IPO pricing: growth rates implied in offer prices

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Abstract

This paper studies the valuation of companies going public in Europe. We find that most of the IPOs in the period 1995-2001 were valued by underwriters using the Discounted Cash Flows (DCF) model and/or the multiples approach. We propose a methodology to infer the growth rates implied in offer prices. Reverse-engineering DCF valuations, we back out implied growth rates of free cash flow over five years. We find that forecasted cash flows are higher than actual realizations. By comparing the IPO prices to the fair values obtained substituting the actual ex-post cash flows in the DCF model, we find that the median IPO firm is overvalued at the offering by 74%. The cross-sectional determinants of such forecast errors are market-to-book ratio, leverage at the IPO, net earnings, underpricing, and firm's age and size (these latter negatively related). We also find evidence of a negative market reaction to post-IPO disclosure of cash flows lower than expectations.

Keywords: Initial Public Offerings, DCF model, valuation, growth rates.

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1. Introduction

When going public, firms are faced with the difficult decision of how to determine the offer price for their shares. This is a question of considerable practical and theoretical importance for both investors and academics. However, despite considerable research efforts, IPO valuations are still largely mysterious. This paper challenges this research gap.

There exist two broad approaches in the valuation literature. The first is a direct valuation approach, in which firm value is estimated directly from its fundamentals; and the second is a relative valuation approach, in which firm value is estimated indirectly by reference to the prices of comparable firms. In both the approaches, the valuation of firms going public poses specific difficulties related to the IPO timing decision. First, firms may time their IPO, in order to take advantage of "windows of opportunities". These are periods of market buoyancy during which companies have an incentive to issue new shares on the base of an over-valuation of other companies in their industry (Loughran and Ritter, 1995). This will yield to investors the risk of over-valuation of the firms priced using relative valuation methodologies. Besides, firms may decide to go public when they are able to display positive growth opportunities, and thus induce optimistic valuations. To do this, firms may time their IPO for when transitory earnings are high, since investors have difficulty distinguishing between transitory and permanent earnings (signal-jamming explanation as in Stein, 1989). Managers may also window-dress their accounting numbers to make the firms look better before public offering (Teoh et al., 1998). This will yield to investors the risk of over-valuation of the firms priced using direct valuation methodologies.

Since the seminal paper on valuing IPOs by Kim and Ritter (1999), a few recent papers have investigated the use of multiples of comparable firms to value IPOs (e.g. Berkman et al., 2000; Purnanandam and Swaminathan, 2004; Jagannathan and Gao, 2005). These studies use value estimations produced by researchers to test the accuracy of valuations and typically find that IPO firms are overvalued at offer prices relative to their comparables.

We take a different perspective and examine the accuracy of 'real world' valuation models, as used by investment banks in Continental Europe. This research setting is unique because information on valuation assumptions and cash flow forecasts of US IPO firms are generally unavailable in SEC documents. US underwriters are indeed prohibited from publishing opinions concerning valuation before listing[1]. On the contrary, some information on the valuation estimates is frequently disclosed in IPO prospectuses of firms going public in Continental Europe. This

[1] Safe harbor provisions for forward-looking statements in the Private Securities Litigation Reform Act of 1995 do not apply to IPOs (Berger, 2002).

difference may be due to a different role of investment banks involved in the IPO process as compared to the US. The difficulties in valuing IPOs leave a great responsibility to investment bank, that in this way are subject to reputation incentives. If the firm is undervalued, its existing shareholders do not appreciate to "leave money on the table"; if the firm is overvalued, the investors will be displeased and cautious in subscribing to future IPOs underwritten by the same investment banks. Since underwriters repeatedly bring firms public, they have strong incentives to build a reputation (Ibbotson and Ritter, 1995). However, if the number of firms going public on a market each year is small, or if the financial analysts' industry is not well-developed, reputation-based incentives for underwriters may be imperfect. In these situations, since disperse investors cannot make direct contact with issuers, the latter have to publicly convey information that can be used to value their shares. This may help reduce information asymmetries between managers and public investors and insists on the need to make explicit in IPO prospectuses the valuation metrics used for pricing.

Hence, the level of disclosure of valuation information for IPOs is higher in Continental Europe compared to the US. Prior studies accessing to these information typically report that underwriters frequently use two or more valuation methods and that the DCF model and multiples are the most widely used methodologies[2]. We carefully read the prospectuses and pre-IPO reports of the 342 non-financial firms that went public in the period 1995-2001 in France (Euronext Paris), Germany (Deutsche Börse) and Italy (Borsa Italiana), excluding new markets. We find that underwriters determine an initial price range for the shares using traditional valuation techniques such as the discounted cash flow (DCF) method or the comparable multiples method. Most of the IPOs were priced using both the DCF model and the peer group multiples valuation. Although IPO prospectuses often specify the comparables selected for valuation, they provide only limited information about the DCF model. We are able to investigate a sample of 184 IPOs priced by investment banks using the DCF model. We use this sample to address a basic research question, that is: at what rate is an IPO firm expected to grow?

To answer, we derive an estimation procedure which infers cash flow growth rates implied in IPO prices. Precisely, we reverse-engineer the DCF model to back out implied growth rates of free cash flow over five years. We find that the market attaches a high growth expectation to IPO firms. Cash flows of the "average" IPO firm are indeed expected to growth by 33% annually. Unfortunately, ex-post realizations do not meet such ex ante targets, as we find only slightly positive actual post-IPO growth rates. We compare IPO prices with fair value estimates obtained by

[2] We are aware of only three other papers doing so. Cassia et al. (2004) investigate how underwriters value the stocks of companies they bring public in Italy, Roosenboom (2007) in France, and Deloof et al. (2007) in Belgium.

using the same assumption of our reverse-DCF model with actual ex-post cash flows and find that the median IPO firm is overvalued at the offering by 74%.

Finally, we perform a regression analysis to identify the cross-sectional determinants of forecast errors, measured as the percent difference between actual vs forecasted cash flows. Upward bias in analysts' forecasts appears determined by (1) market-to-book ratio, (2) leverage at the IPO, (3) net earnings, (4) firm's age at the IPO (negatively related), (5) firm's size at the IPO (negatively related), and (6) underpricing. We also investigate whether forecast errors are associated with long-term stock returns and find that errors in cash flows forecasts are a determinant of the aftermarket stock performance. There is indeed a negative reaction of the market to the disclosure of cash flows lower than expected. An intuitive explanation for this is that, subsequent to listing, investors will be constantly evaluating how accurate were the forecasts and they will revise their price expectations accordingly.

The remainder of the paper is organized as follows. Section 2 reviews the literature. The methodology is described in Section 3 and the sample in Section 4. Section 5 compares estimates with actual realizations. Section 6 investigates the determinants of forecast errors, while Section 7 studies their relationships with stock market returns. Conclusions are discussed in Section 8.

2. Literature review

This study brings together diverse streams of literature in accounting and finance. First, our work aims to extend prior studies on the pricing of IPOs. This field of investigation is opened by Kim and Ritter (1999) that examine the use of multiples of comparable firms to value US IPOs. Considering both historical accounting numbers and forecasted earnings, they find that price-earnings multiples based on forecasted earnings dominate all other multiples in terms of valuation accuracy. Later, Berkman et al. (2000) value 45 newly listed firms in New Zealand and conclude that the DCF and price-earnings valuations have similar accuracy. Purnanandam and Swaminathan (2004) find that the median US IPO in the period 1980-1997 is overvalued at offer price by about 50% to its industry comparables. They attribute the difference in valuations between the IPOs and the comparables to differences in the expected growth rates. Using the Residual Income Model (RIM) and price-earnings, Jagannathan and Gao (2005) study a sample of US IPOs in the period 1981-2002 and find that they are about fairly valued, whatever the methodology used.

An important feature of all the cited studies is the use of value estimations produced ex post by researchers to test the accuracy of valuation methods. In contrast, market participants may have access to non-public information and take into account firm-specific factors not considered by academics. Three prior studies examine the accuracy of the valuation models as used by investment banks.

