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The effect of capital gains taxes on the initial pricing and underpricing of IPOs ☆

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ABSTRACT

We investigate the extent to which capitalization of expected capital gains taxes and the lock-in effect induced by the capital gains tax rate differential simultaneously impact the pricing and underpricing of initial public offerings (IPOs). Using a large sample of IPOs from 1987 to 2010, we estimate regressions of offer prices and first-day underpricing on tax rates. Supporting tax capitalization, IPO offer prices decrease in long-term capital gains taxes. Supporting lock-in, IPO underpricing increases in the long-term and short-term tax rate differential. These effects are consistent with capital gains taxes simultaneously reducing IPO proceeds and exacerbating IPO underpricing.

1. Introduction

A growing literature suggests that share prices are not independent of shareholder taxes and that these taxes can affect asset prices in two different ways: capitalization and lock-in. Tax capitalization represents the proposition that equilibrium asset prices reflect expected after-tax returns. For example, the higher relative price of municipal bonds reflects the exclusion of interest paid on these securities from taxable income. Likewise, when equity prices reflect taxes that investors expect to pay upon the sale of securities, pre-tax returns increase with tax rates (Brennan, 1970). Lock-in is a related argument made by Klein (1999, 2001) and Viard (2000). They posit that equity holders will demand to be compensated for

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any sale that increases or accelerates expected taxes. In other words, lock-in refers to the reluctance of holders to accelerate the sale of securities in the absence of price adjustments that offset incremental taxes.

We investigate whether and how capital gains taxes affect share prices at initial public offerings (IPOs). We conduct our investigation in two stages. First, we posit that the capitalization of capital gains taxes reduces IPO offer prices. We test whether offer prices are inversely related to the expected long-term capital gains tax rates, short-term (ordinary) tax rates, or are unrelated to tax rates. Consistent with tax capitalization, we find that offer prices are negatively associated with the level of long-term capital gains tax rate, but not with short-term tax rate. Second, we posit that the lock-in effect is associated with the magnitude of the first-day IPO stock returns (also called IPO underpricing). We argue that investors who buy IPO shares at the offer price and expect to pay taxes at the long-term capital gains rate can only be induced to sell shares on the first-day if unexpected returns offset the incremental taxes imposed on a short-term sale. Consistent with lock-in, we find that underpricing is positively associated with the difference between short-term and long-term capital gains tax rates.

Further analysis suggests that unidentified temporal phenomena are not responsible for the association between tax rates and offer prices or underpricing on IPO dates. In addition, both the capitalization and lock-in effects are more pronounced for IPOs with more tax-sensitive investors. We also test corollary predictions from the lock-in effect: how investor horizon affects the association between IPO underpricing and capital gains tax and how business cycles affect the time-series variation in the lock-in effect. We find that investors with long horizons are more likely to demand a higher price when selling shares short-term and that the lock-in effect is less pronounced in a down market or in a recession. These results further enhance the notion that long-term capital gains taxes are capitalized into stock prices and that the spread between long-term and short-term capital gains tax rates impacts IPO underpricing.

Our study contributes to the literature on tax capitalization (Erickson and Maydew, 1998; Guenther and Willenborg, 1999; Lang and Shackelford, 2000; Shackelford and Shevlin, 2001; Ayers et al., 2002; Dhaliwal et al., 2003; Guenther and Sansing, 2010) and lock-in (Landsman and Shackelford, 1995; Reese, 1998; Blouin et al., 2003; Ayers et al., 2003). First, we utilize more powerful setting to examine and isolate tax capitalization and lock-in over multiple tax regimes. Dai et al. (2008) point out that prior tax capitalization and lock-in event studies are often a joint test as unexpected events trigger changes in expected tax rates for both sellers and sellers. Identifying the relevant tax rate (long-term or short-term) as well as estimating the magnitudes of tax capitalization and lock-in have eluded researchers in part because it is difficult to obtain information on the marginal investor's expected tax liabilities. In our IPO setting, IPO investors' basis is known and thus we more accurately estimate their tax liabilities. In addition, as no tax is imposed on the seller (issuing corporation), there can be no lock-in reflected in the IPO offer price. Thus, in an IPO setting, tax capitalization reflects only future taxes expected to be paid by investors. Further, IPOs provide an opportunity to test which tax rate, long-term or short-term, if any, is capitalized into the IPO offer price. Second, our results confirm that investor-level taxes have an effect on stock prices both in the form of capitalization and lock-in. We not only quantify the economic magnitudes of tax capitalization and lock-in, but also their joint effect, which is important but is under-investigated in the prior literature (Hanlon and Heitzman, 2010). Third, our results indicate that the effect and the magnitude of capital gains tax depend on investors' tax sensitivities. Given the debate in the literature on this issue (Ayers et al., 2002; Dhaliwal et al., 2003; Guenther and Sansing, 2010), our evidence is important for understanding the role played by taxes on asset prices.

The remainder of this paper proceeds as follows. Section 2 discusses theoretical links between the pricing and underpricing of IPOs and short-term and long-term capital gains tax rates. Section 3 describes our sample selection process and empirical methodologies. Section 4 presents empirical results. Section 5 reports supplemental test results. Section 6 summarizes and concludes.

2. Theory

2.1. Underpricing of initial public offerings

It is commonly believed that IPO offer prices are intentionally set below the value of the shares thereby generating positive first-day returns. This phenomenon is referred to as underpricing and is typically measured as the difference between the offer price and the first-day market price. For example, the average first-day return (underpricing) for IPOs over the period 1987–2010 is 20.66%.[1] Various theories have been developed to explain why firms or their underwriters set offer prices below what the market is willing to pay (Ljungqvist, 2007). Many IPO pricing models are motivated by investor demand (demand-side models). For example, underpricing can be motivated by a desire to compensate investors who are concerned about a winner's curse problem (Rock, 1986), to signal firm quality and future plans (Allen and Faulhaber, 1989), or to avoid litigation (Tinic, 1988). On the other hand, firms can be attempting to reward informed investors (institutions) who regularly participate in IPOs and reveal information about offerings to underwriters via the book building process (Benveniste and Spindt, 1989).

[1] Average initial return is calculated using the sample on Jay Ritter's website. Professor Ritter provides initial return data by month from 1980 to 2012, with the average initial return for the whole period being 17.9%.

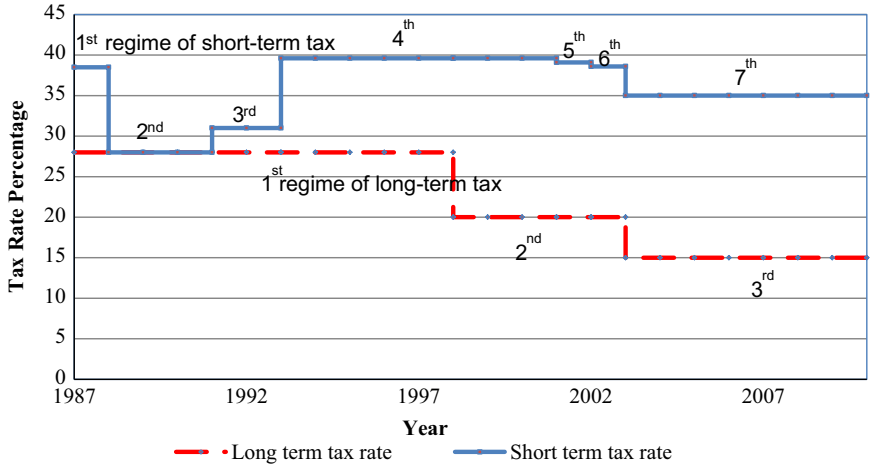

Fig. 1. Short-term and long-term capital gains tax rates 1987–2010. The short-term tax rates are the marginal tax rates facing individuals in the highest income bracket and the long-term tax rates are the rates that apply after the stock has been held for one year. Tax regimes changes occur on the effective dates of the legislation with one exception. The Tax Reform Act of 1997 decreased the maximum long-term capital gains tax rate from 28% to 20% effective May 7, 1997. The change in tax rates in 2003 occurred on May 5, 2003 but was retroactive to the beginning of the year. All other tax rate changes occur at year end.

Behavioral theories of irrational firm insiders (supply-side models) provide alternative models for IPO underpricing. In these models, underwriters set the price low so that offerings are oversubscribed and IPO shares experience a large price run-up on the first day of trading. Loughran (2002) posit that this is due to investor irrationality as insiders focus on their paper wealth. Loughran (2004) argue that during the 1990s and especially the bubble period of 1999–2000, instead of focusing on maximizing IPO proceeds, issuers focused on attracting analyst coverage and finding underwriters who would provide executives with allocations in other underpriced IPOs. In these frameworks, IPO underwriters choose to set offer prices far below investors' reservation value, ignoring marginal effects for investors, such as taxes.

We assume that firms gauge investor demand and set offer prices to maximize IPO proceeds. Within this class of models, IPO underpricing exists as a rational strategy used to induce demand in an IPO. We test whether firms perceive that IPO investors require the magnitude of IPO underpricing to reflect after-tax returns. If this is the case, the before-tax magnitude of IPO underpricing should be a function of capital gains taxes.

2.2. *Tax capitalization and IPO offer prices*

When an individual investor buys a share and later sells it, the resulting gain or loss qualifies for capital gains treatment. Capital losses offset capital gains, and individuals can use excess (net) losses to offset other taxable income, albeit to a very limited extent. When the underlying share is held for more than one year, any resulting net capital gain qualifies for a preferential (lower) tax rate.[2] Otherwise, the gain is taxed at the short-term capital gains tax rate, the same as the tax rate on ordinary income. Hence, the marginal tax rate that an investor faces on the sale of a share depends on the length of time between the purchase and the sale of the share (the holding period). Fig. 1 depicts the seven separate short-term capital gains tax rates and three different long-term capital gains tax rates in effect since 1986.

