SEO Risk Dynamics

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We theoretically and empirically investigate firm-level risk dynamics around seasoned equity offerings. Empirically, beta increases before SEOs and decreases gradually thereafter. Using real-options theory, commitment-to-invest generates a gradual post-issuance beta decline whereas instantaneous investment and standard time-to-build do not. In a behavioral theory, systematic mispricing can cause increasing pre-issuance and decreasing post-issuance risk but idiosyncratic mispricing cannot. In the empirical cross-section, investment, own-firm runup, SEO proceeds, and primary issuance – associated with the real options theory – predict beta declines. Sentiment proxies have weaker effects in the full sample, but are significant in a post-1996 subsample. SEOs coincide with low firm- and market-volatility, suggesting volatility-timing in corporate decisions.

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1 Introduction

The pattern of stock returns through seasoned equity offering (SEO) episodes has attracted a great deal of interest and research. Summarizing a large literature,[1] Ritter (2003) reports an average return of approximately 72% in the year prior to announcement, a two-day cumulative return of -2% around the announcement date, and underperformance of about 5% per year in the five years subsequent to issuance.

Two views of these facts have emerged. Behavioral theories explain that pre-issuance run-up relates to overweighting of positive news; that managers (either deliberately or also through excessive enthusiasm) issue equity while stock prices are high; and that markets only partially react to the SEO announcement, permitting slow learning and long-run underperformance.[2] By contrast, real options theories explain that seasoned equity offerings are associated with real investment, optimally timed to occur after growth options move into the money and stock prices increase. Since the real options theory incorporates rational expectations, announcement of a seasoned offering impacts prices fully and immediately. Apparent long-run underperformance occurs because exercising (or deleveraging) a growth option causes an immediate reduction in asset risk.[3]

The behavioral and real options theories explain the same set of average return facts, but have different implications for risk. In particular, current behavioral theory does not address how risk should evolve through the SEO episode. By contrast, a real options explanation suggests that risk loadings should increase prior to issuance, as optimally timed investment approaches and growth option leverage rises. Further, undertaking investment should cause risk to decline as growth option leverage falls.

In this paper, we present new evidence on the dynamics of firm level risk throughout the SEO episode. Our principal empirical finding is that beta increases prior to the SEO announcement and decreases after issuance. We document this result using a sample of over 5,700 seasoned equity

[1] Evidence on long-run performance is given by Brav, Geczy, and Gompers (2000), Clarke, Dunbar, and Kahle (2001), Eckbo, Masulis, and Norli (2000), Jegadeesh (2000), Loughran and Ritter (1995), Lyandres, Sun, and Zhang (2008), Mitchell and Stafford (2000), and Spiess and Affleck-Graves (1995). Announcement effects are studied by Asquith and Mullins (1986), Masulis and Korwar (1986), Mikkelsen and Partch (1986), and others. Evidence of pre-SEO stock price run-up is given by Korajczyk, Lucas, and McDonald (1990) and Loughran and Ritter (1995). Eckbo and Masulis (1995) survey the earlier literature.

[2] Daniel, Hirshleifer, and Subrahmanyam (1998) develop a comprehensive behavioral theory of SEO episode returns. Loughran and Ritter (1995), Bayless and Chaplinsky (1996), and Baker and Wurgler (2000) give more informal discussions of “windows of opportunity” and “market timing.” Baker, Ruback, and Wurgler (2004) survey the behavioral corporate finance literature.

[3] See, for example, Carlson, Fisher, and Giammarino (2006), who develop a real options theory of SEO episode returns. This theory is broadly linked to contributions by Berk, Green, and Naik (1999), Brennan and Schwartz (1985), Carlson, Fisher, and Giammarino (2004), Cooper (2006), Gomes, Kogan, and Zhang (2003), Kogan (2004), Li, Livdan, and Zhang (2009), Lucas and McDonald (1990), McDonald and Siegel (1985), Pastor and Veronesi (2005), and Zhang (2005).

issuances over a twenty five year period. Our base results use monthly betas calculated from daily data, following the high-frequency or "realized beta" approach.[4] The pattern of average beta dynamics differs significantly from that found in size and book-to-market matches. We show that the basic results are robust to calculating beta over longer time periods, to using leads and lags of the data to control for microstructure issues as in Dimson (1979), and to instrumenting for conditional beta as in Ghysels and Jacquier (2006).

Our finding that beta dynamics of SEO firms are consistent with the predictions of real options models is reenforced in recent work by Hackbarth and Morellec (2008), who follow a similar empirical approach in the context of mergers, and by Cooper and Priestley (2009) who use investment based portfolios to examine risk dynamics. Our study also complements recent findings by Lyandres, Sun, and Zhang (2008), who show that a long-short portfolio based on investment rates gives a priced factor that helps to reduce SEO underperformance.

Although the pattern we find in beta is generally consistent with the predictions of the real options theory, the existing stylized model predicts an immediate decline upon issuance, while we find a gradual decline over a period of three years. The model prediction derives from a strong assumption that when a growth option is undertaken, expansion takes place instantly and is entirely financed by an SEO that is registered and sold simultaneously. Recent research by DeAngelo, DeAngelo, and Stulz (2009), and Kim and Weisbach (2008), suggests that the relation between receipt of SEO proceeds and the timing of investment is more complex. Further, high levels of investment continue in the years following the SEO, and previous research suggests that firms take time to plan and execute investment (e.g., Lamont, 2000).

To reflect richer assumptions regarding investment planning and financing, we extend the basic real options model of SEO episode returns to include: 1) commitment-to-invest in the form of future required outlays related to the project, 2) a generalization of the Kydland and Prescott (1982) time-to-build specification, and 3) financing of follow-on investment through internally generated operating cash flows and/or non-SEO equity financing as for example in many employee compensation plans. We specifically assume that expansion requires a lumpy immediate investment, financed by an SEO, and further commits the firm to invest at a fixed rate over a fixed period of time. Committing to future investment raises the risk of the firm. Intuitively, it engages the firm in a swap where the cash flows to be received (future profits) have much higher risk than the cash outflow

[4]Realized betas are used by Andersen, Bollerslev, Diebold, and Wu (2005), Ghysels and Jacquier (2006), and Lewellen and Nagel (2006), among others. The term "realized betas" is used because of the analogy with realized volatility calculated from high frequency observations, as in, e.g., Schwert (1989) and Andersen, Bollerslev, Diebold, and Ebens (2001).

commitment (capital investment costs).[5] As the firm pays down the investment commitment over time, beta gradually drops. Thus, even without new equity issuances, risk gradually falls as the firm plows back operating cash flows to pay down expansion costs. Following our work, Kuehn (2008) investigates the general equilibrium effects of investment commitment.

The existing behavioral literature does not make any direct predictions about second moments in relation to SEOs. One way to construct such a link is to consider that sentiment waves might jointly drive both market runups and SEO issuance.[6] Under such an assumption, as sentiment becomes a more important part of valuations during a market runup, firms with high sentiment exposures should experience beta increases. After the bursting of a bubble, these same firms should then covary less with the market. We formalize these ideas in a model that extends the existing behavioral literature by considering that sentiment or temporary mispricing may impact either systematic or idiosyncratic components of firm value. The model predicts that overpriced SEO firms will have high betas that decline after issuance only when a systematic component of returns is affected by sentiment.

Our extensions of the real options and behavioral theories are thus both capable of explaining the pattern of average beta dynamics around SEOs. They do, however, deliver distinct cross-sectional implications that we empirically investigate. Three variables closely related to the real options theory, i) investment rate relative to a match, ii) issuance proceeds as a percentage of market capitalization, and iii) primary issuance percentage, significantly negatively predict post-issuance return and equity- and asset-beta changes relative to matches. A fourth variable closely associated with the real options theory, own-firm runup, also negatively predicts post-issuance returns and beta changes with strong significance for beta changes and insignificant results for returns. Two variables closely related to the behavioral theory, i) market runup, and ii) the sentiment index of Baker and Wurgler (2007), do not predict post-issuance performance. Sentiment also does not predict beta changes, whereas market runup significantly negatively predicts equity- and asset-beta changes in our full regression specification. More interesting results emerge from a subsample analysis. Neither of the behavioral variables are significant for returns or betas in the 1980-1996 subsample. However, in the 1997-2005 subsample – closely associated with the DotCom era – both variables negatively predict post-issuance returns and beta changes; these results are highly significant for market runup in the vast majority of regressions, and consistently significant for sentiment in the asset-beta change

[5] The effect of investment commitment on discount rates was first recognized in a capital budgeting context by Rice and Black (1995) in an unpublished working paper. Subsequent research has not used this insight.

[6] Barberis, Shleifer, and Vishny (1998) provide a model of investor sentiment. Although not in the SEO context, Barberis, Shleifer, and Wurgler (2005) discuss comovement as a consequence of sentiment.

regressions.

The third major empirical issue we address is whether volatility dynamics around the SEO are consistent with real options theories. Since real option leverage applies equally to priced and unpriced risk, predictions about risk dynamics carry through to total volatility. We thus expect that total volatility should increase prior to SEO announcement and decrease after issuance. We calculate monthly realized volatilities using daily returns, following Schwert (1989), and find that these decrease prior to issuance and increase thereafter, over a period of several years. This finding is robust to accounting for microstructure issues by filtering out first-order autocorrelations as in Andersen, Bollerslev, Diebold, and Ebens (2001). Volatility dynamics thus contradict the basic real options model of seasoned offerings.

To better understand these volatility dynamics, we examine the volatilities of matched firms as well as market aggregates, and find that equity issues tend to occur during times of relatively low market volatility. This "volatility timing" phenomenon has at least two potential explanations.[7] First, issuers may prefer to come to market during times of relative stability, in order to face less uncertainty regarding the final pricing of the issue. An alternative is that the volatility of fundamentals is stochastic, in which case managers have a rational motivation to endogenously time issuance at points of low volatility, since the option value of waiting is then smaller.

Our work relates to previous studies that examine whether risk changes discretely at the time of equity issuance due to financial leverage, as suggested by Hamada (1972). For instance, Healy and Palepu (1990) find that beta increases after an SEO, while Denis and Kadlec (1994) argue that after accounting for potential microstructure effects, risk falls slightly following an SEO. The focus of these papers is much different than ours, because financial leverage suggests a one-time change in risk. These studies thus examine only the change in beta from pre- to post-issuance over relatively short one-year windows. Our analysis uses a much larger sample, and analyzes dynamics throughout a variety of windows. We robustly find an increase in beta prior to the SEO and a decrease thereafter.

Another related literature examines the link between real investment and expected returns. Authors including Anderson and Garcia-Feijoo (2006), Lamont (2000), Polk and Sapienza (2009), Titman, Wei, and Xie (2004), and Xing (2008) show that firms with higher investment rates tend to experience lower subsequent stock market returns. Many authors attribute these findings to inefficient investment caused by managerial empire-building or managerial overoptimism. Theories

[7] Fleming, Kirby, and Ostdiek (2001) consider volatility timing in a dynamic asset allocation setting. Our results suggest that volatility timing may also be an important consideration for corporate managers.

of optimal real investment (e.g., Carlson, Fisher, and Giammarino, 2006; Li, Livdan, and Zhang, 2009) have recently argued the ability to account for the same facts.

Several recent studies complement our findings regarding risk dynamics. In particular, Campbell, Polk, and Vuoltenahu (2009) and Taliaferro (2006) show that beta is lower after periods of high corporate investment. Further, Brav, Michaely, Roberts, and Zarutskie (2009) find that bank loan spreads decrease following seasoned offerings.[8] These results are consistent with the real options theory that helps to motivate our empirical work.

The paper is divided into three major sections, each of which can be read separately depending on the interests of the reader. Section 2 discusses risk implications of real options theory. We develop a general framework that nests important prior specifications from the literature and extends the analysis of risk dynamics to demonstrate the impact of i) canonical time-to-build as in Kydland and Prescott (1982), and ii) commitment-to-invest. We show that investment commitment has a non-trivial impact on risk dynamics in the post-SEO period and predicts a slow post-issuance decline in risk as investment occurs, whereas canonical time-to-build does not.

Section 3 discusses behavioral theories. Existing models provide predictions for mean returns but not risk dynamics. We add to the literature by developing a model that provides implications for risk when stock prices are subject to temporary mispricing. When sentiment or misvaluation impacts a common factor in stock returns, then stocks that load on this mispriced factor will exhibit non-trivial dynamics in market betas. By contrast, idiosyncratic sources of misvaluation in individual stocks have no impact on market betas.

Section 4 contains our empirical analysis, beginning with a brief summary of the risk and return predictions of the real options and behavioral theories, so that a reader interested primarily in the empirical implications and results will find this section to be self contained. We document our main findings regarding dynamics in returns and beta, examine post-SEO underperformance and beta dynamics in the cross-section, and finally demonstrate the dynamics of volatility around SEOs. Section 5 concludes.

2 Real Options Theory

In recent literature, theories of real options and real investment have been used to model a number of patterns in financial returns. See, e.g., Berk, Green, and Naik, 1999; Carlson, Fisher, and

[8] Other authors have given some evidence of changes in risk around other types of securities issuance. For example, Lewis, Rogalski, and Seward (2002) find that asset risk tends to decrease after convertible debt issuances. Loughran and Ritter (1995) find that beta declines for three years subsequent to an IPO.

Giammarino, 2004; Cooper, 2006; Gomes, Kogan, and Zhang, 2003; Kogan, 2004; Li, Livdan, and Zhang, 2009; Pastor and Veronesi, 2005; Zhang, 2005. In the specific context of seasoned equity offerings, Lucas and McDonald (1990) model returns in the pre-SEO window and announcement date, while Carlson, Fisher, and Giammarino (2006) consider risk and return dynamics throughout the runup, announcement, and post-issuance period.

In this section, we extend the prior literature by considering that a decision to invest entails not only a *current* expenditure and increase in physical capital, but also a commitment to continue to invest at a certain rate for a fixed period of time. This *commitment-to-invest* extension is closely related to the idea of time-to-build, but differs in an important way. In a standard time-to-build model (e.g., Kydland and Prescott, 1982), an investment outlay at date τ does not result in an increase in fully productive capital or output until some future date $\tau + T > \tau$. Majd and Pindyck (1987) and Dixit and Pindyck (1994) incorporate this idea into a real options context by assuming that a firm can invest at a maximum rate per unit time, and that total investment must aggregate to a predetermined quantity before the project is completed and a corresponding increase in output occurs. However, time-to-build models generally do not involve an explicit commitment to continue to invest in the future. For example in Majd and Pindyck the firm may stop investing whenever it likes, and continue investing at some time in the future until the project is completed.

By contrast, the idea of commitment-to-invest that we introduce here corresponds to an assumption that an expansion decision necessarily involves not only current expenditures, but additionally a commitment to a temporary stream of future expenditures while the investment project is completed. We show that, unlike standard time-to-build, commitment-to-invest creates a payoff stream like a swap, which increases risk because the value of capital to be installed is risky while the committed payments are fixed. As the project is completed and future investment commitments are reduced, risk falls as well.

In the larger real options literature, standard investment and disinvestment decisions are commonly related to calls and puts (McDonald and Siegel, 1985, 1986; Brennan and Schwartz, 1985) leading to characteristic patterns in risk dynamics (Carlson, Fisher, and Giammarino, 2004, 2006; Cooper, 2006). Following this logic, Hackbarth and Morellec (2008) observe that an option to merge can be equated to a call or, when equity is the method of payment, an option on an asset exchange, leading to unique predictions for risk dynamics. Building on this line of research, commitment-to-invest can in simplest terms be understood as an option on a forward contract, if the future investment commitment consists of a single fixed payment, or more generally when the commitment is to a stream of payments, as an option on a fixed-for-floating swap.

In the framework below, we nest 1) standard real options models of instantaneous investment, 2) canonical time-to-build as in Kydland and Prescott (1982), and 3) commitment-to-invest, and discuss the distinguishing features of each. The subsequent empirical analysis shows that the risk dynamics of SEO firms are more consistent with the investment commitment model than standard models with or without canonical time-to-build. Our findings regarding the importance of commitment-to-invest are consistent with prior empirical research by Loughran and Ritter (1997) and Lyandres, Sun, and Zhang (2008), who document abnormally high post-SEO investment expenditures that peaks around the time of issuance and declines slowly afterwards, and also consistent with the work of Lamont (2000), who shows that corporate expansion plans can take several years to complete. Building on our work, Kuehn (2008) investigates the general equilibrium implications of investment commitment.

2.1 Operating Cash Flows, Production, and Investment

For $t \geq 0$, let Q_t denote the instantaneous output rate of a single all equity firm. The firm generates operating cash flows $X_t Q_t$, where

$$dX_t = gX_t dt + \sigma X_t dz_t,$$

$g = r - \delta$ is the constant drift under the risk-neutral measure, r is the risk-free rate, $\delta > 0$ is the constant amount by which the risk-free rate exceeds the growth rate g, σ is volatility, and z_t is a standard Brownian motion. These assumptions can be motivated for example by assuming that the firm faces prices of X_t per unit sold and has zero marginal costs of production. Under these assumptions, a profit maximizing firm will always produce at full output, and hence Q_t is equivalent to the maximum output rate of the firm.

The firm begins at $t = 0$ with productive assets κ_0, and has a one-time opportunity to expand. Let τ denote the random time at which the firm exercises its growth option. As in standard models of instantaneous investment, the firm pays a discrete amount $I \geq 0$ at τ. In addition, the investment decision requires a commitment from the firm to continue incurring outlays related to the investment that grow at a rate $\lambda \geq 0$ throughout the interval τ to $\tau + T$, where T is a constant greater than zero. Hence, in this environment, an expansion option has two components, the first related to lumpy up-front costs such as construction down-payments or building design costs, and the second related to continuous flows of investment expenditures. The capital level of the firm, equivalent to its book value, is summarized by

$$K_t = \begin{cases} \kappa_0 & \text{if } t < \tau \\ \kappa_1 e^{\lambda(t-\tau)} & \text{if } \tau \le t \le \tau + T \\ \kappa_2 & \text{if } t > \tau + T \end{cases}, \quad (1)$$

where $\kappa_1 \equiv \kappa_0 + I$, and $\kappa_2 \equiv (\kappa_0 + I)\, e^{\lambda T}$.

The particular functional form of the commitment-to-invest is not essential. For example, we could as easily assume that committed future investment must be paid at a constant rate giving a linear specification, and our results below would not change substantially. The exponential specification corresponds more closely to a setting where investment spending is proportional to size.

The output level of the firm at any date t is given by

$$Q_t = \begin{cases} K_t & \text{if } t < \tau \\ K_t - b\,(K_t - \kappa_0) & \text{if } \tau \le t \le \tau + T \\ K_t & \text{if } t > \tau + T \end{cases}, \quad (2)$$

where $0 \le b \le 1$. The parameter b controls time-to-build of the canonical Kydland and Prescott (1982) type. When $b = 0$, each unit of capital stock produces one unit of output at all points in time. If $b > 0$, then new capital acquired during the interval $(\tau, \tau + T)$ does not achieve its full productivity $Q = K$ until $\tau + T$, reflecting the ideas that new investments may require time to become fully productive.

We now discuss important special cases of the model above, some of which have been studied in prior literature. The instantaneous investment model of McDonald and Siegel (1986) is captured when capital and output discretely increase at the moment of option exercise and nowhere else, hence $I > 0$ and $\lambda = b = 0$. By contrast, the classical idea of time-to-build developed by Kydland and Prescott (1982) is that a current period investment outlay causes output to increase with a discrete delay, which can be achieved when $I > 0$, $\lambda = 0$, and $b = 1$. Partial time-to-build of the Kydland and Prescott form is captured by $I > 0$, $0 < b < 1$.

Distinct from time-to-build, the key parameter controlling commitment-to-invest is λ. If $\lambda = 0$, then there is no commitment-to-invest even though time-to-build may be accommodated with $b > 0$ as discussed above. Conversely, if $\lambda > 0$, then the expansion decision involves future investment commitment. We note that if $\lambda > 0$ and $b = 0$, then we can have commitment-to-invest with no time-to-build: Each dollar of investment expenditure results in an immediate increase in output at a one-to-one ratio.