Cassia et al. (2004) examine the valuation methods that underwriters use to value 83 IPOs in Italy during the period 1999–2002. They find that the approach of comparable firms is the most frequently adopted by IPO underwriters (87% of the IPOs), followed by DCF (80%). No other valuation method is even mentioned. The prominence of the multiples method is due to the high percentage in this period of IPOs by high-tech companies on the Nuovo Mercato. The authors point out the difficulties in using the DCF technique to value high-tech companies, not reporting profits and having a short operating history. Among several multiples, underwriters mainly rely on price-to-book and price-earnings, as the valuation estimates generated by these multiples are closest to IPO prices. Conversely, when using enterprise value ratios comparable firms' multiples are typically higher than those of the firms going public. It is therefore argued that underwriters have the possibility to select comparables that make their valuations look conservative.

Roosenboom (2007) studies 228 French IPOs in the period 1990-1999. He finds that underwriters often use two or more valuation methods, but base their pricing on a particular valuation method depending on firm characteristics, aggregate stock market returns and aggregate stock market volatility in the period before the IPO. In particular, the use of the DCF model is more frequent when aggregate stock market returns are high. These stock market conditions are considered to offer a window of opportunity during which investors are eager to buy stocks and more willing to believe assumptions underlying the DCF method. A higher use of the DCF methods is also found when the aggregate stock market is relatively volatile, that is when investors look for information about fundamental value. The DCF model may perhaps provide investors with this information at the time they need it most.

Deloof et al. (2007) study 33 IPOs in the 1993-2000 period on the Brussels Stock Exchange and find that DCF model is the most popular valuation method, being used to price all the IPOs in the sample. When multiples valuation is used, investment banks rely mostly on forecasted future earnings and cash flows.

Dealing with the pricing of IPOs, our study is also related to the literature studying the accuracy of analysts' forecasts. Several studies in this stream have found that analysts tend to be overoptimistic and that their forecasts systematically exceed the actual figures (see Derrien (2007) for a review). In particular, the pressure on analysts to produce favourable reports on IPO firms, both before and after the offering, is well documented and has attracted considerable regulatory attention. Several papers examine analysts' forecasts for IPO firms finding that analysts are overly optimistic in their forecasts of firms' prospects. The extant literature generally compares the ex-ante expectations to actual ex-post realizations of absolute performance measures such as earnings. Our study employs this methodology to compare actual to forecasted cash flows, with the latter estimated using growth rates implied in IPO prices. The estimation of the short term implied growth rate is in the spirit of accounting studies that invert the Residual Income Model (Ohlson, 1995; Feltham and Ohlson, 1995). Our study is therefore also related to this recent line of research in the accounting literature that reverse-engineers valuation models to obtain estimates of the expected rate of return on equity investment[3].

3. Methodology

3.1 The DCF model

The challenge of using accounting numbers for valuation purposes has tempted financial accounting researchers and professional financial analysts over the years. The value of a business is based on its future prospects so it is understandable that valuation models that involve forecasts have considerable currency. The starting point of direct methodologies is indeed the statement that to value firms, analysts have to forecast their payoffs. In particular, the choice and measurement of suitable accounting numbers constitutes important issues in the financial accounting literature. Among the most important valuation models, DCF and RIM offer alternative specifications. The latter has recently gained much attention in the academic literature. The underlying value attribute of this model is the definition of Residual Income, as follows. In the income statement, the cost of the debt financing is listed in the form of interest payments, but there is no charge for the equity invested in the company. The RIM specifies an explicit charge for equity, and subtracts it from the net income to define the Residual Income. The present value of the Residual Income numbers is added to the book value of equity to arrive at an equity valuation.

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[3] This expanding body of literature typically uses the RIM (O'Hanlon and Steele, 2000; Gebhardt et al., 2001; Easton et al., 2002; Baginski and Wahlen, 2003; Easton, 2006; Easton and Sommers, 2006) or the abnormal growth in earnings model (Gode and Mohanram, 2003; Easton, 2004) to determine the expected rate of return implied by analysts' forecasts, current book values, and current prices. These implied expected rates of return are often used as estimates of the market's expected rate of return and/or as estimates of the cost of capital (Daske, 2006; Dhaliwal et al., 2005; Francis et al.,, 2004 and 2005; Hail and Leuz, 2006; Hribar and Jenkins, 2004). Easton and Sommers (2006) argue that using analysts' earnings forecasts, which are known to be optimistic, to estimate expected rates of return, yield upwardly biased estimates.

Although RIM is attracting considerable attention, there is no evidence of its use by underwriters in the pricing of European IPOs, while DCF is adopted in most of the IPOs (Cassia et al., 2004; Roosenboom, 2007 Deloof et al., 2007). In the enterprise DCF model, the Enterprise Value at time *t* (EV_t) is estimated as the present value of expected future Free Cash Flows to the Firm ($E_t[FFCF_{t+i}]$), conditional on information available at time *t* and discounted at a rate that reflects the relative degree of risk. Then, subtracting the value of Debt Outstanding at time *t* (D_t) yields the estimate of the equity value (E_t)[4]. Unless there are specific plans or reasons for terminating the business in the near-term, the assumption of on-going concern will require estimating the value of the future cash flows for an indefinite period (Equation 1).

$$EV_t = \sum_{i=1}^{\infty} \frac{E_t[FCFF_{t+i}]}{(1+WACC)^i} \qquad \text{Equation (1)}$$

In practice, like other direct valuation models, DCF typically proceeds in two periods. For each year in the first period of explicit forecast, there is an individual forecast of cash flow. In contrast, each year in the post-horizon period is represented by one single continuing value formula, being the steady-state value of the firm's assets at the horizon. This second stage leads to the calculation of the continuing value (or terminal value) of the company in which the dynamic of prospective cash flows is determined by using a steady state growth rate only. This model hypothesizes that future cash flows grow forever at a stable rate g_2 (Equation 2).

$$EV_t = \sum_{i=1}^{\infty} \frac{E_t[FCFF_{t+i}]}{(1+WACC)^i} = \sum_{i=1}^{T} \frac{E_t[FCFF_{t+i}]}{(1+WACC)^i} + \sum_{i=T+1}^{\infty} \frac{E_t[FCFF_{t+i}]}{(1+WACC)^i}$$

$$\textit{Assuming } E_t[FCFF_{t+i}] = E_t[FCFF_{t+T}] \cdot (1+g_2)^{i-T} \quad \forall\, i = T+1,..,\infty$$

$$EV_t = \sum_{i=1}^{T} \frac{E_t[FCFF_{t+i}]}{(1+WACC)^i} + \sum_{i=T+1}^{\infty} \frac{E_t[FCFF_{t+T}] \cdot (1+g_2)^{i-T}}{(1+WACC)^i} \qquad \text{Equation (2)}$$

[4] DCF can be implemented from two distinct perspectives: that of shareholders (equity side or equity DCF) or that of the firm (assets side or enterprise DCF). The most diffused perspective is the latter, which refers to the Free Cash Flows to the Firm (*FFCF*), defined as residual cash flows after deducting the operating costs and taxes, but not the debt interests. *FFCF* are discounted at a discount rate that reflects the firm's degree of business risk. Since a firm can be seen as a set of assets, partly financed with equity and partly with debt, the total cost of the capital is often calculated as the weighted average of the cost of the two types of funding (Weighted Average Cost of Capital, *WACC*). The usual hypothesis is that the firm's financial structure can be considered constant and that the cost of the capital does not change in the future; in this case it follows that the WACC can be considered constant in time. A detailed description of the valuation techniques can be found in text books such as Penman (2001) and Damodaran (2006).

