for the growth-options induced expected idiosyncratic skewness factor ($\text{FISKEW}_{\text{GO}}$), the risk-adjusted return spreads are economically and statistically insignificant for ROE, DR, MAX, and IVOL sorted portfolios: 0.15% per month (t-stat. = 0.74) for ROE, −0.23% (t-stat. = −0.87) for DR, 0.09% (t-stat. = 0.24) for MAX, and −0.18% (t-stat. = −0.76) for IVOL.[15]

Given the central role of growth options behind the above related anomalies, our objective has been to show that GO-driven E[ISKEW] explains the above anomalies whereas conditioning on ROE, DR, MAX, or IVOL does not. To do so, we repeat the above factor analysis using alternative specifications of the expected idiosyncratic skewness factor ($FISKEW_X$) based on the other variables associated with these anomalies. In particular, we examine whether an expected idiosyncratic skewness factor built on an alternative variable X, $FISKEW_X$, is able to explain the above 4 anomalies, instead of $FISKEW_{GO}$ (i.e., when X is GO). Panel B of Table 4 presents the risk-adjusted return spreads using these alternative expected skewness factors. None of these alternative factor specifications, conditioned on ROE, DR, MAX, or IVOL, is able to explain the set of 4 anomalies associated with growth options, as indicated by the predominantly significant alpha spreads. Only the skewness factor based on growth options (with X=GO), $FISKEW_{GO}$, is able to consistently explain the anomalous returns for all 4 related anomalies.[16] The above

[15]Remarkably, a more parsimonious model consisting only of the market factor (MKT) and the skewness factor ($FISKEW_{GO}$) is able to explain the above 4 anomalies (see Supplementary Material Table A.3 Panel A).

[16]The result is robust when we replace the FFCPS model with the market (MKT) model (see Supplementary Material Table A.3 Panel B).

findings confirm that only growth-options driven expected idiosyncratic skewness is both consistently priced in stock returns and is able to explain the above anomalous returns.[17]

A related question is whether the new skewness factor based on growth options can specifically explain the profitability factor or vice versa. Table A.4 of the Supplementary Material provides evidence that the extended factor models including the profitability (ROE) and investment (INV) factors of Fama and French (2015) and the Q-factor model of Hou et al. (2015) are not able to explain our idiosyncratic skewness factor, while our skewness factor explains the profitability factor. Overall, these results suggest that the skewness factor associated with the presence or absence of growth options can be viewed as a close substitute but subsumes the predictive power of profitability.

Finally, given the central role of growth options and their impact via the channel of idiosyncratic skewness in explaining the anomalous returns of the above related anomalies, it is interesting to examine the relationship between ISKEW and the value premium and test whether our idiosyncratic skewness factor (FISKEW) can explain the value premium. Although the average value-minus-growth return spread (average value premium) is not significant in our full sample period, the value premium becomes weaker or insignificant after including the FISKEW factor whenever the value-minus-growth return spread appears significant in parts of the sample period. This holds using either the decile 10 minus decile 1 return spread on the book-to-market portfolios or the HML factor of Fama

[17]Moreover, the results confirm that only the skewness factor based on expected skewness driven by GO is able to explain the 4 mentioned anomalies. By contrast, the skewness factor built only on past idiosyncratic skewness is unable to explain the 4 anomalies (see Panel B of Table A.2).

and French (1993). We provide a discussion and corresponding results in Section II and Figures A.1 and A.2 of the Supplementary Material.

D Univariate Portfolio Analysis and Economic Significance

Table 5 provides further evidence concerning the economic significance of our growth-options driven skewness measure, $\text{E[ISKEW]}_{\text{GO}}$, based on univariate portfolios. For each month we form equal-weighted (EW) and value-weighted (VW) decile portfolios by sorting individual stocks based on their growth-options driven expected idiosyncratic skewness, $\text{E[ISKEW]}_{\text{GO}}$, where decile 1 contains stocks with the lowest $\text{E[ISKEW]}_{\text{GO}}$ and decile 10 contains stocks with the highest $\text{E[ISKEW]}_{\text{GO}}$. Table 5 reports, by row, the average $\text{E[ISKEW]}_{\text{GO}}$, the average 1-month-ahead raw (EW and VW) returns, the risk-adjusted return for each decile, the hedge (10-1) average return difference, and the 10-1 risk-adjusted return (alpha) spread between deciles 1 and 10. Newey and West (1987) adjusted t-statistics are used to determine the statistical significance of average returns and alphas.

In these constructed univariate portfolios of stocks sorted by expected idiosyncratic skewness, the average $\text{E[ISKEW]}_{\text{GO}}$ increases when moving from decile 1 (low-$\text{E[ISKEW]}_{\text{GO}}$) to decile 10 (high-$\text{E[ISKEW]}_{\text{GO}}$) with a large cross-sectional spread in growth-options driven expected idiosyncratic skewness. Specifically, the average $\text{E[ISKEW]}_{\text{GO}}$ increases from a negative -0.14 to a positive 0.62, producing a highly significant cross-sectional spread of 0.76 (t-stat. = 11.94). The average return difference between decile 10 (high-$\text{E[ISKEW]}_{\text{GO}}$) and decile 1 (low-$\text{E[ISKEW]}_{\text{GO}}$) is -0.65% per month with a t-statistic of -1.80 for the EW portfolio and -0.94% per month with a t-statistic of 3.20 for the VW portfolio, indicating that an investment strategy that goes long in stocks with low $\text{E[ISKEW]}_{\text{GO}}$ and shorts stocks with high $\text{E[ISKEW]}_{\text{GO}}$ would yield average returns of 7.81% to 11.24% per annum.

[Table 5 around here]

In addition to average raw returns, Table 5 presents for the VW portfolios of $\text{E[ISKEW]}_{\text{GO}}$ the magnitude and statistical significance of the alphas from 3 different factor models: i) the FFCPS alpha; ii) the 5-factor (FF5) alpha relative to the market (MKT), size (SMB), book-to-market (HML), investment (CMA), and profitability (RWA) factors of Fama and French (2015); and iii) the Q-factor model alpha relative to the market (MKT), size (SMB), investment ($\text{R}_{I/A}$), and profitability (R_{ROE}) factors of Hou et al. (2015).

