# Do mandatory disclosure requirements for private firms increase the propensity of going public?*

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**Abstract**

This paper investigates the effect of mandatory disclosure requirements for private firms on their decision to go public. Using detailed project-level data for biopharmaceutical firms, we explore the effects of a legal reform—the Food and Drug Administration Amendments Act (FDAAA)—which exogenously required that firms publicly disclose information regarding clinical trials. Exploiting cross-sectional heterogeneity in firms' exposure to the regulation based on their internal development portfolios, we find that affected firms are significantly more likely to transition to public equity markets following the reform. We also find that firms that go public due to the increased disclosure requirements subsequently reduce the size of their project portfolios while shifting to safer investments acquired externally. The results suggest that private firms' general information environment and disclosure requirements influence the propensity of going public, and the nature of their subsequent project decisions.

*Keywords*: Initial public offerings, mandatory disclosure, proprietary cost, innovation.
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# 1 Introduction

Private companies typically face limited public disclosure requirements. Unlike public companies, which must publicly release financial statements as well as information that is materially relevant for shareholders, private firms generally face no such obligations. Indeed, one of the primary benefits of remaining private is often said to be limited transparency (e.g., Farre-Mensa (2017)). While the effects of mandatory disclosure for public firms have been well-studied, the effects for private firms are not yet well-understood.[1]

Given the differences in disclosure requirements between private and public firms, one potential consequence of increased requirements for private firms is to affect their decision of whether to remain private or to go public. Conceptually, information disclosure can affect the going-public decision because firms face a trade-off between the cost of revealing confidential information that could be used by competitor firms and the benefit of raising external financing at a lower or more efficient rate (Bhattacharya and Ritter (1983), Maksimovic and Pichler (2001)).[2] Hence, if the proprietary costs of disclosure from becoming a public firm are sufficiently low or are outweighed by the financing benefits, the firm is inclined to go public. An implication of this analysis is that the introduction of mandatory disclosure requirements of proprietary or confidential information would make going public relatively more attractive; firms can no longer avoid proprietary disclosure costs by remaining private and hence the net marginal benefit from going public becomes relatively higher. Consequently, an increase in mandatory disclosure requirements for private firms may lead to an increased propensity to go public.

In this paper, we empirically examine whether this is the case. The questions we seek to address are thus: Does improved transparency in the form of mandatory disclosure for privately-held firms regarding *the company's product development* in the regular course of operations affect the propensity of an eventual initial public offering (IPO)? More broadly, how do public disclosure requirements for private firms influence the decision to transition to public equity markets, and what effect does this have on subsequent firm project decisions? The determinants of what drive a private company to go public are of significant interest to policymakers, as evidenced by recent legislative attempts to encourage more IPOs.[3] Furthermore, being public may lead to different investment incentives for firms, which may illuminate important real downstream consequences for altering the information environment

[1] Beyer et al. (2010) and Leuz and Wysocki (2016) provide reviews.

[2] A similar trade-off is modeled in Yosha (1995) and Spiegel and Tookes (2008).

[3] This is in reference to the 2012 Jumpstart Our Business Startups Act, which included provisions, such as optional compliance of new accounting standards and communication with investors before filing of the registration statement, to entice small firms to go public.

firms operate in. However, cleanly testing the effect of disclosure requirements on private firms is difficult. First, one needs data on private firms as well as the information they disclose, but the vast majority of privately-held firms in the U.S. are subject to almost no public disclosure requirements. Second, since the amount of disclosure by firms is endogenous, an exogenous shock to mandatory disclosure requirements is needed in order to ascertain its effect on private firms.

We attempt to overcome these difficulties and investigate the aforementioned questions using detailed project-level data for a particular industry—the biopharmaceutical (biopharma) industry. The biopharma industry provides an ideal setting to empirically test these questions due to the importance of proprietary information costs for firms in the industry, an active market for IPOs, and the existence of a legislative change where public disclosure of information was directly mandated.[4] Specifically, we use the passage of the Food and Drug Administration Amendments Act (FDAAA) by the U.S. government in 2007 as an exogenous shock to information disclosure requirements. The FDAAA required that the results, as well as other important information, of all clinical trials in Phase II or above of the drug development process be publicly reported. Prior to the reform, firms faced limited reporting requirements; however, the government mandated that companies have a legal obligation to make such disclosures in the FDAAA. Importantly, the law applied to all companies conducting clinical trials, including private firms. Consistent with this, we show that disclosures related to Phase II drugs rose sharply compared to disclosures related to Phase I drugs following FDAAA enactment, and at the same time general disclosures per drug by private firms also increased relative to those by public firms.[5]

We employ a difference-in-differences (hereafter DID) methodology to investigate the effects of strengthened mandatory disclosure requirements for private firms on the propensity to transition to public equity markets. Using data on private firms' project portfolios, we identify treatment intensity using cross-sectional variation in private firms' exposure to the FDAAA disclosure provisions. Specifically, because the FDAAA disclosure requirements are for projects in Phase II or above of the development process, firms with a greater proportion of these projects immediately preceding the enactment of the law are more affected by

[4]The disclosure of project-level information by biopharma firms is especially salient given that the industry is extremely competitive, reliant on innovation, and information releases can work to the detriment of the disclosing firm (Guo et al. (2004), Krieger (2017)). Mandatory disclosure of information pertaining to innovations can thus impose substantial proprietary costs on private firms.

[5]Since public firms already faced greater pressure to disclose details related to their R&D to investors prior to the reform, the idea is that an increase in mandated disclosure should affect public firms relatively less than private firms, which is what we find. See also Kankanhalli et al. (2019), who study redacted information by firms, and show evidence in an additional test consistent with biopharma firms experiencing a decreased incentive to redact information following the FDAAA, which is in line with the effect of increased mandatory disclosure.

the regulation.[6] We note that, while previous studies have documented life-cycle patterns for IPOs, our empirical strategy is not confounded by such effects because (*i*) the DID specification considers the *change* in IPO propensity for more-treated versus less-treated firms specifically following FDAAA passage; (*ii*) it is common for firms in the biopharma industry to go public even though the bulk or the entirety of their projects are in early-stage (e.g., pre-clinical or Phase I) development;[7] (*iii*) firms in this industry often go public even though they have not had a single quarter with positive revenues; and (*iv*) early-stage projects in certain therapeutic categories may have a shorter time to approval than later-stage projects in other categories (Kaitin and DiMasi (2011)).[8]

The main result we find is that private firms which are more affected by the legislation also significantly increase their likelihood of going public relative to less affected firms. This result is robust to a number of specifications and research design choices, including controlling for a wide variety of project portfolio attributes (e.g., risk, number of drugs in development, therapeutic areas of projects) and firm and year fixed effects. We conduct several robustness tests, and show that time trends, portfolio composition changes, and life-cycle effects do not drive our results. The results suggest that the information environment of private firms and their disclosure requirements significantly influence the decision to transition to public equity markets.