Tax capitalization represents the proposition that the price an investor is willing to pay for a share is determined on an after-tax basis. That is, if the tax rate on the expected future appreciation of a share is high, investors will lower the offer price for that share. As explained by Dai et al. (2008), from the perspective of IPO investors, this is a demand-side argument. That is, if IPO investors capitalize capital gains taxes, then IPO offer prices should decrease in expected capital gains taxes. This idea can be easily illustrated in the following way. If a share generates a cash flow C in perpetuity, then its current price P_0 is C/r, where r is the tax-free discount rate. With an introduction of a capital gains tax t, the discount rate becomes $r/(1-t)$. Therefore, the stock price becomes $P_0=C(1-t)/r$, which is reduced by Ct. We investigate the capitalization effect of capital gains taxes by exploring the association between IPO offer prices and capital gains tax rates.[3]

Our capitalization tests are related to Guenther and Willenborg (1999) who present evidence that taxes are capitalized in small IPOs. Guenther and Willenborg (1999) study small IPOs around the 1993 tax law change that imposed a special reduced capital gains tax on gains from sales of certain small business IPOs. They report that small IPOs qualifying for a 14% reduction in capital gains tax rate exhibit a significant reduction (19%) in first-day returns. In contrast, non-qualifying (large) IPOs are not affected by this tax law change, suggesting that capital gains taxes affect IPO underpricing through the capitalization effect. Guenther and Willenborg's (1999) test is restricted to an analysis of a very limited sample of IPOs (177 IPOs)

[2] With the exception of a brief period during 1997, the long-term holding period of one year does not change during our sample period.
[3] Of course, not all IPO investors in IPOs are subject to the same level of income taxes. We examine this issue later in the paper.

around 1993 that appeared to qualify for an unusual capital gains treatment. In contrast, we analyze a large sample of IPOs over 24 years with multiple tax regimes to isolate the effect of tax rates on IPO offer prices. Therefore, we are able to provide more general evidence that taxes impact IPO underpricing through a capitalization effect and a more reliable estimate of the magnitude of this effect.

To determine if capital gains taxes are capitalized into offer prices, we draw a direct link between capital gains tax rate and IPO offer prices. If capital gains taxes are capitalized into IPO offer prices, then offer prices should decrease in capital gains taxes. Therefore, our first hypothesis is:

Hypothesis 1. : IPO offer prices decrease in the capital gains tax rate.

Our IPO setting also allows us to test which, if any, tax rate is capitalized into offer prices. There are three possibilities. If firms set offer prices to attract tax exempt institutions, then we should find no correlation between tax regimes and offer prices (the null hypothesis cannot be rejected). On the other hand, firms can set offer prices to attract short-term speculators or long-term investors. Therefore, we test two versions of our first hypothesis (stated in the alternative) as follows:

Hypothesis 1a. : IPO offer prices decrease in the long-term capital gains tax rate.

Hypothesis 1b. : IPO offer prices decrease in the short-term capital gains tax rate.

Guenther and Willenborg (1999) equate a reduced first-day return or lower underpricing to an increase in offer price. While an increase in offer price can translate into a reduced first-day return, a reduced first-day return does not necessarily translate into an increase in offer price. Instead, it can be a result of a lower first-day closing price. Therefore, it is important to examine the association between IPO offer prices and the capital gains tax rates. It is difficult to test for differences in raw IPO offer prices because of systematic differences between firms. We follow Purnanandam and Swaminathan (2004) and deflate offer prices by the estimated value of shares based on comparable listed firms. We directly examine the association between IPO offer prices and capital gains tax rates while using the implied value of shares to control for systematic differences between firms.

2.3. Capital gains lock-in and IPO underpricing

In contrast to tax capitalization, lock-in represents the proposition that if the prospective tax on a proposed stock sale is unexpectedly high, investors will hold out and demand a higher selling price, thereby reducing the supply of shares offered for sale. From the perspective of IPO investors who purchase shares in the offering, this is a supply-side argument. IPO investors who expect to be taxed at the long-term rate will require higher returns to be induced to sell at high short-term capital gains tax rates. That is, IPO investors will trade off selling the stock and paying taxes at a high short-term capital gains tax rate versus holding the stock and paying taxes at a preferential long-term capital gains tax rate.

This can be illustrated in the following way. We know that a properly determined stock price (without considering other factors) is $P_0=C(1-t)/r$. We take underpricing U, which is caused by many factors as discussed earlier, as given. At the end of the first day, stock price becomes $P_0=C(1-t)/r+U$. Then, we introduce a new tax rule. The tax rate is s (the spread) higher if shares are sold short-term, $t_S=t_L+s$, where t_L is the original tax rate t (the long-term tax rate). To entice IPO investors to sell shares short-term, the after tax cash flow from the underpricing U' will have to be the same as if shares are sold long-term. That is, we should have $U'(1-t_L-s)=U(1-t_L)$ or $U'=\frac{U(1-t_L)}{1-t_L-s}$, which is increasing in the spread s between the short-term tax rate t_S and the long-term tax rate t_L. Hence, we expect the magnitude of first-day return to be related to the tax rate differential between short-term and long-term capital gains tax rates. This is the lock-in effect.

Another way of thinking about lock-in is that the difference between short-term and long-term capital gains tax rates represents potential tax savings from deferring the realization of the initial gain from IPOs. To the extent that IPO investors do not defer the sale of their initial shares, this spread represents a tax burden. In equilibrium, this tax burden is transferred to secondary market investors through a higher selling price by IPO investors. Therefore, our second hypothesis is:

Hypothesis 2. : The magnitude of IPO underpricing increases in the difference between short-term and long-term capital gains tax rates.

Prior studies have attempted to isolate the lock-in effect by evaluating stock price patterns around events such as changes in tax legislations, earnings announcements, and year-ends. A benefit of using the IPO setting is that it is relatively devoid of contemporaneous influences associated with tax legislations or other unexpected information. For example, Dai et al. (2008) isolate the lock-in effect by analyzing stock returns around the announcement of the 1997 reduction in capital gains tax rates. While their research design is especially powerful as it employs multiple dates, we cannot completely rule out the possibility that the price reactions are not due to contemporaneous events. For example, contemporaneous with the 1997 reductions in tax rates, there were significant changes in domestic spending, “startling” reductions in unemployment, and changes in trading increments for stocks on the New York Stock Exchange (Hershey, 1997).

A more important benefit of studying the effect of capital gains taxes on share prices in the IPO setting is that the tax basis of IPO investors is likely known; it is the IPO offer price. Of course, this benefit relies on the assumption that marginal sellers on the first trading day are those receiving initial allocations, not the original owners of the IPO firms. In a typical initial public offering, the original owners of the firm can be bound by underwriter lock-up agreements or by SEC Rule 144 trading volume restrictions, and thus are unable to trade during the first few days after the IPOs. Brav and Gompers (2003)

Table 1
Distribution of sample IPOs and underpricing statistics across tax regimes.

Table 1 reports the frequency distribution by short-term and long-term capital gains tax regimes of a sample of 4,666 IPOs occurring from 1987 through 2010 as identified from Thompson Financial Securities Data Corporation. The sample is limited to firms with stock price data on CRSP and complete regression information. IPOs from closed-end funds, REITS, ADRs, unit offerings, IPOs with an offer price below $5 per share, and financial sector IPOs were eliminated from the sample. Sample IPOs are classified according to the tax rate effective on the issuance date. Tax regimes changes occur on the effective dates of the legislation with one exception. The Tax Reform Act of 1997 decreased the maximum long-term capital gains tax rate from 28% to 20% effective May 7, 1997. The change in tax rates in 2003 occurred on May 5, 2003 but was retroactive to the beginning of the year. All other tax rate changes occur at year end. The short-term capital gains tax rate is the marginal tax rate faced by individuals in the highest income bracket, and the long-term capital gains tax rate is the tax rate applicable after stock has been held for more than one year. IPO underpricing (first-day return) is the change in price from the offering price to the closing price on the first day of trading.

Panel A: Frequency of sample IPOs across short-term capital gains tax rates

Tax Regime	Maximum tax rate	Number of sample IPOs	Percentage of sample IPOs	Average IPOs per Day	Change in Daily Frequency
1987	38.50%	200	4.29	0.8	
1988–1990	28%	255	5.47	0.34	Down
1991–1992	31%	514	11.02	1.028	Up
1993–2000	39.60%	2,942	63.05	1.46	Up
2001	39.10%	51	1.09	0.204	Down
2002	38.60%	48	1.03	0.192	Down
2003–2010	35%	656	14.06	0.328	Up

Panel B: Frequency of sample IPOs across long-term capital gains tax rates

Tax Regime	Maximum tax rate	Number of sample IPOs	Percentage of sample IPOs	Average IPOs per Day	Change in Daily Frequency
1987–1997	28%	2,718	58.25	0.99	
1997–2003	20%	1,292	27.69	0.73	Down
2003–2010	15%	656	14.06	0.328	Down

document that insiders lock up 93% of their shares in IPOs. SEC Rule 144 trading restrictions apply to owners who receive shares that are issued via private placements before a company goes public (restricted shares). As these owners are also likely subject to underwriter lock-ups, their trading is minimal during the first few days after IPOs.

In most other settings, such as mergers and acquisitions (Ayers et al., 2003) and earnings announcements (Blouin et al., 2003), proxies have to be used for investor capital gains tax bases. These proxies almost certainly contain measurement errors. Landsman and Shackelford (1995) use the actual tax basis to examine confidential shareholder records prior to the RJR Nabisco leveraged buyout and find support for the lock-in effect as shareholders with the largest capital gains demanded the highest selling price. Although analyzing the RJR Nabisco transaction in detail provided many insights into investor tax rationality, IPOs provide us with a more general setting with a relatively certain tax basis that varies across many deals over many years.

