



The timing of initial public offerings [☆]

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Abstract

We study the dynamics of IPOs by examining the tradeoff between an entrepreneur's private benefits, which are lost whenever the firm is publicly traded, and the gains from diversification. We characterize the timing dimension of the decision to go public and its impact on firm value and the evolution of firm risk over time. By endogenizing the timing of the decision to go public, we explain the clustering of IPOs and buyouts in time, the industry concentration of IPO waves, the high incidence of reprivatization of recent IPOs, and the long-run underperformance of recently issued stock relative to the shares of longer-listed companies.

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1. Introduction

Several reasons have been proposed to explain why entrepreneurs sell shares of their firms to the public. For example, companies might issue stock to finance investment opportunities. Yet this in itself does not justify initial public offerings (IPOs), since bank loans or private equity placements could equally well fill a need for funds. Moreover, Pagano et al. (1998) find that investments by firms actually *decline* after an IPO. Thus, the decision to go public is likely driven by other reasons. Leland and Pyle (1977) argue that entrepreneurs gain by going public because diversified investors value firm shares more than do underdiversified entrepreneurs. Holmström and Tirole (1993) and Bolton and Von Thadden (1998) suggest that by going public companies subject themselves to monitoring by outsiders (e.g., investment banks, auditors, analysts, investors), activities which might enhance the value of the firm. They also suggest, like Amihud and Mendelson (1988), that IPOs make firm shares more liquid, which also increases firm value. Benveniste and Spindt (1989), Dow and Gorton (1997), Habib and Ljungqvist (1998), Subrahmanyam and Titman (1999), and Maug (2001) argue that IPOs allow entrepreneurs to use share prices to infer investor valuations of their firm; this information can be used in post-IPO investment decisions and for management's incentive compensation. Along similar lines, Chemmanur and Fulghieri (1999) argue that both public and private ownership entail information advantages and that the optimal decision on this structure minimizes the related costs.

All the suggested reasons for going public exhibit some tradeoff between the benefits of being publicly traded and the associated costs. Consequently, as the conditions under which the firm operates change, the incentives to be public or private can also change. Yet the above-cited papers model the decision to go public as a single shot: entrepreneurs have but one chance to decide whether to go public or to stay private. Clearly, this ignores the ability of entrepreneurs to *time* their IPO, since the decision to remain private *today* does not eliminate the possibility of going public at some future date.¹ Furthermore, such analysis also ignores opportunities to take the firm private again, either directly (e.g., in a management buyout—MBO—or a leveraged buyout—LBO) or indirectly (i.e., by being purchased by another company).

This paper complements prior research by explicitly considering the timing dimension of IPOs. We analyze the optimal conditions for taking a company public as well as the circumstances for reversing this decision (to become a private firm again). In our model, we focus exclusively on the ownership question, assuming that firm investments are chosen optimally independent of whether the firm is public or private. The owner takes the company public because outside investors, being more diversified, are willing to pay a higher price for the risky cash flows

¹The only exception we are aware of is the recent analysis by Maksimovic and Pichler (2001) of industries that undergo a technological change. In their analysis, the timing of the establishment of market standards determines the timing of IPOs. Our analysis is different: we analyze IPO timing that is not driven by technological changes. Additionally, we explicitly consider the impact of the option to reprivatize.

of the firm than the entrepreneur's own valuation of these flows. Being private, on the other hand, entails "private benefits of control" (see, e.g., Hart and Moore, 1994, 1995).

The tradeoff between diversification gains and private benefits of control in our model should be viewed as representing the general tradeoff between the benefits and costs of going public. Specifically, the higher price that outside investors are willing to pay for the firm's cash flows captures in our model all other benefits of being a public company: increased liquidity, added value of monitoring, and availability of stock price information to guide management. Similarly, the "private benefits" include any costs avoided by a firm that is not traded publicly. These costs, considered in detail by Jensen (1986), include any costs of separating ownership from control, but can also refer to administrative costs (e.g., filing requirements, audited financial statements, etc.) and the costs of increased disclosure of inside information that might reduce the competitive advantages of the company. A study by PWC Global in 2000 (privately reported to us) estimates average direct costs of being a publicly traded firm at about 10% of profits as of the IPO date. Using Compustat data, we obtain similar results: the increase in SG&A costs of firms from the pre-IPO year to the post-IPO year is \$62 million on average, which is statistically significant (p -value 0.002%), not explained by sales growth following the IPO, and slightly above 10% of average profits.

Going public, therefore, means that the owner gives up private benefits of control for the added value of being a publicly traded firm. If entrepreneurs had but one chance to go public, they would simply trade off the benefits and costs of an IPO and choose their best course of action accordingly. In our model, however, the decision to remain private in any given period can be reversed at later dates (and vice versa). Therefore, the decision to go public entails more than a straightforward comparison of *immediate* costs and benefits. We analyze the optimal timing of an IPO, explicitly considering the dynamics of a firm's cash flows while also allowing for reversibility of today's decisions in future periods.