2.2 Financing and the Investment Decision

Following standard practice, define free cash flows as operating cash flows less net capital expenditures. We assume that the firm maintains zero cash balances at all times, implying that positive free cash flows are paid out immediately to investors as dividends, whereas negative free cash flows must be raised from investors through equity issues. We interpret the lumpy initial investment of I as an SEO. During the expansion period $(\tau, \tau + T]$ that follows the SEO the firm finances the ongoing investment first from operating cash flows. If operating cash flows are not sufficient at any instant, we interpret the non-SEO funds raised as coming from employee financing through stock or option based compensation or conversion of employee options.[9]

The manager's only decision is when to undertake the investment opportunity. We assume that the objective of the manager is to maximize the fundamental value of the firm.[10] Given the Markov structure of the problem, the optimal policy is a stopping time τ associated with the first passage of the state variable X_t to a critical boundary x. Optimal behavior is fully characterized by standard value-matching and smooth-pasting conditions at the investment boundary.

2.3 Valuation and Optimal Investment

We use backward recursion to derive firm values and optimal investment policy. A firm that has completed its expansion is *mature*, and its value is given by

$$V_{2t} = \frac{X_t \kappa_2}{\delta}. \quad (3)$$

This equation corresponds to the perpetuity value of revenues, and can be recognized as the Gordon growth formula.

[9] Recent literature discusses the importance of non-SEO equity financing. See for example Fama and French (2005) and Babenko, Lemmon, and Tsurlukevich (2008). Of course, other sources of investment financing such as retained cash balances or debt may be utilized but these alternatives produce different risk dynamics from those described in this section. For example, the presence of riskless cash balances will offset the leverage effect of growth options. We leave the detailed study of the risk dynamics associated with non-equity financing to future research.

[10] By assuming value maximization we eliminate conflicts of interest that would arise if the manager was concerned with existing shareholders as in, for example, Myers and Majluf (1984).

The valuation formula for a firm undergoing an expansion, an *adolescent* firm, is:

$$\begin{aligned} V_{1t} \;\; &= \;\; \frac{X_t \kappa_0}{\delta} b \left(1 - e^{-\delta(\tau+T-t)}\right) + \frac{X_t \kappa_1 e^{\lambda(t-\tau)}}{\delta - \lambda} (1-b) \left(1 - e^{-(\delta-\lambda)(\tau+T-t)}\right) \\ &\quad + \frac{X_t}{\delta} \kappa_2 e^{-\delta(\tau+T-t)} - \frac{\lambda \kappa_1 e^{\lambda(t-\tau)}}{r-\lambda} \left(1 - e^{-(r-\lambda)(\tau+T-t)}\right). \end{aligned} \tag{4}$$

The first two terms account for operating cash flows generated during the interval $[t, \tau+T]$, the third term captures operating cash flows occurring after the investment interval is completed, and the final term reflects remaining committed capital expenditures during the investment interval. To reflect the decomposition of adolescent value into operating cash flows and committed expenditures, we write

$$V_{1t} = X_t v_{1t}^A - V_{1t}^C, \tag{5}$$

where

$$V_{1t}^C \equiv \frac{\lambda \kappa_1 e^{\lambda(t-\tau)}}{r-\lambda} \left(1 - e^{-(r-\lambda)(\tau+T-t)}\right) \tag{6}$$

and $v_{1t}^A \equiv \left(V_{1t} - V_{1t}^C\right) / X_t$.

We now turn to the optimal investment policy and valuation for a firm that has not yet invested, the *juvenile* firm. It is straightforward to show:

PROPOSITION 1: *The optimal investment strategy for a juvenile firm is*

$$x = \frac{\nu}{\nu - 1} \frac{I + V_{1\tau}^C}{v_{1\tau}^A - \kappa_0/\delta},$$

and the value of a juvenile firm is

$$V_0(X_t) = X_t \frac{\kappa_0}{\delta} + X_t^\nu \frac{\varepsilon}{x^\nu},$$

where $\nu = \sqrt{(\frac{1}{2} - \frac{r-\delta}{\sigma^2})^2 + \frac{2r}{\sigma^2}} + \frac{1}{2} - \frac{r-\delta}{\sigma^2} > 1$ *and* $\varepsilon = \frac{I + V_{1\tau}^C}{(\nu-1)}$.

Hence, with commitment-to-invest the entire discounted value of current and future investment costs, $I + V_{1\tau}^C$, motivates the firm to wait to exercise its growth option. This affects the investment boundary x, but otherwise the valuation equation is similar to the case where there is no investment commitment.

2.4 Risk Dynamics

Define beta as the loading of a firm's instantaneous return on dX_t/X_t, i.e. $\beta_{it} = Cov(dV_{it}/V_{it}, dX_t/X_t)/\sigma^2$. The mature firm's beta is thus $\beta_{2t} = 1$ and it is straightforward to show that the juvenile firm's beta is

$$\beta_{0t} = 1 + \frac{V_{0t}^G}{V_{0t}}(\nu - 1) \tag{7}$$

where the value of the growth option is $V_{0t}^G \equiv X_t^\nu \frac{\varepsilon}{x^\nu}$.

For the adolescent firm, commitment-to-invest has an important effect on risk during the commitment interval. The beta can be expressed as

$$\beta_{1t} = 1 + \frac{V_{1t}^C}{V_{1t}}, \tag{8}$$

for $\tau < t \leq T$, a function that is strictly decreasing in t, falling to one at $\tau + T$. Following equations (8) and (6), the parameter $\lambda > 0$ (commitment-to-invest) generates non-trivial beta dynamics in the post-SEO period regardless of the value of b (canonical time-to-build). In comparison, when $\lambda = 0$ (no commitment-to-invest), the parameter b has no influence on post-SEO beta dynamics. Hence, commitment-to-invest, distinct from canonical time-to-build, is the key driver of post-SEO beta dynamics.

Our model assumes that commitment-to-invest is absolute, but one can weaken this assumption and still maintain non-trivial post-SEO beta dynamics. For example, the model of Majd and Pindyck (1987) can be approximated by our framework when $I = 0$, $\lambda > 0$, and $b = 1$. Like Majd and Pindyck, this specification entails no lumpy up-front costs ($I = 0$), and a finite amount of continuous investment must be completed before new capital becomes productive ($\lambda > 0$, $b = 1$). An important difference is that Majd and Pindyck allow costless temporary suspension of investment activity at any point in time, whereas we abstract from the complications associated with the option to temporarily mothball a project in order to achieve closed-form expressions. Nonetheless, the option to temporarily suspend will not eliminate the post-SEO decline in beta that our simpler model captures. To see this, note that at high levels of demand, even when a firm is not explicitly committed to continue investing, it will optimally continue to do so with very high probability. The high likelihood of future investment will elevate risk, which will decline as investment occurs. A similar linkage between the likelihood of future investment and risk is present in Kogan (2004). In his model, firms facing capped investment rates have elevated risk when plant size is below optimal, motivating a high probability of near-term investment. Similar analogies can be drawn with models of staged investment (see, e.g., Schwartz and Moon, 2000; Berk, Green, and Naik, 2004; Garlappi, 2004; and Hackbarth and Morellec, 2008).

We can now summarize beta dynamics for any firm that undertakes an SEO. Prior to issuance, firm risk depends on the relative value of the growth option. This option has maximal value at the commitment date τ. Betas of SEO firms thus rise in the months preceding an SEO announcement. Our model then predicts a drop in beta on the SEO issue date that is proportional to the amount of proceeds I. Risk then continues to fall throughout the commitment interval to its long-run post-SEO value of one as funds from operations and other sources extinguish the expansion commitment. The relative magnitudes of these effects depends on the parameterization of the model.

Figure 1 compares beta dynamics for different values of time-to-build b and commitment-to-invest λ. Panel A shows that for the standard instantaneous investment real options model ($\lambda = 0$ and $b = 0$), beta rises prior to equity issuance and then drops immediately to equal the beta of assets-in-place. Panel B shows that with standard time-to-build ($b = 1$) and no commitment-to-invest ($\lambda = 0$, solid line), beta dynamics are nearly identical to those produced by the standard instantaneous investment real options model as in Panel A. However, when there is a commitment to future investment involving continuing expenditures ($\lambda > 0$, dashed line), beta remains high following the SEO date and then declines as investment takes place and the commitment level falls. Hence, investment commitment plays a key role in determining the dynamics of post-issuance beta.

In addition to the beta dynamics set out above, this real options model has implications for total volatility. In the theory, the market-model beta does not play any special role. Instead, risk (beta) can be viewed as the loading on an efficient portfolio in any pricing environment. Moreover, since real option leverage applies to unpriced as well as priced risk, all of the real option results for dynamic risk loadings apply equally to total volatility. The behavior of total volatility thus provides a test of the basic real options theory that is robust to any pricing environment.

2.5 Cross-Sectional Implications

We derive implication for risk and return dynamics from cross-sectional dispersion in the value of the growth option V_{0t}^G. Formally, define $\Delta\beta_t \equiv \beta_{2t} - \beta_{0t}$, and from equations (5) and (6) note that

$$\Delta\beta_t = -\frac{V_{0t}^G}{V_{0t}}(\nu - 1),$$

implying that the decrease in beta is larger for larger growth options. Moreover, returns will be proportional to beta so that the larger the price run up, the larger the decrease in return around the SEO.

Cross-sectional tests of the model require simple empirical proxies for growth option value. The following variables are natural candidates.

1. Investment: Prior investment commitment drives up risk, and the act of investment deleverages this risk.

2. Pre-issuance runup in the firm's own stock price: Larger run-ups are associated with greater growth option leverage and hence should predict greater declines in risk and return following an SEO.

3. Proceeds: Proceeds relate to I, the size of the initial investment. Hence, greater proceeds should imply larger risk and return reductions.

4. Primary vs. secondary issuance: Pure secondary issues do not generate new funds for the firm and hence these should not be associated with underperformance or beta dynamics.

We use these instruments in cross-sectional tests of the model in Section 4.

2.6 The Case of Starbucks

To provide a perspective on the degree to which our model captures the actual investment process, consider one firm in our sample, Starbucks. Starbucks undertook an IPO in 1992 when it had 165 stores. On November 8, 1994, Starbucks announced a public SEO of 5.5 million shares. This took place one month after the firm announced detailed plans to open "at least" 200 new stores in fiscal 1995. Since that time the company has not raised funds through an underwritten equity issue though it does continue to retain earnings, issue stock options and issue shares to employees. It has also repurchased shares on several occasions. At year end 2004 the company had over 8,500 stores, 20 times the number of stores that it had after completing the SEO that appears in our data.

Figure 2 presents a time line of investment (change in net plant/plant), and of new equity and debt issues. We also plot our estimate of Starbucks' beta through this period. It certainly seems that Starbucks exercised a growth option, or a series of growth options, and that the firm's IPO and SEOs were important parts of this option exercise. But it is also clear that the growth option was not exercised and beta did not decline instantaneously on the SEO date. Starbucks announced a timetable and a location for store openings just prior to the SEO, so we can infer that it planned an expansion that would last for at least one year. While it may have been possible to stop or scale back these plans, significant non-sunk costs would likely be incurred. To some extent, then, in addition to exercising options to expand immediately, firms simultaneously enter into commitments for further expansion. We also observe that following its SEO, much of Starbucks continuing investment was funded internally by operating cash-flows, and externally by non-SEO equity issues, as in the assumptions of our model.

3 Behavioral Theory

The leading behavioral descriptions of SEO underperformance include Daniel, Hirshleifer, and Subrahmanyam ("DHS", 1998) and the windows of opportunity and market timing theories of Loughran and Ritter (1995) and Baker and Wurgler (2000). These models rely on cognitive biases and persistent mispricing to explain SEO return patterns.

The intuition supporting behavioral models is compelling. Research in psychology establishes that individuals tend to be overconfident about their own abilities. Research also shows that individuals overweight evidence confirming their prior beliefs, and underweight contradictory evidence. This is called biased self-attribution. DHS present a rigorous and complete theory of mispricing based on these findings. Overconfidence is modeled as a belief that the precision of private signals is higher than it actually is. Biased self-attribution is introduced by assuming that overconfidence increases after an investor receives a public signal that is consistent with their private signal. As a result, prices overreact to private signals, and further overreaction occurs when confirmatory public information is released.

DHS also derive implications for event studies. They allow an informed, rational manager to take advantage of overvalued shares through share issues. As with prior adverse selection models (e.g., Myers and Majluf, 1984), DHS assume that investors are aware of the motives of managers. The SEO episode as characterized by this theory thus consists of the following: SEOs are preceded by investors receiving positive private signals and confirmatory public signals that cause overreaction and inflated stock prices. Hence a pre-SEO price run up is predicted. Managers then sell shares, but because this is contradictory public information, investors underreact to it due to biased self-attribution. Prices thus remain higher than their fundamental value even after the public issuance decision, and investors then learn slowly about the overvaluation through subsequent private or public signals. The process of learning tends to drive prices back down to their fair value over time.

To summarize the dynamic implications, behavioral explanations of SEOs imply that returns will behave in a way that is similar to the implications of real options theories: Prices rise through the pre-SEO stage, SEO announcements bring a negative announcement effect, and post-SEO returns are lower than pre-SEO returns. However, existing behavioral models do not have implications for risk dynamics through an SEO episode. We now provide a model of risk dynamics under temporary mispricing that fills this gap in the literature.

3.1 An Extension of Behavioral Theories to Beta Dynamics

The prior behavioral literature does not provide predictions regarding the dynamic evolution of risk associated with temporary mispricing. In this section, we develop a simple model that explores this issue and provides testable implications relative to the real options theory.

Denote the cum-dividend gross return of security i at time t as $R_{it} \equiv (P_{it} + d_{it})/P_{i,t-1}$. We decompose dividends into a systematic component d_t and an idiosyncratic, zero-mean, IID component δ_{it}. To simplify arguments assume that for each stock i there is a time-independent loading b_{iF} on the fundamental source of value. Dividends can thus be represented as $d_{it} = b_{iF}d_t + \delta_{it}$. We denote the fundamental value of a unit claim on aggregate dividends d_t by F_t and its associated return by $R_{Ft} = (F_t + d_t)/F_{t-1}$. To model mispricing, we allow stock prices to also depend on market-wide and stock-specific mispricing:

$$P_{it} = b_{iF}F_t + b_{iS}(S_t + u_{it}),$$

where b_{iS} is the loading on a sentiment factor S_t and u_{it} is an idiosyncratic component of price that may also be subject to misvaluation. The factor S_t is unrelated to any fundamental information regarding cashflows and has a long-run mean of zero but may temporarily deviate. As a result, the return on this factor $R_{St} = S_t/S_{t-1}$ is partially predictable.

To make the distinction between F_t and S_t concrete consider the following example. Let dividends be drawn independently each period from a normal distribution with mean μ_d and variance σ_d^2, and assume a constant required rate of return r. The fundamental factor then has value

$$F_t = F = \frac{\mu_d}{r}$$

for all t. Returns to the fundamental factor are driven solely by stochastic variation in dividends. To capture sentiment, let

$$S_t = e^{S_t^*} - 1,$$

where

$$S_t^* = \rho S_{t-1} + \sigma_S e_{St},$$

$0 \leq \rho < 1$, $\sigma_S \geq 0$, and the innovation e_{St} is an independent unit normal random variable. The idea of a fundamental factor and a mean reverting price deviation is common in the literature on stock-price bubbles (e.g., Blanchard and Watson, 1982).

For convenience let the processes F and S be independent, and assume a large number N of individual stocks with independent and potentially mean-reverting u_{it}, to permit the possibility of idiosyncratic mispricing, such that $\Sigma_{i=1}^{N} u_{it}/N \approx 0$. We normalize $\sum_{i=1}^{N} b_{iF} = \sum_{i=1}^{N} b_{iS} = 1$. The price of the market at any point in time is hence

$$P_{Mt} = F_t + S_t$$

and the associated market return is $R_{Mt} = (P_{Mt} + d_t)/P_{M,t-1}$. Given this form for market prices and returns, it is convenient to renormalize individual security prices as

$$P_{it} = b_i F_t + S_t + u_{it}$$

where $b_i = b_{iF}/b_{iS}$ is a single parameter summarizing the importance of fundamentals, with levels of the parameter $b_i < 1$ indicating a stock is relatively more exposed to sentiment than is the market. Note that this normalization is without loss of generality to the properties of returns since b_{iF} and b_{iS} are assumed to be time independent. Individual stock beta is defined by the ratio $\beta_{i,t-1} \equiv Cov_{t-1}(R_{it}, R_{Mt})/Var_{t-1}(R_{Mt})$.

The following proposition relates stock beta to current levels of sentiment S_{t-1}.

PROPOSITION 2: *The beta of stock i conditional on the current level of sentiment is given by*

$$\beta_{i,t-1} = \frac{1 + \xi_{t-1}}{b_i + \xi_{t-1} + u_{i,t-1}/F_{t-1}} \frac{b_i \frac{\sigma_F^2}{\sigma_S^2} + \xi_{t-1}^2}{\frac{\sigma_F^2}{\sigma_S^2} + \xi_{t-1}^2} \tag{9}$$

where $\xi_{t-1} \equiv S_{t-1}/F_{t-1}$, $\sigma_F^2 \equiv Var_{t-1}(R_{Ft})$, *and* $\sigma_S^2 \equiv Var_{t-1}(R_{St})$.

This formula for beta can be most easily understood by considering the special cases where $\sigma_F/\sigma_S = 1$ and $u_{it} = 0$. We wish to consider the beta dynamics of stocks undertaking SEOs, which are likely to have relatively high exposures to sentiment. Furthermore, we would expect this activity to occur after a runup in the market price due to the factor S_t. To further aid discussion, therefore, consider a stock with $b_i = 0$ so that its price depends only on sentiment. Under these restrictions the stock beta is given by the simple expression

$$\beta_{i,t-1} = \xi_{t-1}\frac{1+\xi_{t-1}}{1+\xi_{t-1}^2}.$$

This expression can easily be shown to be increasing on $\xi_t \in (0, 1+\sqrt{2})$. Beta is zero when market-wide mispricing $S_t = 0$ and then increases as prices reach some high level where SEOs are undertaken. Under this scenario, equity issuers would exhibit a runup in market price, a runup in own-stock price, and a runup in beta. Following the SEO, mean reversion in sentiment will cause market prices, stock prices, and betas to fall on average.

It is interesting to compare these return dynamics with those of a firm where the mispricing is due solely to the idiosyncratic factor $u_{it} > 0$. Stock prices of such firms would increase prior to SEOs, but the runup would not be associated with a runup in the market. Inspection of equation (9) clarifies that the betas of such firms would fall rather than rise prior to equity issuance. Thus, only when mispricing is driven by market-wide sentiment can the model predict a rise and fall in beta around the SEO date.

Figure 3 graphically depicts the dynamics of risk due to variation in systematic sentiment, as captured by equation (9). We assume the idiosyncratic component of prices $u_{i,t-1}$ is zero and consider two securities: the "sentiment" stock ($b_i = 0$, solid line), and the "fundamental" stock ($b_i = \infty$, dashed line). The sentiment stock beta approaches zero when sentiment S_{t-1} is small relative to fundamentals ($\xi_{t-1} = 0$). As sentiment increases, the return on S_{t-1} becomes a more important component of market returns, causing the sentiment stock beta to rise. By contrast, the fundamental stock beta approaches one when sentiment is low. An increase in sentiment initially causes the fundamental stock beta to rise when sentiment is low. To understand this result, note that fundamentals and sentiment are uncorrelated, and hence for low values of sentiment, an increase in sentiment causes market variance to fall. This variance effect dominates the reduced covariance between the market and pure fundamentals stock when ξ_{t-1} is low. Covariance is the dominating factor for fundamental stock betas when ξ_{t-1} is large, and betas therefore eventually decline to zero. The two curves depicted in Figure 3 provide upper and lower bounds for the beta of a stock that is impacted by both fundamentals and sentiment $0 < b_i < \infty$, since such a stock can at any instant be replicated as a portfolio comprised of the two stocks in the figure.

We conclude that when SEO issuance is driven by overvaluation related to an increase in systematic sentiment, the SEO firm beta is likely to decline after issuance. By contrast, SEO's driven by idiosyncratic overvaluation will not produce this effect in the post-issuance beta.

4 Empirical Analysis

This section documents the dynamics of risk around SEOs, and relates our findings to the real option and behavioral theories. We first summarize the predictions of the two models and explain our choice of instruments.