It is also worth noting that if all IPO investors expect to pay taxes at short-term capital gains tax rate, then we will not find evidence of a lock-in effect. Reese (1998) shows that when the short-term capital gains tax rate is higher than the long-term capital gains tax rate, stocks that have appreciated prior to long-term qualification exhibit increased volume and decreased returns immediately after the qualification dates. In contrast, stocks that have declined in value prior to long-term qualification exhibited these same price and volume effects immediately prior to the date for long-term qualification. There can be reasons to believe that the effect of long-term capital gains taxes on the magnitude of IPO underpricing is limited. The incentive of IPO investors to wait to sell their shares right after IPOs may not be as pronounced as right before (after) long-term capital gains qualification dates when their shares have appreciated (depreciated). However, uncertainty over the long run, such as underperformance, can mitigate the incentive to hold shares until long-term qualification (Ritter, 1991; Loughran and Ritter, 1995).

3. Data and method

We collect an initial sample of 9,687 initial public offerings from 1987 to 2010 using Thomson Financial's SDC Global New Issues Database. We choose to initiate the sample in 1987 for several reasons. First, the Tax Reform Act of 1986 reduced both short-term and long-term capital gains tax rates and significantly altered the tax landscape with major revisions of both corporate and individual taxes. Second, prior to 1987, the short-term and long-term capital gains tax rates for individual taxpayers are mathematically related, making it difficult to distinguish the capital gains tax capitalization effect from the lock-in effect.[4] Finally, many of our regression control variables are only available beginning around 1987 (e.g., underwriter rankings, auditors, etc.).

[4] The correlation between long-term and short-term capital gains tax rates is primarily due to the deduction for long-term capital gains. Prior to 1986 the effective long term tax rate was a fraction of the short-term rate, and the fraction was dictated by the percentage of the capital gains deduction. For example, when the capital gains deduction was 60%, the long-term tax rate was effectively 40% of the short-term rate.

We exclude IPOs that are typically excluded from empirical studies: closed-end funds, REITs, ADRs, unit offerings, IPOs with an offer price below $5 per share, and financial sector IPOs (one-digit SIC code 6). We obtain price data from the Center for Research in Security Prices (CRSP) to calculate initial returns. We further limit IPOs to those with initial returns and complete price information. These limitations reduce the regression sample to 4,666 IPOs. The distribution of sample IPOs across short-term and long-term tax regimes is presented in Table 1, Panels A and B, respectively.

3.1. Dependent variables and tax variables

To test for the association between the IPO offer prices and capital gains taxes (tax capitalization), we first deflate offer price by an estimate of the value of IPO shares. This captures variation in market valuation in general and focuses on how IPOs are priced relative to market valuation. Based on Purnanandam and Swaminathan (2004), we use a price-to-value (*P/V*) ratio where *P* is the offer price and *V* is a fair market value computed from comparable firms' price multiples. We use the same matching procedure as Purnanandam and Swaminathan (2004) by matching IPOs with firms that are in the same Fama-French industry category; have not done an IPO in the prior three years; and have the closest sales. Rather than using one matched firm for each IPO and following Purnanandam and Swaminathan (2004), we break each Fama French industry into three portfolios based on size and then match the IPO to one of these portfolios. We then use the median price multiple for the relevant size portfolio as the matched value.

To calculate the *P/V* ratio, we first define the price multiple based on EBITDA for an IPO firm as:

$$\left(\frac{P}{EBITDA}\right)_{IPO} = \frac{Offer\ Price \times CRSP\ Shares\ Outstanding}{Prior\ Fiscal\ Year\ EBITDA}.$$

The price multiple based on EBITDA is the median of the EBITDA price multiples for matched firms within the same size portfolio as the IPO:

$$\left(\frac{P}{EBITDA}\right)_{Match} = median_{sizeportfolio}\left(\frac{Market\ Price \times CRSP\ Shares\ Outstanding}{Prior\ Fiscal\ Year\ EBITDA}\right).$$

The variable *P/V_EBITDA* is based upon the offer price to value ratio on EBITDA defined as follows:

$$\left(\frac{P}{V}\right)_{EBITDA} = \ln\left(\frac{(P/EBITDA)_{IPO}}{(P/EBITDA)_{Match}}\right).$$

Similarly, we replace EBITDA with sales and define the variable *P/V_SALES* as follows:

$$\left(\frac{P}{V}\right)_{Sales} = \ln\left(\frac{(P/Sales)_{IPO}}{(P/Sales)_{Match}}\right).$$

Our test of tax capitalization is then conducted by estimating the following regression model:

$$P/V_{it} = \alpha_0 + \alpha_1 ST\ TAX_{it} \quad \text{and/ or} \quad \alpha_1 LT\ TAX_{it} + controls_{it} + \gamma_{it}, \tag{1}$$

where *P/V* is the logarithm of price-to-value ratio representing the offer prices of IPO firms relative to the market prices of the median matched firms.[5] We argue that the effect of taxes should be detected during the offer price formation stage if capital gains taxes are capitalized. To address correlations among standard errors, we employ a two-way clustering approach in which standard errors are clustered by year and 2-digit industry code.

To test for the association between the magnitude of IPO underpricing and capital gains taxes, we estimate the following regression model:

$$UP_{it} = \beta_0 + \beta_1 TAXDIFF_{it} + \beta_k controls_{it} + \varepsilon_{it}, \tag{2}$$

where *UP* is the dependent variable IPO first-day returns (underpricing).

In both equations, *ST TAX* is short-term capital gains tax rate; *LT TAX* is long-term capital gains tax rate; and *TAXDIFF* is the difference between short-term capital gains tax rate *ST TAX* and long-term capital gains tax rate *LT TAX*. We test the effects of *ST TAX*, *LT TAX* and *TAXDIFF* separately. In Eq. (1), we expect the effect of *LT TAX* on *P/V* to be negative (Hypothesis 1a), if the capitalization of long-term capital gains taxes reduces the IPO offer price (Guenther and Willenborg, 1999). We also test Hypothesis 1b by using *ST TAX* to determine if short-term capital gains taxes affect IPO offer prices. In Eq. (2), we expect the effect of *TAXDIFF* on *UP* to be positive (Hypothesis 2).

3.2. Control variables

Prior underpricing studies have found multiple variables to be associated with initial IPO returns. As the rationale for controls for the first-day price reaction often applies equally to the offer price, we include a same set of control variables in

[5] We transform the *P/V ratios* using logs in order to minimize the effect of extreme observations. In untabulated regressions we utilize the price to value ratios that are not log transformed as well as price to value ratios based upon the closest match to the IPO firm (rather than the median of matching firms). Regression results utilizing these alternative definitions of *P/V* are qualitatively similar to those presented in the tables.

Table 2
Variable definitions.

Dependent variables

Variable	Definition
P/V	The log of the price-to-value ratio that captures the offer prices of IPO firms relative to the market prices of the matched firms based on Purnanandam and Swaminathan (2004). See the definition in Table 4.
UP	The first-day return (underpricing) is the difference between the first trading day closing price reported by CRSP and the initial offer price deflated by the offer price.

Independent tax variables

Variable	Definition
ST TAX	The short-term (ordinary) tax rate is the marginal tax rate faced by individuals in the highest income bracket.
LT TAX	The long-term capital gains tax rate is the maximum tax rate on individuals for net long-term capital gains.
TAXDIFF	The difference between short-term capital gains tax rate, *ST TAX*, and long-term capital gains tax rate, *LT TAX*.

Independent control variables

Variable	Definition
RANK	The reputation of underwriters using the updated Carter-Manaster ranking (Carter and Manaster, 1990) available on Jay Ritter's website.
REVISION	The percentage price revision from midpoint of initial filing range to the offer price.
SPREAD	Underwriters' fees calculated as the total underwriting/management/selling fees as a percentage of the amount offered in the IPO.
VWTOT	The market return preceding samprior to thle IPOs is the sum of the value weighted market return for the two months pe IPO.
IPORET	The average IPO first-day return during the two months prior to a firm's IPO month.
IPOTOT	The total number of IPOs over the two months prior to a firm's IPO month.
AUDITD	An indicator variable that equals one if the auditor of the IPO firm is a big 4 auditor and zero otherwise.
PROCEEDS	The logarithm of IPO proceeds in millions, divided by CPI.
TECH	An indicator variable that equals one for technology firms defined using the four-digit SIC codes in Cliff and Denis (2004).
VC	An indicator variable that equals one where Thompson Financial recorded the IPO as backed by venture capital and zero otherwise.
Turnover	An investor horizon measure follows Gaspar, Massa, and Matos (2005).

Table 3
Statistics for the regression sample 1987-2010.
Table 3 summarizes descriptive statistics for the sample of 4,666 IPOs except *P/V Ratio* which has a sample size of 3,957. Sample derivation is described in Table 1. Capitalization is the market value of all stock outstanding on the offer date, using CRSP shares outstanding and the closing price on the first day of trading. Remaining variables are defined in Table 2.

Panel A: Descriptive statistics

Variable	Mean	Std. dev.	1st Quartile	Median	3rd Quartile
Capitalization ($ in millions)	259.96	355.46	60.09	127.76	293.31
Offer Price	12.42	4.99	9	12	15
Shares Offered (millions)	4.26	8.78	1.6	2.61	4.6
Offering Proceeds ($ in millions)	64.00	86.71	19.5	36.4	71.3
P/V _EBITDA	0.86	1.14	0.11	0.729	1.5
P/V _Sales	1.71	1.67	0.6	1.46	2.5
UP (%)	21.03	37.09	0.45	9.01	25
RANK	8	3.02	6	8	9
REVISION (%)	1.53	24.18	-11.11	0	11.11
IPORET (%)	14.49	17.71	5.31	9.37	15.1
VWTOT	1.41	3.55	0.77	1.5	3.57
IPOTOT	54.99	29.5	32	53	74
Age of Firm in Years	15.4	19.76	5	8	16

Panel B: Frequency distribution over tax regimes

	Subsample	Technology (39.13%)	Venture (47.23%)
Short-term Regimes			
1987	200	26.00%	36.50%
1988–1990	255	32.55%	43.14%
1991–1992	514	29.38%	49.22%
1993–2000	2,942	43.47%	47.45%
2001	51	35.29%	62.75%
2002	48	37.50%	43.75%
2003–2010	656	34.30%	48.63%
Long-term Regimes			
1987–1997	2,718	34.25%	43.64%
1997–2003	1,292	51.86%	54.10%
2003–2010	656	34.30%	48.63%

Table 4
IPO offer price regression results

Table 4 presents estimates of regressions of the log of the ratio of the offer price-to-value (P/V) for 3,957 IPOs. We define P as the offer price and V as the fair market value estimated in two different ways from comparable firms' price multiples. Control variables are defined in Table 2. The two methods of estimating V are based upon Purnanandam and Swaminathan (2004). The price multiple based on EBITDA is defined as follows: $\left(\frac{P}{EBITDA}\right)_{IPO} = \frac{Offer\ Price \times CRSP\ Shares\ Outstanding}{Prior\ Fiscal\ Year\ EBITDA}$.