In additional analyses, we further explore the mechanism which drives the increase in IPO likelihood. If, as argued above, proprietary disclosure costs had prevented firms from going public prior to FDAAA enactment, then firms with higher ex ante proprietary costs from disclosure should have a disproportionate increase in their propensity of going public. We test this channel by partitioning our sample in a number of different ways, and re-running our analysis on the resulting sub-samples. First, we run our analysis after partitioning our sample based on pre-FDAAA disclosure levels. The reasoning is that firms which disclosed more in the pre-FDAAA period, where reporting was largely voluntary, likely had lower ex ante proprietary costs from disclosure (Verrecchia (1983)). Consistent with this argument, we

[6] As we discuss in more detail later, firms are unlikely to change their project portfolios in order to self-select their treatment intensity due to high adjustment costs associated with drug development. We also show evidence that firms did not actively change their project investment strategies in this way before the FDAAA was implemented.

[7] As noted in recent media coverage: "Early stage biotechs—whose products aren't yet tested in human clinical trials or are tested only in early Phase 1 studies—represented 37% of biotech IPOs through the third quarter of 2018 and had an average market value of $535 million ... that is up from 35% of biotech IPOs with an average market value of $471 million in 2015." See "Biotechs With No Drugs in Trial Are Raising Millions in IPOs," *The Wall Street Journal*, October 31, 2018.

[8] This is also in line with the observations of industry practitioners regarding IPO activity. For example, Rubius Therapeutics CEO Pablo Cagnoni notes that "...scientific and technology advances enable companies to tackle multiple diseases over a short span, attracting investors regardless of companies' development stage" (*The Wall Street Journal*, October 31, 2018).

find that the increase in IPO propensity is concentrated among firms that disclosed *less* prior to the reform. Second, we run our analysis after splitting our sample based on the degree of competition that a firm's development portfolio faced prior to the reform—the idea being that firms exposed to greater competition face higher proprietary disclosure costs. In line with this, we find that the increase in IPO propensity is centered around firms that operate in more competitive areas.[9] Put together, these results suggest that a primary mechanism driving the increased IPO propensity is the inability to save proprietary disclosure costs by remaining private following FDAAA implementation.

In our final analyses, we explore how investment and innovation outcomes are affected by the going-public decision due to increased disclosure requirements. Increased access to equity markets through an IPO may alleviate financial constraints and allow increased investment. Conversely, going public may exacerbate agency frictions, which may lead to less investment and innovation, or alter the riskiness or nature of investments (Jensen and Meckling (1976), Ferreira et al. (2014), Boot and Vladimirov (2018)). Leveraging our project-level data, we find that firms which tend to go public due to the FDAAA's disclosure requirements reduce the number of drugs that they develop. In particular, they initiate relatively fewer new drug projects in-house, and suspend more projects in development. This scaling-back of development efforts lead to a reduction in the overall risk of projects that they choose to develop. In line with this, we also find evidence that these firms turn more to external acquisitions of relatively less risky, later-stage projects. This is consistent with firms reducing their innovation following going public, but also shifting to relatively "safer" innovation.[10]

This paper contributes to the literature investigating disclosure and IPOs, such as Guo et al. (2004), Hanley and Hoberg (2010), Dambra et al. (2015), Boone et al. (2016), and Lowry et al. (2018). These studies consider disclosure requirements in the IPO filings, such as the registration (S-1) statement, and thus primarily apply to firms that have already made the decision to go public. Our study complements this literature by examining how disclosure requirements of project-level information during the course of a private firm's operations (and thus not directly related to filing for an IPO) influences IPO decisions. Dambra et al. (2015) consider the 2012 Jumpstart Our Business Startups (JOBS) Act and find that the U.S. market saw significantly more public offerings following the JOBS Act relative to foreign markets. Their findings are consistent with the JOBS Act lowering the

[9] As an alternate test, we examine firms that developed orphan drugs—which by their definition are drugs targeting diseases with few or no existing therapies, and thus little competition—compared to those that do not, and find that our results are centered around those that did not develop orphan drugs prior to the law change.

[10] These results are congruous with the theoretical predictions of Ferreira et al. (2014), who show that private firms are optimally inclined to pursue innovation because they are less transparent and insiders are more tolerant of failures, while public firms are more likely to exploit existing innovations.

proprietary costs endured from prospectus disclosure through its de-risking provisions. The present study differs from Dambra et al. (2015) in that we consider IPO propensity at the firm level related to mandatory disclosure requirements which affect private firms in the regular course of their operations, while Dambra et al. (2015) consider the amount of prospectus disclosure for firms that have decided to go public. In addition, we are able to provide evidence of how this affects subsequent project decisions at the firm level.

This study also contributes to the literature which investigates the determinants of IPO propensity, such as Ritter (1984, 1991), Lerner (1994), Loughran et al. (1994), Pagano et al. (1998), Lowry and Schwert (2002), Brau et al. (2003), Lowry (2003), Brau and Fawcett (2006), Kim and Weisbach (2008), Chemmanur et al. (2010), and Gao et al. (2013), among others.[11] Our paper builds on this literature by providing detailed firm-level evidence using exogenous variation that a private firm's information environment plays a significant role in the going-public decision. In a related study, Ewens and Farre-Mensa (2018) show that the deregulation of private equity markets effectively lowered the cost of being private for firms (i.e., not being able to raise large amounts of capital), thus contributing to a reduction in IPOs.[12] We also examine the relative benefits and costs of being private, but we focus specifically on firm-level decisions following a reduction in the benefit of being private via a different channel—information disclosure. Our paper is also related to the literature examining the effects of mandatory disclosure requirements. While the extant literature has largely focused on public companies (e.g., Engel et al. (2007), Lambert et al. (2007), Zhang (2007), Biddle et al. (2009), Cheng et al. (2013)), research on the effects of mandatory disclosure requirements for U.S. private firms has been quite limited to date. Our work thus sheds light on some of the consequences of increased disclosure requirements for private firms.

Finally, we explore firm-level project and innovation outcomes following IPOs in our additional analyses. Hence, our work contributes to the literature examining post-IPO firm performance, such as Jain and Kini (1994), Pagano et al. (1998), Pástor et al. (2008), Chemmanur et al. (2010), Aggarwal and Hsu (2013), Bernstein (2015), and Acharya and Xu (2017). We add to this literature by showing detailed results, using project-level data, regarding how firms' project portfolios change following the IPO decision when it is driven by increased disclosure requirements. This allows us to see more specifically the effects on innovation after the transition to public equity markets. While we provide evidence consistent with previous

[11] Pagano et al. (1998) discuss the proprietary costs of disclosure faced by public firms (i.e., loss of confidentiality) as one of the determinants that may prevent firms from going public (p. 38). However, as Pagano et al. (1998) note, they are unable to test this channel in their study. The authors instead provide evidence of confidentiality concerns by examining the effect on corporate taxes.