4.1 Predictions of the Real Options and Behavioral Theories

The behavioral and real options theories both predict a runup in returns prior to equity issuance, and lower returns following issuance. The theories also similarly predict that larger runups should lead to greater underperformance, in the real options theory due to exercise of a larger growth option, and in the behavioral theory due to greater mispricing.

The two frameworks differ more in their implications for risk. In previous literature, the real options theory predicts a runup in beta prior to issuance, whereas no prior behavioral theory of SEO risk dynamics exists. Thus, with only prior research framing our initial approach to the data, our first hypotheses are:

H0: Asset beta is constant throughout the SEO episode, and the only change in equity beta occurs at the time of issuance for levered firms, as predicted by Hamada (1972).

HA: (Standard Real Options): Asset beta increases prior to the SEO due to real option leverage, and decreases discretely at the time of issuance/investment, remaining constant after issuance.

The hypothesis *H0* has been the object of considerable prior research in the finance literature, e.g., Healy and Palepu (1990), Denis and Kadlec (1994). Our paper is the first to directly examine the risk implications of the real options theory.

We foreshadow the results of future empirical sections by stating that we find considerable evidence of a runup in beta prior to issuance, as suggested by the real options theory, but we also find a slow, rather than instantaneous, decline in beta after issuance, which is not consistent with any prior theory. This finding motivated us to develop the theoretical extensions of the real options and behavioral theories presented in Sections 2 and 3.

Considering the real options and behavioral models developed in our paper, both can generate high risk around the time of the SEO, declining afterwards. In the real options model, risk declines as the firm invests and reduces its future investment commitment, whereas in the behavioral model, market beta tends to decline after issuance because of mean-reversion in a systematic sentiment factor. Hence, a sharp distinction between the theories relates to instruments that predict the magnitude of beta changes around issuance:

1. Investment: In the real options theory, prior investment commitment drives up risk, and the act of investment deleverages this risk.

2. Pre-issuance runup in the firm's own stock price: In the real-options theory, larger run-ups are associated with greater growth option leverage, and the source of the run-up (systematic vs. idiosyncratic) does not alter growth option or investment commitment leverage. By contrast, in the behavioral theory idiosyncratic overvaluation does not lead to an increase in market betas.

3. Sentiment: In the behavioral theory, the market betas of issuers may rise and then be predicted to fall if they are overvalued because of a movement in a systematic factor temporarily affected by sentiment.

4. Proceeds: In the real options theory, proceeds relate to the size of the initial investment. Hence, greater proceeds should imply larger risk and return reductions.

5. Primary vs. secondary issuance: pure secondary issues do not generate new funds for the firm and hence in the real options theory these should not be associated with underperformance or beta dynamics. By contrast in many behavioral theories, e.g., DHS, insiders are assumed to take advantage of temporary misvaluations which could occur through secondary issuances as well as primary issuances.

These additional predictions provide guidance for our empirical investigation beyond the formal statements in hypotheses *H0* and *HA*, and the following hypothesis summarizes the implications of the extended theories:

HA1: (Extended Real Options and Behavioral Theories): Asset beta may increase prior to issuance and decline gradually thereafter either due to exercise of a growth option with commitment-to-invest (Real Options) or when timing systematic sentiment (Behavioral).

4.2 SEO Data and Average Returns

We construct our sample from the SDC New Issues database common stock issues traded on NYSE, AMEX, or Nasdaq by U.S. companies, and not coded as IPO's, unit issues, ADR's or ADS's.[11] We

[11] Our unit of observation is an equity issue and we treat firms that undertake an SEO more than once as separate observations.

include issuances occurring after January 1, 1980, when large scale coverage of corporate news on Lexis/Nexis and Factiva ("news sources") becomes available, and before December 31, 2005, which permits that three years of post-SEO returns may be available. We also apply the following screens, detailed in the Appendix:

- A unique matching CRSP PERMNO for the relevant date can be identified using the SDC i) CUSIP, ii) Ticker Symbol, or iii) Company Name.
- The CRSP exchange code is NYSE, AMEX, or NASDAQ on the issuance date.
- The CRSP share code is 10 or 11, indicating that the issuance is common stock.
- A valid announcement date for the issuance is available, identified as the earlier of i) the SDC-reported filing date, or ii) the earliest news report or news wire mentioning the issue, obtained by searching the news sources.
- Valid data for computing market capitalization ("size") and book-to-market equity ("B/M") of the issuer is available from CRSP and COMPUSTAT, as of two days prior to the announcement date.
- The CRSP industry code on the date of issuance is not a utility (SIC = 49XX) or financial (SIC = 6XXX).
- At least 63 valid daily returns are available on CRSP in the 252 trading days prior to announcement of the SEO.

The final sample satisfying these criteria consists of 5,740 unique seasoned equity issues.

From the SDC data, we record the size of the issuance in dollars ("proceeds"), the dollar value of the issuance raised directly by the firm ("primary"), and the dollar value of sales by other shareholders ("secondary"). The distinction between primary and secondary is useful because the real options theory is naturally associated with primary issuance, whereas behavioral theory could apply to either primary or secondary issues.

We further categorize SEO's that have some primary proceeds by the firm's stated use-of-funds on the announcement date. We focus on public communications through traditional media outlets, searching the business news wire and major newspaper segments of our news sources. To link with the SDC New Issues database, we searched the news sources in a one year window centered around the issuance date for a combination of the company name and any of the keywords "stock", "equity", or "issue". All returned documents were then manually scanned for information regarding 1) The first announcement date of the issuance, and 2) the stated use-of-funds. Any potentially useful portions of the news releases were recorded into a database.

We first use this new data to refine the SDC announcement date of the issuance as described previously. Second, we create a new data item for the stated use of funds. To generate this variable, we defined the following six categories and associated keywords (in italics):

- Capital Investment (INV): *research, expan, propert, expenditure, construction, develop, build, equip;*
- Acquisition (ACQ): *merge, acqui;*
- Working Capital (WC): *working, inventory, receivable;*
- General Corporate Purposes (GCP): *general corporate purpose;*
- Debt (D): *debt, loan, credit, bank, repay, note, bond, borrow, debenture, redeem;*
- No Information (NI): none of the above.

Observations may belong to more than one category.

Table 1 provides a brief summary of the sample. The majority of the 5,740 issues have some component of the issuance primary, with 1,073 pure secondary issues. Of the primary issues, substantial numbers fall into each of the use-of-funds categories. The average market equity decile of the overall sample (4.2) indicates that the firms are slightly smaller than the median NYSE firm, with pure secondary issues notably larger (5.9) than issues containing a primary portion. The average B/M decile (3.5) indicates that issuers are growth firms, with pure secondary issuers slightly more value-oriented (4.0). The mean ratio of primary issuance to total issuance is 0.71 for the entire sample, and the average issuance is approximately 21% of pre-issuance market capitalization. Pure secondary issues tend to be a smaller fraction of outstanding equity (0.12) than the overall sample.

We follow common practice and obtain matches for our sample firms based on size and B/M characteristics.[12] Specifically, for each seasoned issuer we identify the PERMNO on CRSP that belongs to the same B/M decile as the issuer, has not issued equity in the previous five years, and

[12] To measure the B/M ratio we first obtain the book value of equity following Brav, Geczy, and Gompers (2000) using the quarterly COMPUSTAT filing two quarters prior to the announcement date. If this quarterly filing is not available, we instead obtain the book value of equity from the annual filing, following the procedure of Davis, Fama and French (2000). We divide the book value by the market value of equity on the recorded book-value date. Our market value of equity (ME) is obtained two days prior to the announcement date. We assign ME and B/M to deciles by NYSE breakpoints on the day that the variables are defined.

is the closest size match satisfying these criteria. To address missing data, if the match does not have a valid return on any date in the five years prior to announcement or subsequent to issuance, the missing value is replaced with the return from the next best unused match as of the SEO date. We iteratively follow this procedure until a complete set of matched returns is achieved. We replace any missing returns data for the sample firms with the return from the match series on that date.

Table 2 presents average returns around the SEO date. We measure announcement effects using three different dates. Our baseline choice of announcement date is the earlier of the i) filing date recorded by SDC, and ii) the earliest date from our search of news sources (the “wire date”). The wire date is available for 3,966 firms and provides an earlier announcement date than SDC for 493 firms. Using the earliest date gives an announcement effect for the entire sample of -2.00% in a three-day window centered on the announcement date. Using only the SDC date, which is available for almost all of our sample firms (5,717 of 5,740) gives a less negative announcement effect in the entire sample (-1.89%), indicating that refining the announcement dates using the hand-collected news data provides economically relevant information. Most of the impact of using the wire date is concentrated in the early subsample, for example during 1986-1990 where the announcement effect using the earliest date is -2.05%, relative to -1.70% using the SDC date. By use-of-funds category, pure secondary issuances have the smallest announcement effects (-1.70%), and the largest is for general corporate purposes (-2.20%).[13] The average one-year runup prior to announcement is large in the full sample (106%), and particularly pronounced in the 1996-2000 subsample (144%). The returns of size and book-to-market matches are also high in the pre-announcement window (48%), although not as large as for the issuers.

Underperformance in the post-issuance period is consistent with prior literature. At three years, the average returns of issuers are 10% lower than for size and book-to-market matches (28.6% vs. 38.6%). Consistent with prior literature (e.g., Eckbo, Masulis, and Norli, 2000; Brav, Gezcy and Gompers, 2000), the underperformance when controlling for both size and book-to-market is smaller than documented by Loughran and Ritter (1995), who control for size only. The underperformance is somewhat consistent across subperiods, with the notable exception of 1996-2000 issues, which perform much worse relative to matches (3.1% vs. 21.2%) and 2001-2005, where underperformance is negligible (35.7% vs. 35.8%). By use-of-funds subcategory (Panel C), the three-year post-issuance buy-and-hold returns are lowest for investors (13.8%). The three-year underperformance relative to

[13] For comparison, Heron and Lie (2004) report a mean three-day abnormal return for 3658 SEOs with some primary proceeds of about -2.5% during a 1980-1998 sampling period that is contained in ours. Our finding of a lower announcement effect for pure secondary offerings than mixed or pure primary offerings is also consistent with their results.

matches is interestingly largest for the no-information category (18%), acquirers (15%), and firms issuing to invest (13%).[14]

The group of pure secondary issuers (PS) does not underperform at any investment horizon, consistent with the findings of Lee (1997). Pure secondary issuances are often used to sell the shares of insiders, hence the lack of underperformance in this category indicates that insiders do not on average use this process to sell overvalued equity. By contrast, the real options theory predicts no underperformance for pure secondary issues, consistent with this empirical result.

As in Loughran and Ritter (1995), for the first six months after the SEO, the sample firms outperform the matches by a substantial margin (8.1% to 4.0%), and this result is robust across all time and use-of-funds subsamples with the exception of 2001-2005. After one year, the returns are closer to the matches with the SEO firms still outperforming (11.2% vs. 9.3%). The measured underperformance seems strongest three years after issuance, and does not increase substantially over years 3-5 for the overall sample. Combining this set of facts, most of the SEO underperformance takes place between six months and three years after the issuance date.

Table 3 shows investment, capital structure, and working capital dynamics around the seasoned equity issue. Consistent with prior literature, SEO firms invest heavily relative to size and book-to-market matches. Their level of excess investment is highest in the three-year window surrounding the SEO, and declines steadily thereafter. The level of excess investment is by far highest for the use-of-funds group INV (18.2% the year after issuance relative to 11.1% for matches), followed by ACQ, GCP, NI, and WC. By contrast, the pure secondary issuers invest less than their matches (9.5% vs. 10.2%).

The long-term debt/book assets ratio is relatively stable for SEO firms prior to issuance, drops in the year of issuance, and increases thereafter. Relative to matches, SEO firms have higher book leverage prior to issuance, with the difference especially large for the DEBT subgroup. The difference relative to matches drops substantially in the issuance year and then increases.

The ratio of current assets to current liabilities is stable at about 2.05 for all SEO firms in the three years prior to issuance, increases to 2.30 in the year of issuance, and then declines steadily to 2.09 three years after issuance. Short-term liquidity is highest for the subgroups INV, WC, and GCP and lowest for DEBT and pure secondary issuers. The differences relative to matches are largest for INV, WC, and GCP in the year of issuance, and decline thereafter.

[14] The five-year underperformance is remarkably strong (34.3%) for the "no information" category of firms that do not have a statement in our search of public news sources about the use of issuance proceeds, and have issued some primary shares.

4.3 Average Beta Dynamics

We now document movements in beta, and examine whether these appear consistent with real options and behavioral theories. We wish to assess how average SEO firm risk evolves through event time, and thus divide our sample period into twenty-one trading day periods ("months") prior to the announcement and after issuance. We consider as a single period the interval between announcement and issuance, regardless of how long that interval is.

In each month we regress log returns on a constant and the log return of the value-weighted CRSP index. As suggested by Scholes and Williams (1977), we aggregate returns across any days in which trading volume is zero, which helps to alleviate some of the problems associated with asynchronous trading. In the following subsection we address additional robustness issues related to asynchronous trading.

Figure 4*a* displays our average monthly beta estimates across all sample firms for the ten year period of event time centered on the SEO. In this graph, the value of zero on the horizontal axis corresponds to the time period between announcement and issuance; all positive numbers are months after issuance; and all negative numbers are months prior to announcement. Beta does not change substantially until two years before the SEO. A slight increases in year -2 is followed by a larger increase in the year prior to the SEO. Beta continues to increase sharply until roughly two months after the SEO, when beta peaks, and then declines until approximately three years after issuance.

Risk thus changes considerably throughout the SEO episode, which is consistent with the commitment-to-invest real options theory (Section 2), or the behavioral theory with overvaluation in a systematic factor (Section 3). This pattern is more complex than suggested by *H0*, the hypothesis based on a simple one-time discrete change in beta caused by financial leverage (Hamada, 1972).

Figure 4*b* shows beta dynamics by use-of-funds subsample for primary issuances. All types of primary issuance generate similar beta dynamics, increasing prior to issuance, peaking just after issuance, and gradually declining thereafter. Firms investing in real assets, working capital, acquisitions, and for general corporate purposes appear similar, with the acquirers having a slightly lower beta all around. Firms in the debt category and NI have a less pronounced increase and subsequent decrease in beta. These plots again contradict the simple hypotheses that risk does not change through an SEO episode, or that risk changes only at the instant of issuance.

Figure 4*c* depicts the beta dynamics for pure secondary issuers. These show modest changes in beta around the issuance date but the difference with their size and book-to-market matches is negligible. Pure secondary issuers do not use SEO funds within the firm for investment purposes, hence the real options theory predicts no difference in beta dynamics, consistent with the data.

4.3.1 Robustness of Average Beta Dynamics

The analysis of risk dynamics above uses realized betas calculated from daily returns. We show in this section that our findings are robust to alternative estimation methods. In particular, i) accounting for asynchronous trading using the method of Dimson (1979) does not significantly alter our conclusions; ii) using a standard instrumental variables approach with monthly data gives consistent results; and iii) asset betas show a similar or stronger pattern in their movements relative to equity betas. We address these items consecutively.

A common approach to addressing potential illiquidity in SEO stocks is to calculate betas using the method of Dimson (1979). For example, Denis and Kadlec (1994) regress SEO returns on 2, 5, 10, and 15 leads and lags of market returns, in addition to the contemporaneous market return. The idea is that if a small stock trades several days after some original news affects market returns, the covariance may be better captured by one of the lagged coefficients. Summing the regression coefficients across all leads and lags gives the Dimson (1979) "sum" beta. We follow Denis and Kadlec in choosing lag structures of 0, 2, 5, 10, and 15 days. Figure 5, Panel A shows the effect of using Dimson betas in annual windows 5 years prior to announcement and after issuance. The sum betas increase with the number of lags, demonstrating that some asynchronous trading does exist. The general dynamic pattern in beta is not affected, however. To further demonstrate that beta dynamics are not substantially related to microstructure issues, Panel B plots the difference in beta relative to event time year 1, again showing robustness of the general pattern.

An alternative estimate of beta dynamics uses instrumental variables with monthly rather than daily data. Shanken (1990) and Ferson and Harvey (1999) suggest the simple specification:

$$R_{it} = \alpha_i + \beta_i \begin{bmatrix} 1 & Z_{t-1} \end{bmatrix}' R_{Mt} + e_{it}, \tag{10}$$

where R_{it} and R_{Mt} are monthly excess returns on a stock and the market respectively, the conditional beta $\beta_{it} \equiv \beta_i[\ 1 \quad Z_{t-1}\ ]'$ is a linear function of the instruments Z_{t-1}, and t indexes months. Useful candidate instruments should vary with the conditional beta.

Two such potential instruments are the M/B ratio, which relates to the value of growth opportunities in the real-options theory, and lagged realized betas, which Boguth, Carlson, Fisher, and Simutin (2009) show are useful to estimate conditional loadings. Using the M/B ratio, we estimate

(10) firm-by-firm with the full sample of data available on CRSP for each SEO firm and plot in Figure 6*a* the average fitted conditional beta from these regressions. To use lagged realized betas as instruments, we use 1-month or 3-month pre-return estimation windows, consistent with the fact that the risk dynamics we are investigating are at a relatively high frequency at the firm level.[15] To address errors-in-variables induced by using estimated short-window realized betas as instruments, we follow Ghysels and Jacquier (2006) and use a pooled regression with the two-stage approach described in the Appendix. The average fitted conditional betas obtained by this method are plotted in Figures 6*b* (lagged 1-month realized beta as instrument) and 6*c* (lagged 3-month realized beta as instrument). Figure 6*d* combines the three instruments (M/B, 1-month and 3-month realized betas). All of the results are similar, and give a pattern in beta consistent with the direct calculation of realized betas shown previously.

We can estimate the beta dynamics around SEO's even more directly by using a panel regression with fixed effects in event-time. Consider the regression:

$$R_{i\tau} = \alpha_\tau + \beta_\tau R_{M\tau} + u_{i\tau}, \tag{11}$$

where τ indexes months relative to the SEO issuance date, and the coefficients α_τ and β_τ depend only on event-time. Estimating (11) as a pooled regression from all SEO's in our sample with τ in the window $[-60, 60]$, i.e. 120 time dummies for alpha and beta, gives an essentially non-parametric estimate of the evolution of conditional beta. While this approach has the advantage of placing almost no structure on the time-series specification of β_τ, we should also expect the estimates for each value of τ to be somewhat noisy. A natural alternative is to place more structure on the functional form of conditional beta by using a polynomial approximation of order N:

$$\beta_\tau = \sum_{n=1}^{N} b_\tau \tau^n,$$

which requires estimation of a smaller number of parameters. Figure 7 shows the results of both approaches: the full set of time-dummies as a dotted line, and a polynomial approximation with 5% confidence interval bounds.[16] In both cases, the results strongly confirm that equity beta rises

[15] By contrast, in the application of Boguth, Carlson, Fisher, and Simutin, most of the risk dynamics in momentum arise from turnover in the stocks belonging to the portfolio, rather than from dynamics at the individual stock level. These authors hence use relatively long pre-return windows of 6 or 36 months to obtain realized beta estimates for each stock in the momentum portfolio. Using a longer window reduces estimation error, but would not be appropriate in our setting where our focus is on risk dynamics at the individual stock level.

[16] We use a sixth-order polynomial approximation which is sufficient to smooth the plot and make the curve closely match the nonparametric estimates with time dummies only, but any polynomial approximation of order two or more

prior to an SEO and declines afterwards.[17]

We finally show that the pattern in beta is robust to accounting for time-series and cross-sectional variation in financing, by delevering the equity beta using the simple formula:

$$\beta_{it}^{A} = \frac{ME_t}{ME_t + LTD_t}\beta_{it}^{E}, \tag{12}$$

where ME_t is the market value of equity at calendar time t, LTD_t is the book value of long-term debt, β_{it}^{E} is the equity beta, and β_{it}^{A} is the asset beta. The deleveraging equation (12) is consistent with Ruback (2002) when debt beta is zero. Figure 8 shows the pattern in average asset beta dynamics, obtained by delevering the equity realized betas that produced Figure 4. The asset betas are lower than the equity betas as expected, but have very similar dynamics and if anything the decline in asset beta is more pronounced. Notably, in the post-issuance period the asset betas of the sample-firms are more comparable to those of the matches after five years. These findings are consistent with the fact that SEO firms are more levered than their matches (Table 3), but that the market leverage difference is smallest at the time of issuance due to the large runup in market equity in the year prior to issuance. To summarize, beta dynamics around SEOs are robust to incorporating standard adjustments for microstructure effects, to using alternative estimation methods based on instrumental variables and/or panel data techniques, and to adjusting for changes in financial leverage.[18]

4.4 The Cross-section of SEO Underperformance and Beta Changes

The previous section establishes that beta increases prior to seasoned equity offerings, and declines afterwards. This finding is consistent with both the real options theory presented in Section 2, based on commitment-to-invest, and the behavioral theory presented in Section 3, based on temporary mispricing due to systematic sentiment. Section 4.1 discussed distinguishing features of the two theories. In the real options theory, own-firm runup, primary issuance, size of the issue and investment should predict future underperformance and decline in beta. In the behavioral theory, own-firm runup may predict future underperformance, but only systematic overvaluation as indicated by

produces a pronounced increase prior to issuance and decrease thereafter.