The model can be further simplified in a two-stage model, where the time horizon identifies two regions where cash flows have different (but stable) growth rates. During the first stage of extra-growth, cash flows are supposed to constantly growth each year by an extra-growth rate g_1 (Equation 3).

$$EV_t = \sum_{i=1}^{T} \frac{E_t[FCFF_{t+i}]}{(1+WACC)^i} + \sum_{i=T+1}^{\infty} \frac{E_t[FCFF_{t+T}]\cdot(1+g_2)^{i-T}}{(1+WACC)^i}$$

$$\textit{Assuming } E_t[FCFF_{t+i}] = FCFF_t \cdot (1+g_1)^i \quad \forall\, i = 1,..,T$$

$$EV_t = \sum_{i=1}^{T} \frac{FCFF_t \cdot (1+g_1)^i}{(1+WACC)^i} + \sum_{i=T+1}^{\infty} \frac{FCFF_t \cdot (1+g_1)^T \cdot (1+g_2)^{i-T}}{(1+WACC)^i} \qquad \text{Equation (3)}$$

In this way, the Enterprise Value at time t (EV_t) is expressed as a function of five parameters: the cash flow at time t ($FCFF_t$), the length of the first stage of extra-growth (T), the stable growth rates of cash flows in the first (g_1) and in the second (g_2) stage, and the Weighted Average Cost of Capital ($WACC$) (Equation 4).

$$EV_t = \sum_{i=1}^{T} \frac{FCFF_t \cdot (1+g_1)^i}{(1+WACC)^i} + \sum_{i=T+1}^{\infty} \frac{FCFF_t \cdot (1+g_1)^T \cdot (1+g_2)^{i-T}}{(1+WACC)^i}$$

$$EV_t = FCFF_t \left[\sum_{i=1}^{T} \left(\frac{1+g_1}{1+WACC} \right)^i + \left(\frac{1+g_1}{1+WACC} \right)^T \sum_{i=1}^{\infty} \left(\frac{1+g_2}{1+WACC} \right)^i \right] \qquad \text{Equation (4)}$$

3.2 Reverse-engineering the DCF model

The DCF formula (Equation 4) is applied to value IPO firms. In this study, we invert the DCF model to obtain an estimate of the expected growth rates implied in the IPO prices. To some extent, our approach is similar to the estimation of the internal rate of return on a bond using market values and coupon payments. Using this methodology, we estimate the expected growth rate of the cash flows, as implied in offer prices. Obviously, there would be many firm-specific factors to consider when attempting to forecast such growth rates. However, a simple two-stage model allows us to estimate an indicative short-run growth rates implied in the offer prices.

We use the known *FCFF* prior to the IPO to estimate post-IPO cash flows ($FCFF_t \equiv FCFF_{IPO}$). *FCFFs* are therefore estimated simply by applying growth rates to the pre-IPO cash flow. In particular, *FCFFs* are expected to growth annually by a short-term rate (g_1) in the first-stage of extra-growth immediately after the IPO (from the year of IPO to T years later), whereas in the second long-term period, *FCFFs* are expected to growth at (lower) steady-state growth rate (g_2). Under these assumptions, the Enterprise Value at the IPO (EV_{IPO}) is estimated as the discounted sum of expected future cash flows expressed as a function of the cash flow prior to the IPO (Equation 5).

$$EV_t = FCFF_t\left[\sum_{i=1}^{T}\left(\frac{1+g_1}{1+WACC}\right)^i + \left(\frac{1+g_1}{1+WACC}\right)^T \sum_{i=1}^{\infty}\left(\frac{1+g_2}{1+WACC}\right)^i\right]$$

At the IPO (t=IPO)

$$EV_{IPO} = FCFF_{IPO}\left[\sum_{i=1}^{T}\left(\frac{1+g_1}{1+WACC}\right)^i + \left(\frac{1+g_1}{1+WACC}\right)^T \sum_{i=1}^{\infty}\left(\frac{1+g_2}{1+WACC}\right)^i\right] \qquad \text{Equation (5)}$$

The Enterprise Value at IPO is the sum of the Equity Value at IPO prices (E_{IPO}) and the value of Debt outstanding before the IPO (D_{IPO}), less the IPO Cash Inflow (CI_{IPO}). The Equity value at IPO prices is the market capitalization measured as offer price (P_{IPO}) times the number of shares after the IPO. The latter is defined as the number of shares existing prior to the IPO (NSH_{pre}) plus the newly issued shares (primary shares NSH_{new}). The cash raised by the company at the IPO (CI_{IPO}) is the offer price (P_{IPO}) times the number of newly issued shares offered (NSH_{new}). Hence, the offer price (P_{IPO}) can be expressed as the difference between Enterprise and Debt value at IPO ($\mathrm{EV_{IPO}} - \mathrm{D_{IPO}}$), scaled by the number of shares outstanding before the IPO (Equation 6).

$$EV_{IPO} = E_{IPO} + D_{IPO} - CI_{IPO}$$

$$\textit{Assuming } E_{IPO} = p_{IPO} \cdot (NSH_{pre} + NSH_{new}) \textit{ and } CI_{IPO} = p_{IPO} \cdot NSH_{new}$$

$$EV_{IPO} = p_{IPO} \cdot (NSH_{pre} + NSH_{new}) + D_{IPO} - p_{IPO} \cdot NSH_{new}$$

$$EV_{IPO} = p_{IPO} \cdot NSH_{pre} + D_{IPO}$$

$$p_{IPO} = \frac{EV_{IPO} - D_{IPO}}{NSH_{pre}} \qquad \text{Equation (6)}$$

If we assume that the Enterprise Value at IPO is estimated with the Enterprise DCF model, the offer price can be calculated substituting the Enterprise Value as expressed in Equation (5) in Equation (6). We obtain our final model in Equation (7).

$$p_{IPO} = \frac{FCFF_{IPO}}{NSH_{pre}} \left[\sum_{t=1}^{T} \left(\frac{1+g_1}{1+WACC} \right)^t + \left(\frac{1+g_1}{1+WACC} \right)^T \sum_{t=1}^{\infty} \left(\frac{1+g_2}{1+WACC} \right)^t \right] - \frac{D_{IPO}}{NSH_{pre}}$$

Equation (7)

We use this model to reverse-engineer the DCF model in order to derive growth rates implied in IPO prices. Given the IPO market value of a firm, we use the *FCFF* prior to the IPO ($FCFF_{IPO}$), the long-term growth rate (g_2) and expected cost of capital (*WACC*) to obtain the unknown short-term extra-growth rate (g_1) implicit in the offer price (Equation 7).

As IPO firms are often young and with limited accounting information, we expect that the market will attach high growth expectations to these firms. We are therefore interested in the short term, as this is the period during which the IPO firms are expected to extra-grow on the base of a competitive advantage. In other words, the growth rate that is applied to truncated payoffs must be high when the value of firm is not justified by its accounting fundamentals, as it is often the case of firms at the IPO[5].

In our model (Equation 7), the unknown parameter (g_1) is estimated at firm-specific level as a function of seven other variables. Assumptions for these variables are as follows[6].

(1) p_{IPO} (firm-specific). Offer price.

(2) NSH_{pre} (firm-specific). Number of existing shares prior to the IPO, as reported in the prospectus.

(3) $FCFF_{IPO}$ (firm-specific). Free Cash Flow to the Firm prior to the IPO, as reported in the prospectus (residual cash flows after deducting the operating costs and taxes, but not the debt interests).

(4) D_{IPO} (firm-specific). Debt outstanding at the IPO, as reported in the prospectus.

(5) *WACC* (firm-specific). Weighted Average Cost of Capital (WACC) is computed as: $WACC = [E_{IPO}/(D_{IPO}+E_{IPO})] \cdot K_E + [D_{IPO}/(D_{IPO}+E_{IPO})] \cdot K_D$. Data on pre-IPO debt ($D_{IPO}$) and Equity ($E_{IPO}$) market values are from the EURIPO database. The cost of equity capital (K_E) is calculated using the Capital Asset Pricing Model (CAPM) as:

[5] IPO firms cannot be expected to outperform in the long term, as they will become mature and will normalize their growth rates to that of their competitors. Making assumptions on the long-term growth rates to estimate the short-term ones is therefore coherent with the hypothesis on the transition from the first to the second period of a two-stage DCF model. In theory, indeed, the end of the first stage coincides with the end of any source of extra profitability due to competition forces (Mauboussin and Johnson, 1997; Damodaran, 2006). In the second stage, the company is in steady-state with a perpetual growth rate (g_2) lower than the extra-growth rate of the first stage (g_1).