Some empirical regularities suggest that entrepreneurs indeed time their decisions to go public. For example, there are waves in IPOs, a phenomenon called "hot issue markets" (Ritter, 1984). Moreover, these waves are often disproportionately populated with firms in particular industries. One possible reason for the "hot" markets in IPOs is that firms, especially in certain industries, face better investment opportunities during some periods than in other times, so that IPOs merely allow for increased fund raising. However, similar to the finding of Pagano et al. (1998) about IPOs at large, Loughran et al. (1994) find that hot issue markets do not coincide with a subsequent increase in investment. Rather, IPOs appear to cluster during periods in which investors place relatively high values on firms, either those that are already publicly traded or those that are just being issued. The clustering in time of IPOs, the industry concentration of IPO waves, and the coincidence of IPO waves with relatively high market prices are results we explain in the context of our model, and appear to be confirmed by Lowry and Schwert (2002). We show that entrepreneurs issue shares when the cash flows of their firms are relatively high, periods that coincide with high stock prices since cash flows are cross-sectionally correlated,

especially within industries.² Conversely, our model suggests that firms are taken private when the market valuation of the expected cash flows is low (relative to the private benefits). This is consistent with the evidence of Halpern et al. (1999). Moreover, for the same reason that IPOs are clustered, we expect that reprivatization waves will be dominated by certain industries and will coincide with low share prices.

A puzzling aspect of IPOs, first documented by Ritter (1991) and unexplained to date, is that long-run returns on recently issued stock are substantially below concurrent market returns. Fama and French (2001) report, for example, that over the period 1980–2000, the average excess returns of all new listings is negative in the five years after listing; even the average excess return for *surviving* new listings is negative the first year after listing. To be more precise, the value-weighted excess returns for newly listed *surviving* firms is negative during the first three years after listing, and the equally weighted excess return for surviving firms is negative in the first year.³ Our model explains such underperformance as arising from the existence of an option to reprivatize publicly traded companies when the firm's cash flows have fallen to a level at which the gains from diversification no longer justify the costs of being public. On average, the value of the option to reprivatize represents a larger proportion of total firm value for a company that has recently been listed than for a firm that has traded for a longer period of time. Accordingly, the risk of recently issued “young” firms (for which this “put option” is a relatively large fraction of firm value) is smaller than the risk of “older” companies (with a relatively low “put option” value). Hence, the returns on recently issued stock should be smaller than the returns on longer-listed shares. This is consistent with Eckbo and Norli (2000), who show that IPO firms are less risky and, accordingly, have lower (expected and realized) returns than non-IPO firms.

The remainder of the paper is structured as follows. Section 2 presents the framework within which the entrepreneur's decision to go public is analyzed. In Section 3 we derive the value function for the firm and characterize its properties. Section 4 discusses the empirical implications of our model, including evidence on privatizations and a calibration model that allows us to estimate the value function derived in the paper. Section 5 concludes the paper.

2. The model

We consider a firm that is currently owned by an entrepreneur who can decide, *at the start of each of the coming periods*, whether to take the firm public or to keep it private. We assume that the decision to go public or stay private is reversible: at any

²A recent paper by Wilhelm et al. (2002) suggests that IPO clustering could be related to efforts by investment banks to share information costs. Benveniste et al. (2003) provide supporting evidence for this conjecture.

³Additional evidence is given in papers by Ritter (1991), Loughran and Ritter (1995), Nelson (1999), and Baker and Wurgler (2000). The empirical significance of these findings has been the subject of recent debate (see, for example, Brav and Gompers, 1997; Brav et al., 2000).

point in time the firm can be taken public (if it is private) or can be privatized again (if it is public). At each date, then, the firm faces the question of whether it should be private or public during the next period. We do not require that it is the *same* agent who owns the firm during every period in which it is privately held, but for simplicity we refer to *the* entrepreneur throughout the paper.

In order to abstract from the investment decisions and to focus exclusively on the question of ownership, we assume that the firm will undertake the same investments regardless of whether it is public or private; thus, we take the capital budgeting decisions of the firm as given. These investments generate a stream of uncertain cash flows to the firm's owners, which are taken to be net of the cash necessary for future investments. (In periods in which the firm is private, the technology also returns a flow of "private benefits," which we discuss below).

We model the evolution of the net cash flows in a binomial framework. If at time t the cash flow is CF , then the cash flow at time $t+1$ will be either $u CF$ or $d CF$, where $u > 1 > d$. The states of nature attached to u or d are called the "up state" and the "down state", respectively. Our model has an infinite horizon; u and d are time and state independent.

For every period in which the firm is private, the entrepreneur derives some "private benefits of control". These private benefits, denoted by PB , capture the private value of control as well as any savings in the reporting, monitoring, bonding, and agency costs a public firm incurs due to the separation between ownership and control. In other words, PB can be viewed as capturing any difference between the public and private cash flows of a firm (see the discussion in the introduction).⁴ Hence, at each pair $\{t, s\}$ of time and state, the total stream of benefits from the firm is its cash flow $CF_0 u^s d^{t-s}$ if the firm is public (where CF_0 is the initial cash flow) and $CF_0 u^s d^{t-s} + PB$ if the firm is private.