[17] Note that we should not expect the time dummy estimates to be within the polynomial standard error bounds 95% of the time. The dummy variable estimates are not the unobserved true conditional betas, but are themselves estimates, each with much larger standard error than the conditional betas generated by the polynomials, due to the limited structure imposed by using only dummy variables.

[18] We have also checked that our results are robust in a subsamples of firms with returns available over the entire intervals i) beginning 36 months prior to announcement and ending 36 months after the issuance, and ii) beginning 60 months prior to announcement and ending 60 months after issuance. This demonstrates that our results are not driven by a selection bias related to listing or delisting.

market runup or a sentiment index should predict future changes in market beta for overvalued issuing stocks. We now test the predictions of these theories using the cross-sectional regressions of underperformance and beta changes for SEO firms relative to their matches.

Table 4 provides summary statistics for the variables that we use. The symbol Δ indicates the difference between the SEO firm and its match. We use three distinct dependent variables, shown in Panel A. First, ΔPost-Issue Return is the difference between the log buy-and-hold return of the SEO firm and its match over a three-year window. To obtain the variable ΔEquity Beta Change, we first measure for each SEO firm and its match the realized equity beta in a one year window centered on issuance, and a one-year window three years after issuance. For each firm we define the variable "Equity Beta Change" as the equity beta three years after issuance less the realized beta at issuance. ΔEquity Beta Change is then the difference between the equity beta changes of the SEO firm and its match. Similarly, ΔAsset Beta Change is the difference between the asset beta changes of the SEO firm and its match.

The right-hand side variables to be used in the regressions are described in Panel B. These include a measure of SEO firm investment relative to its match (ΔInvestment), a measure of pre-announcement runup relative to the match (ΔRunup), the market runup in the year prior to announcement (Mktrunup), and the Baker and Wurgler (2007) sentiment index at the time of issuance (Sentiment). We also include the percentage of primary proceeds in the issuance (Primary), SEO proceeds as a percent of capitalization (Proceeds), and the size and book-to-market deciles of the SEO firm at the time of announcement (ME Decile and BM Decile).

To provide a preliminary nonparametric assessment of the cross-sectional drivers of beta dynamics, we sort SEO firms into terciles by their A) own-firm runup, B) pre-issuance market runup, and C) sentiment. Figure 9 plots the average realized betas for each of these groups in event time. Beta dynamics are clearly strongest for the firms with the largest own-firm runups, consistent with the real options theory. By contrast, the general pattern in beta does not appear different when conditioning on pre-issuance market runup or sentiment.

Our full-sample cross-sectional regression analysis of underperformance and beta changes is presented in Table 5. For all three dependent variables (ΔPost-Issue Return, ΔEquity Beta Change, ΔAsset Beta Change) and all specifications, the coefficient on ΔInvestment is negative and significant. The coefficient on ΔRunup is also negative and significant in all beta regressions and negative but not significant in all post-issuance performance regressions. Thus, higher investment and higher own-firm runup predict greater post-issue underperformance and larger declines in beta relative to size- and book-to-market matches. These findings are generally consistent with the real options theory.

The variables suggested by the behavioral theory appear less important to explaining the cross-section of underperformance and beta changes in the full sample. Mktrunup is negatively related to beta change as suggested by the theory, but in contrast to the theory, is insignificant and positive for post-issuance performance. Sentiment has a negative coefficient in all beta regressions, consistent with the behavioral theory, but is never significant. Sentiment has mixed signs and is never significant in the post-issuance performance regressions.[19]

The two variables related to SEO issuance proceeds can also be related to the theories. The relative magnitude of the issuance (Proceeds) is negatively related to the post-issuance returns and the changes in equity- and asset-betas in all regressions, and is significant at the 10% or 5% level in the regressions where ΔInvestment is also included. This is consistent with the simple financial leverage explanation of Hamada (1972) for post-issue performance and equity-beta change, but the asset-beta change results are uniquely implied by the real options theory. More interestingly, the coefficient on Primary is negative in all specifications for all three dependent variables, and always significant for the post-issuance return and asset-beta change regressions. If managers issue overvalued equity, which is a central premise of the DHS theory, there need not be a performance difference between primary and secondary issues. If anything, a high percentage of secondary shares, which are commonly sold by insiders, might be expected to predict worse performance than sales of only primary shares. Contradicting this hypothesis, we find significantly less underperformance for pure secondary issuers, consistent with the findings of Lee (1997). We add to the findings of Lee by showing that pure secondary issuers have less post-issuance decline in beta than primary issuers.

Our left-hand side variables in Table 5 are differences relative to size- and book-to-market matches. We nonetheless include in the cross-sectional regressions the variables ME Decile and BM Decile. Size predicts future underperformance and the declines in beta with similar coefficients and t-statistics in all specifications. The BM Decile can be related to the real options and behavioral theories, and has also been interpreted as a measure of distress (e.g., Davis, Fama, and French, 2000). Whether interpreted as mispricing or growth/distress, one disadvantage of the B/M ratio is that it does not distinguish between systematic and idiosyncratic sources of value as the models in Sections 2 and 3 suggests may be informative. Table 5 shows insignificant coefficients on BM Decile in all regressions. In untabulated univariate regressions we find that BM Decile has a positive sign for asset beta change that is significant at the 10% level, but the coefficient becomes insignificant when own runup is included in the regression.

[19] Similar unreported results hold when using the individual components of the sentiment index.

Table 6 extends our cross-sectional analysis by considering two distinct subperiods of the data. We seek to focus attention on a period that ex post might be viewed as more likely to be affected by sentiment. Hence we choose as our breakpoint the end of the year 1996, just after the famous "irrational exuberance" speech made by Alan Greenspan that for many marks the beginning of the DotCom era. Panel A gives regression results for the 1980-1996 subsample while Panel B corresponds to 1997-2005. The results of Panel A appear mostly similar to the full sample with regards to the significance of the variables related to the real options theory. By contrast, support for the behavioral theory appears substantially weaker and neither market runup nor sentiment is negative and significant for any regression in the 1980-1996 period.

The 1997-2005 subsample presented in Panel B appears interesting and strikingly different. While the findings regarding the real options theory are largely unchanged, support for the behavioral theory is considerably stronger. Notably, Mktrunup and Sentiment are negative in all regressions, Mktrunup is significant for all full-model specifications, and Sentiment is significant for all specifications of the asset-beta change. Hence, there appears to be support for both the real options and behavioral theories in the 1997-2005 period.

4.5 Volatility Dynamics

This section investigates whether volatility dynamics around SEOs are consistent with the behavioral and real options theories. In the real options theory, the market-model beta does not play any special role. Instead, risk (beta) can be viewed as the loading on an efficient portfolio in any pricing environment. Moreover, since real option leverage applies to unpriced as well as priced risk, all of the real option results for dynamic risk loadings apply equally to total volatility. The behavior of total volatility thus provides a test of the basic real options theory that is robust to any pricing environment. On the other hand, the behavioral theory of SEO return dynamics has no clear implications for volatility.

To begin our investigation of volatility dynamics around SEOs, we follow Schwert (1989) and calculate realized volatility as the sum squared returns over twenty-one day periods ("months") prior to the announcement, and subsequent to the issuance. Figure 10, Panel A shows as a solid line the dynamics of issuer average realized volatility around the SEO, for our entire sample. For these firms, volatility falls in the three years leading up to the SEO with a dramatic decrease in the year prior to announcement. Issuer volatility then increases immediately following the SEO and continues to rise for the following five years. This is in contrast to the predictions of standard real options theories, in which revenue volatility is assumed constant and return volatility endogenously increases before and declines after issuance.

One potential concern about the realized volatility calculations is the potential effects of bid-ask bounce, which may induce negative autocorrelations and overstate volatility for illiquid firms.[20] To help mitigate this concern, we follow Andersen, Bollerslev, Diebold, and Ebens (2001) and estimate MA(1) models for each SEO firm in three month intervals, and calculate the filtered residuals from these models. In unreported results, these realized volatilities do not appear substantially different from those shown in Figure 10. The general pattern of a decrease in volatility prior to issuance and increase thereafter thus appears robust to microstructure effects.

To further explore the volatility pattern displayed by SEO firms, we examine the behavior of matched-firm volatility (dashed line in Panel A) and market volatility (Panel B), in the same time frame. Match volatility trends upward steadily over the entire event window, and appears to have a drop in volatility correlated with the sample firms at the time of issuance. Similar to the sample firms, market volatility decreases in the three months prior to announcement and rises for three months after issuance. Over a longer five-year horizon after issuance, market volatility also increases substantially. These results confirm that at least part of the volatility pattern displayed by SEO firms relates to more broad-based changes in volatility, suggesting a "volatility-timing" puzzle in SEO issuance.

We examine the robustness of these results in Panels C to H of Figure 10. Panels C and D show issuer, match, and market volatility dynamics in the 1980-1996 subsample. These results are qualitatively consistent with the full sample results, and evidence of volatility-timing in issuer and market returns remains strong. Panels E and F show the same plots in the 1997-2005 subsample. Volatility is higher overall in this subsample, the decline in issuer volatility prior to announcement is similar, and the increase in sample firm volatility after issuance appears milder. Interestingly, the pattern in market volatility around issuance appears robust in all three subsamples. Panels G and H show sample-firm volatility timing for the investment and acquisition use-of-funds subsamples. The overall evidence from Figure 10 is consistent with low volatility of issuers around the SEO.[21]

We see several possible explanations for apparent volatility timing. First, firms may prefer to come to market at times of relative price stability, in order to have more certainty about the price they will receive in a seasoned issuance. Following the same reasoning, price support in a narrow window around the SEO may explain the spike down in volatility near the time of issuance. From

[20] See, for example, the discussion in Campbell, Lo, and MacKinlay (1996), Section 3.2.

[21] In unreported results, we also examine asset volatility by delevering assuming riskless debt. Though less dramatic, a similar pattern that is inconsistent with the prediction of the real option theory remains. We additionally note that the combination of high systematic risk and low total volatility around the SEO date implies that issuances also time low points of idiosyncratic volatility.

a broader perspective, if the volatility of fundamentals is stochastic, firms will optimally prefer to exercise when volatility is low, since the option value of waiting is smaller. Volatility timing of this sort has not been previously explored in the real options literature, and deserves consideration. Finally, post-SEO firms may be engaging in additional investment commitments, as in the theory presented in Section 4. This could also lead to post-issuance increases in volatility.

To summarize, the volatility pattern shown by SEO firms does not appear consistent with either the basic real options theory or behavioral theories. This evidence of volatility-timing does, however, suggest interesting directions for future theoretical research to consider.

5 Conclusion

This paper explores dynamics in risk around seasoned equity offerings from both a theoretical and empirical perspective. We develop extensions of both real options and behavioral theories that provide rich predictions for the dynamics of risk and return around SEO's. Our real options extension emphasizes the importance of commitment-to-invest. We provide a model that nests traditional time-to-build (Kydland and Prescott, 1982) as distinct from the idea that option exercise may entail a commitment to continue to invest for some period of time in the future. We show that traditional time-to-build does not substantially alter the risk dynamics of the standard instantaneous investment model, whereas commitment-to-invest has a first-order effect on betas and returns. In the SEO setting, the presence of commitment-to-invest implies that firms exercising large growth options should have large runups in risk and returns prior to issuance, followed by abnormally large investment over an extended period of time, and a decline in risk and return after issuance as investment occurs and the commitment level falls.

Existing behavioral explanations of SEO's do not focus on risk, and make no predictions about movements in risk around the SEO. To fill this gap in the literature, we develop a theory of beta dynamics when returns may be driven by a random walk fundamentals and temporary mispricing generated by mean-reverting sentiment. We show that idiosyncratic or systematic misvaluation may predict post-issuance underperformance. However, in this theory beta declines after an SEO only when the issuance is driven by temporary overvaluation of a systematic sentiment factor. This model takes a step towards a fuller development of a behavioral theory of risk dynamics, and given the richness of the subject matter we anticipate future extensions.

We empirically investigate the dynamics in risk around seasoned equity offerings. We find robust evidence of an increase in beta prior to announcement, and a gradual decline subsequent to issuance.

This finding is consistent with both the extended real options and behavioral theories developed in the paper, but not with prior literature focused on instantaneous investment or with one-time changes in risk due to financial leverage (Hamada, 1972). The cross-sectional differences in post-SEO returns and beta changes appear consistent with real options predictions. Specifically, the investment rate of the issuers, the pre-announcement runup, the magnitude of the issuance, and the percentage of primary issuance all help to predict with the correct sign the post-issuance returns and beta declines experienced by issuers. In contrast, support for the behavioral theory appears weaker in the full sample. In addition, neither of the variables related to the behavioral theory, market runup and sentiment, are significant in the 1980-1996 subsample. However and more interestingly, in the most recent 1997-2005 data we find evidence in the cross-section of post-issuance returns and beta changes supportive of both the real options and behavioral theories.

Our empirical investigation provides challenges to both the behavioral and real options theories. For example, the dynamics of total volatility appear to contradict existing real options models. We suggest directions for future theoretical research to consider, including endogenous volatility timing in a real options framework. On a broader level, our study shows that the dynamics of higher moments can help to distinguish theories and motivate the development of more complete models.

6 Appendix

6.1 Proof of Proposition 1

Equations (3)-(4) represent the solutions to the following general valuation expression

$$V_{it} = E_t\left(\int_t^{\infty} e^{-r(s-t)}\left(X_s Q_s - \frac{dK_s}{ds}\right)\right),$$

for adolescent ($i = 1$) and mature ($i = 2$) firms. The expression for Q_s follows from capital and output dynamics given in (1) and (2), and the derivative $dK_s/ds = \lambda\kappa_1 e^{\lambda(s-\tau)}$ when $\tau < s < \tau + T$ and zero otherwise.

The optimal investment strategy and juvenile ($i = 0$) firm valuation follow from application of standard real option techniques (see, e.g., Chapter 5.2 in Dixit and Pindyck (1994)).

6.2 Proof of Proposition 2

The proof derives a convenient expression for stock i beta when $F_{t-1} > 0$ and $S_{t-1} > 0$ which is the region most relevant to our analysis. Rearranging the definition for returns on the market yields

$$\begin{aligned} R_{Mt} &= \frac{1}{F_{t-1} + S_{t-1}}(F_t + d_t + S_t) \\ &= \frac{1}{1 + \xi_{t-1}}(R_{Ft} + \xi_{t-1} R_{St}), \end{aligned}$$

and for stock i yields

$$\begin{aligned} R_{it} &= \frac{1}{b_i F_{t-1} + S_{t-1} + u_{i,t-1}}\left[b_i(F_t + d_t) + S_t + u_{it} + \delta_{it}/b_{iS}\right] \\ &= \frac{1}{b_i + \xi_{t-1} + u_{i,t-1}/F_{t-1}}\left[b_i R_{Ft} + R_{St} + \frac{u_{it} + \delta_{it}/b_{iS}}{F_{t-1}}\right], \end{aligned}$$

where $\xi_{t-1} = S_{t-1}/F_{t-1}$. We then derive

$$\begin{aligned} Var(R_{Mt}|F_{t-1}, S_{t-1}) &= \frac{\sigma_F^2 + \xi^2\sigma_S^2}{(1 + \xi_{t-1})^2}, \\ Cov(R_{it}, R_{Mt}|F_{t-1}, S_{t-1}, u_{i,t-1}) &= \frac{b\sigma_F^2 + \xi_{t-1}^2\sigma_S^2}{(b + \xi_{t-1} + u_{i,t-1}/F_{t-1})(1 + \xi_{t-1})}, \end{aligned}$$

and

$$\beta_{i,t-1} \equiv \frac{Cov(R_{it}, R_{Mt}|F_{t-1}, S_{t-1}, u_{i,t-1})}{Var(R_{Mt}|F_{t-1}, S_{t-1})} = \frac{1 + \xi_{t-1}}{b_i + \xi_{t-1} + u_{i,t-1}/F_{t-1}}\frac{b_i\sigma_F^2 + \xi_{t-1}^2\sigma_S^2}{\sigma_F^2 + \xi_{t-1}^2\sigma_S^2}.$$

If we assume $\sigma_S > 0$ then equation (9) follows immediately.

6.3 Data Construction

To construct our sample, we first download from SDC all common stock issues from January 1, 1980 to December 31, 2005 by U.S. issuers, that are not coded as IPO's, with shares traded on NYSE, AMEX, or Nasdaq, that are not unit issues, excluding those observations coded with a security type of ADR or ADS. The initial sample size obtained from SDC and satisfying these criteria is 10,244.

We then seek to match this sample to the CRSP data by date and one of the three following criteria, in order: 1) eight digit CUSIP, 2) Ticker symbol, 3) Company name. We eliminate all duplicate matches and hand check name matches giving a sample of 10,123 of the original SDC observations with unique matches to a valid CRSP PERMNO. We next filter on the requirement that in the CRSP data the exchange code must be recorded as NYSE, AMEX, or NASDAQ at the date of issuance (eliminating 8 observations), and that the CRSP share code equals 10 or 11 (eliminating 1386 observations), giving a sample of 8,729.

For each firm in the sample, we search news wires and major news sources from Lexis/Nexis and Factiva for stories relating to the seasoned issuance. We search within a time window beginning six months prior to the earlier of the SDC filing date (if available) or the SDC reported issuance date (which is always available), and ending six months after the SDC reported issuance date. We consider the SDC filing date to be the earlier of the filing dates reported from two different SDC distributions (2001 and 2008) to give a larger window within which to search for news items. We designate the announcement date of the issuance as the earlier of the SDC reported filing date (8,033 observations) or the first news item we find related to the issuance (614 observations). After considering all sources, 8,647 of the 8,729 observations have valid announcement dates. We require all observations to have valid size and book-to-market observations as of two days prior to the announcement date. To obtain market equity, we take from the CRSP daily file shares outstanding and price. The book value of equity is obtained either from the COMPUSTAT quarterly file two quarters prior to the market value of equity measurement date, or, if the accounting data is not available from the quarterly file, we use the prior year annual file. After screening for valid data we have 7,474 observations. We eliminate utilities and financials leaving 5,743 observations, and requiring a valid runup (at least 63 daily return observations in the year prior to announcement) gives our final sample of 5,740 SEO's.

6.4 Instrumental Variables Regression with Realized Betas

In Section 4.3.1, we use an instrumental variables approach with lagged realized betas as instruments. The pooled regression we want to estimate is:

$$R_{it} = \alpha + \beta_0 R_{Mt} + b\beta^{RVn}_{i,t-1} R_{Mt} + u_{it}, \tag{13}$$

where t indexes months. In this regression, the parameters to be estimated are α, β_0, and b. The instrument $\beta^{RV}_{i,t-1}$ is a realized beta calculated from daily data in the n-month window ending immediately prior to t. In practice we consider $n = 1$ (Figure 6b) and $n = 3$ (Figure 6c). The conditional beta is $\beta_{it} \equiv \beta_0 + b\beta^{RVn}_{i,t-1}$.