[12] Along similar lines, Engel et al. (2007) and Kamar et al. (2008) provide evidence that the Sarbanes-Oxley Act of 2002 induced small firms to exit public capital markets, due to the various compliance costs related to the Act.

studies, which show a reduction in innovation following the IPO decision, we also provide novel evidence that firms going public in our context shift their development efforts to safer projects.

The paper proceeds as follows. In the next section, we discuss the institutional setting and the conceptual framework. In Section 3 we present the research design and the dataset, while in Section 4, we present the main results as well as robustness tests. Section 5 investigates innovation effects due to the increased IPO propensity, while the final section concludes.

# 2 Institutional background and conceptual framework

In this section, we provide more detail and background regarding the institutional setting. We then discuss the conceptual underpinnings for our main predictions.

## 2.1 Institutional setting

Drug development in the U.S. is regulated by the Food and Drug Administration (FDA), and all drugs must pass certain phases in the FDA's approval process before they can be marketed and sold to consumers. The FDA approval process consists of three main phases—Phase I, II, and III—followed by a final NDA/BLA (new drug application/biologic license application) approval phase.[13] Overall, the development process typically takes a long time to complete (8 years on average; see DiMasi and Grabowski (2007)), entails substantial risk—the unconditional approval probability for drugs ranges from 5% to 25%, depending on the therapeutic area (Thomas et al. (2016))—and requires very high investment costs often exceeding $2 billion per drug (DiMasi et al. (2016)).

While it may take several years for a drug to be developed, it is common for firms in this industry to go public even though their drug portfolios are primarily in pre-clinical or Phase I status. As mentioned previously, 37% of recent biotech IPOs exclusively had projects in Phase I or below. Accordingly, newly public biopharma firms generally have no revenues and negative earnings. Anecdotal evidence suggests that IPO firms with early-stage projects generally rouse investor interest through the potential of the drug and the reputation of management.[14]

[13]Prior to Phase I, firms also engage in a more exploratory pre-clinical phase before deciding to spend substantial resources to enter Phase I.

[14]Media coverage of a recent biotech IPO, *Allogene*, whose main product was in an early phase, quotes an analyst: "Deals like Allogene's are 'a bet on management, reputation and the board of directors. ... It's not a validation of the product or technology—that's going to take many quarters, if not years.'" See "Biotechs With No Drugs in Trial Are Raising Millions in IPOs," *The Wall Street Journal*, October 31, 2018.

An important feature of the three clinical phases is that the trials involve human experimentation. For ethical and practical reasons, the United States government established the website, registry, and searchable database ClinicalTrials.gov through passage of the Food and Drug Administration Modernization Act (FDAMA) in 1997. The purpose of ClinicalTrials.gov is to track the progress of all clinical trials regardless of their funding source (e.g., public, industry, academic). The database was created to provide greater transparency to human experimentation and to ensure that all trials and results could be publicly accessible (U.S. Congress (1997)). The website, operated by the U.S. National Library of Medicine at the National Institutes of Health (NIH), launched and was made publicly available in 2000.

While the database was established by law, reporting on the registry of clinical trials and results was limited and largely voluntary, as the 1997 FDAMA legislation very narrowly defined the legal requirements for reporting. Specifically, the 1997 law required only the *registration* of clinical trials, and only drug trials related to life-threatening diseases had to be registered (Miller (2010)). Moreover, the 1997 legislation did not require that the results of clinical trials be reported. However, in 2007, the U.S. government passed the Food and Drug Administration Amendments Act (FDAAA), which heavily expanded the mandatory reporting requirements for clinical trials on the database (Title VIII, Section 801). In particular, the FDAAA required that the summary *results* from clinical trials in Phase II or above must be reported, and widely expanded the types of trials subject to the mandatory reporting requirements to include all interventional studies of drugs, medical devices, and biologics.[15] However, the legislation did not require the reporting of trials in Phase I or in the pre-clinical phase. The law also specified penalties for noncompliance, which include monetary penalties of up to $10,000 (U.S. Congress (2007)).

The CinicalTrials.gov database is publicly accessible and easily searchable, with language that is accessible to a non-technical audience.[16] The database is also closely watched by practitioners in the biopharma industry. Indeed, an industry has developed with products that synthesize and report the information in ClinicalTrials.gov along with other analyses for biopharma industry professionals. Moreover, media outlets often generate and release news articles based on drug information disclosed through ClinicalTrials.gov.

To confirm the intended disclosure effects of the legislation, we examine the disclosure frequency over time. As shown in the top panel of Figure 1, we see a sharp increase in

[15]The FDAAA also mandated the disclosure of other important information, such as trial details, protocol, outcome measures, and statistical analyses. The FDAAA mandates that trials subject to the requirement must be registered on ClinicalTrials.gov within 21 days of the first patient being enrolled, and the results from the trial must be reported on ClinicalTrials.gov within 12 months of collecting data for the primary outcome measure, i.e., the "Primary Completion Date," of the trial.

[16]Indeed, the FDAAA requires that a non-technical and understandable description of the results be reported along with the technical descriptions (see FDAAA, Section 801, 121 STAT. 912-913).

disclosures by private firms regarding Phase II or above projects in the year that FDAAA was implemented. The bottom panel of Figure 1 depicts the difference between Phase II (and above) disclosures and Phase I disclosures following FDAAA implementation; we see a sharp jump in 2007, which implies that private firms disproportionately increased their disclosures regarding projects in Phase II or above following the reform.

## 2.2 Conceptual framework

The biopharma industry is often characterized as fiercely competitive. Firms survive on their ability to innovate and the proprietary costs from releasing information are high (Guo et al. (2004), Thakor and Lo (2016)). Proprietary costs arise from competition in the industry; disclosure by one firm can lead to information spillovers, with competitor firms adopting the innovations or using the disclosed information to advance their own projects, at the eventual expense of the disclosing firm (Krieger (2017)). As documented by Guo et al. (2004), proprietary cost considerations significantly impacted prospectus disclosure decisions in their sample of biotech IPOs from 1995-1997.

Bhattacharya and Ritter (1983), Maksimovic and Pichler (2001), and Spiegel and Tookes (2008) model the going-public decision as the trade-off from increased disclosure of confidential information, which carries proprietary costs, and the benefit of raising public equity financing. This implies that firms would prefer to remain private if the proprietary disclosure costs from going public are sufficiently high. In the pre-FDAAA period, private firms faced limited disclosure requirements. Public firms, meanwhile, receive much stricter regulatory scrutiny and are required to disclose financial statement information. Moreover, public firms faced strong pressure to disclose project-level information in the pre-FDAAA era, and thus incurred greater proprietary costs from disclosure relative to private firms before the reform.

