Asymmetric information, disclosures of R&D and the choice of equity-selling mechanisms

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Abstract

This study examines the impact of information asymmetry and corporate management monitoring on the choice among different mechanisms for selling equity. More specifically, I study the link between R&D disclosures and other measures of information asymmetry, in addition to ownership measures and firms' choices among various types of rights offerings and private placements. Using a hand-collected sample of mandatory and non-discretionary R&D disclosures from publically listed biotechnology firms, I find that firms tend to issue equity publicly rather than privately following credible R&D disclosures, i.e., when information asymmetry is low. By contrast, I find no support for the monitoring hypothesis. A detailed analysis by investor type confirms that monitoring does not seem to be an important determinant in the choice between private and public financing.

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1. Introduction

When corporate managers decide to raise capital externally by selling equity to finance new investment opportunities, they also must decide which type of equity-selling mechanism to employ: private or public financing[1,2]. For public firms, two main theories have evolved that explain the rationale behind the choice of equity-selling mechanisms: the information asymmetry hypothesis and the monitoring hypothesis. The monitoring hypothesis suggests that private placements—which are associated with more concentrated ownership that can more effectively monitor management—are used when there is a perceived need for such monitoring (e.g., Shleifer and Vishny, 1986). According to the information asymmetry hypothesis, the degree of asymmetric information about firm value affects the choice of equity-selling mechanism (e.g., Hertzel and Smith, 1993). Eckbo and Masulis (1992) show that when the degree of asymmetric information about firm value is high, i.e., when the expected current shareholder take-up is expected to be low, firms may choose more costly standby rights offerings instead of pure uninsured equity rights offerings. However, the degree of asymmetric information is not fixed over time. The time-varying asymmetric information model by Korajczyk et al. (1991, 1992) suggests that few managers will have received a private signal immediately following a release of relevant information and the adverse selection problem is small. As time passes, the adverse selection problem becomes more severe. Therefore, managers have an incentive to issue equity publicly rather than privately following credible information releases.

This paper examines the impact of information asymmetry and the monitoring of corporate managers on the choice among various types of rights offerings and private placements in the biotechnology industry. I study the biotechnology industry for the following five reasons.

(1) Because of the relative scarcity of public information about firms' R&D activities and the importance of these activities to the operations of biotech firms, I use R&D disclosures as the

[1] A popular topic in the academic literature is why firms tend to use private placements in which direct costs can be 20 percent or more (Hertzel and Smith, 1993).

[2] The two most commonly used equity issuance methods for stock markets outside the US are rights offerings and private placements. A private placement is a non-public offering in which securities are typically sold to a small number of chosen private institutional investors (e.g., banks, insurance companies, pension funds, etc.). In a rights offering (or rights issue), existing shareholders are given the preemptive (preferential) "rights" or option to purchase a certain number of shares (on a pro rata basis) at a fixed price within a specified time. A rights offering can be either uninsured (non-underwritten) or insured (underwritten). There are two variants of insured rights offerings: standby rights and firm-commitment offers. In a standby rights offer, an investment bank guarantees that any unsubscribed rights or shares are taken up. In a firm-commitment offer, the investment bank assumes the risk of selling the shares to the market by buying the issue from the issuer. With the exceptions of Japan and France, firm-commitment underwritten offers have not yet spread outside the U.S. (Eckbo, 2008).

major proxy for information asymmetry. Biotech firms differ from other research-intensive firms because their development processes are closely monitored by external regulatory authorities that have considerable experience in evaluating drugs with respect to issues such as efficacy and safety. Biotechnology projects must undergo a thorough and well-documented regulatory review process; therefore, there are mandatory non-discretionary evaluations of the value-creation process. Although disclosures of accounting information may be biased due to the discretionary nature of such information, value-relevant R&D disclosures are thus more likely to be a clean test of the information asymmetry hypothesis.

(2) Information asymmetry is particularly evident in R&D-intensive industries such as the high-technology sector (Himmelberg and Petersen, 1994) and particularly the biotechnology industry (Lerner et al., 2003; Hall, 2002). Because of the considerable information asymmetry associated with R&D (Hall and Lerner, 2009), managers generally know considerably more than outsiders about the specifications of products under development, their likelihood of success, the results of product feasibility tests, and marketing prospects (Aboody and Lev, 2000). Hall and Lerner (2009) argue that the marketplace for financing the development of R&D may look like the 'lemons' market, as suggested by Akerlof (1970, 2002). High-quality firms seeking external financing, therefore, have an incentive to reveal their qualities to the market place when such financing is accessible at low cost.

(3) Most biotech firms are in an early life-cycle stage and invest heavily and on a continuous basis in intangible assets such as research and development (R&D), but they can rarely fund these investments internally. Consequently, they depend on external financing and regularly turn to the equity markets for fresh capital.

(4) The industry-specific sample provides an opportunity to use more direct and less noisy proxies of information asymmetry, which increases the power of testing for the presence of information asymmetry.

(5) Because few biotech firms are profitable and investments are mainly in intangible assets, biotech firms cannot use debt financing and instead typically turn to the equity markets. Therefore, a sample of biotech firms enables a study of private versus public equity financing without having to consider alternative sources of external capital.

Past empirical research on the choice that firms have between private and public financing has verified the importance of both ownership control and asymmetric information[3], but the emphasis has been on ownership control. Using a sample of Swedish publicly listed firms over the period from 1986 to 1999, Cronqvist and Nilsson (2004) find that families' corporate control considerations are important determinants of the choice between private placements and rights offerings, i.e., family-controlled firms tend to avoid issuing methods that dilute the benefits of control or subject the firm to more monitoring. Wu (2004) examines the choice between private placements and public offerings using a sample of US high-technology public firms between 1986 and 1997. He finds partial support for the information asymmetry hypothesis by using microstructure variables as proxies for information asymmetry. However, contrary to prior studies (e.g., Wruck, 1989; Kahn and Winton, 1998), Wu finds that private placements do not result in enhanced monitoring of managers. Chen et al. (2010) examine firms' choices between seasoned equity offerings and private investment in public equity offerings and find that information asymmetry and weak operating performance are key determinants in the choice of equity-selling mechanisms. Gomes and Phillips (2012) verify the importance of information asymmetry as a key determinant in the choice of security type (debt, equity or convertibles) in public and private markets and in the choice of the market in which to issue securities.

The empirical data confirm that firms tend to issue equity publicly rather than privately following credible R&D disclosures, which supports the information asymmetry hypothesis. By contrast, I do not find any support for the monitoring hypothesis. A detailed decomposition of monitoring versus non-monitoring investors also supports the view that monitoring is not an important determinant in the decision about whether to issue equity privately or publicly. The main contribution of this paper is to verify the importance of information asymmetry on the choice between rights offerings and private placements and the use of mandatory non-discretionary R&D disclosures as a proxy for information asymmetry. This is the first study to extensively verify the importance of information asymmetry regarding the choice between private and public financing outside the US. This paper adds to the growing literature addressing the choice of equity-selling mechanisms (e.g., Hertzel and Smith, 1993; Cronqvist and Nilsson, 2004; Wu, 2004; Chen et al., 2010; Gomes and Phillips, 2012).

[3] Although firm size and firm age are frequently used as proxies for the level of information asymmetry in the literature, they do not fit well with the time-varying asymmetric information model developed by Korajczyk et al. (1991, 1992).

The remainder of the paper is outlined as follows. Section two provides a theoretical framework, an overview of prior studies and the research hypotheses. Section three discusses methodological issues related to the study. Section four contains the empirical results. Section five provides additional analyses, and section six concludes.

2. Theory and research hypotheses

When a firm without financial slack has an opportunity to accept a positive net present value project that requires equity financing, it faces a dilemma. Management, who is assumed to act in the interests of current shareholders, will choose to issue equity if the net issue benefit is non-negative, that is, when $b - [d + w(k)] \geq 0$, where b is the value of the project, d is the direct flotation cost and $w(k)$ is the expected wealth transfer from old to new investors. If the firms' managers believe the firm's stock is undervalued, issuing equity to outside investors is costly because it dilutes the value of its existing shareholder stock. If the total flotation cost of issuing exceeds the value of the project, the firm will decide not to issue equity and forego an investment opportunity, which Myers and Majluf (1984) refer to as the "underinvestment problem". Myers and Majluf assume that existing shareholders do not participate in the equity issue, i.e., the flotation method implicit in their model is a direct issue to outside investors. The researchers also rule out an informational role for underwriters.

Eckbo and Masulis (1992) extend the Myers and Majluf model to explain the adverse selection problem by issuers with access to alternative flotation methods, such as pure (uninsured) rights, standby rights and firm-commitment underwritten offerings. Eckbo and Masulis (1992) show that an adverse selection cost problem such as that presented by Myers and Majluf (1984) exists when the fraction of the stock issue (k) expected to be taken up by existing shareholders is less than 100 percent. For a given level of current shareholder take-up (below 100 percent), the greater the undervaluation of the firm's shares, the more likely the firm is not to issue equity. Eckbo and Masulis (1992) argue that certification by an underwriter can mitigate the adverse selection problem. Although k is largely beyond managerial control[4], managers are assumed to have better information than the market about k because subscription pre-commitments from existing shareholders give them a good

[4] The value of k is assumed to be an exogenous factor determined by shareholder characteristics, such as wealth constraints, diversification benefits, and benefits from maintaining a shareholder's proportional ownership of the issuer's equity (Bøhren et al, 1997; Eckbo and Masulis, 1992). In addition, investment funds may have rules that forbid ownership exceding a certain percentage of any given company because of reporting regulations that may become applicable at that level of investment.

approximation of the expected take-up of the issue. If management believes *k* to be high, i.e., if existing shareholders are expected to buy and hold the new shares, a pure (uninsured) rights offer is the lowest-cost flotation method. In the extreme case of $k = 1$[5], current shareholders purchase and hold the entire issue, and there is no wealth transfer to outside investors such that $w(1) = 0$.[6] This is essentially equivalent to having access to an internal source of funds that is not disadvantaged by asymmetric information costs. In this case, both the subscription price[7] and the degree of undervaluation (or mispricing) are irrelevant to shareholders because there is no wealth transfer from current investors (no adverse selection). This implies that adverse selection is low in the pool of uninsured rights, and the market reaction to the announcement is expected to be relatively small (close to zero)[8]. However, if *k* is expected to be less than one, some undervalued firms may find it too costly to issue new equity because of the costs to existing shareholders of selling shares to outsiders at a price below the intrinsic value. Adverse selection effects, and thus *w(k)*, increase as *k* decreases. Hence, low-k issuers are likely to employ a more expensive flotation alternative (standby or firm-commitment) that involves underwriter certification to narrow—but not fully remove—the information asymmetry between the firm and the market as long as the sum of the expected certification benefit and the net project value exceeds the underwriter fee. A negative stock market reaction to rights offerings implies the presence of adverse selection costs. The average market reaction for a sample of US firms to the announcement of standby rights and firm-commitment underwritten is -1.3 and -2.5, respectively (Eckbo, 2008).