The matched price multiple is based on the median price multiple for firms matched by size portfolio with the IPO as follows: $\left(\frac{P}{EBITDA}\right)_{Match} = median_{\text{sizeportfolio}}\left(\frac{Market\ Price \times CRSP\ Shares\ Outstanding}{Prior\ Fiscal\ Year\ EBITDA}\right)$.

The P/V ratio based on EBITDA is defined as the log of the matched price multiple as follows: $\left(\frac{P}{V}\right)_{EBITDA} = \ln\left(\frac{(P/EBITDA)_{IPO}}{(P/EBITDA)_{Match}}\right)$.

Similarly, we replace EBITDA with sales and define the P/V based on sales as the log of:

$\left(\frac{P}{V}\right)_{Sales} = \ln\left(\frac{(P/Sales)_{IPO}}{(P/Sales)_{Match}}\right)$.

The numbers in parentheses are robust t-statistics adjusted for clustering of observations across years and industries; and all tests are two-tail tests where ***, ** and * indicate that coefficient estimates are significantly different from zero at the 1%, 5%, and 10% levels, respectively.

Panel A: Regressions on P/V_EBITDA

	(1)	(2)	(3)
Variables	Coefficient estimates (t statistics)		
Intercept	1.012**	3.718***	3.584***
	(2.215)	(7.967)	(8.036)
ST TAX (−)	1.355		0.389
	(1.621)		(0.795)
LT TAX (−)		−5.500***	−5.442***
		(−8.373)	(−8.557)
VC	0.297***	0.291***	0.293***
	(6.557)	(6.856)	(6.783)
RANK	−0.022***	−0.004	−0.004
	(−2.930)	(−0.522)	(−0.521)
REVISION	1.181***	1.395***	1.396***
	(9.550)	(11.918)	(11.891)
SPREAD	0.084**	0.006	0.005
	(2.316)	(0.210)	(0.172)
TECH	0.085	0.045	0.045
	(0.731)	(0.415)	(0.414)
VWTOT	0.003*	0.006***	0.006***
	(1.826)	(7.580)	(5.654)
IPORET	0.810***	0.426**	0.409**
	(4.155)	(1.989)	(1.999)
IPOTOT	−0.179***	−0.108**	−0.110**
	(−2.597)	(−2.084)	(−2.109)
AUDITD	0.206	0.177	0.145
	(0.296)	(0.260)	(0.219)
LAGE	−0.278***	−0.284***	−0.283***
	(−11.590)	(−12.313)	(−12.488)
PROCEEDS	−0.163***	−0.328***	−0.328***
	(−3.186)	(−7.486)	(−7.377)
Adjusted R^2	0.24	0.27	0.27

Panel B: Regressions on P/V_Sales

	(1)	(2)	(3)
Variables	Coefficient estimates (t statistics)		
Intercept	1.265	3.646***	4.055***
	(1.605)	(4.891)	(4.179)
ST TAX (−)	0.084		−1.171*
	(0.098)		(−1.652)
LT TAX (−)		−5.896***	−6.065***
		(−6.045)	(−6.087)
VC	0.710***	0.670***	0.665***
	(4.351)	(4.400)	(4.456)
RANK	−0.028***	−0.009	−0.008
	(−2.663)	(−0.899)	(−0.874)
REVISION	0.311	0.537***	0.537***
	(1.638)	(2.824)	(2.816)
SPREAD	0.222***	0.147**	0.149***
	(4.027)	(2.582)	(2.693)
TECH	−0.084	−0.137	−0.135
	(−0.444)	(−0.737)	(−0.731)

Table 4 (*continued*)

Panel B: Regressions on P/V_Sales

	(1)	(2)	(3)
Variables	Coefficient estimates (*t* statistics)		
VWTOT	0.006***	0.009***	0.010***
	(4.462)	(6.931)	(9.699)
IPORET	1.666***	1.241***	1.273***
	(9.137)	(8.077)	(8.507)
IPOTOT	−0.159	−0.082	−0.080
	(−1.308)	(−0.680)	(−0.640)
AUDITD	−0.630	−0.588	−0.532
	(−0.705)	(−0.690)	(−0.605)
LAGE	−0.599***	−0.593***	−0.596***
	(−7.559)	(−7.964)	(−7.990)
PROCEEDS	−0.090	−0.276***	−0.274***
	(−1.332)	(−3.531)	(−3.562)
Adjusted R^2	0.32	0.34	0.34

Table 5
IPO underpricing across tax regimes.

Table 5 compares the level of first-day returns between tax regimes to ascertain whether mean or median IPO returns move in concert with tax rate changes. Panel A presents changes in mean and median returns between adjacent short-term tax regimes and Panel B presents changes in mean and median returns for long-term tax regimes. Changes in median returns are tested using the Median test where * indicates that median difference is significantly different from zero at the 5% level.

Panel A: First-day returns (underpricing) by short-term capital gains tax regimes

Tax Regime	Tax Rate	Sample Size	Mean First-Day Return	Median First-Day Return	Tax Rate Change	MedianReturnChange	Change in Daily Frequency
1987	38.50%	200	7.59%	2.12%			
1988–1990	28%	255	8.85%	4.16%	Down	Up*	Down
1991–1992	31%	514	11.13%	5.76%	Up	Up	Up
1993–2000	39.60%	2,942	27.46%	11.69%	Up	Up*	Up
2001	39.10%	51	17.32%	16.04%	Down	Up	Down
2002	38.60%	48	9.97%	8.45%	Down	Down*	Down
2003–2010	35%	656	11.28%	6.31%	Down	Down	Up

Panel B: First-day returns (underpricing) by long-term capital gains tax regimes

Tax Regime	Tax Rate	Sample Size	Mean First-Day Return	Median First-Day Return	Tax Rate Change	Median Return Change	Change in Daily Frequency
1987–1997	28%	2,718	13.75%	7.01%			
1997–2003	20%	1,292	42.01%	19.07%	Down	Up*	Down
2003–2010	15%	656	11.29%	6.32%	Down	Down*	Down

both Eqs. (1) and (2). Further, we include them in the regressions as the offer price enters the computation of both the price-to-value ratio and first-day return. We define control variables in Table 2 and summarize the literature and our expectations below.

Hanley (1993) shows that initial returns are positively associated with the price revision during the bookbuilding process. Thus, we expect price revision (*REVISION*) during the bookbuilding process to be positively associated with *UP*. Underpricing is related to uncertainty about the value of the offering, and IPOs underwritten by high reputation underwriters generally have less underpricing (Carter et al., 1998). However, this association reversed during the 1990s when the most prestigious investment banks underwrote enormously underpriced IPOs. As our sample covers 1987 to 2010, we expect to find a positive association between reputation and first-day returns as in Beatty and Welch (1996) and Loughran (2004). We use Carter and Manaster's (1990) underwriter ranking (*RANK*) and expect *RANK* to have a positive effect on *UP* for our time period.

Other variables related to the quality of the firm, and hence lower underpricing, are firm age (Field and Karpoff, 2002) and auditor prestige (Michaely and Shaw, 1995). *LAGE* is the logarithm of a firm's age at IPO and we expect young firms to have more IPO underpricing. *AUDITD* is a big-auditor indicator that equals one if the auditor of the IPO firm is a big-4 auditor, and zero otherwise. We expect *LAGE* and *AUDITD* to have a negative effect on *UP*.

Table 6
IPO underpricing regression results 1987 – 2010.
Table 6 presents the results from regressing returns for 4,666 IPOs on TAXDIFF. Control variables are defined in Table 2. The numbers in parentheses are robust *t*-statistics adjusted for clustering of observations across years and industries, and all tests are two-tailed where ***, ** and * indicate that coefficient estimates are significantly different from zero at the 1%, 5%, and 10% levels, respectively.

Variables	Underpricing Coefficient Estimates (*t* statistics)
TAXDIFF (+)	0.519***
	(2.796)
VC	0.043**
	(2.366)
RANK	0.012**
	(2.258)
REVISION	0.717***
	(6.319)
SPREAD	0.024**
	(2.350)
TECH	0.053**
	(2.420)
VWTOT	0.100
	(1.537)
IPORET	−0.000
	(−0.100)
IPOTOT	0.586***
	(6.859)
AUDITD	−0.017
	(−0.824)
LAGE	−0.018**
	(−2.309)
PROCEEDS	−0.012*
	(−1.752)
Adjusted R^2	0.45

Lee and Wahal (2004) find that venture-backed IPOs have higher first-day returns than non-venture-backed IPOs. We control for venture capital backing through an indicator variable (*VC*) that equals one if an IPO has venture capitalists' backing and zero otherwise. Consistent with the view that venture capitalists grandstand via taking their investments public (Gompers, 1996; Lee and Wahal, 2004), we expect venture capital backing *VC* to be positively related to *UP*.

Lowry (2003) shows that IPO first-day returns are related to recent past returns and recent IPO activity. We control for hot IPO cycles by including the average first-day return (*IPORET*) and the total number of IPOs (*IPOTOT*) for the two months prior to the IPO. We expect *IPORET* to be positively associated with *UP*. If *IPOTOT* represents the total supply of IPOs, it should be negatively associated with *UP*. We control for the market return preceding sample IPOs using a market return (*VWTOT*) calculated as the sum of the value weighted market return for the two months prior to the IPO. We expect *VWTOT* to be positively associated with *UP*.