Next we specify the valuation in our model. We assume that the risk-free rate of return is $r > 0$ in all periods. We further assume that risk-free investments are equally available to all agents so that the same risk-free rate r is used by both the entrepreneur and outside investors to discount risk-free cash flows. To value risky cash flows, we employ a state-price framework: the firm is valued based on a pair of state prices (one price for the up state and another for the down state). These prices depend on whether the firm is private or public. As explained below, the difference between the private and public pairs of state prices captures the typical situation in which the entrepreneur is less diversified than the investors who own the firm when it is publicly traded.⁵

If the firm is private, its flows are valued by the entrepreneur at the *private* state prices, which we denote by p_u for the up state and p_d for the down state. If the firm is

⁴For ease of exposition, we assume that PB is some positive constant, although the model can readily be extended to the case where private benefits are an increasing function of cash flows, as long as the private benefits do not dominate the gains from public trading.

⁵The entrepreneur's and the diversified investors' state prices can be derived from their respective utilities and probability beliefs (for example, as in Leland and Pyle, 1977). Parsimoniously, we present only the reduced form—the state prices—focusing on the going public/going private implications of the differences in attitudes to the firm's specific risk.

publicly traded, the *public* state prices are given by q_u for the up state and q_d for the down state. Since both the entrepreneur and outside investors can invest in the risk-free asset, the sum of the private state prices and of the public state prices has to be the same

$$p_u + p_d = q_u + q_d = \frac{1}{1+r} \equiv \frac{1}{R}. \quad (1)$$

To capture the incomplete diversification of the entrepreneur's "portfolio", which makes the entrepreneur more averse to the firm's unique risks, we assume that $p_u < q_u$ and $p_d > q_d$. To see intuitively why the *spread* between these prices captures the higher tolerance to the firm's risk of the well-diversified investor than that of the incompletely diversified owner, note that in the up state the entrepreneur has "too much" consumption relative to diversified investors. The entrepreneur would like to sell some of this excess consumption, but such a sale would entail relinquishing private benefits of control. Hence, the private state price, p_u , is *smaller* than the public one, q_u . Similarly, because in the down state the entrepreneur has "too little" consumption relative to a well-diversified investor, the private state price, p_d , is *greater* than the public one, q_d . Thus, these state prices capture the idea that going public allows firm owners to diversify their overexposure to their firms' specific risks. This intuition can be expressed formally by considering the state prices as the probability-adjusted marginal rates of substitution of an investor. If the utility function is concave, the assumed spread in these state prices will result from the lack of diversification—the entrepreneur-owner of a non-public firm has "too much" consumption in the "up" state of the world and "too little" in the "down" state (relative to optimally diversified consumption).

Another intuitive way to interpret our assumption is based on the relative valuations both pairs of state prices imply for the firm's cash flows. Since well-diversified investors are "less averse" to the unique risk of the firm, we expect their valuation of the uncertain cash flows to be higher than the value a nondiversified entrepreneur attaches to the same stream. The following lemma shows that, given our assumptions, the public value of the firm's cash flows is indeed higher than their private value.

Lemma. *If $p_u < q_u$ and $p_d > q_d$, the private value of the uncertain cash flow stream is lower than its public value. That is,*

$$CE^{\text{Private}} \equiv p_u u + p_d d < q_u u + q_d d \equiv CE^{\text{Public}} \quad (2)$$

where CE^{Private} and CE^{Public} denote the private and public certainty equivalents, respectively, of the uncertain cash flow over the next period expressed in units of current cash flows.

Proof. Since we assume that $p_u + p_d = q_u + q_d$, it follows that $q_u - p_u = p_d - q_d > 0$. Hence, as $u > d$, we have $(q_u - p_u)u > (p_d - q_d)d$, which can be rewritten to the result desired.

Finally, we assume that $CE^{\text{Public}} < 1$, which guarantees that the value of the firm is always finite.⁶

3. Value of the firm

In this section we define the value function of the firm and derive its properties. This value function is an option-like function that takes into account that, at any future date, the firm can either be taken public or bought out to become private again.

Consider some time t with an associated cash flow CF . If at the beginning of this date the firm is private, the entrepreneur receives the firm's cash flow, CF , plus the private benefits, PB . On the other hand, in case the firm is public at the beginning of date t , its shareholders only get the cash flow CF .