The last 3 rows of Table 5 show that the FFCPS, FF5 and Q-factor alpha spreads between deciles 1 and 10 are all negative and significant at the 1% level: -0.95% per month (t-stat. $= -3.47$) for the 5-factor FFCPS model; -0.74% (t-stat. $= -2.76$) for the FF5 model; and -0.69% (t-stat. $= -2.34$) for the 4-factor Q model. These economically and statistically significant alpha spreads indicate that stocks in the lowest $\text{E[ISKEW]}_{\text{GO}}$ decile generate about 10% higher risk-adjusted annual return compared to stocks in the highest decile. The inclusion of our skewness factor ($\text{FISKEW}_{\text{GO}}$) makes these alpha spreads insignificant, corroborating the power of $\text{FISKEW}_{\text{GO}}$ (see Supplementary Material Table A.5).

To further examine the economic significance of expected idiosyncratic skewness attributed to growth options, we construct VW bivariate portfolios of $\text{E[ISKEW]}_{\text{GO}}$

controlling for profitability (ROE), distress risk (DR), lotteryness (MAX), and idiosyncratic volatility (IVOL). Table A.6 of the Supplementary Material shows that the predictive power of $\text{E[ISKEW]}_{\text{GO}}$ remains intact after controlling for these variables in bivariate portfolios.

E Explaining the Relation between Skewness and Returns

To help gain a better understanding of what may drive the cross-sectional relation between $\text{E[ISKEW]}_{\text{GO}}$ and returns, we next examine whether this relation is due to outperformance by low-$\text{E[ISKEW]}_{\text{GO}}$, underperformance by high-$\text{E[ISKEW]}_{\text{GO}}$, or both. The results in Table 5 indicate that the predictive power of $\text{E[ISKEW]}_{\text{GO}}$ is mainly driven by outperformance of stocks with negative $\text{E[ISKEW]}_{\text{GO}}$, but not due to underperformance by stocks with positive $\text{E[ISKEW]}_{\text{GO}}$. Specifically, the FFCPS, FF5, and Q-factor alphas for the value-weighted portfolios of stocks with negative $\text{E[ISKEW]}_{\text{GO}}$ (decile 1) are all positive and highly significant: 0.59% per month (t-stat. = 3.60), 0.36% (t-stat. = 2.46), and 0.49% (t-stat. = 2.69), respectively. By contrast, the alphas for the value-weighted portfolios of stocks with positive $\text{E[ISKEW]}_{\text{GO}}$ (decile 10) are all economically and statistically insignificant.

Since large negative idiosyncratic skewness may proxy for a greater mix of assets-in-place that involves greater commitment of fixed capital and adjustment costs and hence greater risk exposure to economic downturns, the significantly positive alpha of decile 1 indicates that investors demand extra compensation in the form of higher expected return for holding stocks with negative $\text{E[ISKEW]}_{\text{GO}}$ or stocks with high left-tail risk exposure.

This result is also supported by the average β^{VXO} values reported for decile 1 versus decile 10 in Panel B of Table A.7 in the Supplementary Material. Stocks with low or negative $\text{E[ISKEW]}_{\text{GO}}$ in decile 1 have a negative β^{VXO} (−0.020), whereas stocks with high $\text{E[ISKEW]}_{\text{GO}}$ in decile 10 have a positive β^{VXO} (0.041). The last row of Table A.7 Panel B further shows that the cross-sectional spread between the average values of β^{VXO} for deciles 1 and 10 is highly significant, indicating that stocks with a negative β^{VXO} are different from those with a positive β^{VXO} in terms of their exposure to good vs. bad states of the economy e.g., as proxied by low vs. high market volatility. Stocks with a negative β^{VXO} are generally viewed as riskier with higher market volatility risks because their returns decrease during periods of high market volatility or bad states of the economy. This is supported by a negative correlation between the skewness factor and changes in market volatility (correlation $= -0.18$) or changes in VXO (correlation $= -0.15$). By contrast, stocks with a positive β^{VXO} may be viewed as effective hedging instruments that provide significant hedging benefits since the returns of these stocks increase during bad periods with high market volatility. Thus, investors demand higher expected returns for holding riskier inflexible stocks with negative $\text{E[ISKEW]}_{\text{GO}}$ or negative β^{VXO}, whereas they are more willing to pay high prices and accept lower expected returns for stocks with positive $\text{E[ISKEW]}_{\text{GO}}$ or positive β^{VXO}.

The above findings support Ai and Kiku's (2013) conjecture concerning the macroeconomic hedging benefits of growth options, as the cost of exercising growth options (the marginal cost of capital goods) is lower in bad economic states and thereby acts as a hedge against macroeconomic risks to assets-in-place. The procyclical dynamics of the equilibrium price of capital goods thus partially offsets the cyclical fluctuations in assets-in-place, making growth options less vulnerable to aggregate risks than assets-in-place. As a result, investors demand lower returns from growth options.

The above is further supported by our finding that the negative skewness premium is higher during bad states of the economy characterized by lower economic activity, higher economic uncertainty and higher market volatility. We use 3 indicators for the state of the economy: i) the Chicago FED National Activity Index (CFNAI), ii) the economic uncertainty index (JLN) of Jurado, Ludvigson, and Ng (2015), and iii) CBOE's S&P100 option implied volatility index (VXO). Good (bad) states of the economy are characterized by high (low) CFNAI, low (high) JLN and low (high) VXO, corresponding to months in which these variables are observed in the top or bottom 30% of their empirical distributions.

Table 6 provides robustness by replicating Table 5 for good and bad states of the economy separately, showing the average return and alpha spreads of the value-weighted portfolios of stocks sorted by $E[ISKEW]_{GO}$. The average return spreads between high-$E[ISKEW]_{GO}$ and low-$E[ISKEW]_{GO}$ deciles are much higher during bad states of the economy: -1.78% per month (t-stat. $= -2.55$) for low CFNAI, -1.62% (t-stat. $= -2.69$) for high JLN, and -2.03% (t-stat. $= -2.37$) for high VXO periods, compared to -0.94% per month (t-stat. $= -3.20$) for the full sample period in Table 5. The corresponding average return spreads are negative for good states of the economy but much lower in terms of economic magnitude: -0.68% per month (t-stat. $= -1.44$) for high CFNAI,

−0.75% (t-stat. = −1.97) for low JLN, and −0.72% (t-stat. = −1.77) for low VXO periods. Similar findings hold for risk-adjusted returns.

[Table 6 around here]

During bad economic states, investors demand higher expected returns for stocks with negative $E[ISKEW]_{GO}$ because negatively-skewed assets are expected to lose more during bad times due to the persistent nature of expected skewness.[18] Thus, if an investor were to choose between positively skewed vs. negatively skewed assets, she would prefer positively skewed assets particularly during bad economic times. Investors would thus be willing to pay high prices and accept lower expected returns for stocks with positive $E[ISKEW]_{GO}$ since these stocks represent good hedges and deliver benefits exactly in bad times when most needed (i.e., when volatility goes up).