Under Myers and Majluf's information asymmetry model for public offerings, the "underinvestment problem" can be avoided if managers are able to convey their private information to the market at no cost. Hertzel and Smith (1993) extend the Myers and Majluf (1984) model to allow for the possibility that private placement investors can assess firm value through their negotiations with management and that private placements confer benefits similar to those suggested for mergers by Myers and Majluf (1984). When *k* is expected to be

[5] Eckbo and Masulis (1992) report average shareholder take-up above 90 percent in pure (uninsured) rights offerings compared to approximately 65 percent for standby rights. Consequently, it is reasonable to assume that $k < 0$ in the majority of rights offerings.

[6] Although there may also be asymmetric information among current shareholders, this study makes no such distinction, i.e., managers act in the interest of current shareholders and only consider wealth transfer effects from current shareholders to outside investors.

[7] Although a deeply discounted rights offering may help ensure the success of an offering, Heinkel and Schwartz (1986) and Loderer and Zimmermann (1988) argue that the subscription price is a signal of firm quality, and that a deep discount conveys negative information to outside investors about the true value of the issue. Managers are therefore reluctant to issue rights with a deep subscription-price discount (Smith, 1977).

[8] If the equity issue announcement discloses the existence of an investment project with a value that is higher than the market anticipates, the stock market reaction may even be positive.

low, in addition to hiring an underwriter (or when no underwriter agrees to underwrite the offering), issuers can attempt to minimize a costly[9] market reaction to SEOs (seasoned equity offerings) by choosing a private placement in which sophisticated investors are given access to proprietary firm information. Therefore, instead of foregoing an investment opportunity and issuing no equity, undervalued firms can choose a private placement over a public issue if this enables existing shareholders to retain a larger fraction of the firm, i.e., when the net present value of the investment opportunity exceeds the total cost of informing private investors about firm value. That is, $b \geq w(k)$ because private placements are assumed to have no direct flotation cost ($d = 0$).

In summary, the public[10] firm's choice between private and public financing may stem from information asymmetry about firm value, which is known as the information asymmetry hypothesis. Another determinant proposed by the theoretical literature is the monitoring hypothesis. The following sections provide details about these two theories.

2.1 The information asymmetry hypothesis

The information asymmetry hypothesis suggests that firms are more likely to choose private placements than public offerings when the degree of asymmetric information about firm value is high (and the expected take-up, *k*, by existing shareholders is assumed to be low) because private placement investors can learn the true value of the firm at some cost (Chemmanur and Fulghieri, 1999; Hertzel and Smith, 1993). Private placements generally involve fewer investors than do public offerings, which indicates that at a given level of information asymmetry, private placements incur lower information production costs (Wu, 2004). Consequently, firms with high information asymmetry may have strong incentives to issue equity privately instead of publicly to reduce the costs of information production. MacKie-Mason (1990) refers to the "hidden-information view" and shows that information problems appear to influence publicly traded firms' choices between private and public financing. According to the "hidden-information view", firms will seek better-informed investors when the hidden-information advantage is high or when the potential difference in valuations due to hidden-information is high (MacKie-Mason, 1990).

[9] Eckbo (2008) demonstrates that a stock market reaction of -2 percent to SEOs translates into an amount equal to 15 percent of the proceeds of the average issue, which is equivalent to more than three times the direct costs of an issue.

[10] Lerner (1994) shows that venture-backed private firms go public when valuations are high and employ private financing when equity values are lower.

Information asymmetries decrease when new value-relevant information is made public. Korajczyk et al. (1991, 1992) argue that information asymmetry is time varying and that, immediately following an information release, few managers will have received a private signal and the adverse selection problem is therefore small. However, as time passes, the adverse selection problem worsens as more managers receive private signals. Investors react to different types of information in the equity issuance setting. Korajczyk et al. (1991) and Denis and Sarin (2001) find that accounting earnings and earnings announcements, respectively, have a significant effect on the market's reaction to the issuance of new equity. Therefore, equity issues tend to follow informative earnings announcements. Information of a more discretionary character appears to be less informative. Loderer and Mauer (1992) find that dividend announcements do not reduce valuation uncertainty. Lin et al. (2008) document similar price reactions, although dividends appear to be associated with volume reactions. Most non-accounting disclosures are discretionary and firms tend to make more such disclosures prior to new equity issuances (Cooper and Grinder, 1996; Lang and Lundholm, 2000).

2.1.1 Information asymmetry, R&D and disclosures of R&D

Corporate investments in intangible assets create information asymmetries because managers can continually observe changes on an individual asset basis (e.g., a drug's pros and cons)[11], whereas outsiders obtain only highly aggregated information at discrete points of time, i.e., when R&D information is made public. The disclosure of R&D information is important for several reasons. First, R&D projects, such as a new drug under development, are unique to a developing firm. Investors generally derive little or no information about the firm's R&D projects by observing the R&D performance of other drugs. Second, although financial assets are traded in organized markets in which prices are observable and convey direct information about values, there are no organized markets for R&D in which prices are available. Third, because of accounting standards, investments in intangible assets, such as R&D, are generally immediately expensed and less often capitalized[12]. Given the relatively sparse amount of

[11] Even when a drug is tested in randomized and double-blinded clinical trials in which either the clinician, the patient or the company has direct information about the safety and efficacy of the drug being tested compared to a placebo, companies generally run additional pre-clinical activities in parallel from which they generally gain substantial knowledge about the drug.

[12] According to International Accounting Standards (IAS38), research costs should be expensed when they are incurred, and development costs can be capitalized if certain criteria are met. One such criterion is whether it is *probable* that the expected future economic benefits will flow to the entity or not.

public information about firms' R&D activities and the importance of these activities to the operations and profit potential of technology and science-based companies, R&D contributes substantially to information asymmetry between corporate insiders and outside investors (Aboody and Lev, 2000). Consequently, Hall and Lerner (2009) suggest that the marketplace for financing R&D looks like the "lemons" market modeled by Akerlof (1970). According to Akerlof's lemon principle (1970, 2002), high information asymmetry in the private equity market is more likely to attract bad-quality firms. In the model by Chemmanur (1993), high-quality firms have incentives to disclose their qualities to increase their market value, whereas low-quality firms have few reasons to reveal their qualities. This discrepancy in incentives implies an association between information asymmetry and firm quality. Managers of high-quality firms with external financing needs will therefore issue new equity when the market is most informed[13].

Biotech firms differ from other research-intensive firms in the sense that their development processes are typically closely monitored by external regulatory authorities with considerable experience in evaluating drugs with respect to issues such as efficacy and safety. Biotechnology projects must undergo a thorough and well-documented regulatory review process; therefore, there are mandatory non-discretionary evaluations of the value-creation process[14]. Thus, although accounting information has a weak association with the value of biotech firms (Dedman et al., 2008; McConomy and Xu, 2004), investors can rely on information that is verified by regulatory authorities acting independently. A candidate drug's progress in clinical trials is a strong signal to investors that the firm is creating value (e.g., Amir and Lev, 1996). R&D disclosures are generally mandatory, non-discretionary and value-relevant. Thus, in particular, I expect that firms are more likely to use rights offerings instead of private placements following credible R&D disclosures (the main proxy for information asymmetry), i.e., when information asymmetry is low. This leads to the first hypothesis:

H_1: Biotechnology firms use rights offerings to a greater extent after they have released disclosures of R&D.

[13] It is important to note that even if managers currently have no private information, they may prefer to wait to issue equity until investors become better informed.
[14] Biotech firms typically cooperate with regulatory authorities in the drug development process because failure to comply with recommendations may ultimately prolong the development process, inhibit a future drug

2.2 Corporate control – the monitoring hypothesis

Corporate governance problems, i.e., agency problems between managers and shareholders, can play a role in the choice of equity-selling mechanisms. In the R&D setting, two agency cost scenarios may co-exist. First, managers may spend cash on activities that simply benefit them (but not the existing shareholders). Second, risk-averse managers may be reluctant to, or even avoid, investing in uncertain and high-risk R&D projects.

The monitoring hypothesis suggests that private placements are used when there is a demand for monitoring. Private placements generally target a few sophisticated investors, which suggests that they will be associated with more concentrated ownership (Shleifer and Vishny, 1986; Kahn and Winton, 1998). The higher the level of ownership concentration, the easier it is for a small group of shareholders to influence management behavior through their voting power. By contrast, the more diverse the shareholding, the easier it is for management to expropriate current shareholders in favor of their own interests or to use cash inefficiently as the level of influence by non-management shareholders decreases (Mitchell, 1983). Under the monitoring hypothesis (Wruck, 1989), private placement investors are assumed to be active in monitoring management to ensure that the resources of the firm are efficiently used.