After receiving the cash flow and the private benefits (if the firm is currently private at t), the entrepreneur can choose whether the firm will be public or private in the next period. Since our model is stationary and has an infinite horizon, the value of the firm is a time independent function of its cash flow, $V(CF)$. Now consider the case in which the firm has decided to stay private at time t . In the next period, the entrepreneur's payoff will be $uCF + PB + V(uCF)$ in the up state and $dCF + PB + V(dCF)$ in the down state. The value of the firm to the entrepreneur in this case is

$$\begin{aligned} V^{\text{Private}}(CF) &= p_u(uCF + PB + V(uCF)) + p_d(dCF + PB + V(dCF)) \\ &= CE^{\text{Private}}CF + \frac{PB}{R} + p_uV(uCF) + p_dV(dCF). \end{aligned} \quad (3)$$

Thus, firm value is the sum of the value of the immediate cash flows, the immediate private benefits, and the future value of the firm, all discounted at the private state prices. Analogously, the value of the firm in case the entrepreneur chooses to go public at date t is

$$\begin{aligned} V^{\text{Public}}(CF) &= q_u(uCF + V(uCF)) + q_d(dCF + V(dCF)) \\ &= CE^{\text{Public}}CF + q_uV(uCF) + q_dV(dCF). \end{aligned} \quad (4)$$

The decision at time t to be public or private during the next period given the firm's current cash flow CF depends on whether $V^{\text{Public}}(CF) \gtrless V^{\text{Private}}(CF)$. This gives the following (recursive) value function:

$$V(CF) = \text{Max}\{V^{\text{Public}}(CF), V^{\text{Private}}(CF)\}$$

⁶The value of an always-public firm is given by

$$V^{\text{Public}} = \sum_{t=1}^{\infty} \sum_{i=0}^t CF_0 \binom{i}{t} u^i d^{t-i} q_u^i q_d^{t-i} = \sum_{t=1}^{\infty} CF_0 (uq_u + dq_d)^t = CF_0 \sum_{t=1}^{\infty} (CE^{\text{Public}})^t.$$

This will be finite if and only if $CE^{\text{Public}} < 1$.

$$= \text{Max} \left\{ \begin{array}{l} CE^{\text{Public}} CF + q_u V(uCF) + q_d V(dCF), \\ CE^{\text{Private}} CF + \frac{PB}{R} + p_u V(uCF) + p_d V(dCF) \end{array} \right\}. \quad (5)$$

Because CE^{Public} , q_u , q_d , CE^{Private} , $1/R$, p_u , and p_d are all less than one, the value function equations define a contraction, which means that a unique value function exists. Note that the definition of the value function V implicitly assumes that upon reprivatization the entrepreneur will have to pay the full private value of the firm (i.e., pay a premium above the firm's public value). This is motivated by free-riding and holdup problems (e.g., see Grossman and Hart, 1980). Allowing for some other, say negotiation-driven, split of the difference between these private and public values of the firm will not change our results.

We divide our discussion of the properties of the value function into two parts. The next proposition derives some relatively obvious, asymptotic properties of the function so its proof is omitted. The second proposition derives some deeper properties of the value function.

Proposition 1. *The following are the asymptotic properties of the value function $V(CF)$:*

- *If the firm is always public, its value is equal to*

$$V^{\text{Public}}(CF) = \left(\frac{CE^{\text{Public}}}{1 - CE^{\text{Public}}} \right) CF.$$

- *If the firm is always private, its value equals*

$$V^{\text{Private}}(CF) = \left(\frac{CE^{\text{Private}}}{1 - CE^{\text{Private}}} \right) CF + \frac{PB}{r}.$$

- *The lemma implies that the slope of the “always public” function is greater than the slope of the “always private” value function*

$$\frac{CE^{\text{Public}}}{1 - CE^{\text{Public}}} > \frac{CE^{\text{Private}}}{1 - CE^{\text{Private}}}.$$

- *If the current cash flow is equal to zero, the firm is always private and its value will be $V(0) = PB/r$.*

The next proposition gives the monotonicity and convexity properties of the value function.

Proposition 2. *The value function $V(CF)$ is continuous, increasing, and convex in CF .*

Proof. Define the continuous, increasing, and convex function $W(CF,t,n)$ for a fixed horizon n by the following recursive relation:

$$W(CF, t, n) = \begin{cases} 0 & t \geq n \\ \text{Max} \left\{ CE^{\text{Private}} CF + \frac{PB}{R}, CE^{\text{Public}} CF \right\}, & t = n - 1 \\ \text{Max} \left\{ \begin{array}{l} CE^{\text{Private}} CF + \frac{PB}{R} + p_u W(uCF, t + 1, n) \\ + p_d W(dCF, t + 1, n), \\ CE^{\text{Public}} CF + q_u W(uCF, t + 1, n) \\ + q_d W(dCF, t + 1, n), \end{array} \right\}, & t < n - 1 \end{cases} \tag{6}$$

V is the limit of $W(\cdot, \cdot, n)$ as n grows to infinity and inherits the properties of W . This means that continuity and the positive slope of V are immediate. It also means that as $CF \rightarrow 0$, the slope of $V \rightarrow CE^{\text{Private}}/(1 - CE^{\text{Private}})$, and that as $CF \rightarrow \infty$, the slope of $V \rightarrow CE^{\text{Public}}/(1 - CE^{\text{Public}})$.