From a real options perspective, negative or low $E[ISKEW]_{GO}$ also represents higher risk exposure in the form of firm rigidity or operating inflexibility risk. From the average firm characteristics of decile 1 of ISKEW-sorted portfolios in Table A.7 Panel B in the Supplementary Material, it can be seen that firms in decile 1 (low skewness) tend to be bigger and more stable (low IVOL), are characterized by higher profitability (ROE) and current asset growth (AG), and have lower future growth options (GO). These firms do relatively better in more stable market environments, but they do not do as well in poor economic states and high volatility environments. When the market declines or the

[18]As Table A.8 in the Supplementary Material shows $E[ISKEW]_{GO}$ is a highly persistent stock characteristic. Thus, during bad economic states with large market declines, investors are exposed to a higher probability of suffering large negative future returns.

economy deteriorates, they face more severe losses as they are committed to higher fixed costs and face higher adjustment costs, but when the market expands they lag behind as they have less growth option potential (i.e., less convexity) to benefit from high volatility. These more rigid and profitable large-scale firms do better in a (middle-of-the-road) stable economic environment, but they are subject to higher market volatility and left-tail (negative skewness) risk as they likely suffer more losses (due to heavier committed scale, fixed and adjustment costs) during market declines. They may also gain less on the upside compared to growth stocks with high positive skewness.[19] While positive return skewness (equity value convexity) provides some hedge against market volatility, low convexity and negative skewness involving more scale commitment and firm rigidity focused on current profitability leaves these inflexible firms exposed to more market volatility and tail risk.

Our main finding (in Table 4) that the proposed skewness factor associated with the presence or absence of growth options helps rationalize the above related anomalies can be seen as follows. Underlying economic shocks involving bad states of the economy and high market volatility lead to low returns for stocks with negative (or low) expected idiosyncratic skewness, such as high asset-in-place or profitability stocks with high risk exposure to firm rigidity or operating inflexibility risk. High profitability (ROE) stocks have a positive exposure to $\text{FISKEW}_{\text{GO}}$, while low profitability (high growth) stocks provide partial insurance against this inflexibility factor (negative exposure). That is,

[19]By contrast, high-growth (and likely low current profitability) firms, which tend to belong in the high skewness subset, would benefit more from high convexity (being out-of-the-money options on the firm's assets) in more volatile environments as they have more optionality to benefit and less (fixed scale) commitment to lose from demand variability.

positively-skewed assets provide a hedge to systematic risk factors, such as market volatility risk, such that investors demand a lower return for these assets. Firms with high expected idiosyncratic skewness and more growth options are therefore less risky due to their lower or negative exposure (hedge) to market volatility and lower cost rigidity. Financially distressed stocks are differentially exposed to these underlying shocks relative to financially healthy stocks, exhibiting different betas (low distress stocks have higher betas to $\text{FISKEW}_{\text{GO}}$). Analogously, stocks with high lotteryness and high idiosyncratic volatility have negative betas, serving as hedging instruments. To further corroborate the above reasoning regarding cost rigidity and firm inflexibility, we follow Anderson et al. (2003) and estimate for each firm the degree of its selling, general and administrative cost (XSGA) stickiness as well as changes in its profitability for negative shocks in revenues. As Table A.9 of the Supplementary Material shows, low-$\text{E[ISKEW]}_{\text{GO}}$ firms exhibit higher cost stickiness compared to high-$\text{E[ISKEW]}_{\text{GO}}$ firms, confirming that they tend to adjust costs more slowly in response to negative economic shocks.

The higher level of XSGA cost stickiness for low-$\text{E[ISKEW]}_{\text{GO}}$ firms translates to lower profit increases during good states of the economy but higher profit decreases during bad states. High-$\text{E[ISKEW]}_{\text{GO}}$ firms experience higher profit increases in good states, while being more protected (suffering lower profit declines) on the downside. In this sense, high-$\text{E[ISKEW]}_{\text{GO}}$ firms involving more growth options provide more hedging benefits so that investors accept lower returns, in line with our above arguments and those of Ai and Kiku (2013), while low-$\text{E[ISKEW]}_{\text{GO}}$ firms have higher risk exposure to negative shocks due to cost rigidity and firm inflexibility (e.g., see also Zhang (2005)), requiring higher returns.

To corroborate the claim that low-E[ISKEW]$_{GO}$ firms involve higher cost rigidity and likely proxy for operating leverage (representing a higher mix of assets-in-place vs. growth options), and hence are more risky requiring higher returns, we examine 2 additional measures: operating leverage (OPLEV) measured as operating costs divided by total assets as in Novy-Marx (2011) and tangible fixed assets (TFA) measured by property, plant and equipment (PP&E) to total assets, therby capturing operating inflexibility in line with Anderson et al. (2003). Results in Tables A.7 and Panel C of Table A.9 in the Supplementary Material confirm that firms in low skewness (ISKEW) or low-E[ISKEW]$_{GO}$ deciles have significantly higher operating leverage and tangible fixed assets as a percentage of total assets, representing greater operating inflexibility and cost rigidity.

Real options theory further suggests that the value of growth options, and consequently their asymmetric impact on returns via idiosyncratic skewness, should be more pronounced in more volatile market environments. To further corroborate this hypothesis, we investigate the predictive power of E[ISKEW]$_{GO}$ for periods of high versus low market volatility. We use the monthly realized variance of the aggregate stock market portfolio to determine high versus low market volatility environments. Following French, Schwert and Stambaugh (1987) and follow-on studies, the monthly realized volatility of the market is estimated as the sum of squared daily market returns in a month. High (low) market volatility periods here correspond to months in which the realized variance of the market is above (below) its median. We then repeat the univariate value-weighted portfolio tests (reported in Table 5) separately for high- and low-market volatility periods. Table 7 shows that the value-weighted (VW) average return spread between high-E[ISKEW]$_{GO}$ and low-E[ISKEW]$_{GO}$ (10-1) deciles is −0.40% per month (t-stat. = −1.49) for low market volatility periods, whereas the corresponding return spread is more significant for high-volatility periods: −1.48% per month (t-stat. = −2.94). Analogous results are obtained based on the risk-adjusted returns using the 3 different factor models. As shown in Table 7, the FFCPS, FF5, and Q-factor alpha differences between deciles 1 and 10 are in the range of −0.60% and −0.77% per month for low market volatility periods, whereas the corresponding alpha spreads are much higher, in the range of −0.78% to −1.35% per month, for high-volatility periods. Overall, these results provide further supporting evidence that the negative cross-sectional relation between E[ISKEW]$_{GO}$ and future returns is more pronounced in volatile markets.