A cost that an issuing firm bears is the fees paid to the underwriting syndicate (Chen and Ritter, 2000). We add a variable (*SPREAD*) that represents the level of underwriter fees relative to the IPO proceeds. We expect *SPREAD* to be positively associated with *UP*. Technology IPOs are represented by a binary variable (*TECH*) that equals one for firms defined as within a technology industry based on the four-digit SIC codes (Cliff and Denis, 2004). We expect *TECH* to have a positive effect on *UP*. We include the size of the issue, *PROCEEDS*, defined as the logarithm of IPO proceeds in millions deflated by CPI. We expect it to have a negative effect on *UP*.[6]

4. Empirical results

The characteristics of control variables are presented in Table 3. Firms in our regression sample have an average (median) market capitalization of $259.96 ($127.76) million, an average (median) IPO size of $64 ($36.4) million and an average offer price of $12.42 ($4.99) per share. As the time period spans more than two decades, rather than using the size of the deal in dollars, we use the logarithm of the deal size deflated by the CPI index. We are able to construct price-to-value ratios for a subsample of 3,957 firms. After log transforming the price-to-value ratios, the average *P/V_EBITDA* based on EBITDA (*P/V_Sales*) is 0.86 (1.71) with a median of 0.73 (1.46). The average initial return (*UP*) is 21.03% with a median of 9.01%, in line with other studies. Most deals are underwritten by high quality underwriters, 47.23% have venture capitalist backing, and 39.13% are in a technology industry. The average (median) firm is just over 15 (8) years old at the time of the IPO. From Panel

[6] We also estimate regressions after excluding *PROCEEDS* and, alternatively, including the inverse of IPO offer price to control for the propensity of firms with a lower offer price to also have high IPO return. Results based on these alternative specifications are qualitatively similar.

Table 7
Monthly regression results 1987 – 2010.

Table 7 presents the results from regressing monthly means in lieu of using each IPO as independent variables. The monthly means are calculated using equally-weighted averages across each dependent and independent variable for each month with at least three observations for each variable. Otherwise, variables are as defined in Table 2. This technique produces 249 observations with available data for the offer price regressions presented in Panel A and 211 observations for the underpricing regressions presented in Panel B from 1987 to 2010. Column (1) of Panel A presents the monthly mean regression results using *P/V*_EBITDA as the dependent variable and column (2) uses *P/V* _SALES as the dependent variable. Panel B presents the results from estimating the underpricing regressions testing *ST TAX* in column (1), *LT TAX* in column (2), the combination of tax rates in column (3), and *TAXDIFF* in column (4). The numbers in parentheses are robust t-statistics adjusted for clustering of observations across years and industries, and all tests are two-tailed where ***, ** and * indicate that coefficient estimates are significantly different from zero at the 1%, 5%, and 10% levels, respectively.

Panel A: Offer Price Regressions

	(1)	(2)
Variables	Coefficient Estimates (*t* statistics)	
Intercept	2.623	4.438**
	(0.888)	(2.097)
ST TAX (–)	0.662	– 1.500
	(0.629)	(– 1.172)
LT TAX (–)	– 4.265***	– 6.890***
	(– 4.681)	(– 5.067)
VC	0.567**	0.671*
	(2.028)	(1.802)
RANK	– 0.030	– 0.017
	(– 0.334)	(– 0.248)
REVISION	1.193***	0.305
	(3.638)	(0.789)
SPREAD	0.048	0.234
	(0.183)	(1.009)
TECH	0.063*	0.056
	(1.767)	(0.172)
VWTOT	– 1.097	– 2.379**
	(– 0.680)	(– 2.145)
IPORET	0.006***	0.010***
	(3.486)	(4.920)
IPOTOT	– 0.078	1.370***
	(– 0.142)	(3.546)
AUDITD	– 0.156	– 0.472
	(– 0.330)	(– 1.014)
LAGE	– 0.241**	– 0.600***
	(– 2.342)	(– 5.190)
PROCEEDS	– 0.273	– 0.381**
	(– 1.584)	(– 2.589)
Adjusted R^2	0.24	0.58

Panel B: Underpricing Regressions

Variables	Underpricing Coefficient Estimates (*t* statistics)
Intercept	– 0.380**
	(– 2.005)
TAXDIFF (+)	0.175*
	(1.657)
VC	0.035
	(1.345)
RANK	0.010
	(1.387)
REVISION	0.221***
	(3.360)
SPREAD	0.042**
	(2.501)
TECH	0.079*
	(1.816)
VWTOT	0.443**
	(2.189)
IPORET	0.000**
	(2.129)
IPOTOT	0.500***
	(27.876)
AUDITD	– 0.020
	(– 0.344)

Table 7 (*continued*)

Panel B: Underpricing Regressions

Variables	Underpricing Coefficient Estimates (*t* statistics)
LAGE	−0.011
	(−0.611)
PROCEEDS	0.018
	(1.162)
Adjusted R^2	0.45

B of Table 3, it is apparent that many of our IPOs occur during the 1993–2000 period, a period characterized by relatively stable tax rates (one short-term regime and two long-term regimes), and the technology bubble.

4.1. Evidence of tax capitalization

Table 4 presents results from estimating regression Eq. (1) designed to test for the capitalization effect of capital gains taxes. The regressions are adjusted for clustering across years and industries, and exhibit reasonable explanatory power. As we note earlier, there is no prior literature on the effects of control variables (untabulated) on the price-to-value ratio. However, we include them in the regressions because the offer price enters the computation of both the price-to-value ratio and the first-day return.

When the dependent variable, *P/V*, is regressed on the short-term capital gains tax rate, *ST TAX*, the coefficient is insignificant whether we use the *P/V* based on EBITDA or sales. When *P/V* is regressed on the long-term capital gains tax rate, *LT TAX*, the coefficient is negative and significant whether we use *P/V* based on EBITDA (−5.500, $t=-8.373$) or sales (−5.896, $t=-6.045$). When the short-term capital gains tax rate and the long-term capital gains tax rate are both included in Eq. (1), we obtain similar results. The coefficient on *ST TAX* is insignificant while the coefficient on *LT TAX* is negative and significant (−5.442, $t=-8.557$ using *P/V_EBITDA*; −6.065, $t=-6.087$ using *P/V_Sales*).[7]

This result suggests that the IPO offer price incorporates the long-term capital gains tax and not the short-term capital gains tax, supporting Hypothesis 1a which predicts IPO offer price to decrease in the long-term capital gains tax rate. Based on regression results using both the long-term and short-term capital gains tax rates and the EBITDA-based price-to-value ratio, *P/V_EBITDA*, in Table 4, a 1% increase in the long-term capital gains tax rate will cause *P/V_EBITDA* to decrease by 0.232% (1%/23.7% × 5.500).[8] Based on results using the sales-based price-to-value ratio, *P/V_Sales* declines by 0.249% (1%/23.7% × 5.896). These estimates are generally consistent with Dai et al. (2008), who documents that a 1% increase in capital gain tax rate leads to a 0.20–0.27% reduction in stock prices.

4.2. Evidence of the lock-in effect

Before analyzing the association between first-day returns and the lock-in effect of capital gains tax rates via regression analysis, we compare the level of first-day returns between tax regimes. This comparison, presented in Table 5, allows us to ascertain whether mean or median returns move in concert with tax rate changes (e.g., returns increase with higher tax rate differentials and drop with lower tax rate differentials). Short-term capital gains taxes have the most variation with different maximum tax rates during seven different tax regimes. All else equal, we would expect changes in the mean (median) first-day return to be positively associated with changes in short-term regimes. However, we observe in Panel A of Table 5 that the change in first-day return is in the same direction as the change in the tax rate for only four of the six short-term regime changes.

Likewise, in Panel B of Table 5, the change in the distribution of first-day returns is in the opposite direction as the change in the tax rate for one of the two long-term regime changes. The last column in Tables 1 and 5 presents the average daily frequency of IPO issuances across each tax regime. All else equal, we would expect IPO volume to change inversely with the top tax rates as high tax rates would inhibit investor demand for shares. However, the pattern of IPOs does not align with the expected tax pattern. Hence, in Tables 1 and 5 we do not observe a strong pattern of first-day returns or IPO volume consistent with a tax hypothesis. Of course, caution should be used in interpreting descriptive statistics without other controls.

[7] Using the *P/V* based on sales, we find a marginally significant coefficient on *ST TAX* only if both *ST TAX* and *LT TAX* are included. To the extent that the magnitude of coefficient on *ST TAX* is also very small, we argue that the impact of short term tax rates on offer price is limited.

[8] As the dependent variable is the logarithmic transformation of $(P/EBITDA)_{IPO}/(P/EBITDA)_{Match}$, the change in the dependent variable can be interpreted as the change in $\log(x+1)$. Therefore, the elasticity of stock price to the capital gains tax changes is (ΔCapital gains tax/mean value of capital gains tax) × coefficient on the capital gains tax (see Eq. (1) of Dai, Maydew, Shackelford and Zhang (2008)). If we take the sample mean long-term capital gains tax rate of 23.7%, then a 1% increase in the long-term capital gains tax rate would result in a 0.232% (1%/23.7% × 5.50%) reduction in *P/V_EBITDA* and a 0.249% (1%/23.7% × 5.896%) reduction in *P/V_Sales*.

Table 8
Initial pricing and underpricing regression results in adjacent tax regimes.

Table 8 presents the results from regressing observations limited to IPOs in adjacent tax regimes with sufficient observations to produce meaningful results. Panel A reports offer price regression results. Columns (1) and (2) of Panel A cover observations during the 1987–1997 and 1997–2003 long-term capital gains tax regimes. Columns (3) and (4) of Panel A cover observations during the 1997–2003 and 2003–2010 long-term capital gains tax regimes. Panel B reports underpricing regression results. Column (1) in Panel B covers observations during the 1988–1990 and 1991–1992 short-term capital gains tax regimes. Column (2) covers observations during the 1991–1992 and 1993–2000 short-term capital gains tax regimes. Column (3) cover observations during the 1987–1997 and 1997–2003 long-term capital gains tax rate regimes. Variables are defined in Table 2. The numbers in parentheses are robust *t*-statistics adjusted for clustering of observations across years and industries, and all tests are two-tailed where ***, ** and * indicate that coefficient estimates are significantly different from zero at the 1%, 5%, and 10% levels, respectively.