To prove convexity of $V(CF)$ we proceed by induction. The function $W(CF, n-1, n)$ is convex since it is the maximum of two linear functions and such a maximum is always convex. Now suppose that $W(CF, n-k, n)$ is convex. Then $W(CF, n-k-1, n)$ is convex as it is the maximum of two convex functions. This proves that $W(CF, t, n)$ is convex for any fixed horizon n . Since, if t is fixed, $V(CF) = \lim_{n \rightarrow \infty} W(CF, t, n)$, this proves the convexity of V .

Propositions 1 and 2 show that the value function looks like the graph shown in Fig. 1. Note that the function looks like the value of a call option on the public value of the firm’s cash flows shifted upwards by PB/r , the present value of all future private benefits. Alternatively, the value function can be viewed as the sum of

- the value of the risky cash flows valued as if the company will always be public, and
- the value of a “put option” allowing entrepreneurs to reclaim (the present value of) the flow of private benefits (in addition to the firm’s stream of uncertain cash flows).

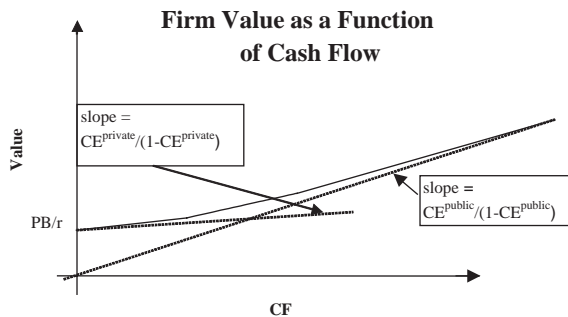


Fig. 1. Firm value as a function of cash flow.

The functional form of the value function suggests that at low cash flow levels the firm is private while at higher levels it is public. This is indeed the case as shown by the next two propositions, which begin our characterization of the optimal timing of IPOs.

Proposition 3. *Suppose that, at time t with current cash flow CF , it is optimal to keep the firm private for the next period, meaning that $V^{\text{Private}}(CF) > V^{\text{Public}}(CF)$. Thus,*

$$V(CF) = CE^{\text{Private}} CF + \frac{PB}{R} + p_u V(uCF) + p_d V(dCF). \tag{7}$$

We say that “ V is private at CF ”. Then V is also private for any cash flow $X < CF$.

Proof. $V(CF)$ is private means that

$$CE^{\text{Private}} CF + \frac{PB}{R} + p_u V(uCF) + p_d V(dCF) > CE^{\text{Public}} CF + q_u V(uCF) + q_d V(dCF). \tag{8}$$

Defining $D/q_u - p_u = p_d - q_d > 0$ and rewriting the inequality, we get that $V(CF)$ is private if

$$(CE^{\text{Public}} - CE^{\text{Private}}) CF + D[V(uCF) - V(dCF)] < \frac{PB}{R}. \tag{9}$$

Intuitively, $V(CF)$ is private if the gains from diversification, both on the immediate cash flows of the current date and on the expected value at the end of the next period, are smaller than the loss of this period’s private benefits. To prove that $V(X)$ is private for all $X < CF$, we have to show that the condition holds for all $X < CF$.

$$(CE^{\text{Public}} - CE^{\text{Private}}) X + D[V(uX) - V(dX)] < \frac{PB}{R}. \tag{10}$$

This is true since $CE^{\text{Public}} > CE^{\text{Private}}$, which implies that

$$(CE^{\text{Public}} - CE^{\text{Private}}) X < (CE^{\text{Public}} - CE^{\text{Private}}) CF. \tag{11}$$

Since $D > 0$, $X < CF$, and $V(CF)$ is convex in CF , this means that

$$D[V(uX) - V(dX)] < D[V(uCF) - V(dCF)]. \tag{12}$$

Proposition 4. *Similarly, suppose that, at time t with current cash flow CF , it is optimal for the firm to be public in the next period, meaning that $V^{\text{Public}}(CF) > V^{\text{Private}}(CF)$. Thus,*

$$V(CF) = CE^{\text{Public}} CF + q_u V(uCF) + q_d V(dCF). \tag{13}$$

We say that “ V is public at CF ”. Then $V(Y)$ is also public at any $Y > CF$. The proof of Proposition 4 is similar to that of Proposition 3 and is, therefore, omitted.

Propositions 3 and 4 imply that there is some critical cash flow level, CF^* , such that for all cash flows greater than or equal to CF^* the firm is public and for all cash

flows below CF^* the firm is private. CF^* is that cash flow at which the firm’s value as a public company for the next period just equals the value of the firm as a privately held entity. The firm goes public when its cash flow rises above CF^* and it is reprivatized when the cash flow falls below CF^* . Note that since all model parameters are time independent, so is CF^* .⁷

Based on the “monotonicity property” derived from Propositions 3 and 4 and on the stationarity of all the parameters in the model, it is trivial to prove the following “triangular” properties.