[6] We thank Jay Ritter for suggestions and comments on the reverse-DCF model and on its assumptions. This section describes the assumptions used throughout the paper. However, a sensitivity analysis was performed for these variables, with similar results. The variables whose variation has the greatest impact on g_1 estimates are, predictably the variables affecting the long-term (i.e. g_2 and *T*). However, neither of these variable can be assumed to be cross-sectional variant (see footnotes 5 and 8. Table 5 report the results of the sensitivity analysis.

$K_E = r_f + \beta_E \cdot (MRP)$, where r_f is the risk free rate, β_E is the firm unlevered beta[7] and *MRP* is the Market Risk Premium. Coherently with the literature (Claus and Thomas, 2001), we adopt the Ibbotson International Cost of Capital Reports to obtain estimations for year and country-specific risk free rates and *MRP*. For each company, we estimate 250-days betas using firm's daily stock returns relative to the market index. The promised return on debt is computed as follows: $K_D = (r_f + \Delta) \cdot (1 - t_C)$. The spread Δ is defined for each firm according to S&P risk class, based on the ratio between operating profit and interest expenses, using conversion tables by Damodaran (2006). The corporate tax rate t_C is the statutory corporate income tax rate for resident companies as reported in the "Corporate Tax Rate Survey" by KPMG and refers to the country of the company headquarter. In alternative, the estimates do not vary significantly using tax rates obtained from the "Worldwide Corporate Tax Guide", published yearly by Ernst&Young.

(6) *T* (constant). The first period of the DCF typically involves a five year forecast, before the continuing value.

(7) g_2 (constant). The long-term growth rate is assumed equal to 2.5%, that is approximately the historical growth rate in real gross domestic product in Europe[8].

4. Sample

4.1 Sample selection

The sample is made of recent European IPOs priced using the DCF model. The list of IPOs is from the EURIPO database that covers all the IPOs taking place in Europe since 1985[9]. We apply

[7] Beta are estimated for the first 250 days of trading after the IPO (excluding the first 21 trading days after the IPO date to avoid a potential bias from the price stabilization of underwriters during that period). These estimates use post-IPO information. We estimated the betas also using ex-ante information (i.e. industry betas for the months prior to the IPO), however the results do not vary appreciably.

[8] The correct value of a firm's stock can be computed by capitalizing nominal cash flows at a nominal rate, or real cash flows at a real rate. Assuming for the second stage of the DCF (infinite horizon) a constant discount rate, inflation rate, and real growth rate, these two methods are equivalent. During periods of inflation, the nominal cost of equity is higher by virtue of higher inflation. However, the nominal growth rate will also be higher – and, consequently, inflations' effect on the real value of the stock will be neutral. As pointed out by Ritter and Warr (2002), misevaluation will occur if investors use a nominal discount rate but fail to incorporate a higher nominal growth rate into their valuations. In our model, the WACC is a nominal amount, so conceptually we are discounting the future more, the higher is expected inflation. However, since inflation is not changing much during our sample period, results are not significantly affected. As mentioned in footnote 5, IPO firms cannot be expected to outperform in the long term, as they will become mature and will normalize their growth rates to that of their competitors. As a consequence, it is not possible a priori to assume higher steady-state perpetual growth rate (g_2) for a particular company or a particular industry (Mauboussin and Johnson, 1997; Damodaran, 2006). The long-term assumption of a general model must necessarily be the same for all the firms.

filters as follows. We select the IPOs between 1995 and 2001 in France (the Premier Marché and the Second Marché of Eurnoext Paris), Germany (the Amtlicher and the Geregelter markets of Deutsche Börse), and Italy (the MTA – Mercato Telematico Azionario of Borsa Italiana). In so doing, we exclude the firms going public on the new stock markets. The sample also excludes financial firms, property companies and investment trusts because their reporting environments are different from those of other IPO firms. Finally, privatization IPOs are excluded as they could potentially distort our sample. Their pricing process may indeed be influenced by specific political objectives, such as dispersing share ownership in order to promote equity investing or currying favour with voters. After applying these filters, the sample is composed of 342 IPOs.

Further filters are applied in order to build an ad-hoc sample of IPOs to test our reverse-DCF model. In particular, we select IPO-firms that respect these three additional restrictions.

(1) The DCF was among the valuation methods used for their pricing (205 IPOs)[10].

(2) Their pre-IPO *FCFF* was positive[11] (loosing 11 IPOs).

(3) Cash flows are available up to five years after the IPO (loosing other 10 IPOs).

The final sample results in 184 IPOs[12]. For these firms, we invert the DCF model (using pre-IPO cash flow, equity book value and debt outstanding) to obtain an estimate of the expected growth rate implied in their offer price.

4.2 Sample description

We find that underwriters determine an initial price range for the shares using traditional valuation techniques such as the discounted cash flow (DCF) method or the comparable multiples method[13]. The valuation process of a typical IPO involves the underwriter using both the DCF and the multiples approach and combining the value estimates to determine their fair value estimate of the IPO firm's equity (Table 1). Indeed, most of the IPOs were priced using both the DCF model and the peer group multiples valuation (this is the case of 166 IPOs, out of 252 where we could find information on the valuation technique used by underwriters). In particular, 213 IPOs were priced using peer group multiples valuation (213-166= 47 IPOs used only the multiples approach) and 205 using the DCF (205-166= 39 IPOs used only the DCF).

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[9] EURIPO is a database on European and American IPOs managed by Universoft, spin-off company of the University of Bergamo (www.euripo.eu).

[10] The valuation process of a typical IPO involves the underwriter using one or more valuation methods and combining the value estimates of these different methods into a composite valuation. This paper focuses on the assumptions implied in the IPO pricing through the DCF model.

[11] Growth rate of a negative number does not make intuitive sense

[12] The sample drops by only 10% (from 205 to 184 IPOs) after applying the filters requiring positive pre-IPO cash flow and availability of cash flows for the 5 years following the IPOs. We therefore do not believe that our sample is significantly affected by survivorship bias.

[13] Other methodologies such as DDM and EVA are also mentioned, but only in a minority of cases.

Table 1 describes our sample by year of IPO (Panel A), by industry (Panel B) and by market of listing (Panel C). The first four years (pre-bubble: 1995-1998) account for 56.4% of the European IPOs, but only for 37.5% of our sample. This is due to the higher percentage in this period of IPOs for which we were not able to access to information on the valuation process. The tendency to use both the DCF and the multiples approach has increased through time, rising from being used by 50 IPOs (out of 114 with valuation information) in the pre-bubble period to 114 (out of 138).

No industry specificity characterizes the sample, where the most representative sector is the Industrials (28%), followed by Consumer Goods, Technologies and Consumer Services (around 19% each). However, it must be noticed that the technology sector represents only 14% of the original sample of IPOs. The higher percentage of tech-firms is our sample is due to their higher presence in the last years of sampling, for which we could find more information on valuation. In terms of valuation techniques, all the tech-firms were valued using the multiples method, often besides DCF. The DCF was instead most commonly used for IPOs in other sectors, such as basic materials and telecommunications.

As for countries, 44% of the IPOs are on the French Euronext Paris, 28.8% on Borsa Italiana, and 27.2% on the German Deutsche Börse. Valuation information was available for all the Italian IPOs (except one) and for only two third of the French and German IPOs. Most of the latter combine multiples and DCF (53 out of 55 IPOs).

To test for possible sample biases, in Table 2 we compare the EURIPO sample of 342 IPOs to our final sample of 184 IPOs and find little significant differences[14]. Sample firms are in median 17 years old at IPO. Median sales are 39 €m and median market value at IPO is 96 €m. As for offer characteristics, the median size of the IPOs is 23 €m, with shares sold by existing shareholders (secondary offer) being 10% of the pre-IPO shares outstanding. The number of newly issued shares (primary offer) over the pre-IPO shares is in median 16%. The offer price is typically lower then the first-day price (median underpricing 3.7%) and higher than the Preliminary Offer Price (median book-building partial adjustment 3.6%)[15].