Panel A: Offer Price Regressions

	(1)	(2)	(3)	(4)
	Coefficient estimates/(*t* statistics) Long-term capital gains tax regimes			
	1987–1997 and 1997–2003		1997–2003 and 2003–2010	
	P/V_EBITDA	*P/V_Sales*	*P/V_EBITDA*	*P/V_Sales*
Intercept	3.017***	3.477***	4.019***	3.350***
	(5.230)	(9.035)	(3.867)	(4.327)
LT TAX (−)	−5.560***	−6.198***	−3.666***	−3.419***
	(−6.888)	(−7.871)	(−3.650)	(−2.973)
VC	0.307***	0.506***	0.396***	0.571***
	(9.029)	(5.648)	(7.583)	(7.122)
RANK	0.002	0.013	0.002	−0.000
	(0.180)	(1.355)	(0.245)	(−0.090)
REVISION	1.277***	0.672***	1.374***	0.650***
	(10.530)	(5.989)	(6.396)	(4.328)
SPREAD	0.088*	0.151***	−0.030	0.118**
	(1.995)	(4.507)	(−0.407)	(2.154)
TECH	0.020	−0.109	0.247***	−0.118
	(0.206)	(−1.050)	(2.932)	(−1.295)
VWTOT	0.007***	0.007***	0.006***	0.010***
	(10.210)	(12.055)	(6.086)	(6.407)
IPORET	0.556**	1.102***	0.331*	0.957***
	(2.302)	(8.847)	(1.706)	(4.938)
IPOTOT	0.003	−0.004	−0.215**	−0.058
	(0.038)	(−0.050)	(−2.215)	(−0.940)
AUDITD	0.399	−0.540	0.621	−0.741
	(0.644)	(−0.990)	(0.973)	(−1.473)
LAGE	−0.351***	−0.518***	−0.387***	−0.636***
	(−12.396)	(−14.743)	(−8.630)	(−8.404)
PROCEEDS	−0.274***	−0.315***	−0.345***	−0.294***
	(−5.396)	(−6.719)	(−5.027)	(−4.822)
Adjusted R^2	0.321	0.482	0.363	0.559

Panel B: Underpricing Regressions

	(1)	(2)	(3)
	Coefficient estimates/(*t* statistics)		
	Short-term tax regimes		Long-term tax regimes
	1988–1990 and 1991–1992	1991–1992 and 1993–2000	1987–1997 and 1997–2003
Intercept	0.023	−0.291*	−0.257*
	(0.175)	(−1.807)	(−1.952)
TAXDIFF(+)	1.407**	0.591**	0.552**
	(2.322)	(2.094)	(2.335)
VC	0.021***	0.042*	0.039**
	(5.031)	(1.908)	(2.073)
RANK	0.002	0.022**	0.019**
	(1.500)	(2.580)	(2.451)
REVISION	0.344***	0.756***	0.741***
	(9.764)	(6.803)	(6.729)
SPREAD	0.015	0.039***	0.034***
	(0.998)	(2.713)	(2.830)
TECH	0.024	0.064**	0.057**
	(1.534)	(2.228)	(2.335)

Table 8 (*continued*)

Panel B: Underpricing Regressions

	(1)	(2)	(3)
	Coefficient estimates/(*t* statistics)		
	Short-term tax regimes		Long-term tax regimes
	1988–1990 and 1991–1992	1991–1992 and 1993–2000	1987–1997 and 1997–2003
VWTOT	0.355***	0.055	0.099*
	(3.910)	(1.309)	(1.729)
IPORET	−0.000	−0.000	−0.000
	(−1.021)	(−0.916)	(−0.333)
IPOTOT	0.244***	0.551***	0.574***
	(3.114)	(4.917)	(5.611)
AUDITD	−0.049***	−0.024	−0.025
	(−8.805)	(−0.786)	(−0.975)
LAGE	−0.014***	−0.021**	−0.019**
	(−3.241)	(−2.238)	(−2.263)
PROCEEDS	−0.001	−0.016**	−0.014*
	(−0.148)	(−2.075)	(−1.934)
Adjusted R2	0.501	0.483	0.474

Table 6 presents results from regressing IPO returns on *TAXDIFF*. The regression model exhibits significant explanatory power and the estimation is consistent with our expectation. The coefficient on *TAXDIFF* is positive and significant (0.519, $t=2.796$), indicating that the magnitude of IPO underpricing is positively associated with the tax rate differential. While it is difficult to predict *ex ante* the sensitivity of underpricing to capital gains taxes, the economic magnitude of the effect of capital gains taxes based on our regression results appears to be significant. In particular, the net effect of lock-in is a 0.519% increase in the magnitude of underpricing when the spread between short-term and long-term capital gains tax rates increases by 1%. Taking into account the capitalization effect in Table 4, the joint effect of capitalization and lock-in is that a 1% increase in long-term tax rate leads to 0.27% (0.519–0.249%) to 0.287% (0.519–0.232%) increase in the first-day closing price, all others equal.

The effects of most of the control variables are consistent with our expectations. The estimated coefficients on *RANK*, *REVISION* and *SPREAD* are positive and significant in all four models, consistent with the literature. The coefficient on *TECH* is positive and significant, suggesting that the magnitude of IPO underpricing is higher for tech firms. While the effect of *VWTOT* is insignificant, there appears to be some IPO momentum in that the coefficients on *IPORET* and *IPOTOT* are positive and significant. The effect of *AUDITD* is negative but insignificant, suggesting that big auditors help reduce the magnitude of IPO underpricing. The coefficient on *LAGE* is negative and significant, consistent with the literature that younger firms have higher underpricing. The effect of *PROCEEDS* is negative and significant, suggesting that size of the IPO negatively impacts underpricing.[9]

5. Supplemental tests

Our tests of the association between the IPO offer prices, underpricing and capital gains taxes are based upon changes in tax rates over the period 1987 through 2010. Despite controls in our primary analyses, it is possible that our tax rate variables may represent other unidentified, but temporally correlated confounds. To discriminate between tax effects and other potentially correlated temporal phenomena, we conduct a battery of supplemental tests. To begin, all regressions in Tables 4 and 6 are estimated after adjusting for clustering across years and 2-digit industry code. In addition, in untabulated analyses we estimate regressions after eliminating each tax regime (one at a time) and examine various additional controls including the size of the offer and institutional holdings. We also test whether temporal clustering of IPOs (i.e., IPO "bubbles") can confound our results by replicating our tests first using variables based upon monthly averages and then testing whether our tax variables are subsumed by ordinal tax regime variables. Next, we replicate our lock-in analysis after limiting the regression sample to adjacent tax regimes. Finally, we also test corollary predictions from the lock-in effect: how investor horizons alter the tax effects, whether investors' tax status has any incremental impact, and what is the time-series variation of the lock-in effect.

[9] We estimate regressions in Tables 4 and 6 after excluding IPOs during the dotcom period of January 1999 through March 2000 and, alternatively, all IPOs from 1999 and 2000. We also estimate regressions in Tables 4, 6, and 8 after including firm assets as a control for differential firm size. Results from these alternative specifications are qualitatively similar.

Table 9
Investors' tax statuses, IPO initial pricing and underpricing.

Table 9 presents the results from regressing IPO based on the institutional investors' tax statuses. We define corporate pension fund, university and foundation endowments and public (private) pension fund as tax insensitive investors. The dependent variables in Panel A are *P/V_EBITDA* and *P/V_Sales*, respectively. The dependent variable in Panel B is the IPO underpricing. Other variables are defined in Table 2.The numbers in parentheses are robust t-statistics adjusted for clustering of observations across years and industries, and all tests are two-tailed where ***, ** and * indicate that coefficient estimates are significantly different from zero at the 1%, 5%, and 10% levels, respectively.

Panel A: Offer Price Regressions

	P/V_EBITDA		*P/V_Sales*	
	Tax-sensitive	Less Tax-sensitive	Tax-sensitive	Less Tax-sensitive
Intercept	2.913***	3.977***	3.144***	5.201***
	(7.007)	(4.977)	(5.975)	(5.325)
ST TAX (−)	−0.778	0.845	−1.139	−1.025
	(−1.029)	(1.051)	(−1.569)	(−1.192)
LT TAX (−)	−6.561***	−4.887***	−6.396***	−5.453***
	(−7.431)	(−10.789)	(−5.913)	(−7.448)
RANK	0.326***	0.303***	0.646***	0.496***
	(12.104)	(7.308)	(6.008)	(3.997)
REVISION	0.000	−0.008	0.011	0.000
	(0.021)	(−0.947)	(0.644)	(0.016)
SPREAD	1.086***	1.470***	0.500***	0.857***
	(6.528)	(14.891)	(3.442)	(5.256)
TECH	0.115***	−0.026	0.221***	−0.025
	(2.615)	(−0.397)	(6.635)	(−0.324)
VWTOT	−0.015	0.039	−0.144	−0.079
	(−0.125)	(0.375)	(−1.140)	(−0.634)
IPORET	0.008***	0.005***	0.007***	0.008***
	(9.545)	(4.242)	(7.669)	(6.829)
IPOTOT	0.532**	0.385	1.149***	1.263***
	(2.422)	(1.361)	(5.528)	(7.495)
AUDITD	−0.048	−0.165	−0.022	−0.096
	(−0.696)	(−1.341)	(−0.195)	(−0.814)
LAGE	1.501	−0.931	−1.249	0.167
	(1.051)	(−1.141)	(−1.346)	(0.236)
PROCEEDS	−0.264***	−0.354***	−0.542***	−0.480***
	(−7.344)	(−14.769)	(−7.839)	(−8.817)
Adjusted R^2	0.228	0.343	0.404	0.434