The empirical findings on the monitoring hypothesis suggest mixed results. Wruck (1989) proposes an ownership structure hypothesis and finds evidence that both changes in and the level of ownership concentration are important. Positive abnormal returns surrounding private placements were found that were directly related to changes in ownership level when the firms were at a low or a high level of ownership concentration after private placements. An inverse relationship was found for the sample of firms with a moderate level of ownership concentration after the placements. Several studies report a positive stock market reaction to the announcement of private placements (e.g., Wruck, 1989; Hertzel and Smith, 1993; Janney and Folta, 2003). A positive stock market reaction to private placements may reflect the market's belief that the new blockholder will play a positive role in monitoring management (Wruck, 1989). Eckbo (2008) provides an alternative explanation to the positive stock market reaction to private placements. Because finding a private placement investor who is willing to invest in the stock requires a favorable review of the issuing firms' future prospects, successful private placements can be viewed as the outcome of a positive selection process that is consistent with the positive stock market reaction to private placements.

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approval, and even lead to private lawsuits and enforcement actions by agencies such as the Securities and Exchange Commission (SEC).

Cronqvist and Nilsson (2004) find that family controlled firms avoid equity issue methods that dilute benefits or subject them to more monitoring. By contrast, Hertzel and Smith (1993) find that institutional ownership decreases after private placements. This lends no support to the monitoring hypothesis. Barclay et al. (2007) show that private placement investors typically are passive but acquire large blocks of stock. Nor does Wu (2004) find evidence for the monitoring view that private placement investors engage in more monitoring than public offering investors. Wu reports that private placements generally target a few institutional investors and because there are no formal methods for selecting private placement investors, managers' preferences can play a role in choosing them. In summary, if there is a demand for monitoring, I expect the level of ownership held by blockholders to increase after private placements. Thus, the second hypothesis is formulated as follows:

H_2: Biotechnology firms use private placements to a greater extent when the level of blockholder ownership is small.

However, it is important to note that monitoring and adverse selection effects are not mutually exclusive. On the basis of the level of asymmetric information (high vs. low) and ownership concentration (high vs. low), there are four different possible outcomes. To discriminate between the monitoring and information asymmetry hypotheses, I include an interaction variable between the proxies for information asymmetry and ownership concentration.

3. Data and model

3.1 Data

To construct the sample of rights offerings and private placements, I utilize the Thomson Reuters Datastream database over the 1990-2012 period to identify changes in the number of shares outstanding for a sample of European public biotechnology[15] firms. I then impose

[15] In this paper, I use the definition of biotechnology company that is common among industry practitioners: "a firm that engages in the research and development of drugs and was founded after Genentech (1976)". Therefore, companies developing tools, instruments, medical devices or providing technology-based services to other healthcare companies are excluded. Although the difference between pharmaceutical and biotechnology companies has become blurred as pharmaceutical companies have begun developing biologicals in addition to small molecules, the key differences are primarily along several dimensions (firm size, number of projects and sales). Most biotechnology companies generally have few clinical projects (and relatively small firm sizes); in addition, in only a few cases do biotechnology companies have products on the market.

several filters: (1) There must be a change of at least 5 percent of the outstanding common stock of a company[16] (the 5 percent cut-off is a commonly applied standard for significant

Table 1. Descriptive statistics

Panel A. Equity issues by year

	Rights offerings			Private Placements		
Year	*n*	*Fraction (%)*	*Amount raised (USD millions)*	*n*	*Fraction (%)*	*Amount raised (USD millions)*
1995	0	0.0%	0.0	1	0.4%	18.9
1996	2	2.2%	243.0	2	0.8%	110.4
1997	0	0.0%	0.0	0	0.0%	0.0
1998	2	2.2%	25.0	2	0.8%	17.8
1999	3	3.3%	46.9	3	1.3%	25.0
2000	0	0.0%	0.0	12	5.0%	168.9
2001	3	3.3%	69.6	3	1.3%	50.3
2002	3	3.3%	59.2	3	1.3%	18.0
2003	4	4.4%	89.6	6	2.5%	115.8
2004	6	6.6%	186.8	8	3.3%	170.6
2005	8	8.8%	312.8	21	8.8%	344.1
2006	4	4.4%	166.3	48	20.1%	1445.5
2007	7	7.7%	601.4	29	12.1%	849.2
2008	5	5.5%	201.6	19	7.9%	294.2
2009	13	14.3%	667.4	30	12.6%	466.9
2010	14	15.4%	684.0	27	11.3%	507.6
2011	9	9.9%	387.4	9	3.8%	178.2
2012	8	8.8%	198.6	16	6.7%	311.9
Total	86	100%	3939.6	226	100%	5093.2

Notes: This table contains the number of equity issuances, the fraction of the total equity issued in our sample through such mechanism and the total amount raised (in US dollars) per year for rights offerings and private placements.

Panel B. Size of equity issues

		Gross proceeds (USD millions)				**Fraction shares issued (%)**			
	n	Mean	Median	Min	Max	Mean	Median	Min	Max
Rights offerings	86	45.1	27.9	2.9	283.9	31.5	27.8	5.9	87.5
Uninsured	62	38.8	25.5	2.9	283.9	29.9	26.0	9.5	75.0
Underwritten	24	61.8	36.4	5.8	229.1	32.9	28.2	5.9	87.5
Private placements	226	21.4	12.9	0.4	359.2	13.2	9.1	1.0	74.0

Notes: This table shows descriptive statistics of the size of equity issuances.

[16] This filter automatically removes less frequently used financing methods, such as equity credit facilities (e.g., committed equity financing facilities (CEFFs) and standby equity distribution agreements)) and warrants issued pursuant to stock option plans are also excluded. Five convertible bond issuances are excluded because this issuance method is uncommon in Europe. In addition, nine firms report 14 issuances of rights offerings and private placements at the same time. These issuances are excluded because they cannot be assigned to one of the two groups. Of the 226 private placements, 19 are to existing investors only. Of the remaining 207 private placements, 18 are to new investors only, whereas the remaining 189 are to both existing and new shareholders.

shareholdings); and (2) Detailed information about the equity issuance had to be reported on corporate webpages or in the Factiva database, otherwise it was excluded. This collection method results in a final sample of 86 rights offerings and 226 private placements made by 91 firms. These numbers indicate that several companies raised external capital more than once over the sample period. Of the 78 firms that made private placements, 18 firms made one, 17 firms made two, and 43 firms made three or more. Of the 39 firms that made rights offerings, 17 firms made one, nine firms made two, and 13 firms made three or more[17]. Table 1 contains information about the private placements and rights offerings in the sample.

Panel A of Table 1 displays both the number and fraction of total equity issued in our sample by year through the rights offering and private placement mechanisms. The largest fraction of rights offerings occurred in 2009 and 2010. By contrast, private placements experienced a peak in 2006 with 48 (20.1 percent of the total amount issued in our sample via private placements), but there were only nine private placements (3.8 percent) in 2011. Panel B of Table 1 shows the size of equity issuances measured as the gross proceeds and the fraction of shares issued for each equity-selling mechanism. Gross proceeds and share proportions issued from rights offerings are in general larger than for private placements. Mean (median) gross proceeds from rights offerings are $45.1 ($27.9), whereas the corresponding figures for private placements are $21.4 ($12.9). The mean (median) fraction of shares issued in rights offerings is 31.5 (27.8) percent and 13.2 (9.1) percent for private placements.

3.2 Model

My main interest is to identify the determinants that affect the decision to raise equity capital through a rights offering or a private placement. In this section, I discuss the dependent variable (i.e., the equity announcement) and independent variables.

In Section 4, I employ a logit model to test the hypotheses regarding the choice between a rights offering and a private placement. In Section 5, I employ a nested logit model (McFadden, 1978, 1981) because this includes two decision levels. The first-level alternatives are rights offerings versus private placements, and the second-level alternatives are uninsured rights offerings and underwritten (standby) rights offerings.

The main proxies for measuring information asymmetry and monitoring are product-related R&D disclosures and blockholder ownership, respectively. I anticipate R&D disclosures to

[17] The regression models control for both year- and firm-specific effects.

play an important role in a firm's choice between private and public financing; after making R&D disclosures, firms generally pursue rights offerings to a larger extent. I use the following model:

$$Prob(Issue_i) = \alpha + \beta_1 R\&D\ news_i + \beta_2 Blockholder_i + \text{Controls} + \mu_i, \quad (1)$$

where *i* indexes a firm. The dependent variable equals 1 for rights offerings and 0 for private placements. The independent variables are classified into two categories: experimental variables and control variables. The experimental variables measure information asymmetry (*R&D news*) and ownership control (*Blockholder*). The control variables capture issue size and region dummies. Table 2 provides variable definitions.

Table 2. Variable definitions

Variable	Definition/description
R&D news	Dummy taking the value of 1 if a disclosure of R&D is made in days t_{-40} to t_0 preceding the equity issue announcement date; otherwise, the value is 0.
Bid-ask spread	The mean daily bid-ask spread over a six-month period preceding the announcement date of the equity issuance.
Trading volume	The average trading volume divided by the average number of shares outstanding over the previous six months.
Firm age	Number of years since the firm was incorporated.
Public firm age	Number of years since the firm went public.
Firm size	The log of the average market value of equity over a six-month period prior to the announcement date of the equity issuance.
Survival time	The cash balance (including marketable securities) scaled by net income from the preceding quarterly report. The inverse of the survival time is used in the regressions.
Momentum	The value-weighted index return from a broad European index (MSCI Europe) and an industry-specific index (NASDAQ biotechnology index) over the three months preceding the announcement date of the equity issuance.
Market liquidity	Dummy taking the value of 1 if there is an above-average number of IPOs undertaken by biotech firms on the NASDAQ/New York stock exchange in a given year; otherwise, the value is 0.
Blockholder	The sum of institutional and non-institutional ownership at the end of the previous fiscal year.
Issue size	The log value of the equity issuance amount. Each equity issuance is converted to US dollars using the exchange rate on the date of its announcement.
Take-up (*k*)	The fraction of the equity issue acquired by existing shareholders. Take-up is proxied by one minus the fraction of rights sold in the secondary market by assuming that each right issued in a rights offering only is traded once during the subscription period. The procedure for estimating expected take-up is described in Appendix.