To address measurement error in $\beta^{RVn}_{i,t-1}$, we use a two-step approach as in Ghysels and Jacquier (2006). In the first stage, estimate the regression

$$\beta^{RVn}_{it} = a + \rho\beta^{RVn}_{i,t-n} + \xi_{it}$$

by OLS and obtain the fitted values $\hat{\beta}^{RV}_{it} \equiv \hat{a} + \hat{\rho}\beta^{RV}_{i,t-n}$. In the second stage, we use the fitted value $\hat{\beta}^{RV}_{i,t-1}$ as a regressor:

$$R_{it} = \alpha + \beta_0 R_{Mt} + b\hat{\beta}^{RV}_{i,t-1} R_{Mt} + u_{it}, \tag{14}$$

and obtain the estimates $\hat{\alpha}$, $\hat{\beta}_0$, and $\hat{b}$. Our estimates of conditional beta are then $\hat{\beta}_{it} \equiv \hat{\beta}_0 + \hat{b}\beta^{RVn}_{i,t-1}$.

The idea of Ghysels and Jacquier (2006) is that the original regressor $\beta_{i,t-1}^{RVn}$ contains measurement error, but the prior window realized beta $\beta_{i,t-n-1}^{RVn}$ should be a good instrument. The two realized betas are likely to be correlated, but should also have independent sources of measurement error since they are from non-overlapping windows. Consistent with this idea, we find that instrumenting with the two-stage procedure makes a substantial difference. For both $n = 1$ and $n = 3$, we obtain estimates of ρ less than 0.2 when estimating (13) with OLS, but the estimates exceed 0.8 after instrumentation. The difference in these estimates is highly significant, which is the basis of the formal test for measurement error of Hausman (1978), and confirms the effectiveness of the instrumentation.

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TABLE 1. – Sample Description

	All	INV	ACQ	WC	GCP	D	NI	PS
N	5740	1472	1448	1462	1732	2050	1158	1073
				A. ME Decile				
Mean	4.177	3.688	3.873	3.592	3.900	3.910	3.608	5.896
SD	2.573	2.280	2.378	2.310	2.331	2.473	2.388	2.643
				B. BM Decile				
Mean	3.539	3.089	3.604	2.977	3.290	4.020	3.206	4.021
SD	2.590	2.377	2.525	2.239	2.451	2.664	2.504	2.783
				C. Primary / Proceeds				
Mean	0.705	0.884	0.872	0.855	0.857	0.876	0.861	0.000
SD	0.395	0.220	0.229	0.244	0.247	0.210	0.227	0.000
				D. Proceeds / ME				
Mean	0.210	0.214	0.246	0.226	0.214	0.247	0.236	0.119
SD	0.263	0.174	0.282	0.205	0.177	0.295	0.351	0.135

Notes: This table describes the SEO sample. We download from the SDC New Issues database common stock issues traded on NYSE, AMEX, or Nasdaq by U.S. companies, not coded as IPO's, unit issues, ADR's or ADS's. We include issuances after January 1, 1980 and before December 31, 2005. Observations must have a unique matching CRSP PERMNO for the relevant date, identified using the SDC i) CUSIP, ii) Ticker Symbol, or iii) Company Name. The CRSP exchange code must be NYSE, AMEX, or NASDAQ on the issuance date, and the CRSP share code must be 10 or 11. A valid announcement date for the issuance must be available, identified as the earlier of i) the SDC-reported filing date, or ii) the earliest news report or news wire mentioning the issue, obtained by searching our news sources. Valid data for computing market capitalization ("size") and book-to-market equity ("B/M") of the issuer must be available from CRSP and COMPUSTAT as described below. The CRSP industry code on the date of issuance must not indicate a utility (SIC = 49XX) or financial (SIC = 6XXX). We require at least 63 valid daily returns are available on CRSP in the 252 trading days prior to announcement of the SEO.

We categorize SEO's that have some primary proceeds by the firm's stated use-of-funds on the announcement date. We search the business news wire and major newspaper segments of our news sources in a one year window centered around the issuance date for a combination of the company name and any of the keywords "stock", "equity", or "issue". All returned documents were manually scanned for information regarding 1) The first announcement date of the issuance, and 2) the stated use-of-funds. Any potentially useful portions of the news releases were recorded into a database. The six use-of-funds dummy variables used to create subsamples of the data are generated by searching the use-of-funds portions of the news stories for the following keywords:

- Capital Investment (INV): *research, expan, propert, expenditure, construction, develop, build, equip;*
- Acquisition (ACQ): *merge, acqui;*
- Working Capital (WC): *working, inventory, receivable;*
- General Corporate Purposes (GCP): *general corporate purpose;*
- Debt (D): *debt, loan, credit, bank, repay, note, bond, borrow, debenture, redeem;*
- No Information (NI): none of the above.

Observations may belong to more than one category. The dummy variable PS (pure secondary) is set equal to one if all SEO proceeds are designated as secondary issuance by SDC.

For the entire sample and for each subsample, the table reports in Panel A the Market Equity Decile two days before announcement using NYSE breakpoints. Panel B reports the book-to-market decile prior to announcement using NYSE breakpoints. As in Brav, Gezcy, and Gompers (2000), we obtain the book value of equity from the COMPUSTAT quarterly report two quarters prior to two days before the announcement. If the data from this quarterly report is not available, we use the annual report following the timing convention in Davis, Fama, and French (2000). In the B/M calculation, the denominator is the market value of equity contemporaneous with the date of the recorded book value. Panel C reports the ratio of primary share issuance to total SEO proceeds as reported by SDC, and Panel D reports the ratio of total proceeds to market equity as of two days prior to the announcement date.

TABLE 2. – AVERAGE RETURNS AROUND SEO'S

	Announcement Effects						Runup		Post-issuance Returns							
	Earliest Date		SDC Date		Wire Date		1-yr		6-mo		1-yr		3-yr		5-yr	
	N	Ann	N	Ann	N	Ann	SEO	Match	SEO	Match	SEO	Match	SEO	Match	SEO	Match
A. Full sample																
1980-2005	5740	-2.00	5717	-1.89	3966	-2.06	106.3	48.1	8.1	4.0	11.2	9.3	28.6	38.6	68.6	80.1
B. By subperiod																
1980-1985	1189	-1.59	1163	-1.50	610	-1.79	99.0	58.8	11.3	7.6	12.6	12.2	46.3	57.7	80.5	102.6
1986-1990	619	-2.05	614	-1.70	336	-2.30	79.0	28.9	-0.8	-3.9	6.6	2.5	19.9	26.7	58.3	59.7
1991-1995	1365	-2.32	1371	-2.21	967	-2.49	95.6	31.5	12.4	6.2	16.5	13.5	38.9	48.4	112.7	112.5
1996-2000	1466	-1.94	1468	-1.89	1199	-1.83	143.9	65.5	9.0	1.6	11.6	5.0	3.1	21.2	26.2	45.2
2001-2005	1101	-2.09	1101	-2.01	854	-1.97	92.9	44.7	3.2	5.1	5.1	10.4	35.7	35.8	59.0	68.2
C. By use-of-funds																
INV	1472	-1.86	1465	-1.76	1367	-1.76	129.4	47.9	7.3	0.5	6.7	2.6	13.8	26.9	49.4	57.1
ACQ	1448	-1.79	1443	-1.68	1344	-1.57	110.9	42.7	6.9	2.5	6.9	5.7	20.2	35.7	57.7	66.6
WC	1462	-2.08	1454	-1.83	1353	-2.00	136.5	56.9	7.8	2.4	9.3	5.4	19.2	30.4	55.9	58.9
GCP	1732	-2.20	1727	-1.98	1605	-2.09	123.2	49.5	6.5	2.3	9.5	6.1	19.7	31.5	53.8	63.0
D	2050	-2.10	2030	-2.05	1887	-2.07	101.6	37.4	7.0	3.0	9.9	8.6	26.1	38.3	65.5	77.1
NI	1158	-1.86	1159	-1.72	716	-2.24	122.1	64.4	9.1	5.4	7.3	10.0	19.1	37.3	46.7	81.0
PS	1073	-1.70	1073	-1.70	-	-	61.4	38.2	10.8	6.2	21.9	14.9	56.9	52.8	111.1	106.7

Notes: This table reports announcement effects, the average pre-issuance runup, and post-issuance returns for SEO firms and matches. The match for each sample firm is defined by identifying the PERMNO on CRSP that belongs to the same B/M decile as the issuer, has not issued equity in the previous five years, and is the closest size match satisfying these criteria. To address delisting of the matches, if the match does not have a valid return on any date, it is replaced on that date with the next best unused match as of the SEO date.

Panel A gives results for the full sample. We report announcement effects relative to three dates: "SDC Date" is the filing date reported by SDC; "Wire Date" is the earliest news report of the issuance found in our search of news sources; "Earliest Date" is the earlier of SDC Date and Wire Date. For each date, the cumulative abnormal return (CAR) for SEO i is defined as the sum over the three-day window centered on the announcement date of the difference between the daily return of SEO i and its match. The announcement effect ("Ann") corresponding to each date is the mean CAR across firms i. The runup for each SEO firm i is defined as $e^{\bar{r}_i * 252} - 1$ where $\bar{r}_i$ is the average valid daily log return for SEO i in the 252 trading days prior to announcement. The average runup reported in the table is the average over all sample firms i, and the average runup for matches is calculated similarly. The post-issuance returns of SEO firms and matches at each horizon are the average across i of buy-and-hold returns from the issuance date over the horizon indicated. If an SEO firm leaves the CRSP database its return for remaining days over the horizon are replaced with the match return. Panel B reports the same results by 5-year subsamples, and Panel C gives results by the use-of-funds subsamples INV (investment), ACQ (acquisition), WC (working capital), GCP (general corporate purposes), D (debt), NI (no information), and PS (pure secondary).

TABLE 3. – Investment, Capital Structure, and Working Capital Dynamics

	(i) 100 * Investment / Assets							(ii) 100 * Long-Term Debt / Assets							(iii) Current Assets / Current Liabilities						
	-3	-2	-1	0	1	2	3	-3	-2	-1	0	1	2	3	-3	-2	-1	0	1	2	3
											A. SEO Firms										
All	11.6	12.1	13.2	13.0	13.3	12.2	10.9	19.4	19.2	19.8	15.6	16.2	17.6	18.2	2.04	2.05	2.04	2.30	2.29	2.15	2.09
I	15.6	16.0	17.9	16.3	18.2	15.6	14.0	14.9	13.7	14.8	9.9	10.1	12.5	13.7	2.38	2.41	2.44	2.96	2.96	2.70	2.52
A	12.3	12.4	14.3	15.3	13.9	11.8	10.4	20.0	19.3	20.5	16.2	18.0	20.2	20.1	2.06	2.08	2.03	2.34	2.33	2.13	2.01
WC	13.8	13.9	15.4	14.1	14.8	13.3	12.5	13.8	13.5	14.1	7.3	7.8	10.3	11.1	2.41	2.38	2.41	2.91	2.92	2.67	2.51
GCP	14.0	14.3	15.2	14.4	15.0	13.8	11.9	15.3	14.4	15.4	8.7	10.2	12.3	13.4	2.26	2.34	2.30	2.75	2.74	2.49	2.36
D	11.5	11.4	12.5	13.1	12.3	11.1	9.3	23.8	24.4	26.9	22.7	22.7	24.2	24.1	1.91	1.86	1.83	1.95	2.03	1.96	1.88
NI	11.5	13.1	14.6	14.3	15.3	14.1	12.0	16.7	16.2	16.5	9.5	11.1	13.7	15.4	2.12	2.14	2.14	2.71	2.65	2.41	2.38
PS	9.7	9.3	9.3	9.4	9.5	9.7	9.5	19.6	19.6	20.3	19.7	19.2	18.9	18.8	1.83	1.82	1.81	1.85	1.82	1.80	1.78
											B. Matches										
All	10.4	10.6	11.0	10.8	10.6	10.5	10.1	11.8	11.6	12.0	11.7	11.9	12.1	11.9	2.13	2.13	2.12	2.14	2.13	2.07	2.07
INV	11.1	11.0	11.7	11.6	11.1	10.8	10.4	9.1	9.5	9.8	9.3	9.6	10.3	8.9	2.20	2.22	2.25	2.30	2.25	2.27	2.22
ACQ	10.1	10.5	11.0	11.0	10.5	10.3	10.0	10.5	10.6	11.2	10.8	11.0	11.3	12.0	2.18	2.18	2.16	2.17	2.18	2.15	2.12
WC	10.7	11.2	11.7	11.6	11.2	11.2	10.7	9.4	8.9	9.1	9.2	9.4	8.9	8.5	2.21	2.23	2.25	2.31	2.26	2.19	2.19
GCP	10.9	10.9	11.4	11.4	10.8	10.8	10.6	10.1	9.6	9.8	9.8	10.1	10.5	10.2	2.17	2.24	2.20	2.23	2.21	2.17	2.19
D	10.2	10.2	10.6	10.4	10.1	10.2	9.7	12.6	13.0	13.3	13.3	13.7	13.4	13.4	2.15	2.09	2.12	2.13	2.15	2.11	2.06
NI	10.9	11.4	11.4	11.4	11.4	11.0	10.2	10.6	10.3	10.5	8.8	9.2	11.2	10.6	2.19	2.19	2.18	2.24	2.16	2.13	2.16
PS	9.9	10.5	10.6	10.3	10.2	10.2	10.3	15.1	14.9	14.9	14.4	14.8	14.9	14.4	1.93	1.95	1.91	1.87	1.87	1.81	1.83
											C. Difference										
All	1.2	1.5	2.2	2.2	2.7	1.7	0.8	7.6	7.5	7.9	3.8	4.3	5.5	6.3	-0.10	-0.07	-0.07	0.16	0.16	0.08	0.02
INV	4.5	5.1	6.2	4.7	7.0	4.8	3.6	5.8	4.2	5.0	0.6	0.5	2.2	4.8	0.18	0.19	0.19	0.66	0.70	0.44	0.30
ACQ	2.2	2.0	3.2	4.3	3.3	1.5	0.4	9.6	8.6	9.2	5.4	7.0	8.9	8.1	-0.11	-0.10	-0.13	0.17	0.15	-0.02	-0.11
WC	3.1	2.7	3.7	2.5	3.6	2.1	1.7	4.5	4.5	5.0	-1.9	-1.7	1.3	2.6	0.20	0.15	0.17	0.60	0.66	0.48	0.32
GCP	3.2	3.4	3.8	3.0	4.2	3.0	1.3	5.2	4.8	5.6	-1.1	0.1	1.8	3.2	0.09	0.10	0.10	0.52	0.54	0.33	0.17
D	1.3	1.2	1.9	2.7	2.2	0.9	-0.4	11.2	11.4	13.6	9.5	8.9	10.8	10.7	-0.24	-0.23	-0.29	-0.18	-0.12	-0.15	-0.19
NI	0.6	1.7	3.3	2.9	3.9	3.0	1.9	6.0	6.0	6.0	0.7	1.8	2.5	4.8	-0.07	-0.05	-0.05	0.47	0.49	0.29	0.22
PS	-0.2	-1.1	-1.3	-1.0	-0.7	-0.5	-0.9	4.5	4.7	5.4	5.3	4.4	3.9	4.4	-0.10	-0.13	-0.10	-0.02	-0.05	-0.01	-0.05

Notes: This table reports the dynamics of investment, capital structure, and working capital for SEO firms and their matches around an SEO. The SEO sample is described in Table 1 and the size and book-to-market matching procedure is described in Table 2. Panel A reports for SEO firms (i) the average Investment / Asset ratio, where "Investment" is obtained from COMPUSTAT in fiscal years ranging from -3 to 3 relative to issuance as the sum of capital expenditures, research and development, and acquisitions, less sales of property, plant, and equipment, following the definition of Titman, Wei, and Xie (2004). "Assets" is the contemporaneously measured book value of assets. The second set of columns (ii) reports the Long-Term Debt to Assets ratio where Assets is again book value. The set of columns (iii) reports the ratio of Current Assets to Current Liabilities, again obtained from COMPUSTAT. Panel B reports the same average statistics for matches, and Panel C reports the difference between the SEO and match averages.

TABLE 4. – Cross-Sectional Regression Variables and Summary Statistics

	Mean	Distribution Percentiles 1	10	50	90	99	N
				Panel A: LHS Variables			
ΔPost-Issue Return	-0.10	-3.82	-1.65	-0.07	1.41	3.78	5740
ΔEquity Beta Change	-0.07	-2.63	-1.19	-0.06	1.05	2.32	4974
ΔAsset Beta Change	-0.09	-2.46	-1.13	-0.08	0.93	2.18	4969
				Panel B: RHS Variables			
ΔInvestment	0.03	-0.41	-0.13	0.02	0.21	0.50	5617
ΔRunup	58.24	-402.54	-64.63	41.06	205.68	682.45	5740
Mktrunup	19.48	-22.55	-6.84	20.02	39.23	67.85	5740
Sentiment	0.23	-1.24	-0.62	0.16	1.13	2.33	5740
Primary	0.70	0.00	0.00	0.96	1.00	1.00	5740
Proceeds	0.21	0.01	0.05	0.16	0.39	0.94	5740
ME Decile	4.18	1.00	1.00	4.00	8.00	10.00	5740
BM Decile	3.54	1.00	1.00	3.00	8.00	10.00	5740

Notes: This table reports summary statistics for the cross-sectional regression variables. Panel A contains dependent variables in the regressions and Panel B gives the dependent variables. "ΔPost-Issue Return" is the difference between the three-year post-SEO buy-and-hold log return of the SEO firm and its match. The matching procedure is described in Table 2. When valid returns for the SEO firm are not available on CRSP for any given day, we substitute the match return. To obtain the variable "ΔEquity Beta Change" we first calculate for each SEO firm and its match the realized equity beta in the one-year window centered on the issuance date, and the realized equity beta in the one-year window centered on the nearest trading day to three years after issuance. The realized betas are calculated by regressing daily log returns of the firm on a constant and daily log returns of the CRSP value-weighted index, requiring at least 21 valid daily returns for each regression. The "Equity Beta Change" for each firm is defined as the realized beta in the window centered on three years after issuance less the realized beta centered on the issuance date. "ΔEquity Beta Change" is defined as the difference between the SEO-firm's Equity Beta Change and the match's Equity Beta Change. We similarly define "ΔAsset Beta Change" as the difference between the SEO firm and match changes in Asset Beta, where the Asset Betas are obtained by delevering the realized Equity Betas using the formula $\beta_{it}^A = \frac{ME_t}{ME_t+LTD_t}\beta_{it}^E$, where ME_t is the market value of equity at time t, LTD_t is the book value of long-term debt, β_{it}^E is the realized equity beta, and β_{it}^A is the asset beta. The variable ΔInvestment is defined as the difference between the SEO firm and its match of the mean of the investment-to-assets ratio in years 0, 1, and 2 relative to issuance as defined in Table 3. The variable ΔRunup is defined as the difference between the SEO firm and its match of Runup, where Runup is defined in Table 2 as the return in the one-year window immediately prior to announcement. Mktrunup is the one year runup in the market prior to announcement, given by $e^{\bar{r}_M*252}-1$ where $\bar{r}_M$ is the average daily log return for the CRSP value-weighted return in the 252 trading days prior to announcement. Sentiment is the value of the Baker and Wurgler (2007) sentiment index as of the issuance date, downloaded from Jeffrey Wurgler's website. Primary is the fraction of the issuance proceeds that are new primary shares issued by the firm, obtained from SDC. Proceeds is the dollar value of SEO proceeds divided by the market value of equity of the SEO firm two days prior to announcement. ME Decile and BM decile are respectively the market equity and book-to-market deciles of the SEO firm two days prior to announcement, using NYSE breakpoints as described in the notes to Table 1.