[Table 7 around here]

V Conclusion

This paper provides new evidence about the economic role of growth options behind several stock market anomalies and the economics of the relationship between growth options and risk exposure. It then develops a measure of the asymmetric impact of growth options on stock returns via the channel of expected idiosyncratic skewness. This measure is able to explain these anomalies (namely the profitability anomaly, the distress risk puzzle, lotteryness, and the idiosyncratic volatility effect). We have shown that this set of anomalies is related to growth options, that the discretionary nature of growth options and real options in general increases idiosyncratic skewness, and that growth options influence stock returns via the channel of expected idiosyncratic skewness (a channel analogous but distinct from the channel of idiosyncratic volatility). Hence, growth options are positive drivers of idiosyncratic skewness and growth-options-induced expected idiosyncratic skewness commands a negative stock return premium. A rational transmission mechanism from growth options to stock returns operates through observable idiosyncratic skewness characteristics. The negative cross-sectional relations found in prior studies between distress risk, lotteryness, and idiosyncratic volatility with stock returns, as well as the positive relation found between profitability and stock returns, can thus be linked to growth options and the resulting skewed distribution of returns associated with the presence or absence of growth options and firm (in)flexibility. Our findings help rationalize the link between growth options, return asymmetry via idiosyncratic skewness, and (lower) risk exposure. Investors are willing to accept lower returns as a result of the more favorable (positively skewed) risk-return profile and resulting macroeconomic hedging benefits associated with growth options and their lower risk exposure. Conversely, investors demand a higher return for operating inflexibility or firm rigidity risk associated with the lack of such growth options or greater capital asset commitment, as it exposes them to more severe losses in bad economic states or periods of high market volatility. Although idiosyncratic skewness may also increase due to other reasons (such as a default/reorganization option associated with distress or due to lottery behavior), we document that it is investors' expectation of idiosyncratic skewness associated with the presence or absence of growth options or firm rigidity in particular that lies behind and thus helps explain the above related anomalous phenomena.

In line with real options theory concerning such growth options, we have further shown that firms' risk exposure to our novel idiosyncratic skewness factor is more severe in volatile market environments and contributes significantly to explaining these anomalies. Firm positive skewness associated with growth options provides a hedge against bad economic states and market volatility risk. Firms with high assets-in-place and negative skewness involving more scale commitment and cost rigidity are, by contrast, exposed to more volatility risk and have higher loadings on the inflexibility skewness factor. The resulting skewness risk premium associated with growth options is economically significant, corresponding to an annualized risk-adjusted return of 8% to 12%. Uncovering the economics of the relationship between growth options, their impact on idiosyncratic skewness and their risk exposure is fundamental in acquiring a deeper understanding of the anomalous returns involving the related "anomalies" of profitability, distress, lotteryness, and idiosyncratic volatility.

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TABLE 1

Summary Statistics of Main Variables

Table 1 reports summary statistics (Panel A) and correlations (Panel B) for the main variables used in our empirical analyses. R is the monthly return; Market risk (BETA) is estimated over a 3-year period using the Sharpe–Lintner CAPM model as in Fama and French (1992); SIZE is measured as the natural logarithm of the market value of equity (ME) (price per share multiplied by number of shares outstanding); Book-to-market (BM) is measured as the book value of equity divided by the market value of equity (ME); MOM is momentum measured as the compound gross return from month $t-12$ to $t-2$; Asset growth (AG) is measured as the percent change in total assets; Profitability (ROE) is calculated as the ratio of operating cash flow to shareholder's equity; Leverage (LEV) is calculated as the ratio of book value of debt to quasi market value of the firm; GO is the value of future growth options calculated as per equation (3); DR is distress calculated as the Merton's (1974) negative distance to default ($-d_2$); MAX is the maximum daily return in the previous month (proxying for lotteryness); TURN is turnover calculated as the ratio of trading volume to total shares outstanding; $E[ISKEW]_{GO}$ is expected idiosyncratic skewness arising from growth options calculated based on equation (4) with coefficients estimated based on equation (2) over a horizon of past 5 years.

TABLE 1 (continued)

Panel A. Summary Statistics

Variable	Mean	Median	Std. Dev.	Min	Max
R	0.93	0.56	13.74	-42.86	68.12
BETA	1.13	1.06	0.77	-0.81	4.02
SIZE	12.34	12.31	2.08	7.86	17.08
BM	0.65	0.49	0.57	-0.32	3.72
MOM	0.13	0.05	0.50	-0.74	2.69
AG	0.11	0.06	0.28	-0.44	1.99
ROE	0.03	0.09	0.33	-2.47	1.53
LEV	0.37	0.35	0.22	0.03	0.89
GO	0.67	0.58	0.76	-1.23	3.90
DR	-6.81	-5.66	4.81	-27.48	-0.36
MAX	0.07	0.06	0.06	0.01	0.37
TURN	1.21	0.75	1.32	0.02	8.22
IVOL	0.04	0.03	0.02	0.01	0.10
$E[ISKEW]_{GO}$	0.12	0.08	0.19	-0.33	1.17

Panel B. Pearson Correlation Coefficients

	R	BETA	SIZE	BM	MOM	AG	ROE	LEV	GO	DR	MAX	TURN	IVOL	$E[ISKEW]_{GO}$
R	1	0.00	-0.02	0.02	0.01	-0.02	0.00	0.02	-0.03	0.01	0.01	-0.01	0.02	0.00
BETA		1	0.12	-0.05	0.04	0.04	0.00	-0.08	0.12	0.16	0.04	0.21	0.11	0.06
SIZE			1	-0.29	0.09	0.05	0.00	-0.28	-0.22	-0.40	-0.35	0.25	-0.60	-0.19
BM				1	-0.08	-0.10	-0.01	0.36	0.01	0.18	0.11	-0.09	0.08	0.04
MOM					1	-0.04	0.00	-0.20	-0.06	-0.01	-0.06	0.15	0.08	0.04
AG						1	-0.01	-0.09	0.02	0.01	-0.01	0.06	0.04	0.01
ROE							1	0.00	-0.01	0.00	0.00	0.00	0.00	-0.01
LEV								1	-0.14	0.52	0.09	-0.13	0.03	-0.04
GO									1	0.06	0.20	0.02	0.30	0.49
DR										1	0.25	0.04	0.42	0.12
MAX											1	0.16	0.48	0.21
TURN												1	0.02	0.02
IVOL													1	0.34
$E[ISKEW]_{GO}$														1