Notes: This table provides variable definitions of experimental and control variables.

The Pearson correlation matrix for the independent variables used in the multivariate logit regressions is presented in Table 3. None of the bivariate correlations exceeds a value of 0.51.

Table 3. Pearson correlation matrix

	R&D news	Bid-ask spread	Trading volume	Firm age	Public firm age	Firm size	Survival time	Momentum	Market liquidity	Blockholder	Issue size
R&D news											
Bid-ask spread	0.064 (0.277)										
Trading volume	-0.036 (0.544)	-0.046 (0.436)									
Firm age	0.020 (0.728)	0.012 (0.841)	0.000 (0.997)								
Public firm age	0.012 (0.790)	-0.054 (0.359)	0.050 (0.394)	0.464*** (0.000)							
Firm size	0.120** (0.038)	0.308*** (0.000)	-0.128** (0.025)	0.102* (0.076)	0.204*** (0.000)						
Survival time	-0.034 (0.592)	0.019 (0.764)	-0.151** (0.017)	-0.128** (0.043)	-0.154** (0.015)	-0.368*** (0.000)					
Momentum	0.008 (0.890)	-0.036 (0.540)	-0.051 (0.380)	-0.006 (0.920)	-0.005 (0.936)	0.109 (0.055)	0.023 (0.717)				
Market liquidity	-0.039 (0.504)	0.011 (0.847)	0.092 (0.115)	0.078 (0.173)	0.039 (0.493)	0.146** (0.011)	-0.081 (0.202)	0.121** (0.033)			
Blockholder	0.002 (0.980)	-0.073 (0.230)	-0.239*** (0.000)	-0.243*** (0.000)	-0.151** (0.012)	-0.094 (0.115)	0.286*** (0.000)	0.078 (0.191)	-0.193*** (0.001)		
Issue size	0.300*** (0.000)	0.138** (0.017)	0.111* (0.055)	0.173*** (0.002)	0.096* (0.094)	0.505*** (0.000)	-0.420*** (0.000)	0.003 (0.957)	0.137** (0.016)	-0.222*** (0.000)	

Notes: This table shows pair-wise correlations for the experimental and control variables in the regression equations. The variables are described in Table 2. *, ** and *** denote that the pair-wise correlations are significantly different from zero at the 10%, 5%, and 1% levels, respectively. P-values are in brackets.

3.3 Variables associated with information asymmetry

3.3.1 Information asymmetry and R&D disclosures

Korajczyk et al. (1991, 1992) hypothesize that corporate managers can reduce information asymmetry prior to issuing equity by releasing information before the announcement date. To test the information asymmetry hypothesis, I include an R&D-related variable (R&D) in the analysis. R&D is a dummy variable that equals 1 if an R&D announcement occurs within 40 trading days prior to announcement of the equity issuance and 0 otherwise[18]. R&D news announcements can be either positive (e.g., a drug demonstrates efficacy against a pre-defined endpoint) or negative (e.g., the drug causes severe side effects). Whereas both positive and negative R&D news announcements reduce information asymmetry, negative news announcements do not carry a subsequent capital requirement and generally induce a significant negative share price reaction. Dittmar and Thakor (2007) argue that firms will issue equity when stock prices are high, but only if a high stock price coincides with low adverse selection. In this study, neither private placements nor rights offerings are preceded by negative R&D news announcements.

There are certain discretionary elements in the disclosure of R&D news announcements regarding biotechnology research projects in their early stages, in particular. Before initiation, regulatory authorities approve the design of a study, including primary and secondary endpoints, but they frequently do not scrutinize the clinical results before the biotech firm initiates the next phase. Opportunistic interpretations of results would, however, lead to serious discontent from both investors and regulatory authorities. In addition, R&D disclosures are generally mandatory, non-discretionary and value-relevant (e.g., Cerbioni and Parbonetti, 2007).

3.3.2 Other firm-specific variables associated with information asymmetry

Bid-ask spread

Glosten and Milgrom (1985) document the relationship between bid-ask spreads and information asymmetry by proposing that the larger the information asymmetry, the wider the spread. Bid-ask spread is measured as the mean daily relative bid-ask spread over a six-month period preceding the equity issuance.

[18] In an untabulated test, I verify that expansion of the window to 30 and 60 calendar days does not have a material effect on the inferences. A biotechnology company typically has few clinical research projects, and each project separately takes approximately one to three years to complete, which indicates that major clinical results are typically announced only a few times per year.

Stock return volatility

French and Roll (1986) find that stock return volatility is primarily related to the flow of information to investors, i.e., the higher the quality and quantity of information, the lower the stock return variability. Stock return volatility is measured as the standard deviation of daily stock returns over a six-month period prior to the equity issuance.

Trading volume (liquidity)

Frequently traded stocks tend to have greater information production, whereas less frequently traded stocks typically have more information problems (Diamond and Verrecchia, 1991). I measure trading volume as the average trading volume divided by the average number of shares outstanding over the previous six months.

Firm age and public firm age

Following James and Wier (1990), Krishnaswami et al. (1999) and Wu (2004), I use firm age to measure the potential information asymmetries that a firm faces. I include the log of firm age (number of years since the firm was founded) and public firm age (number of years since the firm went public) as proxies for the level of asymmetric information.

Firm size

Information asymmetry tends to decrease with firm size (e.g., Vermaelen, 1981). Large firms may face less information asymmetry because they tend to be more mature, have established and time-tested disclosure policies and practices, and receive more attention from the market and regulators (Diamond and Verrecchia (1991) and Harris (1994)). Because few biotech firms hold debt capital and investments in R&D are generally not capitalized, I include the average market value of equity over the six-month period prior to the announcement date of the equity issuance as a proxy for the level of information asymmetry (instead of the log of total assets)[19].

Financial distress (Survival time)

Firms in financial distress are generally considered to be suffering from severe information asymmetries, such as a firm that is undergoing debt restructuring (Gilson et al., 1990). Following Lerner et al. (2003), survival time is measured for each quarter as the firm's beginning-of-period cash balance scaled by net income. Net income is used as a proxy for cash flows because biotech firms tend to expense most investments immediately and, in

[19] Larger firms disclose more R&D news and are less dependent on individual news announcements. Therefore, firm size reduces scaling problems associated with news announcements.

addition, these firms rarely gain revenue from continuous operations. In the nested logit models, I use the inverse of the firms' survival time. Because there is no association between positive earnings and survival time (i.e., when earnings are positive, the survival time is infinite), the measure is set to zero for profitable firms (Lerner et al., 2003).

3.3.3 Market specific variables associated with information asymmetry

Business cycle (Momentum)

Choe et al. (1993) show that the volume of equity issuances is higher during periods of economic growth and after periods of a stock market run-up (which is an indication of momentum); these authors propose that firms face less adverse selection at business cycle peaks than at troughs. I measure business cycle (or momentum) as the value-weighted market return from a broad European index (MSCI Europe) and an industry-specific index (NASDAQ biotechnology) over the three months prior to the issuance ending the calendar month before the issue occurs.

Market liquidity

I measure market liquidity as an indicator variable that takes the value of 1 if there are an above-average number of IPOs (scaled by number of listed stocks) made by biotech firms on the NASDAQ/New York stock exchange in a given year, and 0 otherwise.

3.4 Ownership structure variable

Blockholder

Similar to several prior studies (e.g., Wruck, 1989; Wu, 2004), I measure ownership by the blockholder variable, which is defined as the sum of either institutional and/or non-institutional ownership that owns more than 5 percent of the outstanding shares of common stock at the end of the previous fiscal year. Changes in blockholder ownership are defined as the difference between the sum of institutional and non-institutional ownership owning more than 5 percent at the year-end of the previous fiscal year compared to the year-end after the issuance.

3.5 Control variables

I also include three control variables—issue size, take-up and regional dummies. These variables are briefly discussed below.

Issue size

Private placements tend to be smaller in issue size than public offerings[20]. This also holds for the fraction of shares issued. Issue size is measured as the log value of the equity issuance.

Take-up (k)

In the model by Eckbo and Masulis (1992), the adverse selection cost problem exists when the fraction of the stock issue expected to be taken up by existing shareholders (denoted *k*) is less than 100 percent. The procedure for estimating expected take-up is detailed in Appendix.

Region dummies

Market efficiency and the level of shareholder protection are known to vary across institutional settings. To mitigate this problem, I use dummies for the four regions specified by La Porta et al. (1998): Anglo-Saxon, Germanic, French and Scandinavian legal origins. I use the Anglo-Saxon legal system as the reference.

3.5 Interaction effects

I also examine interaction effects between *R&D news* and *blockholder*. Unlike the interaction effect in linear models, the interaction effect in non-linear models is conditional on the independent variables (Ai and Norton, 2003; Norton et al., 2004; Powers, 2005); therefore, both the magnitude and statistical significance of the interaction term can vary across observations. For example, when one continuous variable (*blockholder*) and one dummy variable (*R&D news*) are interacted, the interaction effect is the discrete difference (with respect to *R&D news*) of the single derivative (with respect to *blockholder*). In the probit model, the correct marginal effect of a change in the interaction variable between the *R&D news* dummy variable and *blockholder* is:

$$\frac{\Delta \frac{\partial F(u)}{\partial blockholder}}{\Delta R\&D\ news} = (\beta_1 + \beta_{12}) * f[(\beta_1 + \beta_{12}) * blockholder + \beta_2 + X\beta] - \beta_1 * f(\beta_1 * blockholder + X\beta) \quad (2)$$

[20] The board of directors is typically given authorization by the prior annual shareholders meeting to resolve the directed issuance of new shares with deviation from the existing shareholders' pre-emptive rights. The authorization generally restricts the board of directors to issuing no more than 5 to 10 percent of the outstanding share capital on one or several occasions during the period before the next annual shareholders meeting. A private placement is typically completed over several days or overnight through an accelerated bookbuilding procedure. In rights offerings, the board's resolution to issue new shares is typically subject to approval at an extraordinary shareholders' meeting. It is important to note that this study does not try to explain the relationship between issue proceeds and equity-selling mechanism choices.

where $F(u) = \Pr(Issue)$, which is given in equation (1). Equation (2) demonstrates that the marginal effect of the interaction variable may not be zero even when β_{12} is zero. Consequently, the coefficient of the interaction term may have an incorrect magnitude, standard error or sign relative to the real interaction effect (Lel and Miller, 2008). I employ the methodology developed by Norton et al. (2004) to calculate the correct marginal effect of the interaction variables. Norton et al. (2004) show that the interaction effect may have different signs for different covariate values. Thus, I display the graphs of the distribution of marginal effects and the associated *z*-statistics over the entire range of predicted probabilities.