TABLE 5. – THE CROSS-SECTION OF UNDERPERFORMANCE AND BETA CHANGES

	(i) ΔPost-Issue Return						(ii) ΔEquity Beta Change						(iii) ΔAsset Beta Change					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
Const	-0.098	-0.077	-0.104	0.317	0.322	0.329	-0.069	-0.064	0.005	0.091	0.145	0.169	-0.092	-0.082	-0.018	0.036	0.107	0.111
	[-5.42]	[-4.13]	[-3.90]	[5.20]	[5.02]	[5.10]	[-5.02]	[-4.50]	[0.27]	[1.79]	[2.72]	[3.25]	[-7.39]	[-6.41]	[-0.98]	[0.80]	[2.31]	[2.41]
ΔInvestment		-0.711		-0.701		-0.706		-0.224		-0.207		-0.219		-0.349		-0.333		-0.344
		[-5.09]		[-4.92]		[-4.96]		[-2.39]		[-2.19]		[-2.35]		[-3.92]		[-3.71]		[-3.87]
ΔRunup			-0.027		-0.029	-0.029			-0.079		-0.079	-0.078			-0.081		-0.080	-0.080
			[-1.38]		[-1.46]	[-1.47]			[-9.78]		[-9.69]	[-9.61]			[-10.15]		[-10.02]	[-10.03]
Mktrunup			0.130		0.049	0.018			-0.128		-0.143	-0.152			-0.108		-0.119	-0.135
			[1.35]		[0.52]	[0.19]			[-1.74]		[-1.96]	[-2.06]			[-1.65]		[-1.82]	[-2.04]
Sentiment			-0.016		0.012	0.010			-0.012		-0.007	-0.011			-0.024		-0.018	-0.021
			[-0.67]		[0.49]	[0.43]			[-0.66]		[-0.35]	[-0.55]			[-1.41]		[-1.04]	[-1.21]
Proceeds				-0.131	-0.100	-0.123				-0.168	-0.082	-0.144				-0.115	-0.085	-0.093
				[-1.93]	[-1.55]	[-1.82]				[-2.53]	[-1.04]	[-2.14]				[-2.21]	[-1.58]	[-1.76]
Primary				-0.139	-0.174	-0.131				-0.080	-0.066	-0.055				-0.084	-0.077	-0.058
				[-3.02]	[-3.83]	[-2.82]				[-2.37]	[-2.00]	[-1.63]				[-2.84]	[-2.65]	[-1.99]
ME Decile				-0.061	-0.060	-0.062				-0.017	-0.016	-0.018				-0.016	-0.016	-0.017
				[-8.50]	[-8.36]	[-8.59]				[-2.78]	[-2.61]	[-3.10]				[-3.00]	[-3.10]	[-3.29]
BM Decile				-0.004	-0.006	-0.005				0.002	-0.002	-0.002				0.009	0.004	0.005
				[-0.60]	[-0.92]	[-0.76]				[0.33]	[-0.41]	[-0.45]				[1.97]	[0.95]	[1.04]
N	5740	5617	5740	5617	5740	5617	4974	4908	4974	4908	4974	4908	4969	4908	4969	4908	4969	4908
R2	-	0.007	0.002	0.019	0.013	0.021	-	0.001	0.023	0.004	0.025	0.027	-	0.004	0.030	0.007	0.032	0.036

Notes: This table reports OLS coefficient estimates from regressions of the dependent variables (i) ΔPost-Issue Return, (ii) ΔEquity Beta Change, and (iii) ΔAsset Beta Change, defined in Table 4, on the right-hand side variables defined in Table 4. The regressions use all sample firms with valid data. Heteroskedasticity-consistent t-statistics are reported in brackets.

TABLE 6. – Cross-Sectional Regressions by Subsample

	(i) ΔPost-Issue Return						(ii) ΔEquity Beta Change						(iii) ΔAsset Beta Change					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
							A. 1980-1996 Subsample											
Const	-0.048	-0.028	-0.093	0.345	0.312	0.320	-0.091	-0.084	-0.056	0.109	0.153	0.167	-0.105	-0.093	-0.063	0.000	0.051	0.062
	[-2.31]	[-1.32]	[-2.82]	[4.97]	[4.19]	[4.26]	[-5.26]	[-4.72]	[-1.99]	[1.75]	[2.32]	[2.52]	[-6.69]	[-5.81]	[-2.53]	[0.01]	[0.88]	[1.05]
ΔInvestment		-0.639		-0.643		-0.635		-0.307		-0.302		-0.292		-0.403		-0.397		-0.384
		[-3.33]		[-3.33]		[-3.29]		[-2.51]		[-2.46]		[-2.41]		[-3.58]		[-3.51]		[-3.43]
ΔRunup			-0.020		-0.026	-0.026			-0.091		-0.093	-0.091			-0.092		-0.093	-0.092
			[-1.24]		[-1.64]	[-1.60]			[-6.04]		[-6.12]	[-5.98]			[-6.19]		[-6.19]	[-6.07]
Mktrunup			0.237		0.178	0.151			0.085		0.058	0.051			0.054		0.041	0.028
			[1.93]		[1.44]	[1.22]			[0.86]		[0.58]	[0.50]			[0.61]		[0.46]	[0.31]
Sentiment			0.018		0.029	0.033			-0.013		-0.011	-0.014			-0.004		-0.003	-0.003
			[0.66]		[1.04]	[1.15]			[-0.53]		[-0.43]	[-0.53]			[-0.16]		[-0.11]	[-0.15]
Proceeds				-0.152	-0.137	-0.140				-0.230	-0.191	-0.211				-0.133	-0.104	-0.112
				[-2.30]	[-2.16]	[-2.18]				[-2.87]	[-2.34]	[-2.63]				[-2.24]	[-1.71]	[-1.89]
Primary				-0.135	-0.162	-0.132				-0.066	-0.067	-0.057				-0.045	-0.047	-0.033
				[-2.82]	[-3.37]	[-2.70]				[-1.57]	[-1.61]	[-1.36]				[-1.20]	[-1.27]	[-0.88]
ME Decile				-0.053	-0.053	-0.054				-0.023	-0.025	-0.026				-0.014	-0.017	-0.018
				[-6.83]	[-6.85]	[-6.85]				[-3.09]	[-3.43]	[-3.60]				[-2.21]	[-2.68]	[-2.85]
BM Decile				-0.008	-0.008	-0.009				-0.001	-0.003	-0.004				0.007	0.004	0.004
				[-0.99]	[-1.05]	[-1.12]				[-0.19]	[-0.52]	[-0.66]				[1.31]	[0.77]	[0.73]
N	3571	3489	3571	3489	3571	3489	3118	3066	3118	3066	3118	3066	3118	3068	3118	3068	3118	3068
R2	-	0.006	0.002	0.018	0.013	0.019	-	0.002	0.018	0.007	0.023	0.025	-	0.005	0.023	0.007	0.026	0.030
							B. 1997-2005 Subsample											
Const	-0.182	-0.159	-0.101	0.240	0.316	0.312	-0.032	-0.030	0.075	0.049	0.098	0.126	-0.072	-0.064	0.044	0.093	0.174	0.167
	[-5.37]	[-4.53]	[-2.53]	[2.02]	[2.67]	[2.57]	[-1.42]	[-1.28]	[2.60]	[0.56]	[1.14]	[1.45]	[-3.45]	[-3.00]	[1.67]	[1.20]	[2.23]	[2.15]
ΔInvestment		-0.774		-0.750		-0.794		-0.127		-0.093		-0.143		-0.284		-0.245		-0.302
		[-3.75]		[-3.50]		[-3.70]		[-0.88]		[-0.63]		[-0.97]		[-2.01]		[-1.70]		[-2.10]
ΔRunup			-0.028		-0.028	-0.028			-0.071		-0.071	-0.070			-0.072		-0.070	-0.070
			[-1.03]		[-1.05]	[-1.09]			[-7.61]		[-7.49]	[-7.49]			[-7.83]		[-7.64]	[-7.78]
Mktrunup			-0.278		-0.335	-0.388			-0.343		-0.350	-0.353			-0.352		-0.361	-0.382
			[-1.61]		[-1.97]	[-2.27]			[-2.86]		[-2.90]	[-2.91]			[-3.21]		[-3.30]	[-3.48]
Sentiment			-0.115		-0.060	-0.072			-0.046		-0.043	-0.046			-0.087		-0.072	-0.079
			[-2.42]		[-1.25]	[-1.50]			[-1.48]		[-1.34]	[-1.40]			[-3.07]		[-2.49]	[-2.71]
Proceeds				-0.054	0.036	-0.010				-0.052	0.104	0.009				-0.082	-0.009	-0.015
				[-0.28]	[0.23]	[-0.05]				[-0.42]	[0.82]	[0.07]				[-0.79]	[-0.08]	[-0.14]
Primary				-0.139	-0.184	-0.114				-0.106	-0.075	-0.063				-0.146	-0.121	-0.095
				[-1.55]	[-2.07]	[-1.25]				[-1.87]	[-1.35]	[-1.10]				[-2.94]	[-2.51]	[-1.94]
ME Decile				-0.070	-0.064	-0.067				-0.004	0.002	-0.001				-0.017	-0.012	-0.012
				[-4.75]	[-4.38]	[-4.52]				[-0.39]	[0.21]	[-0.12]				[-1.89]	[-1.30]	[-1.34]
BM Decile				0.002	-0.006	-0.003				0.006	-0.001	0.000				0.009	0.001	0.002
				[0.15]	[-0.50]	[-0.20]				[0.65]	[-0.06]	[0.01]				[1.18]	[0.19]	[0.31]
N	2169	2128	2169	2128	2169	2128	1856	1842	1856	1842	1856	1842	1851	1840	1851	1840	1851	1840
R2	-	0.008	0.006	0.020	0.016	0.025	-	0.001	0.036	0.003	0.037	0.037	-	0.003	0.047	0.009	0.050	0.054

Notes: This table reports OLS coefficient estimates from regressions of the dependent variables (i) ΔPost-Issue Return, (ii) ΔEquity Beta Change, and (iii) ΔAsset Beta Change, defined in Table 4, on the right-hand side variables defined in Table 4. Panel A uses the subsample of SEO firms that issue in 1980-1996, and Panel B uses the subsample of SEO firms that issue in 1997-2005. Heteroskedasticity-consistent t-statistics are reported in brackets.

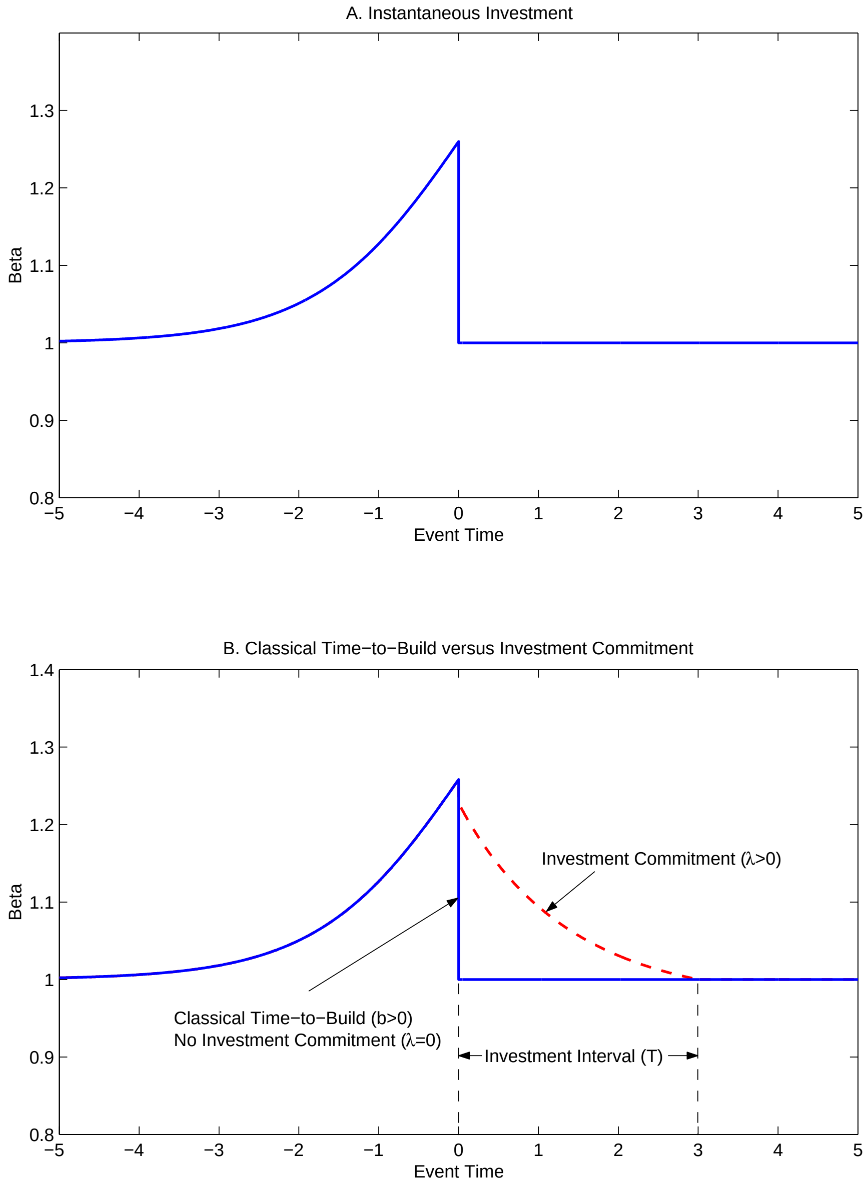

Figure 1: Beta dynamics in the extended real options model. This figure illustrates beta dynamics in the real options model extended to incorporate investment commitment and time-to-build. Panel A shows that for the standard instantaneous investment real options model ($\lambda = 0$ and $b = 0$), beta rises prior to equity issuance and then drops immediately to equal the beta of assets-in-place. Panel B shows that with standard time-to-build ($b > 0$) and no investment commitment ($\lambda = 0$, solid line), beta dynamics are nearly identical to those produced by the standard instantaneous investment real options model as in Panel A. However, when there is a commitment to future investment involving continuing expenditures ($\lambda > 0$, dashed line) beta remains high following the SEO date and then declines as investment takes place and the commitment level falls. The parameters used to produce the figure are $r = 0.04$, $\delta = 0.025$, $\sigma = 0.2$, $T = 3$, $\kappa_0 = 1$, and $\kappa_2 = 3.25$. To insure that the installed capital level κ_2 is comparable in all of the cases illustrated, we set $\lambda = 0$ and $I = 2.25$ in Panel A and in Panel B for the case with no investment commitment, and we set $I = 0.25$ and $\lambda = \ln(2)/3$ in Panel B for the case with investment commitment.

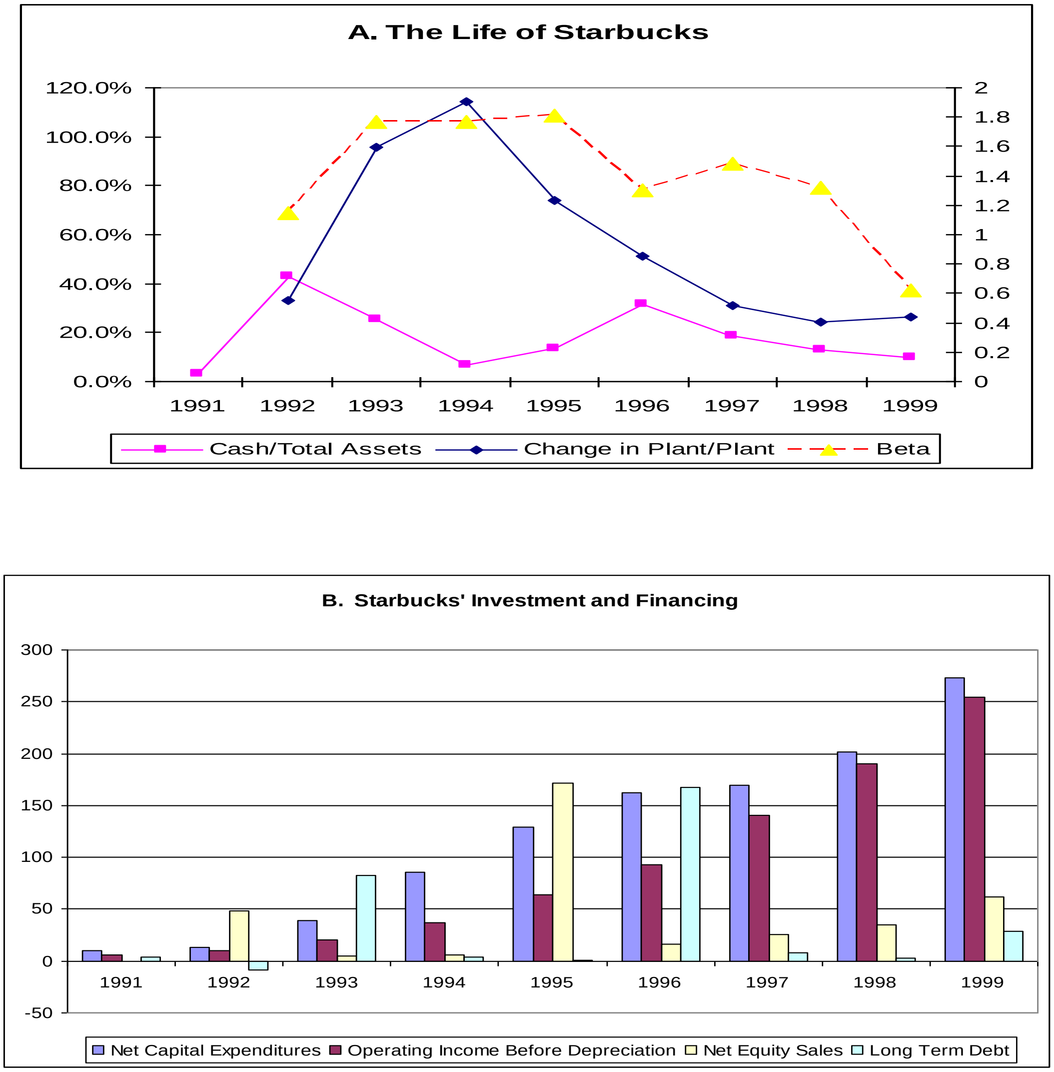

Figure 2: The Starbucks SEO Episode. Panel A shows the timing of major financing events for Starbucks, as well as the evolution of beta, asset growth, and working capital. The monthly realized betas are estimated from non-overlapping windows of twenty-one trading days. We regress the Starbucks log returns on a constant and the log return of the CRSP value-weighted index. In Panel B, we show from Starbucks annual report the Net Capital Expenditures, Operating Income, Net Equity Sales, and net Long-term Debt proceeds.

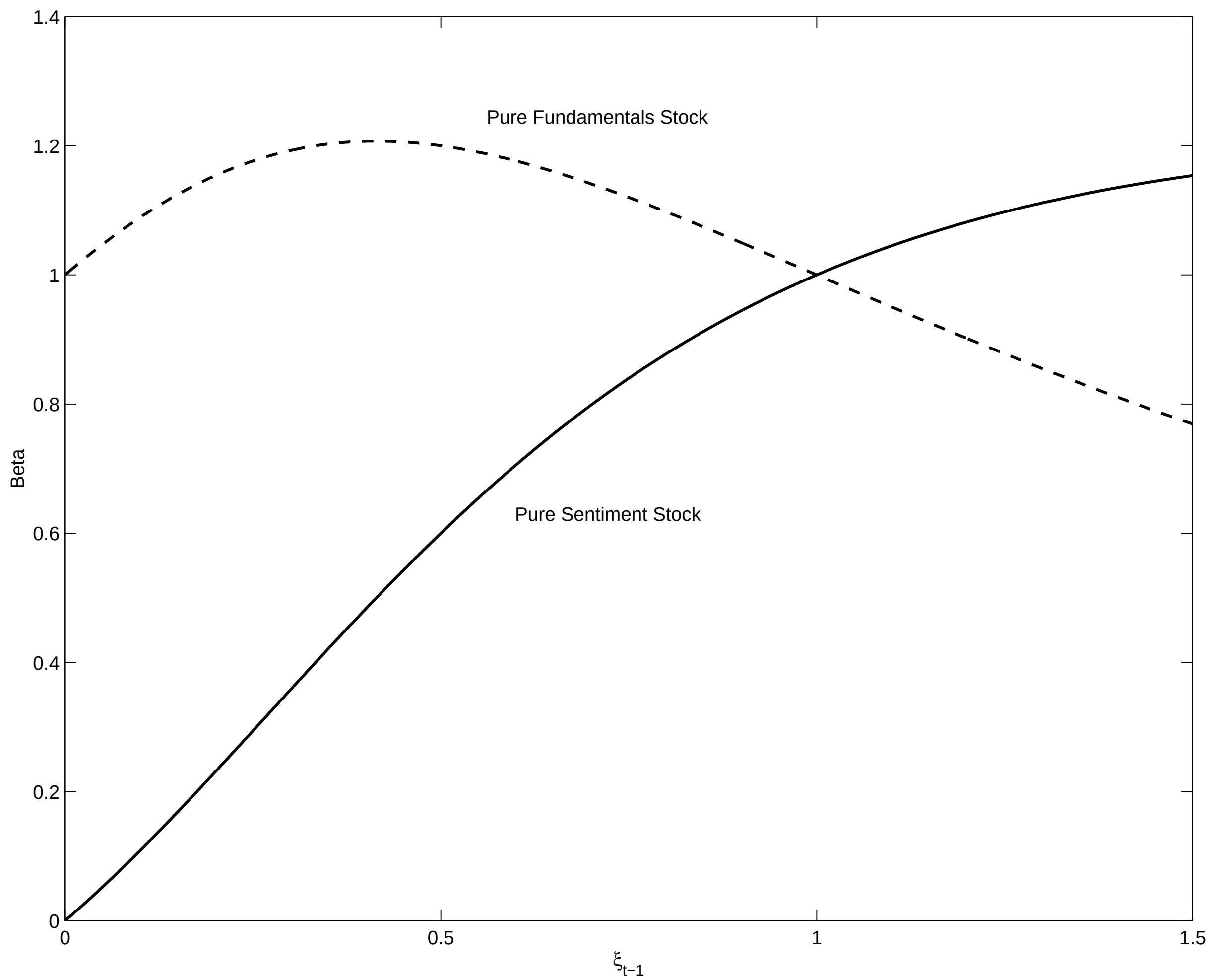

Figure 3: Beta dynamics with mean-reverting sentiment. This figure plots equation (9) for a pure sentiment stock ($b_i = 0$, solid line) and a pure fundamentals stock ($b_i = \infty$, dashed line). Both curves are drawn assuming equal fundamental and sentiment return volatilities $\sigma_F = \sigma_S$, and no idiosyncratic component of prices $u_{it} = 0$.