TABLE 2

Cross-Sectional Determinants of Idiosyncratic Skewness

Table 2 presents the time-series average of the slope coefficients from the monthly cross-sectional regressions of idiosyncratic skewness on growth options (GO), other real option-related variables (ROE, DR, MAX, IVOL) and several control variables as in equation (2). The dependent variable is the realized idiosyncratic skewness (ISKEW) estimated over a period of 5 years ($T = 60$ months from t to $t + T$). To make the estimation feasible all independent variables are lagged and fully observable at time $t - 1$. The values in parentheses are Newey and West (1987) t-statistics computed with 6 lags. GO is the growth option (GO) value calculated as per equation (3); ROE proxies for profitability calculated as the ratio of operating cash flow to shareholder's equity; Distress risk (DR) is the Merton's negative distance to default (-d_2); MAX is the maximum daily return observed in the previous month and IVOL is the lagged idiosyncratic volatility. Other controls include asset growth (AG) calculated as the percent change in firm total assets over the previous year; (AG $\times$ IVOL) is the interaction between the percent change in total assets of the previous year AG and lagged idiosyncratic volatility IVOL; Book-to-market ratio (BM) is calculated as the ratio of shareholder's equity value to market capitalization; turnover (TURN) is calculated as the ratio of trading volume to total shares outstanding; leverage (LEV) is calculated as the ratio of total liabilities to quasi market value of the firm; lagged idiosyncratic skewness (ISKEW) is the realized idiosyncratic skewness calculated in the preceding non-overlapping 5 years; SMALL and BIG are 2 binary dummies built on the bottom 30% and top 30% of lagged market capitalization; INDU and EXCH are dummies for the Fama and French 10 industries and for the NASDAQ. The last row reports the average adjusted R^2 values. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. $N = 335$ monthly observations.

TABLE 2 (continued)

Variable	1	2	3	4	5	6	7
Constant	0.583*** (18.00)	0.787*** (25.25)	0.909*** (24.93)	0.621*** (14.72)	0.330*** (5.57)	0.240*** (5.61)	0.179** (2.56)
ISKEW						0.080*** (6.81)	0.057*** (4.61)
GO	0.203*** (12.88)					0.179*** (11.53)	0.138*** (9.64)
ROE		-0.291*** (-11.47)					-0.052** (-2.07)
DR			0.025*** (16.93)				0.008*** (5.42)
MAX				1.697*** (10.99)			0.716*** (5.08)
IVOL					13.377*** (12.18)		7.386*** (6.83)
AG						-0.065** (-2.02)	-0.281*** (-4.26)
(AG × IVOL)						— —	4.093** (2.00)
BM						0.074*** (5.49)	0.082*** (5.52)
TURN						-0.023*** (-3.23)	-0.060*** (-8.19)
LEV						0.624*** (8.06)	0.542*** (6.87)
SMALL	0.843*** (22.02)	0.849*** (22.68)	0.804*** (18.92)	0.827*** (21.52)	0.701*** (21.74)	0.677*** (22.76)	0.534*** (19.83)
BIG	-0.443*** (-16.95)	-0.422*** (-16.98)	-0.359*** (-15.49)	-0.440*** (-17.47)	-0.353*** (-13.17)	-0.320*** (-14.12)	-0.186*** (-7.17)
INDU EXCH	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
R^2	11.0%	10.7%	10.4%	10.9%	11.4%	12.9%	13.6%

TABLE 3

Cross-Sectional Regressions of Future Returns on E[ISKEW]$_{GO}$ and Control Variables

Table 3 examines the cross-sectional relation between E[ISKEW]$_{GO}$ and 1-month-ahead return at the stock-level using Fama and MacBeth (1973) regressions. Reported coefficients are the time-series averages of month-by-month standardized regressions over 335 months (from Feb. 1988 to Dec. 2015). The t-statistic is the average slope divided by its time-series Newey and West (1987) standard errors. BETA is the firm's market beta; BM is book-to-market ratio; SIZE is the natural logarithm of the market value of equity; MOM is momentum measured as the compound gross return from month $t-12$ to $t-2$; ROE is return on equity; AG is asset growth; E[ISKEW]$_{GO}$ is expected idiosyncratic skewness attributed to growth options alone as per equation (4) over a horizon of 60 months. Panel B shows robustness regressions within various subsamples. "Big" refers to the subsample of firms in the top (66th) percentile on market equity (ME), "Liquid" refers to firms in the lowest (33rd) percentile of bid–ask spread, "Big and Liquid" refers to a joint subsample of Big and Liquid firms, "Low Price excl." excludes firms with market price less than $1, and "NYSE" refers to a subsample of firms traded only on the NYSE. Specification Low vs. High volatility runs separately on firms in the lowest (bottom 33rd) and highest (top 33rd) percentiles of idiosyncratic volatility. Panel C shows additional robustness after controlling for additional covariates like distress risk (DR), lotteryness (MAX), idiosyncratic volatility (IVOL), exposure to changes in CBOE's VXO (β^{VXO}) calculated as in Ang et al. (2006) and analysts' forecast dispersion (DISP) following Diether et al. (2002). *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

TABLE 3 (continued)