Proposition 5. *If V is public (private) at both uCF and dCF , then V is also public (private) at CF .*

Proposition 6. *If V is public (private) today at CF , then V is public (private) in at least one state of the world tomorrow.*

These key properties of our value function and of the optimal timing of IPOs can be derived without specifying the probabilities of the up and down state (i.e., without any specification of the expected return of the firm’s activities). Next, we characterize the evolution of the risk of the firm over time and provide a sufficient condition for the value of the firm to rise, on average, over time (i.e., for the expected return to be positive in terms of capital gains).

Proposition 7. *Denote the probability of the up state by π and the rate of return of the firm by $r_s = (V(s CF) - V(CF))/V(CF)$, where $s \in \{u, d\}$. The variance of this return, $\text{Var}(r_s)$, is increasing in the firm’s cash flow.*

Proof. The variance of the firm’s rate of return can be expressed by

$$\text{Var}(r_s) = \pi(1 - \pi) \left[\frac{V(uCF) - V(dCF)}{V(CF)} \right]^2. \tag{14}$$

Since $0 < \pi < 1$, we have to prove that for all $Y > X$,

$$\frac{V(uY) - V(dY)}{V(Y)} > \frac{V(uX) - V(dX)}{V(X)}. \tag{15}$$

As $V(CF)$ is convex, we know that for $Y > X$,

$$\frac{V(uY) - V(dY)}{(u - d)Y} > \frac{V(uX) - V(dX)}{(u - d)X}. \tag{16}$$

A sufficient condition for the inequality in Eq. (15) to hold is that $V(Y)/Y < V(X)/X$ for all $Y > X$, i.e., the function $V(X)/X$ declines monotonically in X . This follows from Propositions 1 and 2, which jointly imply that

$$V(X) \leq \frac{CE^{\text{Public}}}{1 - CE^{\text{Public}}} \leq \frac{V(X)}{X}. \tag{17}$$

⁷The formal analysis of this section ignores switching costs of going public or private. Such costs create a region of inaction for the firm owners but do not affect the conclusions of our analysis. Proofs of our results with transaction costs are available upon request.

Proposition 7 means that as the firm's cash flow grows, so does the variance of its rate of return. This is an outcome of the convexity of the value function, which reflects the option to reprivatize publicly traded firms: the option to reprivatize provides a downside protection to stockholders, a protection that is proportionally more valuable at low cash flows than at high cash flows. In other words, the return variance is relatively high when cash flows are high since the option to reprivatize the firm (for its private benefits of control) has relatively little value when cash flows are high. Note that, since firm value— $V(CF)$ —increases in CF , Proposition 7 also implies that the variance of the firm's return also increases in firm value.

Proposition 8. *If $\pi u + (1 - \pi)d \geq 1$, the expected value of the firm at the end of the next period will be higher than its current value: $\pi V(uCF) + (1 - \pi)V(dCF) > V(CF)$, i.e., the expected rate of return in terms of capital gains, $E(r_s)$, is positive.*

Proof. Let π^* be such that $\pi^* u + (1 - \pi^*)d = 1$. Then, by the convexity of $V(CF)$,

$$\pi^* V(uCF) + (1 - \pi^*) V(dCF) \geq V(CF) \quad (18)$$

with a strict inequality if $V(CF)$ is strictly convex. As $u > d$, $\pi u + (1 - \pi)d > 1$ for all $\pi > \pi^*$. Since $V(CF)$ is monotone, for all $\pi > \pi^*$ it holds that

$$\pi V(uCF) + (1 - \pi) V(dCF) > \pi^* V(uCF) + (1 - \pi^*) V(dCF) \geq V(CF). \quad (19)$$

The intuition underlying Proposition 8 is based, like the intuition of Proposition 7, on the convexity of the value function entailed by the option to reprivatize the firm. Note that, under the conditions of the proposition, the dispersion of the cash flows the firm can possibly generate strictly increases over time. Since firm value reflects shareholders' option to reprivatize the firm, which makes firm value a convex function of the cash flows, the increase in the cash flow dispersion causes the expected value of the firm to rise over time. This means that the expected rate of return on the firm's activities (in terms of capital gains) is positive even if the cash flows are expected to remain constant over time and, even more so, in case the current cash flow is expected to grow.

4. Empirical implications

In the preceding sections, we characterize the timing of the decision to go public or to reprivatize based on the tradeoff between private benefits of control and better diversification of the firm's risk. We show that the optimal timing of an IPO occurs when the firm's cash flow rises above a certain critical level, which we denote by CF^* . At this cash flow level, the value of the firm as a privately held entity is equal to its value as a publicly traded company. The reverse is true for the decision to take the company private again: it is optimal to buy out the firm (e.g., by an MBO, an LBO, an acquisition by private parties, etc.) when its cash flow falls below CF^* . Because the company can be reprivatized, firm value is a convex function of its cash flows. Intuitively, the value function looks like the present value that well-diversified investors attach to firm cash flows plus the value of a "put option" allowing

entrepreneurs to reclaim (the present value of) the private benefits. The characterization of the optimal timing of IPOs and the resulting value function has several empirical implications, which we discuss in this section. We show that the model can help explain some of the stylized facts regarding IPOs and privatizations.