This heightened disclosure pressure for public firms is due to several factors. First, public firms are required to disclose material information. The current judicial standard for materiality was established by the Supreme Court whereby information is material if there exists a "substantial likelihood that the disclosure of the omitted fact would have been viewed by the reasonable investor as having significantly altered the 'total mix' of information made available."[17] Second, there is greater demand by capital market participants, such as sell-side security analysts and institutional investors, for information concerning public companies. Moreover, managers of public firms cannot disclose otherwise non-public information to

[17]From *TSC Industries v. Northway, Inc.* (1976). See Heitzman et al. (2010) for a thorough discussion. Additionally, in the MD&A section, public firms must disclose "such other information that the registrant believes to be necessary to an understanding of its financial condition, changes in financial condition, and results of operations" (Item 303, Regulation SK).

analysts or selected investors due to Regulation Fair Disclosure (RegFD). As a result, any project-level information the firm wishes to convey to security analysts or certain investors must be publicly disclosed. Finally, public firms face greater threats of shareholder litigation for withholding news (e.g., Skinner (1994, 1997)), which increases pressure to disclose private information.

Figure 2 illustrates the project-level disclosure frequency over time for public and private firms. Following the passage of FDAAA, we see in the top panel an increase in disclosure frequency for both groups. However, the increase is sharper for private firms. Indeed, as shown in the bottom panel of Figure 2, the difference in the number of project-level disclosures between public and private firms substantially diminishes in the post-FDAAA era. This is consistent with the notion that public firms faced greater pressure to disclose proprietary information prior to FDAAA implementation.

In contrast to pubic firms, private firms generally face no such regulatory or capital market demand for public disclosure. Although private firms may also be pressured to reveal information to investors, there is no requirement that such disclosures must be *publicly* made. Hence, private firms were largely shielded from the proprietary costs of disclosure in the pre-FDAAA era. However, with the passage of FDAAA, private firms were required to publicly disclose project-level information. This effectively minimized one of the major benefits from remaining private—reduced disclosure costs—as private firms must now endure these costs. This implies that the *marginal benefit* of remaining private is lower and going public becomes relatively more appealing following FDAAA implementation. Put differently, based on the models of Bhattacharya and Ritter (1983) and Maksimovic and Pichler (2001), if proprietary costs from disclosure are unavoidable for the firm regardless of whether or not they are private, then firms will be more inclined to go public. Therefore, following the passage of FDAAA, we expect an increase in the propensity of private biopharma firms to go public.

# 3 Research Design and Data

## 3.1 Empirical Methodology

In order to explore the impact of increased mandatory disclosure requirements of the FDAAA on the propensity to go public, we exploit within-industry heterogeneity across firms with respect to their exposure to the FDAAA disclosure requirements. In particular, because the FDAAA mandates that Phase II and above projects are subject to increased disclosure, while Phase I (and pre-clinical) projects are exempt, we construct a continuous treatment

variable that measures the proportion of a firm's drug development projects that are in Phase II or above immediately prior to FDAAA implementation. The idea is that firms with a higher proportion of their drug portfolio in Phase II or above will be more affected by the requirements of the FDAAA.[18]

Specifically, we estimate the following linear probability difference-in-differences (DID) regression at the firm-year level:

$$IPO_{i,t} = \alpha + \beta_1 PropPhaseII_i \times FDAAA_t + \beta_2 PropPhaseII_i + \beta_3 FDAAA_t + \gamma X_{i,t} + \varepsilon_{i,t}. \tag{1}$$

In equation (1), $PropPhaseII_i$ is our treatment variable, which measures the proportion of firm $i$'s drug portfolio as of 2006 that is in Phase II or above. $FDAAA_t$ is a dummy variable that takes a value of one if year $t$ falls in 2007 or later, and zero otherwise. The interaction between these two variables is therefore the DID estimator, and the associated coefficient $\beta_1$ gives the marginal impact of a change in the treatment variable following FDAAA enactment. Our dependent variable is $IPO_{i,t}$, which is a dummy variable that takes a value of one if a firm has undertaken an IPO, and zero otherwise.

Our main prediction specifies that firms more subject to the regulation should be significantly more likely to go public since they can no longer avoid incurring the proprietary costs from disclosure. With the above specification, we test the *change* in the propensity of going public for firms with various levels of Phase I and Phase II (and above) concentration following FDAAA implementation. In other words, we should see a disproportionately greater change in IPO propensity following the reform for firms with a greater concentration of projects that are subject to the regulation as compared to the change in IPO propensity for firms with a lower concentration of projects subject to the regulation.

A potential concern is that firms with a higher proportion of their drug portfolio in Phase II or above are intrinsically different from firms with a higher proportion of Phase I drugs. For example, there may be less asymmetric information about such firms and investors may view them as being less risky, which may naturally give them a higher propensity to go public irrespective of the rule change we examine. While we will demonstrate that the parallel trends assumption holds in our setting, and moreover our results are robust to a variety of

[18] For example, consider two firms, A and B, each with a single project in development as of the time of the FDAAA. If firm A's project is in Phase II, it will immediately have to disclose additional detailed information about the project. If firm B's project is in Phase I, then it will not face any immediate requirement to disclose additional information about its project. While firm B may face disclosure requirements *in the future* if its project were to succeed and move to Phase II, there is substantial ex ante uncertainty regarding both whether and when it will pass Phase I (given the low success rates in drug development and the long development times; see DiMasi et al. (1991) and DiMasi et al. (2016)).

placebo tests, we also address this general concern by including a battery of control variables and fixed effects, denoted by $X_{i,t}$ in equation (1).

First, we include a wide variety of controls at the firm-year level related to a firm's drug portfolio. Specifically, in order to control for firm size, we include $NumDrugs_{i,t-1}$, which is the (lagged) total number of drugs in a firm's development portfolio. In order to control for firm risk, we include $LOA_{i,t-1}$, which is the average (lagged) likelihood of approval of all drugs in the firm's portfolio.[19] We also include a set of 624 dummy variables that indicate whether a firm has a drug in development in a given year in each of the individual therapeutic categories in the database.[20] This allows us to control for inherent differences in the nature of developing in one therapeutic area versus another. Second, in equation (1), we include year fixed effects and we also include firm fixed effects in our most stringent specifications. With the inclusion of these controls and fixed effects, the interpretation of regression (1) is therefore that we are examining the decision of a firm to go public due to the requirements of the FDAAA, conditional on a given firm and year, and controlling for differences in the size and risk of a firm's project portfolio as well as the therapeutic areas that the firm is working in.[21]

We estimate equation (1) from 2004 to 2009, which gives us a window of six years surrounding the enactment of the FDAAA (three years in the pre-period, three years in the treatment period). We choose a relatively short window since, as noted by Bertrand et al. (2004), DID estimators may be biased when run over a long sample period due to autocorrelation. Moreover, since we define our treatment variable as of the year before the implementation of the FDAAA, as a practical matter this identification will become less valid as more time passes.