	BETA	SIZE	BM	MOM	ROE	AG	E[ISKEW]$_{GO}$	R^2
Panel A. Fama and MacBeth (1973) Cross-Sectional Regressions								
1	-0.002	-0.268**	0.176	0.279***				2.61%***
	(-0.02)	(-2.26)	(2.79)	(3.16)				(9.94)
2	0.031	-0.271***	0.117**	0.245***	0.146**	-0.352***		3.23%
	(0.33)	(-2.56)	(1.96)	(2.83)	(2.49)	(-8.54)		(10.2)
3	0.113	-0.437***	0.065	0.129	0.010	-0.277***	-0.338***	3.52%***
	(1.23)	(-4.73)	(1.06)	(1.52)	(0.21)	(-6.83)	(-5.13)	(10.6)
Panel B. Robustness on Various Subsamples Based on Model 3								
Big	0.009	-0.051	0.043	0.200*	0.055	-0.135***	-0.319***	7.65%***
	(0.09)	(-0.91)	(0.84)	(1.89)	(1.48)	(-3.65)	(-6.72)	(13.4)
Liquid	0.031	-0.128*	0.059	0.287***	0.053	-0.150***	-0.437***	7.15%***
	(0.31)	(-1.88)	(0.87)	(2.64)	(1.24)	(-3.49)	(-6.29)	(14.7)
Big and Liquid	0.000	-0.063	0.021	0.281**	0.051	-0.080*	-0.342***	8.28%***
	(0.01)	(-1.13)	(0.31)	(2.49)	(0.97)	(-1.93)	(-5.46)	(13.7)
Low Price excl.	0.100	-0.313***	0.063	0.182*	0.019	-0.251***	-0.364***	3.75%***
	(1.16)	(-3.87)	(1.08)	(1.88)	(0.39)	(-5.76)	(-5.43)	(11.1)
NYSE	0.020	-0.154**	0.089	0.200	0.005	-0.105**	-0.337***	5.80%***
	(0.29)	(-2.08)	(1.25)	(1.62)	(0.14)	(-2.45)	(-7.56)	(14.0)
Low volatility	0.033	-0.220***	-0.020	0.234***	0.040	-0.089***	-0.319***	3.66%***
	(0.79)	(-3.77)	(-0.48)	(3.08)	(1.21)	(-3.11)	(-7.69)	(16.6)
High volatility	0.181**	-0.741***	0.100	0.136	0.024	-0.346***	-0.414***	2.80%***
	(2.17)	(-6.04)	(1.23)	(1.35)	(0.45)	(-5.17)	(-5.03)	(11.4)

TABLE 3 (continued)

Panel C. Robustness of Model 3 Controlling for DR, MAX, IVOL, β^{VXO} and DISP

	BETA	SIZE	BM	MOM	ROE	AG	$E[ISKEW]_{GO}$	DR	MAX	IVOL	β^{VXO}	DISP	R^2
4	0.133	-0.456***	0.067	0.156	-0.006	-0.243***	-0.362***	-0.140***					3.92%***
	(1.55)	(-5.57)	(1.11)	(1.61)	(-0.13)	(-5.54)	(-5.65)	(-2.62)					(11.33)
5	0.123	-0.445***	0.058	0.164*	-0.004	-0.262***	-0.350***		-0.142*				4.07%***
	(1.45)	(-5.83)	(0.91)	(1.67)	(-0.08)	(-6.09)	(-6.24)		(-1.79)				(11.12)
6	0.101	-0.421***	0.060	0.119	0.016	-0.275***	-0.355***			0.029			3.91%***
	(1.34)	(-6.08)	(0.99)	(1.38)	(0.41)	(-6.41)	(-6.62)			(0.28)			(10.79)
7	0.113	-0.437***	0.066	0.127	0.010	-0.276***	-0.337***				-0.088***		3.63%***
	(1.23)	(-4.72)	(1.07)	(1.49)	(0.24)	(-6.85)	(-5.08)				(-2.81)		(10.74)
8	0.074	-0.199***	0.054	0.213**	0.032	-0.210***	-0.353***					-0.097***	5.51%***
	(0.78)	(-2.78)	(0.81)	(2.19)	(0.75)	(-6.42)	(-6.19)					(-2.97)	(13.56)
9	0.057	-0.203***	0.084	0.188*	0.015	-0.192***	-0.345***	-0.099***	-0.140***	0.150*	-0.043	-0.143***	6.66%***
	(0.78)	(-3.54)	(1.35)	(1.82)	(0.39)	(-5.38)	(-6.57)	(-3.03)	(-2.95)	(1.85)	(-1.31)	(-3.08)	(14.37)

TABLE 4

Factor Analysis and Explained Anomalies

Panel A of Table 4 contains risk-adjusted returns (in percentages) for 10 value-weighted decile portfolios sorted by ROE, DR, MAX, and IVOL. Risk-adjusted returns (alphas) are obtained by regressing each portfolio's excess return on the market (MKT), size (SMB), and book-to-market (HML) factors of Fama and French (1993), the momentum (MOM) factor of Carhart (1997), and the liquidity risk (LIQ) factor of Pastor and Stambaugh (2003). "FFCPS Alpha Diff." is the risk-adjusted return spread between decile 1 and decile 10. Alpha(FFCPS + $\text{FISKEW}_{\text{GO}}$) is the risk-adjusted return obtained by augmenting the 5-factor model with a factor $\text{FISKEW}_{\text{GO}}$ built on expected skewness differentials attributed to GO as per equation (4). Alpha(FFCPS + $\text{FTSKEW}_{\text{GO}}$) is the risk-adjusted return obtained by augmenting the 5-factor model with a factor $\text{FTSKEW}_{\text{GO}}$ built on expected total skewness differentials attributed to GO. Panel B presents results with alternative factors FISKEW_{X} built on expected idiosyncratic skewness attributed to ROE, DR, MAX, or IVOL. Newey and West (1987) corrected t-statistics with 6 lags are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. $N = 335$ monthly observations.

TABLE 4 (continued)

Panel A. Market Anomalies and Expected Skewness Factor Based on Growth Options

Portfolios	Profitability ROE 1	Distress DR 2	Lottery MAX 3	Volatility IVOL 4
1 (Low)	-0.383*** (-2.59)	0.192** (2.15)	0.121 (1.22)	0.177** (2.11)
2	-0.187 (-1.56)	0.168** (2.05)	0.129 (1.53)	0.104 (1.14)
3	-0.155* (-1.74)	-0.021 (-0.24)	0.078 (0.60)	0.009 (0.13)
4	-0.017 (-0.21)	-0.139 (-1.13)	0.208 (1.48)	0.025 (0.26)
5	-0.093 (-1.01)	0.039 (0.33)	0.138 (1.17)	-0.087 (-0.96)
6	-0.038 (-0.56)	-0.063 (-0.45)	-0.279 (-1.64)	0.207* (1.86)
7	0.033 (0.51)	-0.126 (-0.95)	0.181 (0.85)	-0.071 (-0.67)
8	0.176* (1.95)	-0.295* (-1.81)	-0.155 (-0.99)	0.237 (1.56)
9	0.179** (2.50)	-0.263 (-1.37)	-0.406* (-1.70)	-0.049 (-0.30)
10 (High)	0.203** (2.18)	-0.316 (-1.36)	-0.726** (-2.30)	-0.566*** (-2.93)
FFCPS Alpha Diff. $(10-1)$ *t*-stat.	0.586*** (2.91)	-0.509** (-2.02)	-0.847** (-2.46)	-0.743*** (-3.08)
(FFCPS + $\text{FISKEW}_{\text{GO}}$) Alpha Diff. *t*-stat.	0.154 (0.74)	-0.233 (-0.87)	0.090 (0.24)	-0.179 (-0.76)