4.1. Privatizations

The value function we derive depends on the reversibility of the going-public decision. In this subsection we examine the evidence and show that reprivatizations are a significant empirical regularity.

Welch (1999) reports that almost half (45.2%) the firms that went public in the period 1980–1994 are delisted, one way or another, within five years after the IPO (versus a small fraction of “old” firms that are delisted). Similarly, Fama and French (2001) report the ten-year survival rate for new listings as 63.5% for 1963–1972, 45.8% for 1973–1979, and 35.6% for 1980–1990. The Welch statistics might overestimate the reprivatization rate, since firms can be delisted or absorbed into another firm for reasons other than to save the costs of running them as public companies. To check what fraction of delistings are not due to other reasons, we searched the Center for Research in Security Prices (CRSP) for firms that continue to exist but no longer trade publicly, using the CRSP’s separate delisting codes. CRSP reports 23,412 IPOs in the period 1926–2000. Within three years after the IPO, 3,019 firms (12.9%) delisted simply because they stopped trading (i.e., not because of liquidation, acquisition, or merger). This delisting category can be interpreted as pure reprivatization. However, 12.9% *underestimates* the true reprivatization rate since other forms of delisting—such as the 5,833 (24.9%) reported by CRSP as delisted because of liquidation—can also be motivated by reprivatization considerations.

To gain additional understanding of the actual likelihood of reversals, we make use of the fact that Compustat requires firms to furnish financial reports from periods preceding their listing and for some periods following a delisting (this is especially true for firms with publicly traded debt). For these firms, we can compute the probability of transition from being a publicly traded firm to being a privately held firm and vice versa. In the period 1982–2000, the transition matrix computed from the Compustat dataset is

	Three years later	
	Public(%)	Private(%)
Public in a given year	94.8	5.2
Private in a given year	64.7	35.3

As can be seen from the data, 5.2% of firms that are public in a given year go private within three years. These are firms that, while no longer publicly traded,

continue to exist and are included in the Compustat database. Because of Compustat's exclusive interest in publicly traded firms, however, this transition percentage strongly underestimates the true rate of privatization. Furthermore, 35.3% of the private firm population goes public within three years of being included in the Compustat database. Thus, even with the strong selection bias of the Compustat data base, it appears that neither being private nor being public is a permanent condition—firms seem to move between being private and public. This is confirmed by data for the U.K: a recent paper by [Weir and Laing \(2002\)](#) reports that reprivatizations account for 24% of all acquisition activity over the period 1990–2000.

Overall, these data suggest that the option to reprivatize is important in understanding the public/private decision and that it should have a significant impact on firm value and firm risk. In particular, the high delisting incidence is surprising since the delisted firms have recently expended significant resources to list their shares. Our model is able to explain the significantly higher incidence of delistings in newly issued firms and, more importantly, use it to explain the puzzling underperformance of newly issued firms relative to established firms.

Empirical evidence suggests that privatization is also reversible. [Kaplan \(1991\)](#) studies privatized firms in the period after their LBO and shows that most of the privatized firms went public again, being private for a median of 6.8 years. Our model ties this finding to the cash flow dynamics of the firm. Public firms reprivatize when their cash flows decline and go public again when the cash flows return to higher levels and the diversification gains outweigh the private benefits.

4.2. *IPO timing*

Our model goes some way toward explaining the “hot issue” phenomenon—the observation that many firms go public at about the same time. We explain hot issue markets via the cross-sectional correlation in the profitability of firms. Since changes in macroeconomic conditions simultaneously affect multiple industries and companies, firm profitability tends to be positively correlated. In particular, good economic circumstances positively affect the cash flows of many firms. Our model predicts that firms go public when their cash flows are high, which means that when one firm finds it optimal to issue stock, so do other firms. Therefore, our model predicts that IPOs will come in waves. Furthermore, since the correlation between the cash flows of firms within the same industry is likely to be greater than the cross-sectional correlation at large, our results are consistent with the industry concentration that characterizes waves in IPOs. Finally, good economic conditions affect the cash flows of both publicly traded and privately held firms. Hence, the waves in IPOs, which occur when the cash flows of the issuing firms are high, happen when the cash flows of publicly traded firms are high as well. Thus, IPO waves coincide with times of relatively high share prices.

For the same reasons outlined above, our model predicts that going-private transactions (by an MBO, LBO, or otherwise) will also occur in waves, and that these waves will coincide with times of relatively low stock prices. The model also

predicts that buyout waves will be concentrated in specific industries for which cash flows are especially low.

While there is little direct empirical evidence on time patterns of reprivatizations, there is some indirect support for our prediction of clustering of going-private transactions. Kaplan and Stein (1993), for example, document the “hot privatization market” of the 1980s, and a recent article in the *Economist* (in January 2003) reports a wave of privatizations in the U.K. and the U.S. As suggested by our theory, the recent surge in U.K. and U.S. privatizations (+64% in 2002, according to the *Economist*) follows declines in firm profits and stock prices.