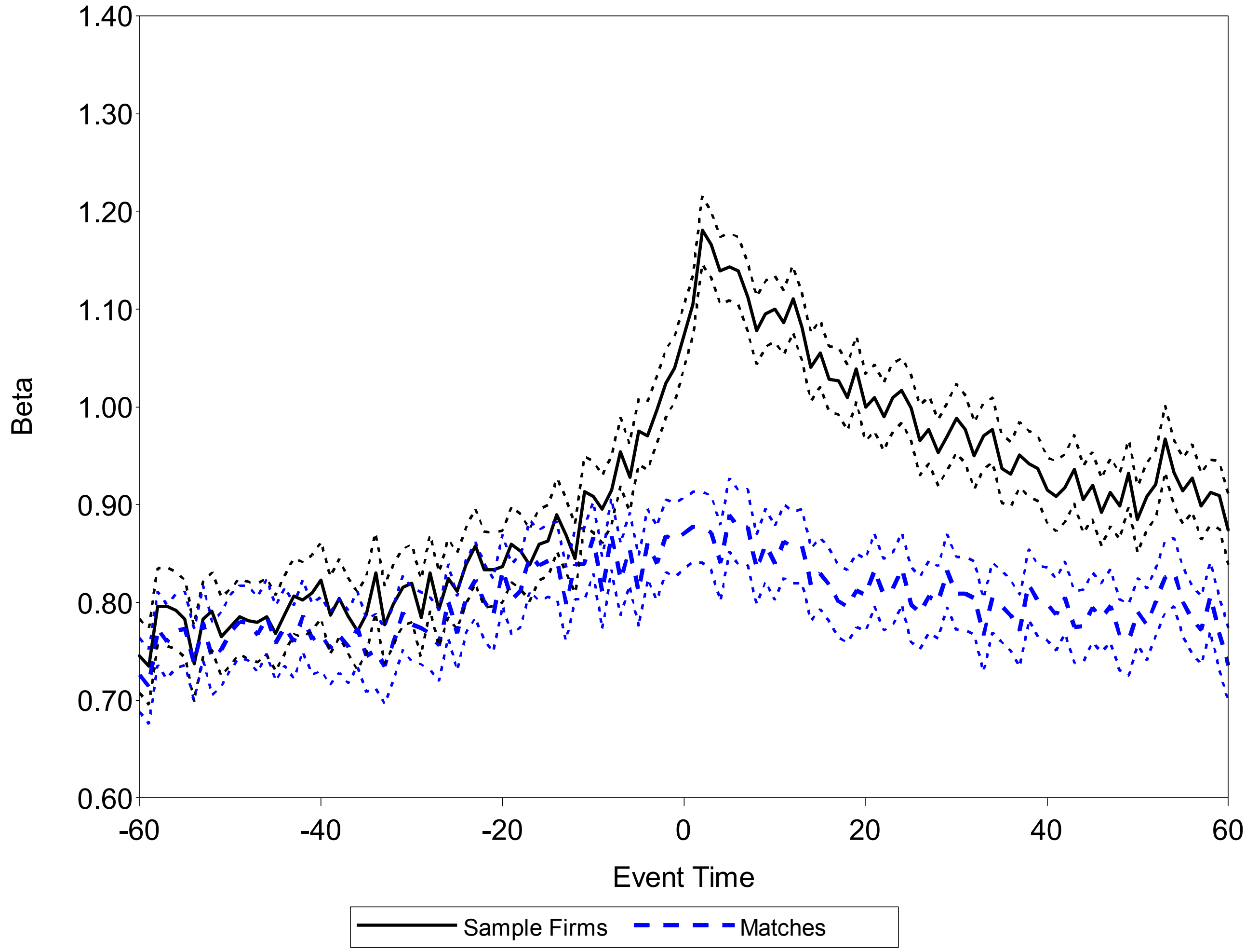

Figure 4a: Realized beta dynamics for the full sample. This figure shows the dynamic pattern in beta for the full sample of SEO firms and their matches. Realized betas are calculated in 21-day windows ("months") prior to the announcement date and after issuance. We consider as a single period the interval between announcement and issuance, regardless of how long that interval is. In each month we regress the daily log returns for firm i on a constant and the log return of the value-weighted CRSP index. Following Scholes and Williams (1977), we aggregate returns across any days in which trading volume is zero. We require a minimum of fifteen valid returns for firm i in month t to produce a realized beta β_{it}. The solid line in the plot shows the average across all firms i of β_{it}, where t is measured in event time. The dashed line represents average betas of size and book-to-market matches, and is calculated similarly. To obtain match returns, for each seasoned issuer we identify the PERMNO on CRSP that belongs to the same B/M decile as the issuer, has not issued equity in the previous five years, and is the closest size match satisfying these criteria. To address potential delisting, if the match does not have a valid return on any date in the five years subsequent to the SEO, it is replaced on that date with the next best unused match as of the SEO date. Dotted lines represent the 95% confidence interval of the mean.

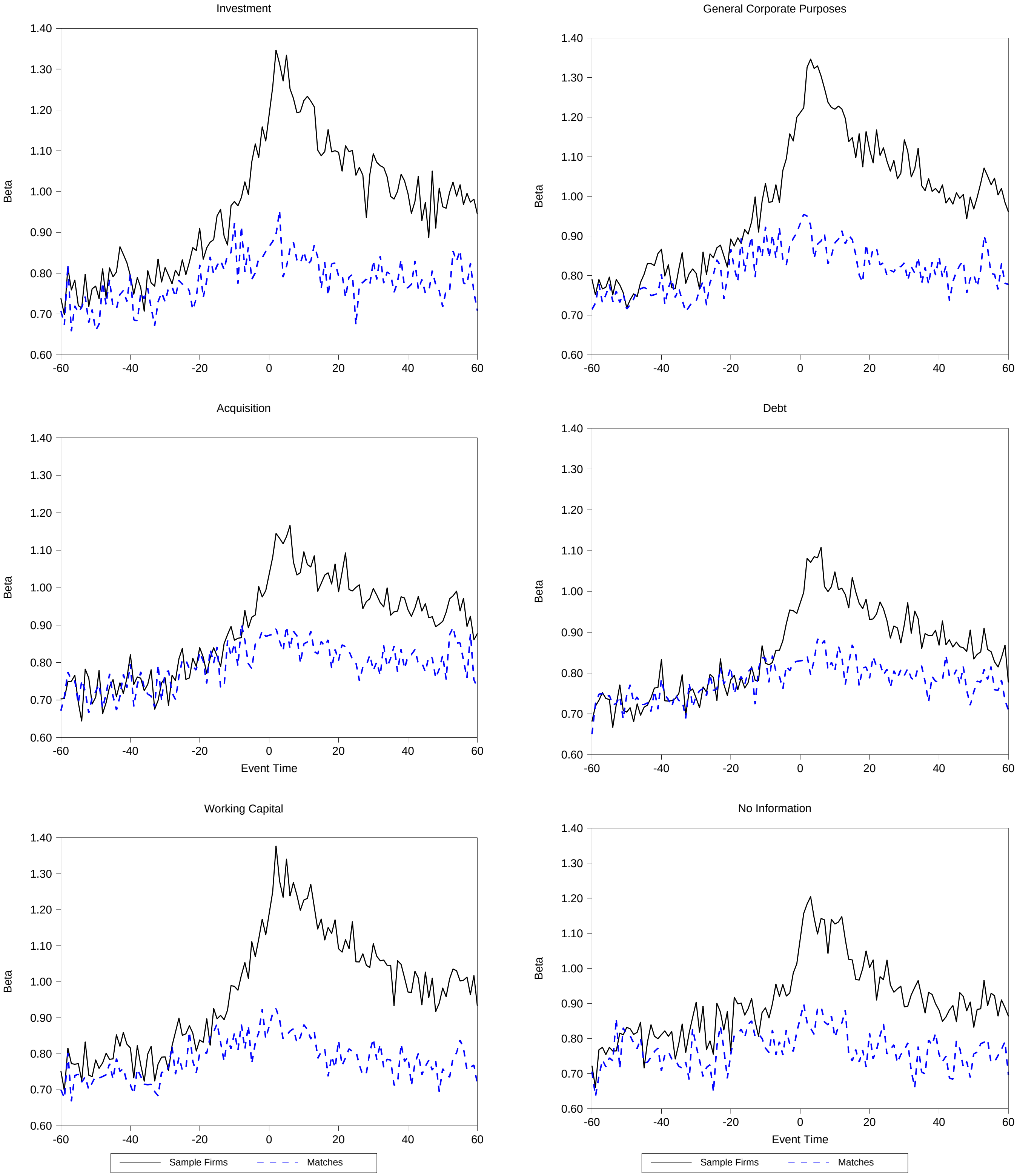

Figure 4b: Realized beta dynamics by use-of-funds subsample. This figure shows the average realized beta, calculated as in Figure 4a, by use-of-funds subsample. The use-of-funds categories are defined as described in detail in the text by searching our news sources, Lexis/Nexis and Factiva, for stories related to the issuance use-of-funds. The exact definitions and sample sizes for each category are given in the notes to Table 1. The average betas of size and book-to-market matches are represented as the dashed line.

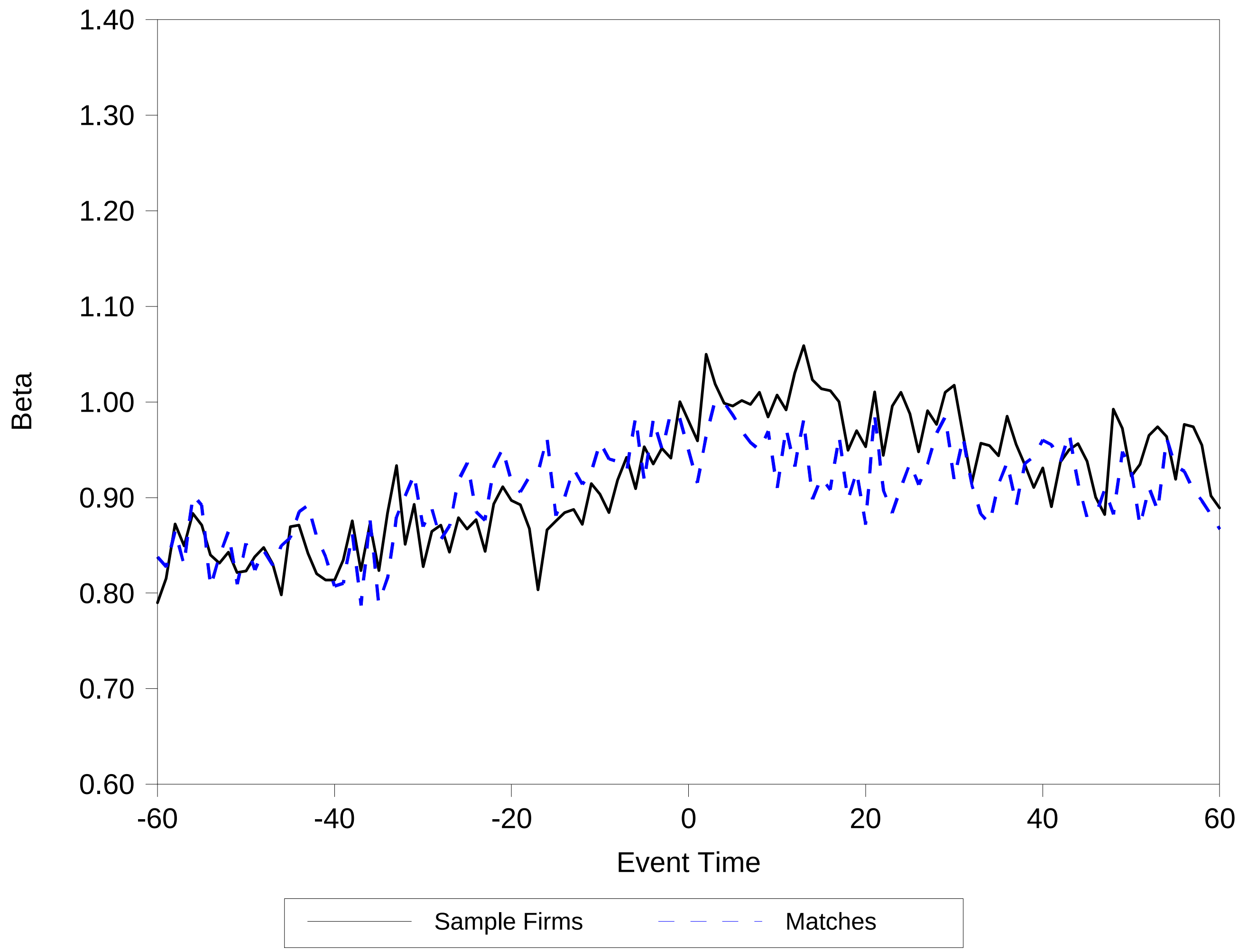

Figure 4c: Realized beta dynamics of pure secondary issues. This figure shows shows the beta dynamics of pure secondary issuers, defined as issues where all proceeds will be used to purchase shares of existing shareholders. Under the real options theory, such issuances would have no impact on risk dynamics, consistent with the results.

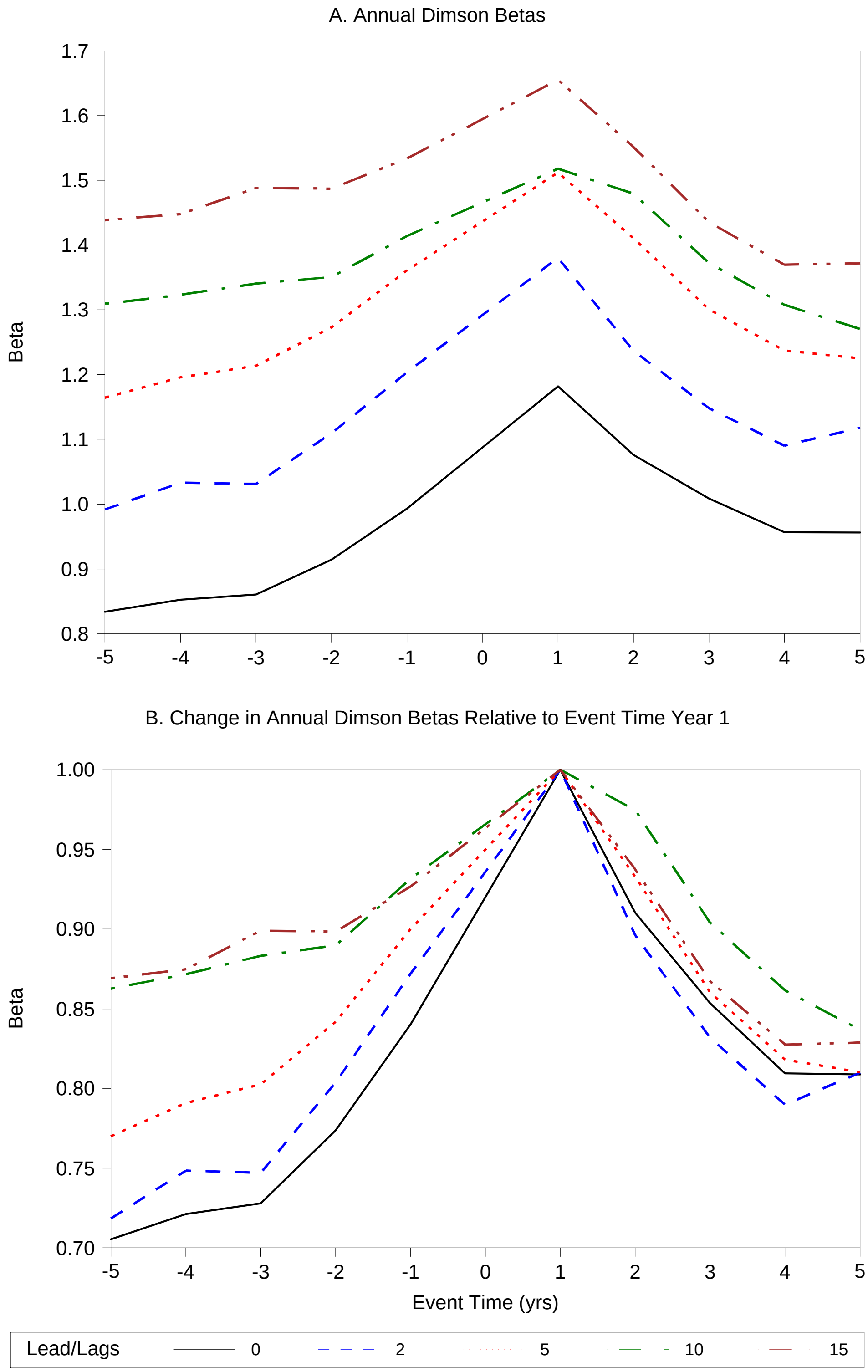

Figure 5: Realized beta dynamics with Dimson (1979) adjustments. This plot shows the robustness of beta dynamics to accounting for non-synchronous trading using the method of Dimson (1979). For each firm i in each year τ relative to issuance, we run the regression $r_{it} = a_i + \sum_{n=-N}^{N} \beta_{in} r_{M,t+n} + e_{it}$, where r_{it} and r_{Mt} are daily log returns for firm i and the market respectively. We use as a proxy for the market the value-weighted CRSP index. The Dimson beta is defined as the sum over n of β_{in}. Following Denis and Kadlec (1994), we use the number of lags N equal to 0, 2, 5, 10, or 15 days, each depicted as a different plot in Panel A. Panel B shows the differences relative to the first year of event time. The figures show that adjusting for possible asynchronous trading as suggested by Dimson increases the overall level of the betas, but does not alter the general pattern.