The key to our identification strategy is that our treatment variable, the proportion of the firm's drug portfolio as of 2006 that is in Phase II or above, is "as-if" random with respect to the implementation of the FDAAA in 2007. In other words, firms should not self-select their level of treatment (proportion of their drug portfolio in Phase II or above) in 2006 in order to affect their level of exposure to the mandated disclosure requirements in 2007. We

[19]This is an important control because Phase II drugs, given that they are further along the development process, inherently have a higher likelihood of succeeding conditional on a given drug. However, different drugs in different therapeutic areas would have different likelihoods of approval—i.e., a cancer drug in Phase II may still have a lower likelihood of success than a hematology drug in Phase I, since cancer drugs are substantially riskier than hematology drugs (see Hay et al. (2014) and Jørring et al. (2017)). The therapeutic category dummies that we describe next also help to account for this.

[20]These categories represent the intended disease/condition target of the drug. Examples of these therapeutic categories include "Asthma", "Hematologic Cancer", and "Rheumatoid Arthritis".

[21]We allow entry of new private firms over our sample period; since they do not have existing projects, the proportion of projects in Phase II or above for such firms is zero. Our results are robust to excluding these entering firms.

believe that this assumption holds in our setting for the following reasons. First, as we will show in Section 4, the parallel trends assumption holds in our setting with regard to our main outcome variable. Second, decreasing the number of projects in Phase II or above to avoid disclosure cost requirements is likely an infeasible strategy for firms given that they would have to abandon later-stage projects or increase their initiations of new projects.[22] The high development costs associated with drug development (e.g., DiMasi et al. (2016)), and thus high adjustment costs, would also render such a strategy generally intractable.

## 3.2 Data and Summary Statistics

We obtain our dataset of private firms from the BioMedTracker (BMT) database, which is a competitive intelligence database that compiles information on the drug portfolios of every biotechnology and pharmaceutical firm (both public and private) that operates in the U.S. The database includes detailed information on each drug project that a firm is developing at any given point in time, what phase in the FDA development process the drug is in, and the therapeutic indication category the drug falls into. The BMT database also contains information on disclosures, news updates, and regulatory events for each drug. Thus, the database allows us to identify private firms, and track the make-up and progress of their drug portfolios over time.[23]

The BMT database also includes estimates of the eventual likelihood of approval by the FDA of each drug at any given point in time, which we include as a control variable. These probabilities are updated any time that there is an announcement or news related to the particular drug. In order to construct these likelihood of approval probabilities, BMT uses historical approval rates as well as analyst adjustments based on development events. In particular, when a drug initially begins development, BMT assigns it an approval probability based on the historical approval rates of drugs in the project's particular disease/condition group. This probability is then updated for the drug each time there is relevant news about the drug. If the event conveys no relevant information about the eventual development

[22] We find no evidence that firms in our sample engage in these actions. In Table A1 in the Appendix, we examine whether firms change their drug portfolios based on the proportion of their projects in Phase II or above in the years leading up to the passage of the FDAAA. If firms are strategically changing their investments before the FDAAA's requirements became active, then we should see a significant correlation between firms' Phase II and drug portfolio composition and their subsequent investment behavior in the pre-FDAAA period. This correlation is insignificant for the number of drugs under development, initiations of new drugs, suspensions of existing drugs, and drug acquisitions.

[23] In particular, the BMT database collects information for drug portfolios from *all* sources, including any regulatory filings, press releases, conference calls with management, news articles, disclosures by the company, and also postings on ClinicalTrials.gov. Furthermore, information for the previous development history of drugs will also be back-dated into the database if any relevant information is released at a later date.

success of the drug, then the approval probability is unchanged. However, if the event does contain relevant information (such as trial results), then the approval probability is adjusted either upward or downward depending on the nature of the information (i.e., if it is positive or negative). The magnitude of the change in the approval probability is determined by BMT, who evaluates the event and assigns a change in likelihood based on pre-specified criteria.

The BMT database also allows us to identify when a firm has initiated trials of a new drug project, whether it has suspended trials of an existing drug project, and when it acquires a drug project (i.e., in-licenses a project) from another firm. We use these outcomes for additional tests exploring how firms' innovation incentives are affected as a result of IPOs induced by increased mandatory disclosure.

Finally, we manually match these private firms in the BMT database to Compustat, to identify the dates of when any of the firms went public over our sample period. In order to exclusively focus on private firms, we exclude any firms that had undertaken an IPO prior to our sample period (before 2004). This provides us with a base sample of 1,262 firms and 5,181 firm-year observations, with 37 IPOs, from 2004 to 2009.[24]

Table 1 provides summary statistics for our key variables and controls. Across our sample, $PropPhaseII_i$ has a mean of 59.3% and a median of 74.5%, indicating that more than half of firms' drug portfolios over our sample consist of projects in Phase II or above. However, the standard deviation is 42.7%, indicating that there is substantial variability across firms, which we exploit in our empirical tests. $IPO_{i,t}$ has a mean of 2.8% and a median of 0%, indicating that the majority of our firms do not undertake an IPO during the sample period. $LOA_{i,t-1}$, the (lagged) likelihood of approval, has a mean of roughly 28% and a standard deviation of 20%, showing that while firms have a relatively low probability of eventual development success—in line with evidence on the riskiness of the biopharma industry—there is still substantial variability both across firms and across time regarding the riskiness of the projects that they are developing. Finally, the mean number of drugs, $NumDrugs_{i,t-1}$, that firms have in their development portfolios is between five and six, with a standard deviation of about 16. This indicates that, similar to public firms, there is heterogeneity in the size of private firms. We directly account for this variation by including this variable as a control in our analysis.

[24]This is a similar number of IPOs to Pagano et al. (1998), who study the reasons for going public over an 11 year period with 40 independent IPO listings. While the relatively low number of IPOs has the potential to reduce our power, this will work against us finding an effect. Indeed, the variation that we are capturing comes from the propensity to do an IPO at the firm-level, and therefore any effect we find will come from firms that choose to make the switch from being private to being public.

# 4 Results

In this section we provide our main results. We first examine the propensity to go public following FDAAA enactment. We then perform a variety of robustness tests.

## 4.1 Main Results: Propensity to Undertake an IPO

As a prelude to our main results, we first establish that the parallel trends assumption likely holds in our setting. This amounts to showing that there is no significant difference between firms with higher versus lower values of $PropPhaseII_i$ (the proportion of their portfolios comprised of Phase II and above projects in 2006) in terms of their propensity to go public prior to the implementation of the FDAAA. In order to show this, we estimate regression (1), but interact the treatment variable with a fixed effect for each year. The resulting coefficients, along with confidence intervals, are plotted in Figure 3. We expand the sample to include additional years compared to our regression sample in order to provide a broader examination of any trends.