[TABLE 1 AND 2 ABOUT HERE]

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[14] Table 2 reports the mean and median values of several variables (see the appendix for notation and variable definition) and compares our sample of 184 IPOs with the initial EURIPO sample of 342 IPOs. Tests on the differences (Mann-Whitney U-test of equal medians, and *t*-tests of equal mean) show that there was no substantial sampling bias due to the filters applied. Indeed, we did not find any statistical difference over 5%.

[15] Preliminary Offer Prices (POP) are measured as the midpoint of the book-building price range. Partial adjustment is per cent difference between offer price and the midpoint of the book-building range.

5. Implied growth rates, overconfidence and forecast errors.

We estimate at what rate an IPO firm is expected to grow. To do this, we reverse-engineer the DCF model using IPO prices and other variables using the model expressed in Equation (7). Panel A of Table 3 reports the results of our estimation. We find that the "average" IPO firm is expected to grow at 33.8% annual rate in its first five years as a public company[16].

We compare these expected *FCFF* to actual cash flow growth rates (*CAGR*). For each firm *j*, expected cash flows for the year *i* after the IPO are estimated conditional on information available at the time of the IPO using our reverse-DCF model (Equation 8). Ex-ante (implicit) analysts' expectations are compared to actual ex-post figures by measuring Forecast Errors ($FE_{i,j}$), defined as the difference between expected and actual cash flows, scaled by expected cash flows (Equation 9).

$$E_{IPO}[FCFF_{i,j}] = FCFF_{IPO,j} \cdot (1+g_1)^i \text{ for firm } j \text{ in event year } i \qquad \text{Equation (8)}$$

$$FE_{i,j} = \frac{FCFF_{IPO,j} \cdot (1+g_1)^i - FCFF_{i,j}}{FCFF_{IPO,j} \cdot (1+g_1)^i} \text{ for firm } j \text{ in event year } i \qquad \text{Equation (9)}$$

In light of analysts' tendency to be optimistic, estimates of the expected rate of return implied in IPO prices are likely to generally be higher than actual realizations. Results are confirmative (Panel B of Table 3). The median values of Cumulated Average Growth Rates (*CAGR*) of *FCFF* are negative in the first years after the IPO. In particular, the *CAGR* for the first year is in median less than -100%. This means that most of the companies in our sample, although with positive *FCFF* prior to the IPO (this is a selection criterion), shows a negative *FCFF* the following year. This evidence may be due to engagement in high investment activities after listing or to market timing motivations to go public (i.e. signal-jamming or window-dress hypotheses). Cash flows recoup as time passes, with positive median *CAGR* five years after the IPO. However, even at this time, actual growth rates are much lower than expected (1.8% vs 21.4% implied in offer prices).

Panel C of Table 3 gives details on Forecast Errors (FE) estimated as in Equation (9). We find median FEs of 99.6% three years after the IPO, and 85.5% at five years[17]. There seems

[16] Averages are 38.1% if referring to first-day prices rather than offer prices, 33.1% to preliminary offer prices. Estimations using the first-day prices yield higher results due to the underpricing phenomenon (offer price typically lower then firs-day price), while estimations with preliminary offer prices yield to lower results, due to the partial adjustment phenomenon (offer price typically higher than preliminary offer price). See Table 2. Median values of growth rates are lower than averages (between 19% and 22%).

[17] We do not report *FE* one year after the IPO as most of $FCFF_1$ are negative.

therefore to be evidence of over-optimism in the assumptions of the DCF model used to value IPOs. We further investigate this issue by comparing IPO prices (p_{IPO}) with fair value estimates. We define the fair value of a company at the IPO (v_{IPO}) by using the same assumptions of our reverse-DCF model with actual ex-post cash flows. In other words, we apply the same DCF model, this time not only conditional on information available at the time of the IPO, but also using ex-post realizations (actual *FCFF*) for five years after the IPO. With the same long-term hypothesis applied to the reverse-DCF model, we infer the fair value of IPO firms using actual post-issue (rather than estimated) cash flows (Equation 10).

$$\begin{cases} p_{IPO} = \dfrac{EV_{IPO} - D_{IPO}}{NSH_{pre}} \\ p_{IPO} = \dfrac{FCFF_{IPO}}{NSH_{pre}} \left[\sum_{t=1}^{T} \left(\dfrac{1+g_1}{1+WACC} \right)^t + \left(\dfrac{1+g_1}{1+WACC} \right)^T \sum_{t=1}^{\infty} \left(\dfrac{1+g_2}{1+WACC} \right)^t \right] - \dfrac{D_{IPO}}{NSH_{pre}} \end{cases}$$

$$\begin{cases} v_{IPO} = \dfrac{EV_{IPO}^{actual\ FCFF} - D_{IPO}}{NSH_{pre}} \\ v_{IPO} = \dfrac{1}{NSH_{pre}} \left[\sum_{i=1}^{T} \dfrac{FCFF_{t+i}}{(1+WACC)^i} + \sum_{i=T+1}^{\infty} \dfrac{FCFF_{t+T} \cdot (1+g_2)^{i-T}}{(1+WACC)^i} \right] - \dfrac{D_{IPO}}{NSH_{pre}} \end{cases}$$

Equation (10)

Finally, we define an OverConfidence Index as the difference between real IPO prices (p_{IPO}) and fair values estimated using ex-post actual *FCFF* (v_{IPO}), scaled by IPO prices (Equation 11). We find that the median IPO firm is overvalued at the offering by 74% (Panel D of Table 3).

$$Overconfidence\ Index = \frac{p_{IPO} - v_{IPO}}{p_{IPO}} \qquad \text{Equation (11)}$$

[TABLE 3 ABOUT HERE]

Table 4 provides the breakdown of the estimates of implied growth rates by year of listing, industry, and stock exchange. Table 5 reports the results of a sensitivity analysis for the variables, whose variation has the greatest impact on g_1 estimates, namely the long-term variable g_2 and the length of the DCF first-stage *T*. Assuming higher long-term growth rates (g_2), of course, downsize our short terms estimates (g_1). However, the rationale of our analysis does not change.

[TABLE 4 AND 5 ABOUT HERE]

6. Determinants of forecast errors

The cross-sectional determinants of Forecast Errors are investigated using a hierarchical regression. When identifying the explanatory variables, we focused on variables that prior studies show have some predictive power and checked for absence of correlation (correlation matrix in Appendix). The final model considers 6 variables: the logarithm of one plus the age of the firm at the IPO (AGE), the logarithm of sales (SIZE), Net Earnings in the year before listing (NE), leverage at the IPO (LEVERAGE), book-to-market ratio (B2M), and the first-day return (UNDERPRICNG)[18]. The regression model is defined as follows.

$$FE = \alpha + \beta_1 \cdot [AGE] + \beta_2 \cdot [SIZE] + \beta_3 \cdot [NE] + \beta_4 \cdot [LEVERAGE] + \beta_5 \cdot [B2M] + \beta_6 \cdot [UNDERPRICING] + \varepsilon_j$$

Table 6 reports estimates of Equation (12) using forecast errors three or five years after the IPO[19]. In particular, AGE and SIZE are significantly and negatively related to forecast errors, which means that older and larger firms have smaller forecast errors. Future cash flows may indeed be easier to predict for more mature companies, for which more information is available. Expectations of future cash flows of younger and smaller companies tend to be overvalued compared to ex-post realizations. On the contrary, we find a positive relationship between forecast errors and net earnings in the year before listing. The leverage at the IPO is also positively related to forecast errors. Therefore, more indebted firms are more often priced at the IPO upon unfulfilled expectations in cash flow growth rates. The book-to-market ratio (B2M) is negatively related to forecast errors. Firms with high positive difference between market and book value of equity at the IPO are priced on the prospects of growth that are at least partially overestimated. Finally, a higher underpricing is a predictor of a higher probability of forecast errors.

As a sensitivity analysis, we include other covariates in the regression. None of these variables have statistical significance. Only the market momentum, measured over the 6 months prior to the listing, is weakly negatively correlated with the 3-year forecast errors (statistical significance 10%).