4. Empirical results

In this section, I present empirical results for tests of the predictions in Section 2. First, I present a univariate analysis of information asymmetry and monitoring in rights offerings and private placements. Next, I present results from the multivariate logit regressions regarding the choice of equity-selling mechanisms.

Table 4. Univariate analysis of information asymmetry and monitoring

	Rights offerings			**Private placements**			**Difference**	
	Mean	*Median*	*Std*	*Mean*	*Median*	*Std*	*Mean*	*Median*
Information asymmetry								
R&D news	0.625	1.000	0.487	0.164	0.000	0.371	0.461***	1.000***
Bid-ask spread	0.386	0.093	2.173	0.183	0.078	0.641	0.203	0.015
Trading volume	3.141	1.851	3.490	3.391	2.298	4.220	0.251	-0.447
Firm age	12.888	12.000	5.168	11.335	11.000	6.356	1.553**	1.000***
Public firm age	6.269	5.244	3.769	5.929	5.293	3.647	0.341	-0.049
Firm size	1.899	1.954	0.629	1.990	1.999	0.617	-0.092	-0.045
Survival time	0.469	0.319	0.340	0.444	0.364	0.344	0.025	-0.045
Momentum	0.056	0.074	0.158	0.078	0.072	0.173	-0,022	0.002
Market liquidity	0.638	1.000	0.484	0.713	1.000	0.454	-0.075	0.000
Ownership structure								
Blockholder	0.313	0.259	0.272	0.268	0.258	0.249	0.044	0.001
Δ Blockholder	-0.035	0.000	0.202	0.198	0.000	1.838	-0.233*	0.000
Others								
Issue size	1.405	1.437	0.461	1.034	1.109	0.519	0.370***	0.328***
Take-up (*k*)	0.741	0.781	0.169	0.632	0.645	0.172	0.109***	0.136***
n		86			226			

Notes: The variables are described in Table 2. *, ** and *** denote that the value is significantly different from zero at the 10%, 5%, and 1% levels, respectively. Differences in mean values between rights offerings and private placements for each variable are calculated using a two-sample mean-comparison test with unequal variances. Differences in median values between rights offerings and private placements for each variable are calculated using the Wilcoxon rank-sum test.

4.1 Univariate analysis of information asymmetry and monitoring

Panel A of Table 4 shows the univariate analysis. I employ two tests: a two-sample mean-comparison test with unequal variances and the non-parametric Wilcoxon rank-sum test. I include several information asymmetry measures (for detailed definitions of the variables, see Table 2). The information asymmetry proxy, R&D news, provides support for the information asymmetry hypothesis, whereas the ownership variable (blockholder) does not support the monitoring hypothesis. Of the rights offerings, 61 percent are preceded by the disclosure of R&D news, whereas 17 percent of private placements disclose R&D news prior to the equity issue announcement. The mean-comparison test is positive and statistically significant ($p < 0.01$). The mean blockholder ownership for rights offerings and private placements are 31.3 and 26.8 percent, respectively. The mean-comparison test indicates that there is no difference between rights offerings and private placements ($p > 0.10$).

4.2 The choice of equity-selling mechanisms

The results of the multivariate logit regression analysis are summarized in Panel A of Table 5. Consistent with expectations, the coefficients for R&D news are positive and statistically significant (1 percent level). The results are robust when controlled for issue size and take-up (see Model 3), which indicates that there is a higher probability that firms issue equity publicly rather than privately following credible R&D disclosures. The marginal effects show that firms that disclose R&D news are 40 percent more likely to choose a rights offering over a private placement. In untabulated tests, I calculate the predicted probabilities if R&D news is equal to 1 and all other variables are held constant. The predicted probabilities for rights offerings and private placements are 0.699 and 0.301, respectively. In Model 4, the proxy for the ownership variable (*Blockholder*) is insignificant (*z*-statistics = 1.08). However, when controlling for issue size and take-up, the blockholder variable is significant at the 5 percent level (*z*-statistics = 2.14).

Next, I examine other proxies for information asymmetry (see Panel B of Table 5). None of the other proxies are significant at the 5 percent level (untabulated). However, when controlling for the size of the issuance, three variables are significant (firm size, survival time and market liquidity). The firm size variable is negative, which indicates that smaller firms tend to issue equity publicly rather than privately. This contrasts with prior empirical studies (e.g., Cronqvist and Nilsson, 2005), which suggest that larger and older firms are more likely to issue equity publicly rather than privately. The financial distress variable (survival time) is

positive and statistically significant, which implies that firms with capital needs facing the risk of running out of cash tend to choose rights offerings over private placements. When including all variables (Model 9), the coefficient for R&D news is positive and statistically significant (z-statistics 4.002), which lends support for H1. By contrast, the coefficients for the blockholder variable and for the changes in blockholder ownership are both statistically insignificant, which indicates that monitoring is not an important determinant in the choice of equity-selling mechanisms (i.e., there is no support for H2). In untabulated tests, I examine whether there is a non-linear relationship between the level of blockholder ownership and the choice of public or private financing; however, the coefficient is statistically insignificant.

Table 5. Multivariate logit analysis: rights offerings vs. private placements

Panel A. R&D news and blockholder

	Predicted Sign	(1)	(2)	(3)	(4)	(5)	(6)
Intercept		-2.139	-1.749	-2.163	-1.477	-2.490	-2.480
Panel A. Information Asymmetry							
R&D news	+		1.196 [0.402]*** (6.17)	1.078 [0.358]*** (5.41)			1.074 [0.355]*** (5.31)
Panel B. Ownership							
Blockholder	+				0.366 [0.116] (1.08)	0.780 [0.238]** (2.14)	0.732 [0.217]* (1.83)
Panel C. Others							
Issue size		0.751 [0.231]*** (3.91)		0.448 [0.133]** (2.23)		0.860 [0.262]*** (4.27)	0.548 [0.162]** (2.57)
Take-up (*k*)	+	0.642 [0.342]*** (3.23)		0.638 [0.339]*** (3.42)		0.658 [0.351]*** (3.57)	0.688 [0.388]*** (3.22)
Dummies for regions		Yes	Yes	Yes	Yes	Yes	Yes
Number of observations		282	281	280	284	282	280
χ^2-statistic (*p*-value)		57.13*** (0.000)	71.58*** (0.000)	72.11*** (0.000)	41.34*** (0.000)	54.17*** (0.000)	76.19*** (0.000)
Pseudo R^2		0.187	0.266	0.282	0.142	0.210	0.298
Panel B. Interaction effect.							
Mean interaction effect for *R&D news* and *Blockholder*							-0.774 (0.313)

Notes: This table provides the estimates from the logit regressions (Panel A). The sample consists of 226 private placements and 86 rights offerings made by publicly listed European biotechnology firms during the 1995-2012 period. The dependent variable equals 1 for rights offerings and 0 for private placements. I report coefficient estimates, marginal effects (within angle brackets) and *z*-statistics for marginal effects (within brackets). All regressions contain White´s heteroskedastic-consistent standard errors. The variables are described in Table 2. *, ** and *** denote that the value is significantly different from zero at the 10%, 5%, and 1% levels, respectively. Panel B reports interaction effects using the methodology suggested by Norton et al. (2004). The mean interaction effect is reported with corresponding *z*-statistics within brackets.

Panel B. Other measures of information asymmetry and blockholder

	Predicted Sign	(7)	(8)	(9)
Intercept		-1.374	-2.130	-2.583
Panel A. Information Asymmetry				
R&D news	+			1.201 [0.329]*** (4.002)
Bid-ask spread	-			-0.191 [-0.042] (-1.15)
Trading volume	+			-0.048 [-0.011] (-1.34)
Firm age	+			0.009 [0.002] (0.42)
Public firm age	+			0.078 [0.017]** (1.97)
Firm size	+			-1.817 [-0.404]*** (-4.81)
Survival time	-			0.936 [0.208]** (2.04)
Momentum	+			-0.465 [-0.103] (-0.42)
Market liquidity	+			-0.269 [-0.063] (-0.90)
Panel B. Ownership				
Blockholder	+			0.198 [0.044] (0.36)
Δ Blockholder	+	-0.169 [-0.053] (-1.09)	-0.289 [-0.086] (-0.50)	-0.101 [-0.022] (-1.48]
Panel C. Others				
Issue size			0.740 [0.221]*** (3.77)	2.490 [0.553]*** (5.65)
Take-up (*k*)			0.725 [0.361]*** (3.42)	0.651 [0.340]*** (3.21)
Dummies for regions		Yes	Yes	Yes
Number of observations		284	282	230
χ^2-statistic (*p*-value)		42.88*** (0.000)	59.13*** (0.000)	89.77*** (0.000)
Pseudo R^2		0.146	0.193	0.487