Panel B. Robustness Using Alternative Expected Skewness Factors Based on Other Variables

Hedge Portfolios	Profitability ROE 1	Distress DR 2	Lottery MAX 3	Volatility IVOL 4
(FFCPS + $\text{FISKEW}_{\text{ROE}}$) Alpha Diff. *t*-stat.	0.452** (2.39)	-0.331 (-1.30)	-0.591* (-1.87)	-0.565** (-2.44)
(FFCPS + $\text{FISKEW}_{\text{DR}}$) Alpha Diff. *t*-stat.	0.472** (2.39)	-0.338 (-1.30)	-0.660* (-1.78)	-0.582** (-2.43)
(FFCPS + $\text{FISKEW}_{\text{MAX}}$) Alpha Diff. *t*-stat.	0.584*** (2.92)	-0.506** (-2.06)	-0.838*** (-2.64)	-0.739*** (-3.31)
(FFCPS + $\text{FISKEW}_{\text{IVOL}}$) Alpha Diff. *t*-stat.	0.512*** (2.60)	-0.446* (-1.80)	-0.706** (-2.36)	-0.619*** (-2.95)

TABLE 5

Univariate Portfolio Analysis and Economic Significance of E[ISKEW]$_{\mathbf{GO}}$

Table 5 presents the univariate portfolio results from sorting stocks into decile portfolios based on expected idiosyncratic skewness arising from growth options, E[ISKEW]$_{\mathrm{GO}}$. The first row presents the average E[ISKEW]$_{\mathrm{GO}}$ of individual stocks in each decile. The second and third rows report the equal-weighted and value-weighted average returns of each decile. The last 3 rows show the risk-adjusted returns (alphas) on the value-weighted portfolios with respect to 3 different factor models: i) FFCPS alpha is with respect to the market (MKT), size (SMB), book-to-market (HML), momentum (MOM), and liquidity risk (LIQ) factors of Fama and French (1993), Carhart (1997), and Pastor and Stambaugh (2003); ii) FF5 alpha is with respect to the market (MKT), size (SMB), book-to-market (HML), investment (CMA), and profitability (RMW) factors of Fama and French (1993), (2015); and iii) Q-factor alpha is with respect to the market (MKT), size (SMB), investment ($\mathrm{R}_{I/A}$), and profitability ($\mathrm{R}_{\mathrm{ROE}}$) factors of Hou et al. (2015). The last column reports the $10-1$ differences in average E[ISKEW]$_{\mathrm{GO}}$, average raw returns, and alphas. t-statistics in parentheses are corrected for autocorrelation and heteroskedasticity using Newey and West (1987) standard errors with 6 lags.

TABLE 5 (continued)

	$E[ISKEW]_{GO}$										
	1 (Low)	2	3	4	5	6	7	8	9	10 (High)	Hedge (10 − 1)
$E[ISKEW]_{GO}$	-0.139 (-8.76)	-0.008 (-1.02)	0.036 (4.98)	0.066 (8.23)	0.092 (9.75)	0.121 (10.56)	0.155 (11.00)	0.206 (11.13)	0.298 (10.88)	0.616 (10.79)	0.755*** (11.94)
EW raw return	1.641 (4.63)	1.445 (4.79)	1.222 (4.13)	0.984 (3.31)	0.913 (3.12)	0.747 (2.40)	0.578 (1.72)	0.580 (1.47)	0.556 (1.20)	0.990 (1.82)	-0.651* (-1.80)
VW raw return	1.162 (4.28)	0.878 (3.60)	0.804 (3.29)	0.579 (2.41)	0.733 (2.97)	0.328 (1.17)	0.317 (0.98)	0.685 (1.75)	0.278 (0.71)	0.225 (0.52)	-0.937*** (-3.20)
(FFCPS) Alpha	0.587 (3.60)	0.284 (2.58)	0.314 (2.60)	0.007 (0.09)	0.123 (1.27)	-0.383 (-3.34)	-0.380 (-2.69)	-0.161 (-0.91)	-0.456 (-2.17)	-0.361 (-1.39)	-0.947*** (-3.47)
(FF5) Alpha	0.364 (2.46)	0.148 (1.18)	0.238 (1.99)	-0.078 (-1.02)	0.079 (0.73)	-0.324 (-2.88)	-0.318 (-1.78)	-0.003 (-0.01)	-0.233 (-1.17)	-0.375 (-1.27)	-0.738*** (-2.76)
(Q-factor) Alpha	0.493 (2.69)	0.178 (1.23)	0.353 (2.82)	-0.049 (-0.56)	0.041 (0.32)	-0.383 (-3.11)	-0.438 (-2.31)	0.006 (0.02)	-0.184 (-0.76)	-0.194 (-0.62)	-0.687** (-2.34)

TABLE 6

Expected Skewness Premium during Bad and Good States of the Economy

Table 6 presents the univariate portfolio results from sorting stocks into value-weighted (VW) decile portfolios based on E[ISKEW]$_{\text{GO}}$ for bad and good states of the economy separately. We use 3 economic indicators to determine the states of the economy: i) The Chicago Fed National Activity Index (CFNAI); ii) the Jurado et al. (2015) uncertainty index (JLN); and iii) the CBOE's S&P 100 volatility index (VXO). High (low) periods correspond to months in which the realized variable is in the top (bottom) 30%. The first row reports the value-weighted average raw returns of High (top 10th decile) minus Low (bottom 1st decile) portfolios based on E[ISKEW]$_{\text{GO}}$. The last 3 rows show the risk-adjusted returns (alphas) of the High minus Low portfolios with respect to 3 different factor models: i) FFCPS, using the market (MKT), size (SMB), book-to-market (HML), momentum (MOM), and liquidity risk (LIQ) factors of Fama and French (1993), Carhart (1997), and Pastor and Stambaugh (2003); ii) FF5, using the market (MKT), size (SMB), book-to-market (HML), investment (CMA), and profitability (RMW) factors of Fama and French (1993), (2015); and iii) Q-factor, using the market (MKT), size (SMB), investment ($R_{I/A}$), and profitability (R_{ROE}) factors of Hou et al. (2015). t-statistics in parentheses are corrected for autocorrelation and heteroskedasticity using Newey and West (1987) standard errors with 6 lags are given in parentheses.