[18] Underpricing is not actually a variable known prior to the IPO. Still, a more parsimonious model without this variable yields similar results for the other 4 variables.
[19] An examination of the correlations indicates that multicollinearity is not a problem (see the appendix).

[TABLE 6 ABOUT HERE]

7. Forecast Errors and Long Run performance

We examine whether forecast errors are associated with long-term stock returns. The aftermarket performance is measured using Buy-and-Hold Abnormal Returns (BHAR), which are calculated for stock *i* for time period *T* as follows.

$$BHR_{i,T} = \left[\prod_{t=1}^{T} (1 + R_{i,t}) \right] - 1$$

$$BHAR = \frac{1}{N} \sum_{i=1}^{N} \left[\left(\prod_{t=1}^{T} (1 + R_{i,t}) \right) - \left(\prod_{t=1}^{T} (1 + R_{M,t}) \right) \right]$$

where $R_{i,t}$ is the return of the stock *i* at time *t*, and *T* is the time period for which *BHR* is determined, and *N* is the number of stocks in the portfolio. The DJ EURO STOXX index is used as a benchmark[20].

Figure 1 plots the average BHARs over the period of analysis. We find that our sample firms under-perform the benchmark index by about 10% in three years and 5% in five years. However, splitting our sample by year of listing, we find that the long-term performance is affected by the IPO year. In particular, the performance between three and five years after the IPO is very different between IPOs occurring before (1995-1998) and during (1999-2001) the Internet Bubble period. Companies that went public in the pre-bubble period under-perform the market by around 20%. Companies that went public during the bubble period perform much better, with no evidence of underperformance.

[FIGURE 1 ABOUT HERE]

The cash flows forecast is a major factor in valuing new issues and so errors in these forecasts are expected to be an important determinant of aftermarket stock performance. IPOs whose actual ex-post cash flows exceed their forecasts are likely to experience higher abnormal

[20] We exclude the first 21 trading days after the IPO date to avoid a potential bias from the price stabilization of underwriters during that period. To check for the robustness of our results, we also apply the three-factor model of Fama and French (1993) with SMB (small minus big) and HML (high minus low) to capture size and book-to-market characteristics, respectively. We repeated the analysis by employing the local Datastream market indexes. The empirical findings reported here are robust with respect to the index employed.

returns in the years after issue, and those whose *FCFFs* are less than expected are likely to suffer lower BHARs. We hypothesise that FE will be negatively correlated with BHAR if investors use cash flows forecasts implicit in valuing IPOs. If the forecasts turn out to be erroneous, stock prices should react accordingly. To investigate the relationship between forecast errors and aftermarket performance, we run a regression, whose results are presented in Table 7. Our main variable of interest, FE, has a negative coefficient in both the 3-year and the 5-year BHAR regressions. This confirms the reaction of the market to the disclosure of cash flows lower than those expected.

We find also a significant negative relation between BHARs and other variables, such as leverage at the IPO (LEVERAGE), market-to-book ratio (inverse of B2M) and underpricing (UNDERPRICING). A negative effect on the post-IPO market performance is also found for firms going public after a period of market extra-returns for the seasoned companies in their sector (SECTOR ER) and for venture-back IPOs (D_VC)[21]. As expected, the Bubble dummy is positive (D_BUBBLE).

[TABLE 7 ABOUT HERE]

8. Conclusions

IPOs can be valued using a variety of methods, but there will generally be a DCF calculation (Mills, 2005). This paper studies a sample of 184 European IPOs priced using the DCF model and infers the growth rates implied in offer prices. We find the IPO firms are typically priced on the base of high-growth expectations. The cash flows of the "average" IPO firms are indeed expected to growth by 33% annually over five years. Nevertheless, ex-ante implied growth rates are not sustained by ex-post actual realizations. Actual CAGR of cash flows are indeed much lower than expected. Such over-optimism is measured by comparing the IPO prices to the fair values obtained substituting the actual ex-post cash flows in the DCF model. We find that the median IPO firm is overvalued at the offering by 74%.

[21] Our results do not confirm previous US-based findings of venture-backed IPOs outperforming non-venture backed IPOs (Megginson and Weiss, 1991; Brav and Gompers, 1997). However, evidence on the performance of venture-backed IPOs in Continental Europe is mixed. Given the relevant differences in the nature of venture capitalists in Europe and in the US, findings on the role of venture capitalists in the US and their influence on the long-run market performance of IPO firms can generally not be transferred to European countries (Hege et al., 2006). For instance, Rindermann (2004) find that venture-backed IPOs in France, Germany and UK in the period 1996 to 1999 do not outperform those without venture backing. Studying German Neuer Markt IPOs, Kraus and Burghof (2003) find that venture-backed IPOs have an inferior mean abnormal return in comparison to non venture-backed IPOs.

Among the determinants of over-optimism, there are market-to-book ratio, leverage at the IPO, net earnings, underpricing and firm's age and size (these latter negatively related). Firms with high positive difference between market and book value of equity at the IPO are priced on the prospects of growth that are at least partially overestimated. We also find evidence of a negative market reaction to post-IPO disclosure of cash flows lower than expectations.

We expect this research to be of interest for both financial academics and practitioners. From an academic perspective, this study addresses the issue of over-optimism and provides empirical evidence of it. This paper also contributes to the literature on IPO pricing by proposing a reverse-DCF model to estimate implied expected growth rates. From the perspective of investors, this study aims to contribute to the understanding of the helpfulness and limits of the analysts' forecasts in investment decisions and, more generally, of the determinants of IPO valuations.

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Appendix. Filters applied to the sample of IPOs and definition of variables

Filters applied to the EURIPO sample: 342 IPOs

- EURIPO database in the period 1995-2001
- Euronext, Deutsche Börse, or Borsa Italiana, excluding new markets
- excluding financial and insurance companies and privatizations

Filters applied to the sample used to estimate the implied growth rates: 184 IPOs

- DCF model used to price IPO (205 IPOs)
- Positive value of cash flow $FCFF_{IPO}$ (194 IPOs)
- Data availability: $FCFF_{IPO}$ to $FCFF_5$ (184 IPOs)

Notation.

Symbol	Notation
EV_t	Enterprise Value at time t
E_t	Equity value at time t
D_t	Value of Debt outstanding at time t
$FCFF_t$	Free Cash Flows to the Firm at time t
$E_t[FFCF_{t+i}]$	Expected Free Cash Flows to the Firm (forecasted at time t for time $t+i$)
$WACC$	Weighted Average Cost of Capital
g_1	Growth-rate of the first stage (extra-growth) of the DCF model
g_2	Growth-rate for the second stage (stable-growth) of the DCF model
T	End of the first stage (extra-growth) of the DCF model (years)
$FCFF_{IPO}$	Free Cash Flows to the Firm prior to the IPO, as reported in the prospectus
EV_{IPO}	Enterprise Value at IPO $EV_{IPO} = E_{IPO} + D_{IPO} - CI_{IPO}$
E_{IPO}	Equity value at IPO price $E_{IPO} = p_{IPO} \cdot (NSH_{pre} + NSH_{new})$
D_{IPO}	Value of Debt outstanding before the IPO, as reported in the prospectus
CI_{IPO}	Cash Inflow at the IPO due to the subscription of the newly issued shares $CI_{IPO} = p_{IPO} \cdot NSH_{new}$
NSH_{pre}	Number of shares existing prior to the IPO
NSH_{new}	Number of the newly issued shares (primary offer)
p_{IPO}	Offer price $p_{IPO} = (EV_{IPO} - D_{IPO}) NSH_{pre}$
v_{IPO}	Fair price $v_{IPO} = (EV_{IPO}^{actual\ FCFF} - D_{IPO}) NSH_{pre}$
$FE_{i,j}$	Forecast Error for firm j in event year i $FE_{i,j} = (E_{IPO}[FCFF_{i,j}] - FCFF_{i,j}) / E_{IPO}[FCFF_{i,j}]$
$OverConfidence$	OverConfidence Index (OCI) $(p_{IPO} - v_{IPO}) / p_{IPO}$

Definition of the variables used in the regressions.