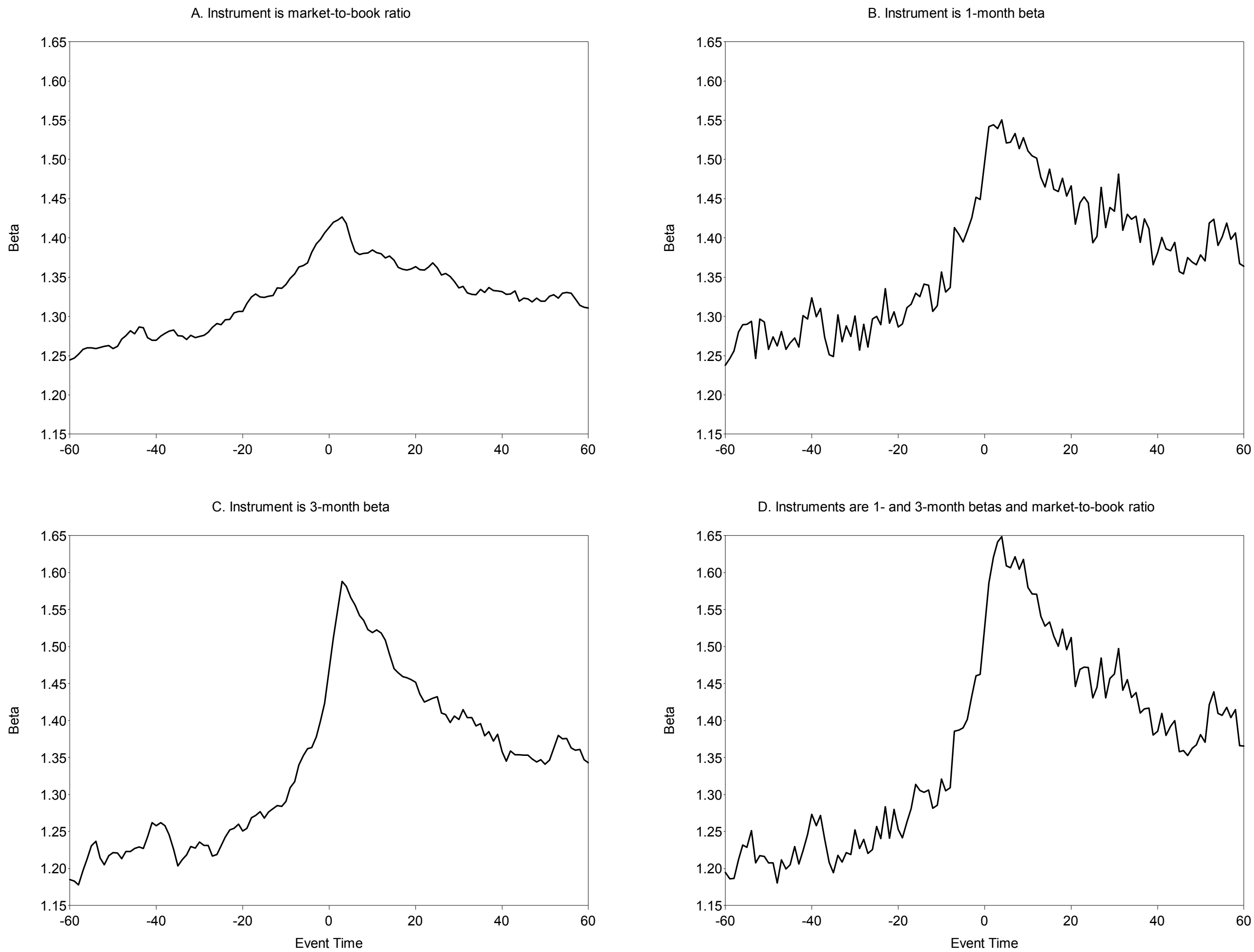

Figure 6: Conditional betas instrumented by M/B and lagged realized betas. This figure shows the average conditional beta of SEO firms in event time, obtained from monthly returns data using the linear instrumental variables regression (10). Panel A uses only the M/B ratio as an instrument. The instrumental variables regression is estimated firm-by-firm using all data available for the firm from CRSP, and the average fitted betas are averaged across firms in event time. Panel B uses the lagged realized beta in the prior 1-month window as the only instrument, and Panel C uses the realized beta estimated from the prior 3-month window. Panels B and C use pooled two-stage regressions to account for measurement error in the short-window realized betas, as described in the Appendix. Panel D uses all three instruments together.

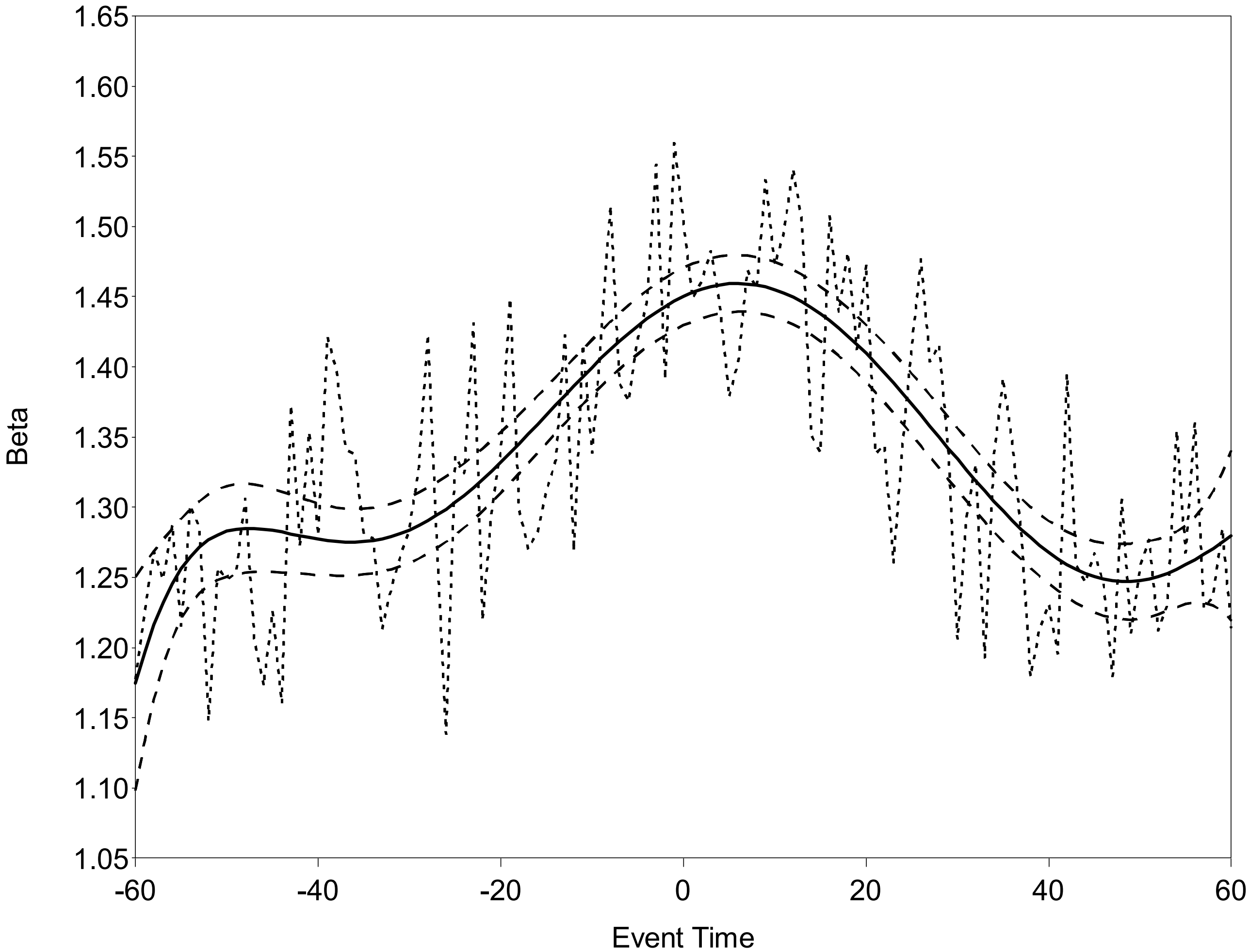

Figure 7: Conditional beta instrumented by event time. This figure shows as a dotted line results from the pooled regression $R_{i\tau} = \alpha_\tau + \beta_\tau R_{M\tau} + u_{i\tau}$, where $-60 \leq \tau \leq 60$ indexes months relative to the SEO issuance date, and the coefficients α_τ and β_τ depend only on event-time. The regression produces 120 coefficients on the time dummies for alpha and beta, and the coefficients on beta are plotted as the dotted line. To obtain the solid line, we run the same pooled regression imposing that the beta coefficients are a polynomial in τ of order N: $\beta_\tau = \sum_{n=1}^{N} b_\tau \tau^n$.

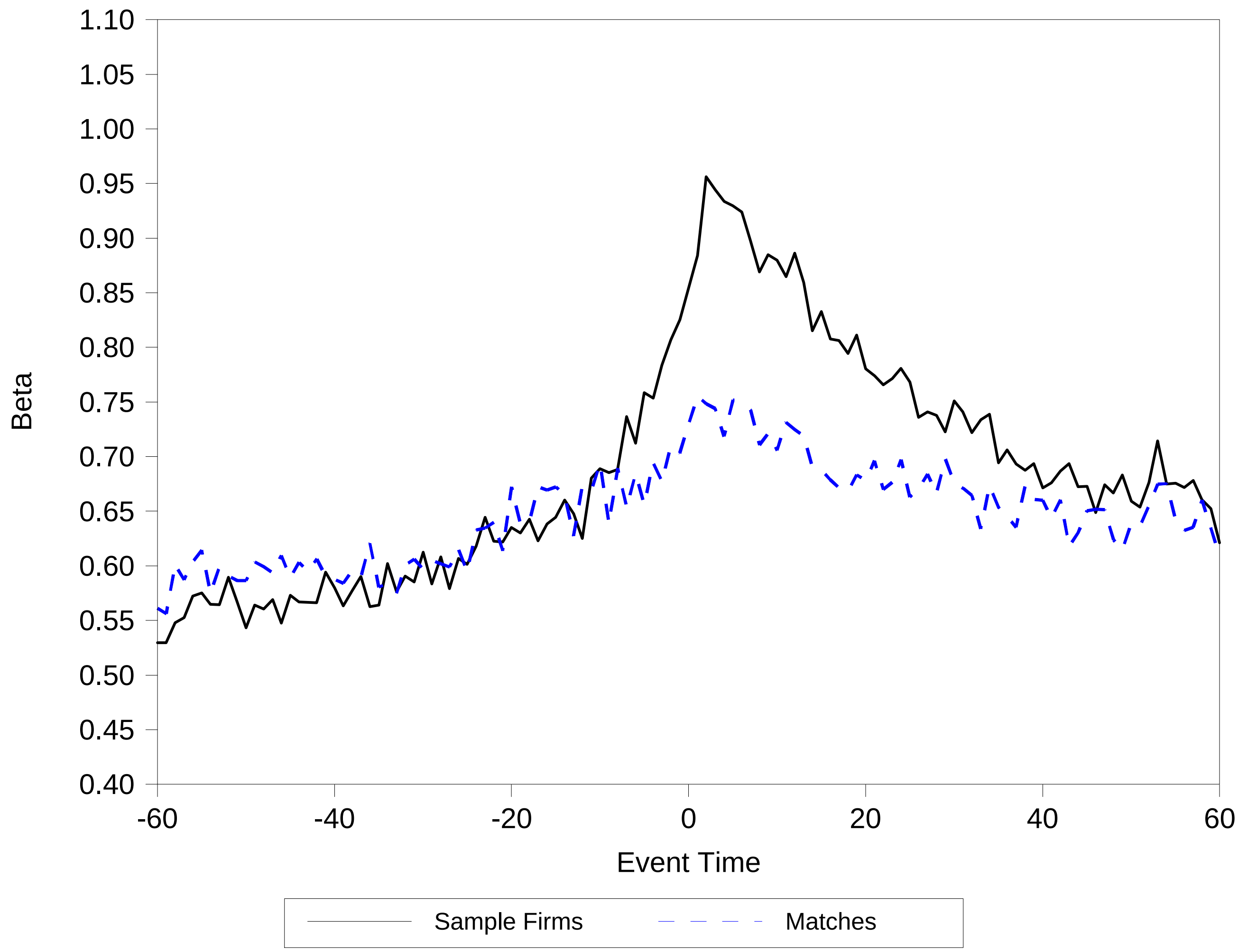

Figure 8: Realized asset beta dynamics. For each firm i and month t we delever the equity beta calculated as described in Figure 4 to obtain the asset beta using the formula: $\beta_{it}^{A} = \frac{ME_t}{ME_t+LTD_t}\beta_{it}^{E}$, where ME_t is the market value of equity at time t, LTD_t is the book value of long-term debt, β_{it}^{E} is the equity beta, and β_{it}^{A} is the asset beta. This deleveraging equation is consistent with Ruback (2002) when the debt beta is zero. Asset betas of size-and-book to market matches are calculated similarly. The figure plots as a solid line the average asset beta of SEO firms, and as a dashed line the average asset beta of matches.

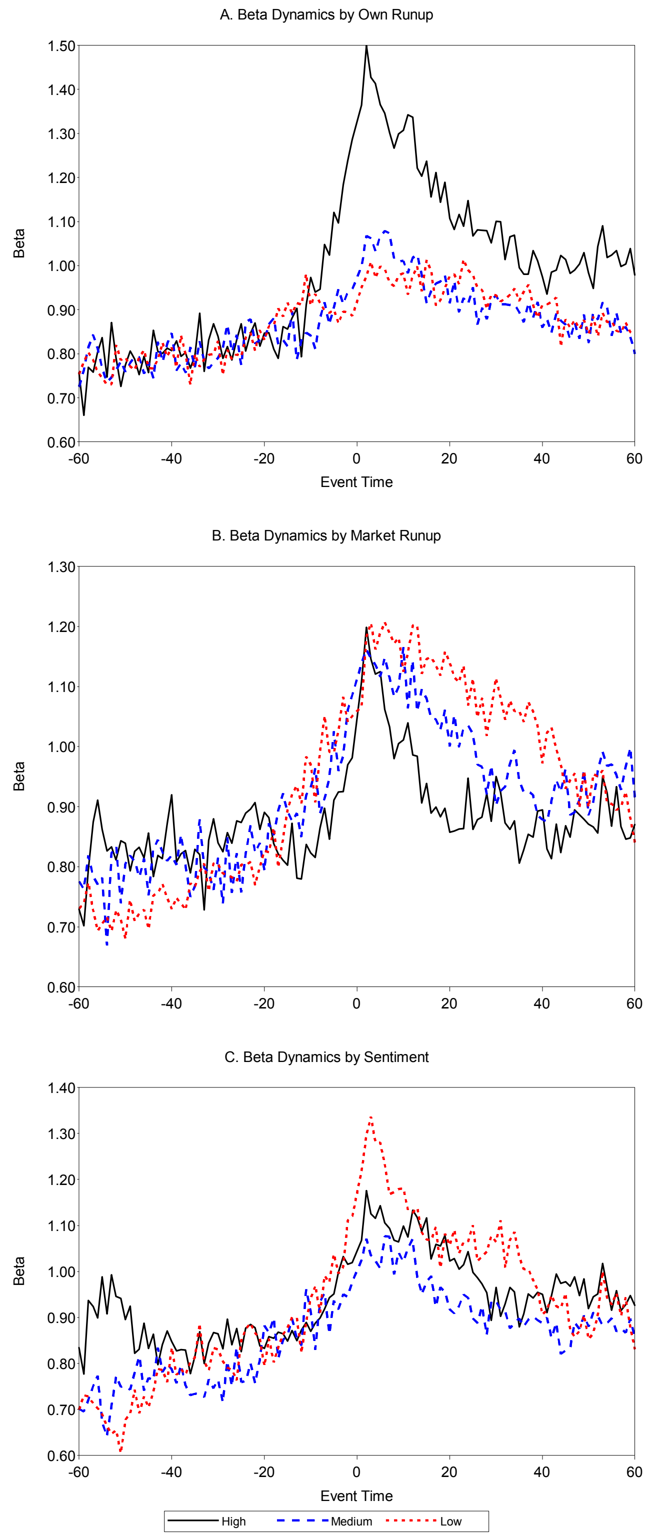

Figure 9: The cross-section of beta dynamics. In Panel A we sort SEO firms into terciles based on Runup, as defined in Table 2 to capture the own-firm runup in the one-year window prior to announcement. The panel displays the average beta dynamics for each tercile. In Panel B, we form terciles using Mktrunup, as defined in Table 4 to capture the one-year runup in market returns prior to announcement. Panel C sorts into terciles using Sentiment, the index defined by Baker and Wurgler (2007), as of the time of issuance.

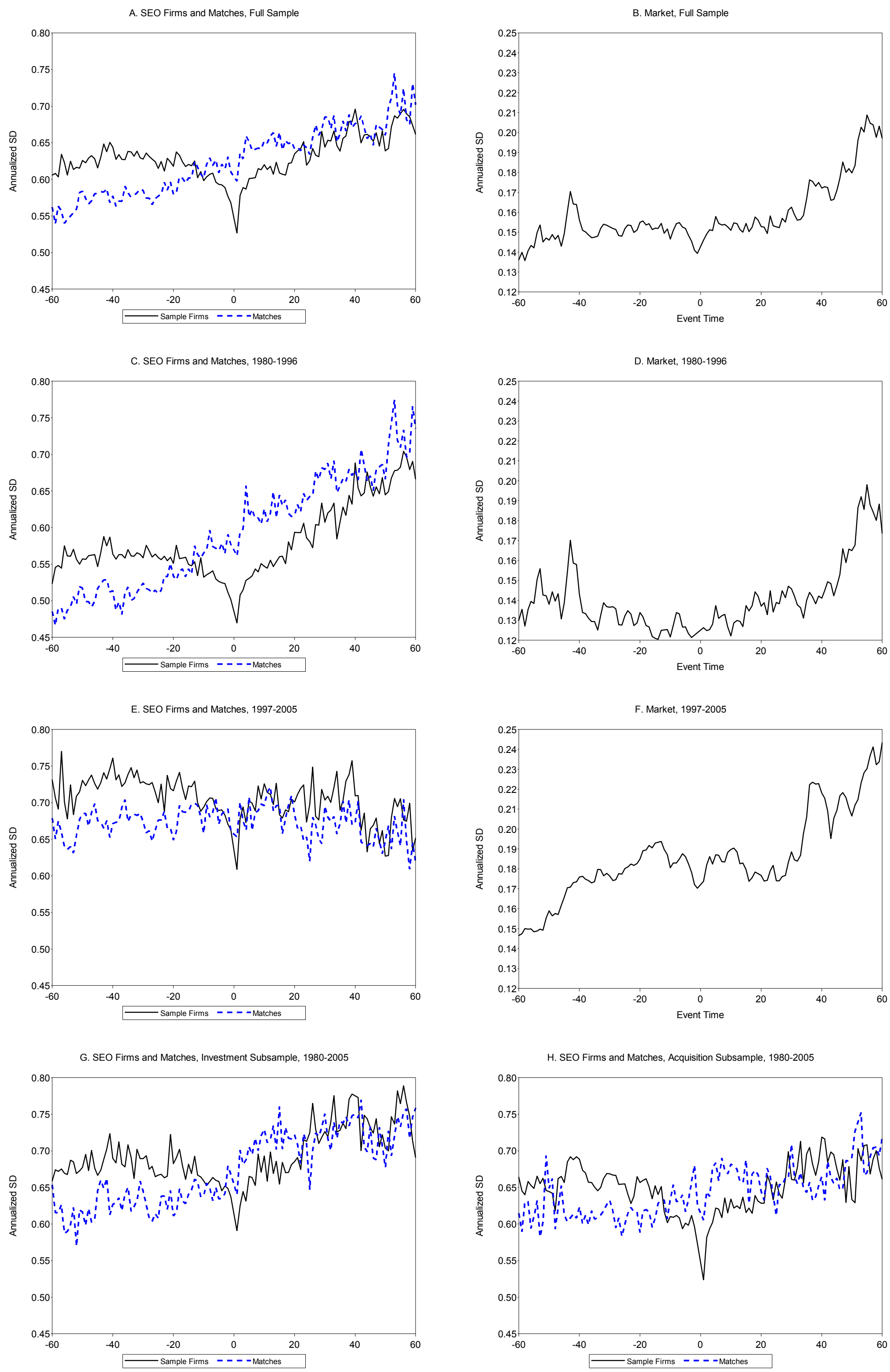

Figure 10: Realized volatility dynamics of SEO firms, matches, and the market in event time. Panel A shows volatility dynamics for the full sample of SEO firms and their matches. For each firm in each month, we follow Schwert (1989) by calculating realized volatility as the sum of squared daily returns. The solid line shows the average realized volatility for SEO firms and the dashed line shows the average for matches. Panel B shows the average volatility dynamics for market returns in event time over our full sample period. Panels C and D show the volatility dynamics for SEO firms, matches, and the market in the 1980-1996 subsample. Panels E and F correspond to the 1997-2005 subsample. Panels G and H show sample and match volatility dynamics for the investor and acquirer use-of-funds subsamples respectively.