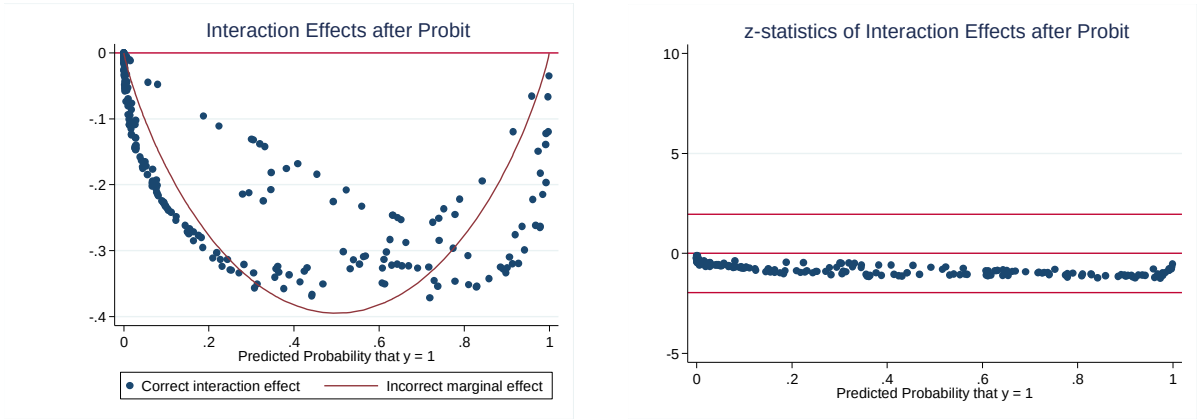
Notes: This table provides the estimates from the logit regressions. The sample consists of 226 private placements and 86 rights offerings made by publicly listed European biotechnology firms during the 1995-2012 period. The dependent variable equals 1 for rights offerings and 0 for private placements. I report coefficient estimates, marginal effects (within angle brackets) and *z*-statistics for marginal effects (within brackets). All

regressions contain White´s heteroskedastic-consistent standard errors. The variables are described in Table 2. *, ** and *** denote that the value is significantly different from zero at the 10%, 5%, and 1% levels, respectively.

4.2.1 Interaction effects

Next, I examine interaction effects between asymmetric information (*R&D news*) and ownership concentration (*Blockholder*). The lowest level of information asymmetry may occur in cases where firms with concentrated ownership have disclosed R&D information, which according to theory implies that these firms are more likely to use (uninsured) rights offerings rather than private placements. Employing similar reasoning, the highest level of asymmetric information may occur in cases where the firm ownership is dispersed and no R&D information has been disclosed. In this latter case, firms have incentives to choose private placements rather than (uninsured) rights offerings.

Figure 1. Interaction effects – Blockholder and R&D news



Notes: The graphs above display the interaction effects and corresponding *z*-statistics on the interaction variable reported in Table 5, estimated using Norton et al. (2004). The pair of interaction variables include *Blockholder* and *R&D news*. The lines above and below 0 on the figure to the right represent 5 percent significance levels (±1.96).

Unlike the interaction effect in linear models, the interaction effect in non-linear models is conditional on the independent variables (Ai and Norton, 2003; Norton et al., 2004; Powers, 2005) therefore; both the magnitude and statistical significance of the interaction term can vary across observations. I employ the methodology developed by Norton et al. (2004) to calculate the correct marginal effect of the interaction variables. Panel B of Table 5 reports both the mean interaction effect and the corresponding *z*-statistics for the interaction variable. The mean interaction effect is not statistically significant (-0.774, *z*-statistics = -1.01). However, the interaction effect may have different signs for different values of covariates (Norton et al., 2004). Figure 1 displays the graphs of the distribution of the marginal effects and associated *z*-statistics over the entire range of predicted probabilities for the main models.

The interaction effects are largely negative and statistically insignificant for most observations, which implies that there is no association between information asymmetry and ownership concentration with respect to the choice between private and public financing.

4.3 Additional analysis of monitoring

The theoretical literature explains that private placements are often motivated by management monitoring because private placements are associated with concentrated ownership and restrictions on post-placement trading (e.g., Wruck, 1989; Kahn and Winton, 1998). Although concentrated ownership enhances monitoring incentives (Shleifer and Vishny, 1986), the ownership concentration measure may be limited because private placements do not necessarily improve monitoring if ownership is concentrated in the hands of passive investors. Barclay et al. (2007) show that private placement investors typically are passive despite their acquisitions of large blocks of stock. An alternative hypothesis might be related to managerial entrenchment (e.g., Wruck, 1989); Wu (2004) argues that because there is no formal way to select the investors for private placements, managerial preferences (e.g., investors who are aligned with and vote in favor of the managers selected) can play a role in the choice of private placement investors. In the US, most private placements involve restricted shares (issued pursuant to registration exemptions under Regulation D or Regulation S), which typically indicates that the shares purchased in such private placements cannot be sold until two years after they are purchased (issued)[21]. No such regulation on private placements exists in Europe, which enables a clean-test of economic determinants that drives the choice of equity-selling mechanisms as opposed to regulatory differences[22].

To further evaluate the monitoring hypothesis, I follow Wu (2004) and decompose aggregate ownership according to the identities of blockholders and study changes in ownership structure on investor identity levels before and after equity issuance announcements. Consistent with several prior studies (e.g., Admati and Pfleiderer, 1994; Sahlman, 1990), pension funds and venture capital funds are classified as monitoring agents. Ownership data are mainly collected from annual reports and proxy statements. Pre-issuance ownership data are collected from the nearest year prior to the equity issuance announcement date. Post-

[21] For example, in the sample of private placements by Wu (2004), 37 private placements are unrestricted, whereas 301 are restricted.

[22] Nevertheless, when a private placement is directed only to new private placement investor(s), approval from existing shareholders is frequently required in cases in which the existing shareholders hold a large fraction of the shares in the firm. For example, on March 6, 2013, Active Biotech announced that its two largest shareholders, with a joint holding of votes and shares of approximately 44 percent, had approved a private placement to a new outside investor.

issuance ownership data are collected from the nearest year after the first trading day of the newly issued shares. Table 6 presents changes in ownership concentration for private placements (Panel A) and rights offerings (Panel B).[23]

Table 6. Detailed univariate analysis of monitoring

	Pre-issue ownership (%)		Post-issue ownership (%)		Change in ownership (%)		Number of observations
	Mean	*Median*	*Mean*	*Median*	*Mean*	*Median*	
Panel A. Private placements.							
Blockholders	40.5	38.1	37.6	33.1	-2.9**	-5.0***	136
Institutional blockholders	32.8	26.3	30.5	25.7	-2.2*	-0.6**	118
Venture funds	27.9	19.4	18.2	14.8	-9.7***	-4.6***	48
Pension funds	11.9	8.2	15.4	9.9	3.5*	1.7	31
Others	21.5	16.5	20.8	15.4	-0.7	-1.1	89
Non institutional blockholders	28.3	15.5	23.9	13.7	-4.4***	-1.8***	54
Panel B. Rights offerings.							
Blockholders	46.6	44.1	42.2	31.4	-4.4*	-12.7	51
Institutional blockholders	39.5	32.5	38.2	25.8	-1.3	6.7	45
Venture funds	29.3	24.5	21.3	12.9	-8.0***	-11.6**	18
Pension funds	7.9	6.9	8.5	6.9	0.7	0.0	11
Others	32.2	20.3	30.1	14.1	-2.1	-6.2	33
Non institutional blockholders	21.8	11.8	18.4	7.7	-3.4***	-4.1***	25

Notes: This table provides a univariate analysis of monitoring. Ownership data are obtained from annual reports and the Amadeus database. Venture capital funds, including private equity funds, are identified from the National Venture Capital Association (NVCA), the European Private Equity and Venture Capital Association (EVCA) and IPO prospectuses. Pension funds are identified from the Pension Handbook and Morningstar's Mutual Fund Sourcebook. The ownership structure is categorized at year-end if no date of ownership structure is given. "Blockholders" refers to owners holding at least 5 percent of shares. I categorize blockholders as institutional or non-institutional. Pension funds, insurance companies, mutual funds, venture capital funds, corporate partners, banks, foundations and endowments are categorized as institutional blockholders. Individuals, families and non- financial companies are classified as non-institutional blockholders. Venture funds and pension funds are referred to as monitoring and the rest are referred to as non-monitoring. *, ** and *** denote that the value is significantly different from zero at the 10%, 5%, and 1% levels, respectively.

[23] The ownership data are based on 5 percent threshold levels, i.e., shareholders owning a minimum of 5 percent or more. As a result, a two-sample mean-comparisons test and a Wilcoxon matched-pairs signed-ranks test (non-parametric test) only compare data for which there are available data points both before and after the issuance announcement.

On an aggregate level, the mean (median) blockholder ownership decreases significantly by 2.9 (5.0) percent and 4.4 (12.7) percent for private placements and rights offerings, respectively. Although the decrease in blockholder ownership in private placements is smaller in relative terms, the smaller pre-issue ownership levels in private placements compared to rights offerings do not support the view that private placements are motivated by a demand for monitoring.

To further illustrate the changes in ownership concentration, I decompose blockholders into institutional and non-institutional categories. Pension funds, venture capital funds, mutual funds, insurance companies and banks are classified as institutional blockholders. Individuals and families are classified as non-institutional blockholders. Institutional blockholders are further classified as either monitoring (venture capital funds and pension funds) or non-monitoring. Venture capital funds, including private equity funds, are identified from numerous sources, including the National Venture Capital Association (NVCA), the European Private Equity and Venture Capital Association (EVCA) and from IPO prospectuses. Pension funds are identified from the Pension Handbook and Morningstar's Mutual Fund Sourcebook. I crosscheck and confirm—and if necessary correct—the information with the classification in the Amadeus database.

The decomposition highlights a few interesting observations that are illustrated in Table 6. Panel A shows that the mean (median) institutional blockholder ownership decreases significantly in private placements but not in rights offerings. Furthermore, studying the two monitoring classes (venture capital funds and pension funds) separately reveals certain interesting results. For private placements, the mean (median) venture fund ownership significantly decreases by 9.7 (4.6) percent. Although the mean (but not the median) pension fund ownership increases for private placements (3.5 percent, statistically significant at the 10 percent level), the net effect of monitoring shareholders is negative and statistically significant (not tabulated). For rights offerings, the change in venture fund ownership is negative and statistically significant, whereas the change in pension fund ownership is statistically insignificant. Untabulated tests show that there is no significant difference between private placements and rights offerings for either venture capital ownership or pension fund ownership, which seems to be inconsistent with the monitoring hypothesis that private placements are motivated by a demand for monitoring.