Panel B: Under-pricing Regressions

	Underpricing	
	Tax sensitive	Less tax sensitive
Intercept	−0.337**	−0.014
	(−2.074)	(−0.145)
TAXDIFF (+)	0.592**	0.492**
	(2.560)	(2.550)
VC	0.047*	0.037***
	(1.655)	(4.278)
RANK	0.019**	0.007*
	(2.199)	(1.783)
REVISION	0.705***	0.718***
	(6.532)	(6.051)
SPREAD	0.039***	0.013
	(2.680)	(1.417)
TECH	0.053*	0.050***
	(1.817)	(3.080)
VWTOT	−0.000	−0.000
	(−0.148)	(−0.403)
IPORET	0.590***	0.559***
	(6.313)	(7.022)
IPOTOT	−0.025	−0.010
	(−0.686)	(−0.598)
AUDITD	−0.146	0.331
	(−1.056)	.
LAGE	−0.022**	−0.012**
	(−2.024)	(−2.483)
PROCEEDS	0.005	−0.024***
	(0.338)	(−2.798)
Adjusted R^2	0.463	0.480

Table 10
Investor horizons and lock-in effect.
Table 10 presents the results from regressing 1,930 IPO based on the ranks of institutional investors' investment horizons every year. The definition of investor horizon follows Gaspar, Massa, and Matos (2005). Column (1) presents the result estimated from regressions limited to IPOs whose institutional investors have longer investment horizons. Column (2) presents the result estimated from regressions limited to IPOs whose institutional investors have shorter investment horizons. The dependent variable is the underpricing. Other variables are defined in Table 2.The numbers in parentheses are robust t-statistics adjusted for clustering of observations across years and industries, and all tests are two-tailed where ***, ** and * indicate that coefficient estimates are significantly different from zero at the 1%, 5%, and 10% levels, respectively.

Variables	(1) Longer horizon	(2) Shorter horizon
Intercept	−0.014	−0.143
	(−0.405)	(−1.413)
TAXDIFF (+/?)	0.517**	0.280
	(2.159)	(0.969)
VC	0.052**	0.029
	(2.083)	(1.301)
RANK	0.009	0.011**
	(1.583)	(2.522)
REVISION	0.599***	0.681***
	(4.467)	(4.552)
SPREAD	0.009	0.024*
	(0.000)	(1.951)
TECH	0.058*	0.053***
	(1.856)	(4.550)
VWTOT	0.051	0.332**
	(0.145)	(2.323)
IPORET	−0.000	0.000
	(−0.787)	(0.734)
IPOTOT	0.631***	0.955***
	(6.221)	(26.288)
AUDITD	−0.004	−0.053*
	(−0.162)	(−1.660)
LAGE	−0.008**	−0.029***
	(−2.338)	(−2.638)
PROCEEDS	−0.028***	−0.003
	(−3.008)	(−0.210)
Adjusted R^2	0.42	0.58

5.1. Time clustering

Over time, the number of companies going public fluctuates, resulting in hot and cold IPO markets. This means that our sample is clustered in time with some months having many more observations than other months. As time periods are not weighted equally in our regressions, coefficient estimates can be influenced by hot IPO months. We address this possibility by estimating both Eqs. (1) and (2) using each month as our unit of observation, rather than each IPO.[10] We calculate monthly averages for all variables and estimate regressions using each month with complete data for at least three IPO observations. Even with a reduction in sample size, Table 7 presents results consistent with those presented in Tables 4 and 6. We conclude that time clustering is unlikely to be responsible for our results.

5.2. Ordinal tax regime variables

To determine whether our regression results are driven by specific time periods or the magnitude of the changes in tax rates over time, we constructe three ordinal variables alternatively representing short-term tax regimes (*STREG*), long-term tax regimes (*LTREG*), and the combination short-term/long-term tax regimes (*STLTREG*). These ordinal variables represent the tax regimes in effect in each period. For example, *STREG* equals one for the tax rate in effect in 1987, two for the tax rate in effect from 1988 through 1990, three for the tax rate in effect from 1991 through 1992, and so forth. We then re-estimated our *P/V* and *UP* regressions including both the tax rate variable (*ST TAX*, *LT TAX*, and *TAXDIFF*) as well as the appropriate tax regime variable (*STREG*, *LTREG*, and *STLTREG*). In the resulting regressions (untabulated) the tax regime variable is always statistically insignificant while the tax rate variable is consistent with results presented in Tables 4 and 6. The only exceptions are regressions limited to *LT TAX* and *LTREG* where high levels of multicollinearity (condition index over 100) prevented any meaningful interpretation.

[10] We also re-estimate regressions after including annual fixed effects, but a high level of multicollinearity (condition indices ranged from 97 to 493) prevents any serious interpretation of the regression results.

Table 11
Business cycles and the lock-in effect.
Table 11 presents the results from regressing 4,666 IPO first-day returns on tax regimes variables. The definitions of down market and boom market are based on the signs of past 12-month market return. The definition of recession periods follows the NBER classifications. Other variables are defined in Table 2. The numbers in parentheses are robust t-statistics adjusted for clustering of observations across years and industries, and all tests are two-tailed where ***, ** and * indicate that coefficient estimates are significantly different from zero at the 1%, 5%, and 10% levels, respectively.

	Under pricing			
	Down market	Boom market	Recession	Non-recession
Intercept	−0.091***	−0.178*	0.148	−0.195*
	(−2.877)	(−1.662)	(0.823)	(−1.771)
TAXDIFF (+)	0.302**	0.553***	−0.074	0.661***
	(2.239)	(2.779)	(−0.434)	(3.379)
VC	−0.013	0.045**	0.017***	0.045**
	(−0.641)	(2.389)	(4.259)	(2.218)
RANK	0.014***	0.012**	−0.001	0.013**
	(5.145)	(2.201)	(−0.382)	(2.362)
REVISION	0.303***	0.727***	0.337***	0.755***
	(9.704)	(6.325)	(17.792)	(7.004)
SPREAD	0.021***	0.026**	0.006	0.027**
	(6.584)	(2.371)	(0.349)	(2.387)
TECH	0.042	0.054**	0.029*	0.055**
	(1.285)	(2.368)	(1.667)	(2.337)
VWTOT	0.000	−0.000	−0.000	−0.000
	(0.508)	(−0.152)	(−0.691)	(−0.551)
IPORET	0.491***	0.578***	0.312***	0.563***
	(4.925)	(6.574)	(2.858)	(6.320)
IPOTOT	−0.056	−0.013	−0.068	−0.010
	(−1.488)	(−0.574)	(−0.000)	(−0.446)
AUDITD	0.207	0.111**	0.459	0.078
	(0.652)	(2.406)	(0.000)	(0.961)
LAGE	−0.013	−0.018**	−0.018***	−0.020**
	(−1.203)	(−2.318)	(−3.526)	(−2.313)
PROCEEDS	−0.010	−0.011	0.004	−0.014**
	(−0.000)	(−1.568)	(0.351)	(−2.045)
N	240	4256	559	3937
Adjusted R^2	0.219	0.471	0.272	0.475

5.3. Adjacent regime comparisons

We expand our IPO offering price and underpricing analyses to adjacent regimes to determine whether the negative (positive) association between IPO offer price (IPO underpricing) and the long-term capital gains tax rate (the difference between long-term and short-term capital gains rates) holds across adjacent regimes.

When examining the negative association between IPO offer price and the long-term capital gains tax rate across adjacent long-term capital gains tax regimes, we use all three long-term capital gains tax regimes. Panel A, Table 8 presents the capitalization results. The coefficients on *LT TAX* are all negative and significant (−5.560, $t=-6.888$ in Column (1); −6.198, $t=17.871$ in Column (2); −3.666, $t=-3.650$ in Column (3); and −3.419, $t=-2.973$ in Column (4)).[11] Therefore, we find evidence of capitalization in adjacent regimes.

We also examine the positive association between IPO underpricing and the long-term and short-term capital gains tax rate differential in long-term and short-term capital gains tax regimes. There are sufficient IPO observations to estimate regressions across two short-term capital gains tax regime changes (1988–1990 versus 1991–1992 and 1991–1992 versus 1993–2000) and one long-term capital gains tax regime change (1987–1997 versus 1997–2003). We present results in Panel B, Table 8. For the two short-term capital gains tax regime changes, the coefficients on *TAXDIFF* are positive and significant (1.407, $t=2.322$ for 1988–1990 versus 1991–1992; 0.591, $t=2.094$ for 1991–1992 versus 1993–2000).[12] For the long-term capital gains tax rate regime change (1987–1997 versus 1997–2003), the coefficient on *TAXDIFF* is also positive and significant (0.552, $t=2.335$).[13] Therefore, we find evidence of lock-in in adjacent regimes.

[11] We find that the coefficients on *ST TAX* are insignificant when using adjacent short-term capital gains tax regimes.

[12] We do not compare the 1st versus the 2nd, the 4th versus the 5th, the 5th versus the 6th and the 6th versus the 7th short-term capital gains tax regimes (Fig. 1) as at least one of the regimes of each pair is short in duration (one year), yielding insufficient observations.

[13] We choose 1987–1997 and 1997–2003 as the adjacent regimes for the long-term capital gains tax to examine the lock-in effect because they are not accompanied by offsetting short-term capital gains tax rate changes. The change in the spread between short-term and long-term capital gains tax rates is marginal after 2003 (Fig. 1). While the long term capital gains tax rate reduces from 20% to 15% on 2003, the short term capital gains tax rate also reduces from 38.6% to 35% during the same year, yielding a slight increase in the spread by 1.4% from 18.6% to 20%.

5.4. Tax-sensitive investors versus less tax-sensitive investors

Investors differ in tax status (Dhaliwal et al., 2003; Dhaliwal et al., 2005). While there is a debate about the role played by the marginal investor versus the average investor in determining stock prices (Dhaliwal et al., 2003; Dhaliwal et al., 2005; Guenther and Sansing, 2006, 2010), the difference between the marginal investor and the average investor becomes less important if we consider a continuum of investors with different tax rates. If this is the case, then the capitalization and the lock-in effects will be more pronounced in firms held by more tax-sensitive investors.