As can be seen in the figure, the coefficients are all insignificantly different from zero for the years prior to FDAAA enactment, indicating that there is *no* significant difference in terms of the propensity to go public between firms with different levels of $PropPhaseII_i$ for any of the years.[25] In contrast, after 2007, the coefficients increase and become significant, indicating that firms with a higher value of $PropPhaseII_i$ begin to significantly increase their propensity to go public compared to other firms once the FDAAA was in place. This provides evidence of the validity of the parallel trends assumption for our empirical tests.

Table 2 provides results for regression (1). Across specifications (1) to (5), the interpretation is that we are comparing the IPO propensity of firms with different levels of the treatment before and after FDAAA implementation, controlling for differences in their project portfolios (size, risk, and project areas) and time effects affecting all firms. In all of these specifications, the DID estimator is positive and significant. In particular, the magnitudes of the coefficients indicate that on average, compared to before FDAAA enactment, shifting from a firm with no projects in Phase II or above to a firm with all of its projects in Phase II or above increases the likelihood of going public by 2.1 to 3.0 percentage points.

Column (6) shows results for our most stringent specification, which includes all controls, project portfolio therapeutic category indicators, and year fixed effects, but also adds firm fixed effects. The disadvantage to including firm fixed effects in our setting is that we run the risk of reducing our power, given that our outcome variable is binary and therefore firm fixed

[25] We also provide additional supporting regression evidence of this using a placebo test in the next subsection.

effects may absorb much of its variation. However, the advantage is that firm fixed effects allows us to examine *within*-firm effects. In other words, conditional on a given firm and a given year and controlling for the firm's project portfolio, the test examines whether the FDAAA increased the propensity for each specific firm to go public. Even when including firm fixed effects, our result remains significant, and with a similar magnitude as the other specifications.

We now further investigate the mechanism driving the main results. As discussed in Section 2, firms are more inclined to go public in the post-FDAAA period as they can no longer save the proprietary costs of disclosure by remaining private. One implication of this mechanism is that firms for which the proprietary costs of disclosure are greater should be more affected by FDAAA implementation. This occurs because proprietary disclosure costs would not be as salient in the IPO decision for firms with low proprietary costs from disclosure, as the benefit of raising equity financing at a lower rate would exceed the cost from disclosing confidential information (Bhattacharya and Ritter (1983)). As a consequence, FDAAA implementation would not significantly alter the propensity of going public for low disclosure cost firms.

To proxy for the variation in firms' level of proprietary disclosure costs, we first consider firm disclosure behavior prior to FDAAA enactment. Recall that in the pre-FDAAA era, reporting requirements were extremely limited, and hence most of the project-level disclosures were *voluntary*. Consequently, firms which disclosed more frequently per drug likely had lower proprietary disclosure costs (Jovanovic (1982), Verrecchia (1983)). To test this implication, we track the annual number of disclosures per drug made by each firm between 2000 and 2006. We then split our sample based on whether a firm made an above-median or below-median number of disclosures per drug during this period, and re-run our main test for each sub-sample. Table 3 presents the results of these tests. For firms that engaged in a relatively low number of disclosures prior to the FDAAA, the DID estimator is again positive and significant, indicating that these firms are more likely to go public as a result of the increased mandatory disclosure requirements. However, for firms that engaged in relatively greater disclosure prior to FDAAA implementation, the DID estimator is insignificant.

As an additional proxy for firms' level of proprietary disclosure costs, we also consider the competitiveness of the development areas that firms operate in. The intuition is that firms which operate in more competitive areas will be more exposed to the competitive costs of disclosure. To examine this, we re-run our main tests after partitioning our sample based on whether a firm's drugs faced an above-median or below-median number of competing drugs in the same therapeutic class developed by other firms in 2006. As shown in Table 4, we find that our IPO results are stronger for firms whose drug portfolios faced greater

competition.[26] These findings provide additional evidence to our hypothesized mechanism that, once proprietary disclosure costs became unavoidable for private firms, the marginal benefit of going public became relatively higher following FDAAA implementation and led to increased IPO propensity.

## 4.2 Robustness: Placebo Test for FDAAA

A potential concern in any DID setting is that the effects are driven by some type of pre-trend that is unrelated to the event in question. Although our examination of the parallel trends in Figure 3 suggests that this is not the case, we further examine this possibility through a placebo test in which we falsely specify the year in which the FDAAA was enacted.

More specifically, we re-run regression (1), but over an earlier period prior to the FDAAA, from 2000 to 2005. We define a variable, $PlaceboTime_t$, that falsely defines the enactment of the FDAAA as 2003.[27] The results are provided in Table 5. In all of the different specifications, the DID estimator is insignificant. This provides evidence that the effects we document in the previous subsection are not simply the continuation of a trend that began before our sample period.

## 4.3 Robustness: The Financial Crisis

A possible shortcoming of our setting is that our treatment period (2007-2009) includes the financial crisis of 2007-2008. In general, the increase in financial frictions during the crisis should make IPOs more difficult for firms, and thus work against us finding an effect. However, if financial frictions related to the crisis differentially affect firms based on our treatment variable, it raises the possibility that our effects are driven partly by the crisis. For example, there may be more asymmetric information surrounding firms with higher proportions of Phase I drugs (i.e., firms that have a lower treatment intensity in our setting). The financial crisis could amplify the effect of such frictions, and may make it especially difficult for these types of firms to raise equity through an IPO. This could cause us to find an effect in our tests because these "control" firms are simply displaying a relatively lower propensity to go public due to the crisis.

[26] As an additional test of this channel, we also examine firms that developed orphan drugs compared to those that did not prior to the FDAAA. Since orphan drugs target diseases with few or no existing therapies, they thus face less development competition by their definition. These results are provided in Table A2 in the Appendix. In line with the previous test, our results are stronger for firms that did not develop orphan drugs prior to the FDAAA.

[27] We also re-define our treatment variable ($PropPhaseII_i{}'$) as the proportion of the firm's drug development portfolio in 2002 that is in Phase II or above, to stay consistent with our previous methodology.

Figure 3 shows that this channel is not likely driving the results, given that the effects persist even *after* the financial crisis. Furthermore, we include a wide variety of fixed effects and drug portfolio controls in order to control for differences between firms. Nevertheless, we now attempt to more formally preclude this possibility. We first re-run our analysis by excluding the height of the financial crisis (2007-2008) from our sample. These results are provided in Table 6. Across all specifications, the DID estimator remains positive and significant, which suggests that the effects are not driven by events during the financial crisis.