4.3. Underperformance of IPOs

Our model explains the relative underperformance of IPOs based on the option to reprivatize and the ability to time IPOs. Our explanation is based on our characterization of the value of the firm as the sum of two values: the “public” value of the risky cash flows and the value of the option to reprivatize the firm to regain its stream of private benefits. This decomposition of firm value implies that firm risk also has two components: cash-flow risk and the risk of the reprivatization option. Generally, cash flows are positively correlated with the economy, whereas the value of the reprivatization option moves opposite to the economy at large. Moreover, the option to reprivatize has a proportionally higher value for firms with borderline cash flows (i.e., close to CF^* and to IPO) than for companies with high levels of cash flow. This means that the “put option” represents a larger proportion of firm value for recently listed shares than for longer-traded stock, since the cash flows of these “young” firms, by definition, are closer to CF^* , while the “older” (public) companies have higher cash flows. Hence, our model predicts IPO underperformance, since the average risk of recently issued shares is lower than that of longer-listed stock. Eckbo and Norli (2000) also suggest that IPOs close to their issuance have lower risk, but they explain this by liquidity and leverage considerations.

To gain some insight on plausible values for underperformance, we build a calibration model that allows us to simulate market values and the IPO/privatization decision. In the simulations reported below, the firm has a mean cash flow growth of 20% with a standard deviation of 40%. The public and private state prices correspond to a private firm discount of 30%, the middle of the discount range of 10–50% reported by Koeplin et al. (2000). Finally, we use a range of private benefits centered on 10% of initial cash flows, which corresponds to the values reported above (see footnote 2).

Given these parameter values, we can compute the value of the firm when it is always private, when it is always public, and when it can utilize the IPO/privatization option. We compute the value of the IPO/privatization option, defined as the value of the firm when it optimizes its public/private decision minus firm value when the timing option is not available. The value of the firm without the IPO/privatization option is defined as the maximum between its value as an always-public firm and its value as an always-private firm. In our simulations, option values representing

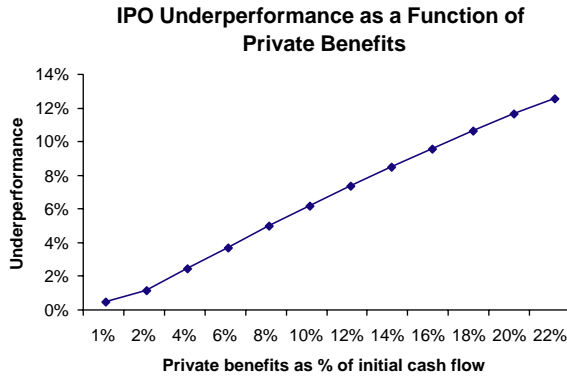


Fig. 2. IPO underperformance as a function of Private Benefits.

5–12% of total firm value are typical. Fig. 2 shows the estimated annual underperformance of recent issues relative to “old” firms as a function of the magnitude of private benefits, which determine the size of the reprivatization option.

The simulation results suggest that, given the magnitude of private benefits actually observed (about 10% of cash flows), the underperformance of recently issued firms relative to “old” firms is about 6% per annum, very close to the actual underperformance rate. Thus, the option to reprivatize, with its implication for owner strategies and firm risk, could explain most, if not all, of the observed underperformance of recent issues.

5. Conclusions

In this paper, we study the timing dimension of the decision to go public. The current literature on IPOs considers the going-public decision as a one-shot decision: entrepreneurs have but one chance to take their firm public. We complement this literature by examining the ability of entrepreneurs to *time* their IPO and also investigate the possibility of reprivatizing publicly traded firms.

In our model, the entrepreneur trades off the gains of diversification against the benefits of being private. During times in which cash flows are sufficiently high, the potential advantages from diversification outweigh these private benefits and the firm goes public. Because entrepreneurs can choose to take their firm public at any date and reverse this choice later on, the decision to go public reflects more than the *immediate* costs and benefits.

We characterize the optimal timing of IPOs and derive implications for firm value and firm risk. Our results are consistent with, and give insight to, several empirical regularities:

- The documented clustering of IPOs over time in “hot issue markets,” which are often disproportionately populated with firms in a particular industry. Moreover, we derive mirror implications regarding the timing of going-private transactions.

- The stylized fact that waves in IPOs coincide with times of relatively high stock prices. Again, the mirror prediction of our model regarding waves in buyouts is that these transactions coincide with periods of relatively low stock prices.
- The abnormally high frequency of delistings among recently issued firms relative to the delisting rate of established firms.
- The puzzling below-market returns earned by recently issued shares over several years following the IPO relative to the stock returns of companies that have been listed for a long time.

The model's results are robust to two extensions. The first extension allows for switching costs: transaction costs of going public or costs attached to buyouts. The second extension allows for private benefits to increase in the firm's cash flow. In sum, endogenizing the timing of the decision to go public can explain heretofore puzzling phenomena. Further research on reprivatization would help to confirm our results.

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