Variable	Definition
Short Term Implied Growth Rate (g_1)	The short-term extra-growth rate (g1) implicit in IPO prices that it is computed trough the reverse DCF model.
Forecast Error (FE)	Forecast Errors defined as the difference between forecasted and actual cash flows, scaled by forecasted cash flows: $FE_{i,j} = \frac{E_{IPO}[FCFF_{i,j}] - FCFF_{i,j}}{E_{IPO}[FCFF_{i,j}]} = \frac{FCFF_{IPO,j} \cdot (1+g_1)^i - FCFF_{i,j}}{FCFF_{IPO,j} \cdot (1+g_1)^i}$
AGE	Natural log of one plus firm age, measured as calendar year of the IPO minus the calendar year of founding.
SIZE	Natural log of pre-IPO sales
LEVERAGE	Book value of debt over book value of equity at the IPO.
INCOME	Net income (year before listing)
Book to Market (B2M)	The ratio between book and market value of equity. Book value is the pre-IPO book value of equity plus the capital inflow at the IPO (primary offer); market value is the number of shares outstanding after the IPO times the offer price.
D_VC	Venture Capital dummy, equal to 1 if one ore more venture capitalists are pre-IPO shareholders, 0 otherwise.
SECTOR ER	Sector extra-return for the 6 months prior to the listing (extra-return of the European Datastream sector index over European Datastream index).
MOMENTUM	Market momentum, measured as Datastream Country Market index return over the 6 months prior to the listing, for each firm in the sample.
D_BUBBLE	Internet Bubble, equal to 1 if the company went public during the period 1999-2001, 0 otherwise.
DILUTION	The ratio between the number of newly issued shares and the number of pre-IPO shares.
PARTICIPATION	The ratio between the number of existing shares sold by the existing shareholders and the number of pre-IPO shares.

Correlation matrix.

	FE_5	FE_3	g_1	B2M	LEV	UNDPR	D_VC	D_BUBBLE	MOM	S ER	PART	DIL	INCOME	SIZE
FE_3	**0.95**	1												
g_1	0.16	0.13	1											
B2M	**-0.49**	**-0.48**	**-0.34**	1										
LEVERAGE	0.14	0.11	**-0.23**	0.17	1									
UNDERPRICING	0.02	0.05	0.12	**0.48**	**-0.25**	1								
D_VC	0.05	0.01	0.11	0.05	-0.01	0.15	1							
D_BUBBLE	0.10	0.06	0.18	-0.16	**-0.28**	0.03	-0.09	1						
MOMENTUM	-0.11	-0.09	-0.06	0.01	0.06	-0.05	0.14	**-0.65**	1					
SECTOR ER	0.02	0.03	0.03	0.02	-0.07	0.06	0.02	-0.05	0.17	1				
PARTICIPATION	-0.01	0.00	**-0.24**	**0.21**	**0.25**	0.02	0.09	-0.16	0.13	0.04	1			
DILUITION	0.01	0.00	0.04	-0.13	-0.25	0.01	-0.01	0.14	-0.18	0.06	-0.20	1		
INCOME	0.00	-0.01	-0.08	0.16	-0.06	0.13	-0.02	0.06	-0.10	0.01	0.04	-0.03	1	
SIZE	0.01	-0.01	-0.15	0.14	**0.22**	0.02	-0.07	-0.04	-0.05	0.00	0.12	-0.08	**0.62**	1
AGE	**-0.26**	**-0.27**	**-0.27**	**0.27**	0.17	-0.06	-0.04	-0.15	-0.02	0.02	0.09	-0.05	0.09	0.10

Matrix of correlation coefficients. Significant correlations are indicated in bold type.

Table 1. Valuation techniques and the sample of IPOs.

	European IPOs		Valuation techniques				Sample	
	No.	*%*	No infos	Multiples	DCF	Both	No.	*%*
Total	342		90	213	205	166	184	
Panel A. IPOs by Year								
Pre-Bubble 1995-1998	193	*56.4*	79	86	80	52	69	*37.5*
Bubble 1999-2001	149	*43.6*	11	127	125	114	115	*62.5*
Panel B. IPOs by Industry								
Industrials	100	*29.2*	25	61	61	47	50	*27.2*
Consumer Goods	81	*23.7*	25	44	42	30	41	*22.3*
Consumer Services	73	*21.3*	24	45	41	37	37	*20.1*
Technology	49	*14.3*	1	48	41	41	36	*19.6*
Other	39	*11.4*	15	15	20	11	20	*10.9*
Panel C. IPOs by Stock Exchange								
Borsa Italiana	81	*23.7*	1	66	64	50	53	*28.8*
Deutsche Börse	81	*23.7*	26	54	54	53	50	*27.2*
Euronext	180	*52.6*	63	93	87	63	81	*44.0*

The table reports the number of IPOs by year, by industry, and by stock market. The final sample of 184 IPOs is compared to the 342 IPOs taking place in the period 1995-2001 on the stock markets in France, Germany, and Italy, excluding new markets (source: EURIPO). Companies are distinguished between those that adopted the multiples method or the DCF method (or both) for pricing the IPO (no information means that we did not find information on the valuation technique). Industry classification based on the Industry Classification Benchmark (ICB) system; the sector 'Other' is composed of basic materials, utilities and telecommunications.

Table 2. Descriptive Statistics.

	European IPOs	Sample
Age	27.8	25.8
	18.0	*17.0*
Sales (€m)	449.8	415.5
	59.1	*39.4*
Growth (%)	102.2	71.3
	21.1	*27.1*
Return-On-Assets (%)	15.4	16.3
	15.1	*15.9*
Market value (€m)	477.0	387.7
	65.5	*95.7*
Size of the offer (€m)	102.7	108.6
	16.9	*22.7*
Dilution (%)	18.2	20.7
	12.5	*16.2*
Participation (%)	15.2	13.8
	15.7	*10.0*
Market-to-book	4.0	5.1
	3.1	3.8
Underpricing (%)	14.0	26.4
	3.3	*3.7*
Partial adjustment (%)	2.4	3.1
	2.8	*3.6*
Valuation uncertainty (%)	18.8	15.8
	16.8	*14.9*

The table reports the average and median value (in *italics*) for the sample of 184 IPOs as compared to the 342 IPOs taking place in the period 1995-2001 on the stock markets in France, Germany, and Italy, excluding new markets. Variables definition as follows. Age is measured as calendar year of the IPO minus the calendar year of founding; Sales are relative to the year before listing; Growth is defined as per cent sales growth; Return-On-Assets is operating income over capital invested; Market value is at IPO prices (number of shares outstanding after the IPO times offer price); Size of the offer is number of shares offered (both primary and secondary shares) times offer price; Dilution is the ratio between the number of newly issued shares and the number of pre-IPO shares; Participation is the ratio between the number of existing shares sold by the existing shareholders and the number of pre-IPO shares; Market-to-book is the ratio between book and market value of equity at the IPO; Underpricing is the first day return; Partial adjustment is per cent difference between the offer price and the midpoint of the book-building range; Valuation Uncertainty is defined as the ratio between the book-building price range and the midpoint of the range itself.

Table 3. Implied growth rates, Overconfidence Index, and Forecast Errors.