As another test of this channel, we run a placebo test where we re-estimate our main specification, but define our treatment variable in a different way. In particular, we re-define our treatment variable as $PropPhaseIII_i$, which is the proportion of firm $i$'s drug development portfolio in 2006 that is in Phase III or above, excluding companies with drugs in Phase I. Thus, our placebo treatment variable captures the number of Phase III (or New Drug Application (NDA)/Biologic License Application (BLA), the final approval phase) projects relative to the number of Phase II projects that a firm is developing. The idea is that, since Phase III or above projects are more mature and closer to being approved, there is less asymmetric information about such projects. If the channel described above for the crisis is driving our results, then firms with a relatively higher proportion of Phase III or above projects should have a higher propensity to go public in the post-2007 period because they face less adverse selection. Put differently, finding such an effect would mean that our results are not driven by the threshold between Phase I and Phase II established by the FDAAA, but more generally by having more mature or "proven" projects in the crisis period.[28]

The results of this placebo test are provided in Table 7. Across all specifications, the placebo DID estimator $PropPhaseIII_i \times FDAAA_t$ is insignificant. This provides further evidence suggesting that the results are not driven by a channel unrelated to the FDAAA, such as adverse selection effects during the crisis.

## 4.4 Robustness: Life-cycle Effects

A more general concern along the lines of the above is if our results are driven mainly by life-cycle effects for firms, i.e, firms with a greater concentration of later-stage projects or recent development successes may simply be further along in their life-cycle and thus could be more likely to go public (e.g., Jain and Kini (1994), Chemmanur et al. (2010)). We attempt to rule out this channel here.

If such an effect is driving our results, then one would expect to find that firms with a

[28]In the next subsection, we further examine whether our results are driven by firm life-cycle effects related to having more mature projects.

higher proportion of later-stage projects should go public in our sample irrespective of the passage of the FDAAA. We test if this is the case by exploring whether the relative phase composition of a firm's portfolio predicts its propensity to do an IPO in the pre-FDAAA period from 2000 to 2006.

The results are provided in Table 8. In Panel A, we define $PropPhaseII_i$ as the proportion of projects in Phase II or above that a firm has at the beginning of the pre-FDAAA period, and examine whether a portfolio that has a relatively higher concentration of later-stage projects predicts IPO propensity. In all of the specifications, we find that the portfolio composition at the beginning of the period does not have any significant predictive power for the propensity to do an IPO. In Panel B, we conduct a similar exercise, but allow the proportion of the firm's projects in Phase II or above to vary over time.[29] We find that the relative proportion of a firm's portfolio in Phase II or above does not significantly predict the firm's propensity to go IPO in the subsequent year. Put together, these findings are inconsistent with the notion that our results are being driven by firm life-cycle effects.

We note that our results should not be interpreted as providing evidence contrary to documented IPO life-cycle effects, but rather that our treatment is unlikely to be correlated with or driven by such effects. For example, previous studies such as Jain and Kini (1994) and Chemmanur et al. (2010) find that, consistent with life-cycle effects, firms tend to go public at the peak of their innovation. In contrast, *PropPhaseII* focuses on incremental progress within the drug development process. Moreover, *PropPhaseII* may not capture firm or drug maturity, because, depending on the therapeutic category (which we control for), some drugs in early-stage development may ultimately take less time to receive FDA approval than later-stage traditional drugs (Kaitin and DiMasi (2011)). Beyond this, the stylized facts of IPO activity in the biopharma industry suggest that the life-cycle channel may be relatively less salient for firms in this industry. As we discussed previously, firms in the biopharma industry often go public while their drug portfolios are in early-stage development and when they have not had a quarter with positive revenues.

## 4.5 Robustness: Autocorrelation

A general concern with DID estimators is that the results may be biased toward finding an effect if there is autocorrelation in the data (Bertrand et al. (2004)). Although one reason why we choose a relatively short sample window is to allay this concern, we also more explicitly control for autocorrelation here by re-running our main results using Newey and

[29] Since $PropPhaseII_{i,t-1}$ also has time-series variation (as a given firm's project decisions change over time), it allows us to include firm fixed effects.

West (1987) heteroskedasticity and autocorrelation adjusted (HAC) standard errors with up to two lags. The results are shown in Table 9. All of our results continue to hold when explicitly adjusting for autocorrelation in our sample using HAC standard errors.

# 5 Project Decisions and IPOs

Having provided evidence of the increased propensity to go public following the increased mandatory disclosure requirements of the FDAAA, we now turn to the effect this had on project investment decisions by firms. Conceptually, the influx of cash from the IPO may lead to increased investment post-IPO, which could not have been explored pre-IPO due to capital constraints. However, becoming public may open the door to or worsen agency problems (Jensen and Meckling (1976)) that could adversely impact innovation, or other frictions that could change the type of innovation firms pursue in other ways.[30]

Previous papers (e.g., Asker et al. (2014), Bernstein (2015)) have documented a relative reduction in innovation following IPO decisions by firms. Here, we explore whether this is the case in our setting—specifically, whether IPO decisions driven by information disclosure requirements lead firms to alter their investment and innovation decisions. An advantage of our setting is that our detailed project-level data allows us to track firms' investment projects at a granular level, enabling us to closely track changes in firms' investment portfolios and innovation activity over time, and without having to rely on patent data and some of the related shortcomings (e.g., Freilich (2018)).[31] Exploring such an effect also allows us to ascertain a potential downstream effect on investment and innovation related to increased information disclosure requirements.

## 5.1 Empirical Strategy

Our empirical approach is to exploit the exogenous variation in the propensity to undertake an IPO caused by the FDAAA, and use that to examine drug development portfolio decisions over time. In order to do so, we use a two-stage least squares (2SLS) strategy. In the first stage, we utilize equation (1) to capture the variation in IPOs due to the FDAAA once it went into effect. The idea of the first stage is that the proportion of a firm's projects in Phase II or above in 2006 measures the exposure of a firm to the information disclosure requirements

[30]For example, Ferreira et al. (2014) predict that it is optimal for private firms to explore more innovative ideas and public firms to invest in existing ideas, due to agency and informational frictions. Boot and Vladimirov (2018) predict that private firms will pursue more early-stage innovation, while public firms will coordinate on existing technologies, due to informational frictions.

[31]In particular, patents can be issued in many cases for ideas that a firm does not intend to invest further in or pursue.

of the FDAAA. We therefore use this exposure as an instrument for the propensity to go public in the post-FDAAA period. This allows us to capture the exogenous component of engaging in an IPO (due to increased disclosure requirements) and therefore its effect on investment and innovation decisions isolated from any other potential confounding effects.