We therefore explore cross-sectional variation in the lock-in effect due to differences in investor tax status. We expect a more pronounced lock-in effect for tax-sensitive investors, such as hedge funds, than for less tax-sensitive investors, such as pension funds. Following prior literature, we classified corporate pension funds, university and foundation endowments and public (private) pension funds as less tax-sensitive investors (Guenther and Sansing, 2006; Dai et al., 2008; Chyz and Li, 2012; Blouin et al., 2014). Based on such a classification, we further define investors of a particular IPO firm as being more (less) tax-sensitive if the fraction of tax-sensitive investors' shareholding is higher than (equal to or lower than) the sample median. We re-estimate Eqs. (1) and (2) using these two sub-samples. This allows us to determine whether tax-sensitive investors are more likely to engage in tax-efficient investment in response to the tax rate spread than less tax-sensitive investors.

Results are reported in Table 9. Consistent with expectations, we find a significant difference in the capitalization and lock-in effects across different clienteles. In the offer price regression in Panel A, we find that the coefficient on the long term tax rate is -6.561 ($t=-7.431$) when IPO investors are tax-sensitive. In contrast, we find a weaker effect when IPO investors are less tax-sensitive. The coefficient on long term tax rate is -4.887 ($t=-10.789$) for less tax-sensitive investors. An SUE test with industry level clustering suggests that the difference is statistically significant ($Chi^2=3.01$, $p=0.082$).[14] We find a similar effect when the relative offer price is measured as *PV_Sales*.

In the underpricing regression, our results further reinforce the argument that tax-sensitive investors engage in tax-efficient investment. In Panel B, the coefficient on *TAXDIFF* is positive and significant (0.592, $t=2.560$) for tax-sensitive investors. It is positive and significant (0.492, $t=2.550$) but smaller in magnitude (though the difference is insignificant) for less tax-sensitive investors. In general, our results suggest that the capitalization effect is stronger when IPO investors are more tax-sensitive.

5.5. Investor horizons and the lock-in effect

Our prediction is based on the argument that IPO investors who expect to be taxed at the long-term rate will require higher returns in order to sell at high short-term capital gains tax rates. As such, the tradeoff between selling the stock and paying taxes at high short-term capital gains tax rates versus holding the stock and paying taxes at low long-term capital gains tax rates takes place only when the IPO investors are long-run investors. That is, investors with long-term horizon, such as mutual funds, will need to recover additional tax cost when selling short-term by charging a higher selling price, leading to a higher level of IPO underpricing. However, we cannot ascertain which IPOs are more likely to be sensitive to tax rates or investment horizon. While we do not have a good measure of the number of shares allocated to and purchased by institutions in any specific IPO, we can collect *ex post* investment horizon of institutional investors from Spectrum SEC 13F reports.

We measure the investment horizon of an institutional investor based on its portfolio churn ratio, which reflects how frequently an institution reshuffles its portfolio (Lang and McNichols, 1997; Bushee, 1998; Bushee and Noe, 2000; Gaspar et al., 2005). The underlining rationale is that short-horizon institutions tend to re-balance their portfolio frequently whereas long-horizon institutions, such as pension funds and insurance companies, primarily adopt a buy-hold strategy. To derive firm-level investor horizons, we average the portfolio churn ratios across all its institutional investors.

In particular, to estimate the churn ratios, we first defined the aggregate net buys and net sales for institutional investor i during quarter t as follows:

$$NetBuy = \sum\nolimits_{j \in Q} |S_{i,j,t} - S_{i,j,t-1}| \times P_{j,t},\ S_{i,j,t} > S_{i,j,t-1},$$
$$NetSell = \sum\nolimits_{j \in Q} |S_{i,j,t} - S_{i,j,t-1}| \times P_{j,t},\ S_{i,j,t} < S_{i,j,t-1}, \quad (3)$$

where Q denotes the universe of stocks held by institution i for two consecutive quarters

(quarter $t-1$ and t), $P_{j,t-1}$ and $P_{j,t}$ are stock j's prices at the end of quarter $t-1$ and t, $S_{i,j,t-1}$ and $S_{i,j,t}$ are the number of shares of stock j held by institution i at the end of quarter $t-1$ and t, respectively. We account for stock splits and dividends by using the CRSP cumulative price and share adjusted factors. The institutional portfolio churn ratio (CR) is defined as

$$CR = \frac{min(NetBuy_{i,t},\ NetSell_{i,t})}{Asset_{i,t-1}}, \quad (4)$$

[14] Inference is the same when we use interaction regressions.

where $Asset_{i,t}$ is the market value of the portfolio held by institution i in quarter t, defined as $Asset_{i,t} = \sum_{j \in Q} S_{i,j,t} \times P_{j,t}$. Finally, the institutional investment horizon for each firm k, $Turnover_{k,t}$, is defined as the ownership-weighted average of portfolio churn ratios overall all its institutional investors (Gaspar, Massa, and Matos, 2005):

$$Turnover_{k,t} = \sum_{i \in S} |\omega_{k,i,t} AvgCR_{i,t}| = \sum_{i \in S} \omega_{k,i,t} \left(\frac{1}{4} \sum_{r=1} CR_{i,t-r+1} \right), \quad (5)$$

where S denotes the set of institutional investors of firm k at the end of quarter t and $\omega_{k,i,t}$ is the weight of institution i's position in firm k as a percentage of total positions held by all institutions at the end of quarter t. The measure of *Turnover* is an opposite measure of institutional investor horizon. As such, a low value of *Turnover* reflects that the firm's institutional investors have long investment horizons. Although we use an *ex post* measure of investor horizon, our identification is unlikely to be biased given that the churn ratio (*CR*) has been shown to be persistent over time (Derrien et al., 2013; Harford, 2012).

We successfully identify investor horizons for 1,930 of the 4,666 IPO firms from 13F fillings database. To test whether the association between taxes and first-day returns is stronger for firms whose institutional investors have a longer investment horizon, we divide our full sample it into subsamples with long investment horizon and short investment horizon based on the annual sample median of the turnover ratio.[15] We then estimate Eq. (2) using the difference between short-term and long-term capital gains tax rates, *TAXDIFF*, for subsamples partitioned based on the full sample median of the *Turnover* ratio. If investors identified as have a long-term horizon have capitalized expected taxes using the long-term tax rate, we expect that this will result in a higher asking price leading to a higher level of IPO underpricing.

Results are reported in Table 10. For stocks with long investment horizon, the coefficient on *TAXDIFF* is positive and significant (0.517, $t=2.159$), consistent with long-term investors charging a higher price when selling shares short-term to cover additional tax cost. For stocks with short investor horizon, the coefficient on *TAXDIFF* is insignificant (0.280, $t=0.969$). The difference between these two coefficients is statistically significant ($Chi^2=3.8$, $p=0.052$), further confirming that it is investors with long horizon, and not whose with short horizon, who need to recover additional tax cost when selling short-term.

5.6. Lock-in effect through business cycles

The prediction on the negative association between the tax spread and IPO underpricing relies on the assumption that IPO investors have positive net capital gains in their portfolios. However, in a down market, investors are more likely to have net capital losses rather than net capital gains in their portfolios. Investors with net capital losses have less incentive to hold out for long-term status because they can use short-term gains to offset their capital losses. Thus, we predict the lock-in effect to be less pronounced in down markets than in up markets. To test this prediction, we first separate the full sample into two sub-samples based on the signs of past 12 months' cumulative market returns and then re-estimate Eq. (2) in these two sub-samples. Consistent with our prediction, we find a smaller lock-in effect in down markets. Specifically, the coefficient on *TAXDIFF* is 0.302 ($t=2.239$) in down markets, whereas it is 0.553 ($t=2.779$) in up markets. A SUE-test suggests that such a difference is statistically significant at 5% level ($Chi^2=4.419$, $p=0.0340$). In Columns (3) and (4), we further sort the full sample based on NBER's classification of business cycles. Consistent with results in Columns (1) and (2), we find a significantly more pronounced ($Chi^2=11.32$, $p=0.0005$) lock-in effect during non-recession periods (0.661, $t=3.379$) than during recessions (-0.074, $t=-0.434$).[16]

6. Conclusion

We empirically examine whether the pricing of IPO shares is related to capital gains taxes. First, we argue that if investors in IPOs evaluate returns on an after-tax basis, then underwriters should consider investor taxes when setting offer prices to provide adequate after-tax returns. Following prior literature, we expect IPO initial offer prices to decrease in long-term capital gains taxes. Next, we argue that IPO underpricing should be associated with the differential between short-term and long-term capital gains tax rates. The long-term capital gains tax rate is historically lower than the short-term capital gains tax rate, and thus, investors benefit from delaying the realization of initial IPO returns. The lower the long-term capital gains tax rate relative to the short-term rate, the more reluctant IPO investors are to sell their shares on the IPO dates. Therefore, we expect IPO underpricing to increase with the differential between short-term and long-term capital gains tax rates.

Using a large sample of IPOs spanning the period 1987–2010, we find a negative association between IPO offer prices and the long-term capital gains taxes, supporting the capitalization effect. We find a positive association between IPO underpricing and the spread between short-term and long-term capital gains tax rates, supporting the lock-in effect. These results

[15] An assumption in this test is that at least some of the long-run investors are tax-sensitive.

[16] We also sort the full sample based on the signs of first day returns and re-estimate Eq. (2) using two sub-samples. We find a negative association between the tax rate spread and first day return when the first day return is negative (-0.115, $t=-2.854$). This evidence suggests that a larger spread between long-term and short-term tax rates conceptually speeds up selling when there are first-day losses (around 24% in our sample), leading to price pressure and a lower first day return.

reinforce the notion that taxes are a factor, among others, that determines the pricing of IPOs. More broadly, our results suggest that taxes influence asset prices through both the capitalization and lock-in effects.

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