TABLE 6 (continued)

	Hedge (10 − 1)					
	CFNAI		JLN Uncertainty Index		VXO	
	Low	High	Low	High	Low	High
VW raw ret.	-1.782**	-0.678	-0.754**	-1.622***	-0.718*	-2.030**
	(-2.55)	(-1.44)	(-1.97)	(-2.69)	(-1.77)	(-2.37)
(FFCPS) Alpha Diff.	-1.770***	-0.795*	-0.585	-1.631***	-0.203	-1.635**
	(-3.55)	(-1.87)	(-1.52)	(-4.21)	(-0.40)	(-2.51)
(FF5) Alpha Diff.	-0.974*	-0.463	0.006	-1.028**	-0.021	-1.091
	(-1.89)	(-1.47)	(0.02)	(-2.26)	(-0.05)	(-1.60)
(Q-factor) Alpha Diff.	-1.040	-0.274	-0.444	-1.324***	-0.676	-1.162*
	(-1.53)	(-0.62)	(-1.01)	(-2.59)	(-1.28)	(-1.75)

TABLE 7

Market Volatility Effect

Table 7 presents the univariate portfolio results from sorting stocks into decile portfolios based on $E[ISKEW]_{GO}$ for periods of high versus low market volatility. Market volatility is calculated as the standard deviation of daily market returns over the previous month. High (low) market volatility periods correspond to months in which the realized variance of the market is above (below) its median. The first row presents the average $E[ISKEW]_{GO}$ of individual stocks in each decile. The second and third rows report the equal-weighted and value-weighted average returns of each decile. The last 3 rows show the risk-adjusted returns (alphas) with respect to 3 different factor models: i) FFCPS alpha is with respect to the market (MKT), size (SMB), book-to-market (HML), momentum (MOM), and liquidity risk (LIQ) factors of Fama and French (1993) , Carhart (1997), and Pastor and Stambaugh (2003); ii) FF5 alpha is with respect to the market (MKT), size (SMB), book-to-market (HML), investment (CMA), and profitability (RMW) factors of Fama and French (1993, 2015); and iii) Q-factor alpha is with respect to the market (MKT), size (SMB), investment ($R_{I/A}$), and profitability (R_{ROE}) factors of Hou et al. (2015). The last column reports the $10-1$ differences in average $E[ISKEW]_{GO}$, average raw returns, and alphas. t-statistics in parentheses are corrected for autocorrelation and heteroskedasticity using Newey and West (1987) standard errors with 6 lags.

TABLE 7 (continued)

	1 (Low)	2	3	4	5	6	7	8	9	10 (High)	Hedge (10 − 1)
Panel A. E[ISKEW]$_{GO}$: Low Market Volatility											
E[ISKEW]$_{GO}$	-0.139	-0.005	0.036	0.064	0.088	0.114	0.145	0.189	0.270	0.525	0.665***
	(-5.08)	(-0.42)	(3.21)	(5.29)	(6.38)	(6.99)	(7.39)	(7.61)	(7.42)	(7.35)	(8.32)
EW raw ret.	2.698	2.371	2.189	1.914	1.807	1.815	1.606	1.724	1.666	2.158	-0.540**
	(8.49)	(10.15)	(9.24)	(8.10)	(7.49)	(6.56)	(5.30)	(4.95)	(4.17)	(4.84)	(-2.01)
VW raw ret.	1.937	1.775	1.525	1.451	1.477	1.136	1.469	1.753	1.502	1.538	-0.399
	(7.81)	(8.37)	(6.92)	(5.70)	(5.93)	(4.49)	(4.52)	(3.62)	(3.98)	(4.14)	(-1.49)
(FFCPS) Alphas	0.371	0.428	0.127	0.086	-0.038	-0.521	-0.684	-0.487	-0.443	-0.231	-0.602
	(1.76)	(2.97)	(1.13)	(0.73)	(-0.36)	(-3.28)	(-4.52)	(-2.50)	(-2.04)	(-0.69)	(-1.62)
(FF5) Alphas	0.204	0.230	0.037	-0.014	-0.053	-0.639	-0.344	0.137	-0.140	-0.393	-0.597*
	(0.91)	(1.38)	(0.31)	(-0.13)	(-0.61)	(-3.99)	(-2.20)	(0.39)	(-0.64)	(-1.20)	(-1.80)
(Q-factor) Alphas	0.269	0.292	0.129	-0.029	-0.105	-0.794	-0.496	0.177	-0.186	-0.501	-0.770**
	(1.03)	(1.49)	(0.92)	(-0.23)	(-0.92)	(-4.06)	(-2.71)	(0.32)	(-0.64)	(-1.42)	(-2.16)
Panel B. E[ISKEW]$_{GO}$: High Market Volatility											
E[ISKEW]$_{GO}$	-0.139	-0.011	0.035	0.067	0.096	0.127	0.166	0.224	0.327	0.707	0.846***
	(-10.98)	(-1.64)	(5.81)	(8.86)	(9.76)	(10.12)	(10.08)	(9.79)	(9.55)	(9.58)	(10.19)
EW raw ret.	0.577	0.513	0.249	0.047	0.013	-0.328	-0.457	-0.571	-0.561	-0.184	-0.762
	(0.97)	(0.99)	(0.49)	(0.09)	(0.02)	(-0.61)	(-0.80)	(-0.83)	(-0.71)	(-0.19)	(-1.21)
VW raw ret.	0.382	-0.025	0.078	-0.298	-0.016	-0.486	-0.842	-0.390	-0.954	-1.095	-1.477***
	(0.83)	(-0.06)	(0.19)	(-0.72)	(-0.04)	(-1.01)	(-1.54)	(-0.61)	(-1.34)	(-1.42)	(-2.94)
(FFCPS) Alphas	0.683	0.201	0.366	0.007	0.266	-0.235	-0.501	-0.045	-0.634	-0.669	-1.352***
	(2.85)	(1.15)	(1.88)	(0.05)	(1.76)	(-1.53)	(-2.05)	(-0.20)	(-1.91)	(-1.80)	(-3.41)
(FF5) Alphas	0.463	0.105	0.390	-0.104	0.165	-0.142	-0.387	0.022	-0.258	-0.312	-0.775*
	(2.19)	(0.55)	(2.03)	(-0.80)	(0.90)	(-0.92)	(-1.19)	(0.10)	(-0.77)	(-0.64)	(-1.70)
(Q-factor) Alphas	0.654	0.135	0.464	-0.025	0.144	-0.180	-0.517	-0.027	-0.319	-0.212	-0.866*
	(2.60)	(0.67)	(2.50)	(-0.19)	(0.76)	(-1.20)	(-1.72)	(-0.08)	(-0.87)	(-0.47)	(-1.91)