	Average	25th	50th (Median)	75th	St. Dev.
Panel A. Forecasts (short-term implied growth rate)					
g_1 POP	33.1	-3.6	19.7	53.0	0.54
g_1 Offer	33.8	-3.6	21.4	56.9	0.54
g_1 1st Day	38.1	-1.9	22.4	55.9	0.60
Panel B. Realizations (Actual CAGR of FCFF)					
$CAGR_1$	-1,645.9	-447.1	-137.6	15.7	129.4
$CAGR_3$	-111.3	-240.8	-71.1	14.8	2.1
$CAGR_5$	-55.5	-191.3	1.8	29.8	1.3
Panel C. Forecast Errors					
FE_3 POP	122.9	-23.8	95.2	230.9	5.2
FE_3 Offer	145.8	-22.3	99.6	247.6	5.5
FE_3 1st Day	125.7	-15.2	99.6	251.7	4.7
FE_5 POP	93.6	-53.3	65.0	128.6	6.1
FE_5 Offer	85.5	-55.4	85.5	126.6	0.9
FE_5 1st Day	127.3	-31.7	127.3	119.3	1.3
Panel D. Over-Confidence index					
OCI POP	125.9	-13.6	74.2	119.7	7.6
OCI Offer	119.7	-16.1	73.9	117.7	7.1
OCI 1st Day	86.5	-0.6	73.8	113.4	4.6

The table reports the average and first, second (median) and third quartiles of the short-term implied growth rate (Panel A), the actual post-IPO cash flows (Panel B), the Forecast Errors (Panel C) and the OverConfidence Index (Panel D). POP refers the Preliminary Offer Price (midpoint of the book-building range), Offer to the offer price, 1st Day to the FirstDay price. All values are in percentage and refer to the sample of 184 IPOs.

Table 4. Implied growth rates breakdown.

	No. Obs.	Average	25th	50th (Median)	75th	St. Dev.
Panel A. IPOs by Year						
Pre-Bubble 1995-1998	69	21.14	-7.03	10.52	36.47	0.47
Bubble 1999-2001	115	41.35	1.29	26.53	69.29	0.57
Panel B. IPOs by Industry						
Industrials	50	24.24	-9.37	13.30	31.39	0.41
Consumer Goods	41	22.85	-13.25	-2.03	39.67	0.49
Consumer Services	37	38.25	1.89	18.48	58.21	0.58
Technology	36	58.50	18.45	36.75	90.89	0.59
Other	20	27.35	-8.94	10.79	45.49	0.55
Panel C. IPOs by Stock Exchange						
Borsa Italiana	53	33.32	-9.99	12.81	60.15	0.59
Deutsche Börse	50	51.96	15.85	34.87	85.69	0.60
Euronext	81	23.01	-5.81	10.23	34.70	0.43

The table reports the short-term implied growth rate estimated using offer prices. The sample of IPOs is classified by listing year, industry, and stock exchange.

Table 5. Sensitivity analysis.

	T		
g_2	4	5	6
2	46.96	35.24	28.46
	(27.98)	*(22.98)*	*(19.72)*
2,5	45.03	33.85	27.38
	(25.79)	*(21.49)*	*(18.70)*
3	42.99	32.36	26.23
	(24.44)	*(20.41)*	*(17.74)*

The table reports the average and median value (in *italics*) short-term implied growth rate estimated applying our model, as expressed in Equation 7, to our sample of 184 IPOs. The sensitivity analysis is conducted for the following input: the growth-rate g_2 for the second stage (stable-growth) of the DCF model and the length T of the first stage (extra-growth) of the DCF model (years).

Table 6. Determinants of Forecast Errors

	Forecast Errors Year IPO +3 (FE_3)			Forecast Errors Year IPO +5 (FE_5)		
COEFFICIENT	(1)	(2)	(3)	(4)	(5)	(6)
AGE	-0.062*	-0.062*	-0.069**	-0.033*	-0.033*	-0.036*
	(0.032)	(0.033)	(0.033)	(0.019)	(0.020)	(0.020)
SIZE	-0.696*	-0.757**	-0.698*	-0.417*	-0.433*	-0.410*
	(0.378)	(0.381)	(0.377)	(0.226)	(0.229)	(0.225)
INCOME	0.019**	0.020**	0.019**	0.012**	0.012**	0.011**
	(0.008)	(0.008)	(0.008)	(0.005)	(0.005)	(0.005)
LEVERAGE	0.206***	0.202***	0.202***	0.128***	0.126***	0.128***
	(0.031)	(0.032)	(0.031)	(0.018)	(0.019)	(0.019)
B2M	-0.317***	-0.324***	-0.318***	-0.189***	-0.191***	-0.188***
	(0.028)	(0.029)	(0.028)	(0.017)	(0.017)	(0.017)
UNDERPRICING	0.995***	1.014***	0.974***	0.565***	0.568***	0.553***
	(0.138)	(0.140)	(0.138)	(0.082)	(0.084)	(0.082)
D_VC		-1.728			-0.117	
		(2.193)			(1.318)	
DILUITION		0.279			0.527	
		(2.674)			(1.606)	
PARTICIPATION		1.096			4.467	
		(0.785)			(4.715)	
SECTOR ER			0.723			0.398
			(0.578)			(0.345)
MOMENTUM			-1.641*			-0.922
			(0.939)			(0.561)
D_BUBBLE			-2.943			-0.564
			(2.761)			(1.650)
Intercept	6.925***	5.927***	10.250***	3.228***	2.574**	4.369***
	(1.294)	(1.845)	(2.742)	(0.774)	(1.108)	(1.638)
Adj R^2 (%)	46.21	46.02	46.50	45.82	45.18	46.23
F-Value	27.20***	18.34***	18.67***	26.79***	17.76***	18.48***

The table contains the results of OLS regressions with Whites heteroscedasticity-consistent standard errors. The dependent variable is Forecast Error. See variables definition in Appendix. The sample is made of 184 IPOs. */**/*** denotes significance at the 10%/5%/1% level.

Table 7 Forecast Errors and Long-run performance

	BHAR Year IPO +3			BHAR Year IPO +5		
COEFFICIENT	(1)	(2)	(3)	(4)	(5)	(6)
FE_3	-0.032***	-0.032***	-0.032***	-0.029**	-0.030**	-0.033**
	(0.011)	(0.011)	(0.011)	(0.014)	(0.014)	(0.014)
FE_5	-	-	-	-0.073	-0.071	-0.083
				(0.105)	(0.107)	(0.108)
D_VC	-0.230**	-0.212**	-0.220**	-0.225*	-0.214	-0.235*
	(0.105)	(0.107)	(0.109)	(0.134)	(0.137)	(0.138)
LEVERAGE	-0.344**	-0.342**	-0.343**	-0.416**	-0.434**	-0.399**
	(0.150)	(0.153)	(0.156)	(0.190)	(0.195)	(0.199)
B2M	0.581***	0.465**	0.487**	0.588***	0.476*	0.527**
	(0.174)	(0.189)	(0.193)	(0.223)	(0.242)	(0.247)
UNDERPRICING	-0.229***	-0.191**	-0.201**	-0.268***	-0.235**	-0.248**
	(0.076)	(0.080)	(0.081)	(0.097)	(0.102)	(0.103)
D_BUBBLE	0.377***	0.393***	0.516***	0.329**	0.348***	0.452**
	(0.100)	(0.100)	(0.161)	(0.127)	(0.129)	(0.206)
SECTOR ER	-0.194*	-0.184*	-0.190*	-0.339**	-0.328**	-0.335**
	(0.104)	(0.104)	(0.105)	(0.132)	(0.133)	(0.133)
g_1		-0.159	-0.154		-0.134	-0.160
		(0.100)	(0.102)		(0.128)	(0.130)
DILUITION		0.009	0.036		-0.065	-0.040
		(0.127)	(0.130)		(0.162)	(0.166)
PARTICIPATION		0.057	0.068		0.158	0.170
		(0.378)	(0.381)		(0.485)	(0.487)
MOMENTUM			0.395			0.384
			(0.408)			(0.519)
AGE			0.001			-0.002
			(0.002)			(0.002)
SIZE			0.004			-0.002
			(0.009)			(0.012)
Intercept	-0.433***	-0.393***	-0.549***	-0.274**	-0.240	-0.287
	(0.093)	(0.116)	(0.190)	(0.120)	(0.152)	(0.245)
$AdjR^2$ (%)	19.96	19.81	19.00	13.21	12.45	12.08
F-Value	7.41***	5.45***	4.25***	4.42***	3.33***	2.77***

The table contains the results of OLS regressions with Whites heteroscedasticity-consistent standard errors. The dependent variable is Buy-and-Hold Abnormal Returns (3 and 5 years). See variables definition in Appendix. The sample is made of 184 IPOs. */**/*** denotes significance at the 10%/5%/1% level.

Figure 1. Long-run performance (BHARs).