5. Additional tests

5.1 Uninsured vs. underwritten rights offerings

Firms issuing equity publicly can choose between an uninsured rights offering and the more expensive underwritten rights offers, such as standby rights and firm-commitment offers[24]. The adverse selection model by Eckbo and Masulis (1992) suggests that firms should employ lower-cost flotation methods, such as pure (uninsured rights), when managers believe the expected take-up (*k*) by existing shareholders will be high. With intermediate expected levels of *k*, firms should use standby rights, whereas firms should employ firm-commitment underwritten offers with lower expected levels of *k*. Firm-commitment underwritten offers have not yet spread outside the US—with the exception of Japan and France (Eckbo, 2008). Consistent with this prediction, the actual shareholder take-up is higher for uninsured rights offerings than for standby rights offerings (mean and median values of take-up are displayed in Appendix.

Following Cronqvist and Nilsson (2005), I employ a nested logit model (McFadden, 1978, 1981) to examine the second-level decision between uninsured vs. standby rights offerings. The proxies for information asymmetry, except for the bid-ask spread and firm size, are statistically insignificant in all models (untabulated). Although the results indicate that larger firms are more likely to use standbys than smaller firms, an alternative explanation may be that underwriters do not take on standbys (and are even less likely to take on firm-commitment offers) from small firms with illiquid stocks because of the financial and reputational risk of being unable to sell the shares to the market; this observation might indicate that there are determinants in addition to information asymmetry that impact the choice between uninsured and standby rights offers.

5.2 Subscription pre-commitments

High-*k* issuers selecting uninsured rights have an incentive to inform the market about their private information regarding subscription pre-commitments from large shareholders for several reasons. First, the value of any underpricing is captured mainly by existing shareholders (minimizing wealth transfers from current to new investors). Second,

[24] The underwriter is generally paid an underwriting fee for its commitment (to compensate for the risk of subscribing for shares that are not taken up by shareholders) and is frequently also paid an amount per share for each unsubscribed share purchased in connection with the rights issuance. The underwriting fee in an underwritten rights offering typically ranges from 2 to 6 percent of the total proceeds. In comparison, direct issuance costs associated with an uninsured rights offering are generally 1 percent to 2 percent of total proceeds.

subscription pre-commitments by large shareholders are, in practice, likely to influence the subscription decisions of small and relatively uninformed shareholders. Third, subscription pre-commitments may help debilitate any negative market reaction to the announcement of the issuance and reduce the likelihood of offer failure. Following this reasoning, actual shareholder take-up and subscription pre-commitments are expected to be higher for uninsured rights than for standby rights.

In this study, the proportion of rights offerings with pre-commitments is 61.6 percent, i.e., 66.1 percent for uninsured rights and 50.0 percent for standby rights. Table 7 shows total[25] subscription pre-commitments as percentages of shares issued for uninsured and standby rights.

Table 7. Subscription pre-commitments and actual subscription data

	Subscription pre-commitments in percentage of shares issued		Percentage of issue subscribed			
	Mean	*Median*	*Mean*	*Median*	*Min*	*Max*
Uninsured rights	48.0	53.4	89.4	100.0	21.1	100.0
Standby rights	26.8	8.0	99.3	100.0	91.8	100.0

Notes: This table reports the mean (median) percentage of the share issue pre-committed to be subscribed and the percentage of the issue subscribed for uninsured and standby rights offers by European biotechnology firms during the 1995-2012 period. The data are primarily collected from prospectuses, press release information from corporate webpages and the Factiva database.

The mean (median) subscription pre-commitment for uninsured rights is 48.0 (53.4) percent. As expected, the mean (median) subscription pre-commitments for standby rights is significantly lower, at 26.8 (8.0) percent. Actual subscription rights in uninsured rights offers average 89.4 percent compared to 99.3 percent for standby rights. A large fraction (76 percent) of the uninsured rights have an actual percentage of issuance subscribed that exceeds 90 percent. However, six uninsured rights report have actual percentages of subscribed issuance in the range of 20 to 30 percent, with a minimum of 21.1 percent.

In the nested logit model between uninsured vs. standby rights offerings, I include a dummy variable that equals 1 if there are subscription pre-commitments[26]. The coefficient on subscription pre-commitment is insignificant, which suggests that a subscription pre-

[25] The total subscription pre-commitment is the sum of the pro-rata allotment and the pre-commitment to exercise rights beyond the pro-rata allocation should other shareholders not fully exercise their rights.
[26] In an untabulated test, I verify the results that setting the threshold levels at 50 percent, 75 percent or 95 percent did not have any effect on the inferences.

commitment is not an important determinant between the choice of an uninsured and a standby rights offering.

5.3 Stock market response to rights offerings and private placements

Similar to Cronqvist and Nilsson (2004), I examine whether the stock market reactions to the announcement of rights offerings and private placements are consistent with the findings previously reported. Stock market reactions provide important information about whether there are adverse selection costs. According to the shareholder take-up model from Eckbo and Masulis (1992), the market reaction to SEOs should be most negative for firm commitment offerings (where the potential for wealth transfer is greatest) and least negative (or zero) for pure rights, with standby rights in between. Several studies (e.g., Korajczyk et al., 1990; Lucas and McDonald, 1990, Choe et al., 1992; Eckbo and Masulis, 1992) report negative stock market reactions to standbys and firm-commitment offers. The negative stock market reaction is consistent with the view that outside investors are hedging to compensate for their informational disadvantage because those SEOs that tend to be issued are likely to be overpriced (and thus the term "adverse selection"). The positive stock market reaction to private placements, which may be viewed as a means of reducing adverse selection costs, may be motivated by two alternative explanations. First, finding a private placement investor willing to invest requires a favorable review of the issuing firms' future prospects. Consequently, successful private placements can be viewed as the outcome of a positive selection process, which is consistent with positive stock market reactions at the announcement of private placements (Eckbo, 2008). Second, a positive stock market reaction to private placements may reflect the market's belief that the new blockholder will play a positive role in monitoring management (Wruck, 1989).

I use the event-study methodology (e.g., Brown and Warner, 1985; Campbell et al., 1997) to document the stock-price reaction to announcements of rights offerings and private placements. The market model[27] is used to estimate predicted returns. The estimation period includes day -250 through -30, with day 0 being the public announcement of the equity issue.

[27] For robustness reasons, I also employ two additional models: 1) the Fama-French three factor model and 2) a two-factor model, in which the first factor is the market index (MSCI Europe) and the second factor is an industry index (STOXX Europe 600 Healthcare). Sharpe et al. (1999) suggest using a second factor when the sample is comprised of rims in a single industry in order to explain more of the variation in the normal return. All models yield similar results.

Abnormal returns are the difference between a firm's predicted and actual stock prices. Cumulative abnormal returns are formed by summing and then averaging the abnormal returns. Panel A of Table 8 reports average abnormal returns and cumulative average abnormal returns (CARs) around equity issue announcements for uninsured rights, standby rights and private placements.

Table 8. Stock price behavior before and around issue announcements

Panel A. Stock price behavior around issue announcements

	Rights offerings				Private placements	
	Uninsured rights		*Standby rights*			
Day	*AR (%)*	*CAR (%)*	*AR (%)*	*CAR (%)*	*AR (%)*	*CAR (%)*
-3	-0.236 (-0.51)	-0.236 (-0.51)	-0.830 (-0.84)	-0.830 (-0.84)	-0.307 (-1.35)	-0.307 (-1.35)
-2	0.526 (1.16)	0.205 (0.45)	0.416 (0.66)	-0.292 (-0.43)	0.282 (0.88)	-0.018 (-0.06)
-1	-0.790** (-2.05)	-0.289 (-0.70)	0.090 (0.09)	-0.187 (-0.21)	-0.318 (-1.07)	-0.198 (-0.73)
0	-4.263*** (-5.33)	-2.382*** (-4.89)	-5.639*** (-4.39)	-2.982*** (-3.34)	1.240* (1.65)	0.448 (0.99)
1	-1.824** (-2.43)	-2.946*** (-5.91)	-1.700** (-2.28)	-3.427*** (-3.77)	-0.611 (-1.53)	0.128 (0.31)
2	-0.181 (-0.33)	-2.763*** (-5.52)	-0.218 (-0.31)	-3.217*** (-3.80)	-0.241 (-1.07)	0.018 (0.05)
3	0.268 (0.54)	-2.457*** (-4.90)	-1.174 (-1.07)	-3.423*** (-3.74)	0.133 (0.52)	0.067 (0.18)

Notes: This table provides average abnormal returns and cumulative average abnormal returns (CARs) around issue announcements for rights offerings and private placements. Abnormal returns are calculated as the difference between actual returns and predicted returns. Predicted returns are estimated using a single-factor model over a time window of day t_{-250} to day t_{-21}. *t*-statistics are reported in parentheses. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel B. Pre-announcement abnormal stock price behavior

	Rights offerings		Private placements
	Uninsured rights	*Standby rights*	
Abnormal return [-60,-2]	-5.57* (-1.85)	12.39 (1.50)	12.78*** (4.17)

Notes: This table provides average abnormal returns for rights offerings and private placements in the 3-month period preceding the equity issue announcement date (day -60 through day -2). *t*-statistics are reported in parentheses. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

The mean abnormal return on the day of the equity issuance announcement for pure (uninsured) rights is -4.3 percent (*t*-statistic = -5.33) and the three-day (+1, -1) cumulative average abnormal return is -2.9 percent (*t*-statistic -5.91). In comparison, the average day-zero market reaction to standbys is -5.6 percent (*t*-statistic = -4.39). This is consistent with prior studies that document negative reactions to rights offerings (e.g., Eckbo and Masulis, 1992; Eckbo, 2008). The negative stock market reaction to pure and standby rights offerings is consistent with the existence of adverse selection costs, and shareholder take-up by existing shareholders is less than one ($k < 1$). Contrary to rights offerings, the stock market reaction to private placements on the day of announcement is positive and statistically significant at the 10 percent level (1.24 percent, *t*-statistic 1.65). This is consistent with several prior studies (e.g., Wruck, 1989; Hertzel and Smith, 1993; Janney and Folta, 2003). For example, Janney and Folta (2003) document CARs over a three-day period (-1, +1) of 2.65 percent for a sample of US biotechnology firms between 1973 and 1998.[28]

To provide additional context to the stock market reactions to rights offerings and private placements, I examine the average abnormal stock price run-up over the three months before the announcement date for uninsured rights, standbys and private placements (see Panel B of Table 8). Consistent with the adverse selection hypothesis, standbys are associated with a positive stock market run-up of 12.4 percent prior to the announcement, but are not statistically significant (*t*-statistic = 1.50). This is consistent with the view that adverse selection problems arise when undervalued firms with low expected shareholder take-up do not issue equity, whereas issuing firms that go ahead with standby rights tend to be overvalued, on average. Because the probability of being overvalued is greater following a period of a stock price run-up, it is reasonable to expect that the sample of standbys will have a positive stock price run-up. By contrast, there is evidence of basically no stock price run-up before uninsured rights offers (-5.6 percent, *t*-statistic = -1.85).

In summary, the results from these additional tests indicate that the stock market reacts negatively to the disclosure of uninsured standby rights, according to the predictions. The

[28] Although private placements are frequently employed in the biotechnology industry, and although the stock market reacts positively to announcements of such placements, the disclosure of investor identity tends to be a strategic decision by managers. For example, issuing firms only report the investor identity in less than one-third of the 226 private placements in this study, a variable that may convey important information to potential investors. This figure is significantly lower than the one found in the study by Janney and Folta (2003), who report that approximately 50 percent of private placements convey information about investor identity. An untabulated mean-comparison test shows that CARs to firms that disclose investor identity in private placements is 1.7 percent higher (1.18 percent vs. -0.52 percent) than CARs to private placement firms that do not disclose investor identity.

positive stock market reaction to private placements may be driven by a favorable review of the issuing firms' future prospects rather than by the belief that the new blockholder will play a positive role in monitoring management.

6. Conclusions

This paper examines the impact of of information asymmetry and monitoring on the choice of equity-selling mechanisms. The empirical study is based on 86 rights offerings and 226 private placements made by all publicly listed European biotechnology firms during the 1995-2012 period. The results provide evidence that information asymmetry is an important determinant of the choice of equity-selling mechanisms, whereas no support is found for the monitoring hypothesis.

The information asymmetry hypothesis suggests that rational corporate managers acting in the interest of existing shareholders issue equity publicly rather than privately when information asymmetry about firm value is low (Chemmanur and Fulghieri, 1999; Hertzel and Smith, 1993). The time-varying asymmetric information model by Korajczyk et al. (1991, 1992) suggests that information asymmetry is not fixed over time and that equity issues occur following credible information disclosures. This paper uses R&D disclosures as the main proxy for measuring information asymmetry and finds evidence that there is a higher probability that firms will issue equity publicly rather than privately following credible R&D disclosures, i.e., when information asymmetry is low.

The monitoring hypothesis suggests that private placements are used when there is a demand for monitoring because private placements are associated with more concentrated ownership (e.g., Shleifer and Vishny, 1986). The results of the analysis in this study indicate that monitoring is not an important determinant in the choice of equity-selling mechanisms. A detailed analysis of investor identities shows that the mean (median) of venture capital ownership decreases for both private placements and rights offerings and that there are no differences in means (medians) between the two equity issuance methods. Although there is an increase in pension fund ownership following private placements, the net effect of monitoring agents is negative.

Although the adverse selection costs hypothesis provides a rational and clear prediction for which issue method is preferred based on the expected take-up levels of existing shareholders,

the monitoring hypothesis is more problematic because managerial objectives may play a role. Wu and Wang (2005) argue that private placements may be inferior to uninsured rights as a flotation method in cases where entrenched managers want to avoid creating a monitoring blockholder. Wu (2004) suggests that private placements may be preferred in cases where managers find investors willing to align with managers (in return for an offer price discount). Furthermore, Hertzel and Smith (1993) propose that the relative importance of private placements for resolving information asymmetries about firm value versus monitoring management may depend on firm size. Morck et al. (1988) propose that monitoring and aligning managerial incentives may be relatively less important for small firms, which constitute the majority of the firms in this study and which typically tend to have high managerial ownership compared to large firms.

The biotechnology industry is, arguably, different from other industries in the sense that firms typically operate with large negative free cash flows and have no other choice but to regularly ask investors for (equity) financing for their research projects. In other words, the findings lend support for studying the choice of equity-selling mechanisms based on the argument that managers rationally go to public equity markets when there is a chance that investors will better understand the firm's prospects. This is consistent with the adverse selection model by Eckbo and Masulis (1992), which suggests that firms will employ lower-cost flotation methods when the level of asymmetric information about firm value is low, i.e., when the expected level of take-up in the equity issuance is high.

Further research can investigate questions such as: How does the private/public equity choice interact with alliance funding? What is the relationship between the future performance of a project and the choice of equity-selling mechanisms? How are private placement investors chosen and what type of investors are likely to participate in private placements?

Appendix. Estimation of expected shareholder take-up (*k*)

This section describes the three-step procedure to estimate shareholder take-up. In the first step, actual take-up is calculated for all firms selecting a rights offering. The fraction of rights traded is observable during the subscription period and assuming that each right is only traded once, take-up is defined as one minus the fraction of rights traded in the rights offering. In the second step, a linear regression model of actual shareholder take-up is employed using several *ex ante* explanatory variables, including ownership concentration (blockholder), issue size,

firm size, price discount and prior returns (run-up). In the third step, the coefficient estimates are used to calculate predicted values of shareholder take-up for the firms in the sample.

Table 9 reports actual shareholder take-up (*k*) in the rights offering sample. The model by Eckbo and Masulis (1992) predicts that high-*k* issuers will choose uninsured rights, whereas low-k issuers will choose standby rights. Consistent with this prediction, Table 9 displays that actual shareholder take-up is higher for uninsured rights offerings than for standby rights offerings. The mean (median) take-up for uninsured rights is 74.9 (77.5) percent, whereas the mean (median) take-up for standby rights is 69.5 (71.0) percent.

Table 9. Shareholder take-up in seasoned equity offerings by European biotechnology firms, 1995-2012

	n	*Mean*	*Std*	*25%*	*50%*	*75%*
Uninsured rights	54	74.9	0.163	61.1	77.5	89.1
Standby rights	18	69.5	0.219	55.1	71.0	89.3
Total	72	73.6	0.177			

Notes: This table reports shareholder take-up levels (k) for uninsured and standby rights by European biotechnology firms during 1995-2012. Take-up is defined as the fraction of the issue acquired by the existing shareholders. $k \in [0, 1]$. Assuming that each right issued in a rights offering only is traded once, take-up is proxied by one minus the fraction of rights sold in the secondary market (Bøhren et al., 1997). Data on the number of rights sold in the secondary market were obtained from stock exchanges, such as the NASDAQ OMX Group.

The *ex ante* explanatory variables are proxies for determinants affecting existing shareholders' likelihood to take part in the equity issue. Several of the explanatory variables have previously been used in Bøhren et al. (1997), Cronqvist and Nilsson (2004) and Balachandran et al. (2008).[29] Ownership concentration (blockholder), which is defined as the sum of institutional and non-institutional ownership owning more than 5 percent at the year-end of the previous fiscal year, shows that a large pre-issue shareholder ownership by existing blockholders increases the probability that the issue is value-maximizing, which may increase other shareholders' propensity to participate (Cronqvist and Nilsson, 2004). In addition, Balachandran et al. (2008) argue that large shareholders may have incentives to preserve their proportional ownership due to monitoring and control-oriented benefits. The log of issue size shows that the larger the equity issue, the greater is the likelihood that existing shareholders

[29] As Balachandran et al. (2008) point out, a range of variables are excluded due to potential multicollinearity problems. For this reason, I exclude stock return volatility from the model, which is correlated with run-up. In untabulated tests I exclude firm size from the model, as firm size may be correlated with issue size, and verify that the results are robust.

face capital or diversification constraints preventing them from participating in the equity issue. The log market value of equity (firm size) shows that a larger firm provides a higher-quality signal about the investment (Balachandran et al., 2008) and larger firms tend to have dispersed ownership, which can increase existing shareholders' participation (Cronqvist and Nilsson, 2004). Price discount shows the larger the price discount, the greater is the probability of existing shareholder participation. Prior return (run-up), which is defined as the stock return over a six-month period prior to the equity issuance, shows that a positive stock price performance in the period preceding the equity issue announcement may induce shareholders to participate in the equity issue. The regression results are displayed in Table 10.

Table 10. Regression model for existing shareholder take-up (*k*)

	Predicted Sign	Coefficient	*t*-statistic
Intercept		0.718***	3.11
Blockholder	+	0.494***	3.92
Issue size	-	-0.297**	-2.33
Firm size	+	0.119	1.17
Price discount	+	-0.054	-0.31
Run-up	+	0.111*	1.77
Number of observations		72	
R^2		0.363	
F-value		11.66	
(*p*-value)		(0.000)	

Notes: This table provides the estimates from the linear regressions of expected take-up. The sample consists of 54 uninsured rights offerings and 18 standby rights offerings. Take-up is defined one minus the fraction of rights sold in the secondary market (Bøhren et al., 1997). *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 10 shows that the coefficients for several of the explanatory variables (e.g. blockholder, issue size and run-up) have their signs according to predictions and are statistically significant. The coefficient estimates from this model are used to calculate expected shareholder take-up for the firms in the sample.

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