Using instrumented IPO from the first stage, in the second stage we examine how IPOs driven by these disclosure requirements affect a firm's project decisions:[32]

$$Y_{i,t} = \alpha + \eta_1 \hat{IPO}_{i,t} + \delta X_{i,t} + \epsilon_{i,t}. \tag{2}$$

We estimate the above over the same sample window as our main tests, from 2004 to 2009.[33] In each stage, we include in $X_{i,t}$ our previous set of lagged controls, project portfolio therapeutic category indicators, and year fixed effects.[34]

As our main outcomes for $Y_{i,t}$, we explore a number of different variables. We look at the number of drugs that a firm is developing in the given year, $NumDrugs_{i,t}$, in order to see if a firm expands or contracts the size of its project portfolio. To further investigate what might drive a change in the size of a firm's project portfolio, we examine the number of exploratory trial initiations for new drugs that a firm is undertaking, $Initiation_{i,t}$, as well as the number of drugs in development that a firm decides to suspend or terminate, $Suspension_{i,t}$, as additional outcome measures. These variables give us a glimpse into whether a firm is deciding to internally innovate by starting the development of new drugs, or whether that firm is deciding to end development of projects. We also consider the number of acquisitions of drug projects from other firms that a firm undertakes, $Acquisition_{i,t}$. This allows us to see whether a firm decides to externally acquire existing innovation from other firms, rather than develop something new in-house. Finally, we examine the overall risk of a firm's portfolio, $LOA_{i,t}$, as an outcome variable.

[32]This 2SLS procedure is a fully-estimated instrumented difference-in-differences (DDIV) specification (see Hudson et al. (2017); a similar approach has also been used in Duflo (2001) and Abdulkadiroğlu et al. (2016), among others). This methodology allows us to estimate the local average treatment effect (LATE) of a firm whose private-public status was changed by the treatment. To further underscore the validity of this approach, in untabulated results, we use regression (1) to explore (in a reduced-form manner) whether the law affects innovation outcomes for firms that choose to remain private, and we do not find a significant effect on these outcomes. This suggests that the effect of the FDAAA on our innovation outcomes operates specifically through the IPO channel.

[33]As an alternative specification, we also run these 2SLS regressions in the post-FDAAA period from 2007 to 2009, but include only $PropPhaseII_i$ as a cross-sectional instrument for $IPO_{i,t}$ in the first stage. While the shorter sample window reduces our power in this specification, the results are largely consistent across the specifications. These results are provided in Table A3 in the Appendix.

[34]We do not include firm fixed effects because doing so absorbs the majority of our variation jointly between the first and second stages, since our first-stage has a 0-1 outcome variable, we include project therapeutic category fixed effects, and most firms develop low numbers of drugs and therefore engage in few initiations/suspensions/acquisitions in any given year.

## 5.2 Project Decision Results

The results of regression (2) are provided in Table 10.[35] Using instrumented IPO, $\hat{IPO}_{i,t}$, as an estimate for predicted IPOs due to the increased disclosure requirements of the FDAAA, we examine project decisions in columns (1) through (4) of Table 10. The results in column (1) indicate that firms with a greater propensity to go public due to the FDAAA significantly reduce the number of drugs in development in their project portfolios. The magnitude suggests that firms that go public due to disclosure requirements develop an average of four fewer drugs compared to other firms. While the magnitude of the coefficient suggests a large decline in the number of drugs, the point estimate is partly influenced by the presence of firms with large development portfolios. Excluding firms in the extreme 1% tails of the size distribution yields a reduction in the number of drugs in development to less than two.

Peering more closely into the cause of this decline in development projects, in column (2) we find that this is due to such firms reducing their innovation—they initiate significantly fewer new projects in-house. This is consistent with previous evidence by Bernstein (2015), whereby internally-developed innovation falls following the IPO. Our results suggest that this also holds when examining actual project investment decisions rather than patenting activity, and also when such IPOs are driven by increased disclosure requirements unrelated to filing an IPO. Column (3) examines project suspensions, and we find that these firms are also more likely to suspend or terminate existing projects. This provides evidence that post-IPO firms may be reducing their innovation activity by terminating existing innovation that they had already begun. Column (4) examines acquisitions of existing projects from other firms, and shows that firms tend to increase their acquisition activity and thus seem to turn to in-sourcing existing projects that were developed externally. To examine the overall effect of these actions on the nature of the firm's investments, we examine the risk of the firm's development portfolio in column (5). We find that firms' development portfolios become significantly *safer* (i.e., higher likelihood of approval) following going public, when the IPO is driven by a change to disclosure requirements.

In order to further understand these effects, we run a final analysis in which we examine the nature of the new projects that firms acquire after going public. In columns (1) and (2) of Table 11, we examine whether the new acquisitions are either more or less risky than a firm's existing portfolio (based on the average likelihood of approval of the firm's development portfolio). We find that post-IPO firms engage in acquisitions of projects that are relatively less risky than their existing portfolios, while they do not engage in acquisitions

[35]The first stage of the regression is the same as in Table 2. This indicates that the proportion of Phase II/above project in a firm's portfolio in 2006 makes it more likely to go public in subsequent years.

that are more risky than their current portfolios. Examining the stage in development of these acquisitions in columns (3) and (4), we find that firms increase their acquisitions of late-stage development projects (Phase II and above), but not early-stage projects (Phase I or pre-clinical).[36]

Put together, the evidence suggests that firms which transition to public equity markets due to non-prospectus increased disclosure requirements appear to reduce the number of drugs that they hold in development. They do so by reducing the number of new drugs that they initiate in-house and abandoning projects currently in development. Firms replace some of these projects through acquisitions of projects from other companies, but the acquisitions are of relatively less risky, later-stage projects. This effect substantially reduces the overall risk of the firm's development portfolio, and provides evidence that firms gravitate towards safe projects following going public.[37] This is consistent with theories that predict a reduction in innovation activity and a shift in investment towards existing (less risky) ideas by firms after going public (e.g., Ferreira et al. (2014)). Our results suggest that these effects may be viewed as an unintended consequence of increased mandatory disclosure requirements for private firms.

# 6 Conclusion

The determinants of what drives a private company to go public are of significant interest to lawmakers and researchers. In this paper, we show that increased mandatory disclosure requirements for private firms significantly increases their propensity of going public. We exploit a shock to disclosure requirements and utilize data regarding private firms in the U.S. Further analyses provide evidence that the mechanism underlying this increase is attributed to the proprietary costs of disclosure. This suggests that private firms' information environment and their ability (or lack thereof) to withhold project-level information in the normal course of their operations plays a significant role in the decision to transition to public equity markets.

The results are robust to a number of specifications and placebo tests. We additionally examine the project decisions of post-IPO firms, when the IPO is induced by the disclosure requirements. Our analysis using granular project-level shows the precise innovative effects due to the going-public decision. This contributes to our understanding of how firms' innova-

[36]This helps to explain the move towards less-risky acquisitions documented in columns (1) and (2). Since later-stage drugs are closer to approval, they will be less risky than early-stage drugs, all else being equal.

[37]This replacement effect rationalizes the magnitude of the increase in likelihood of approval provided in Table 10. For example, acquiring drugs in different, less risky therapeutic areas or acquiring later-stage drugs could substantially increase the average likelihood of approval of the drug portfolio (Wong et al. (2019)).

tive focus changes after their IPO. In particular we find that, not only does innovation decline following the IPO, but firms shift their development efforts towards safer projects. These results have potentially important implications for laws that mandate additional disclosure requirements for private firms.

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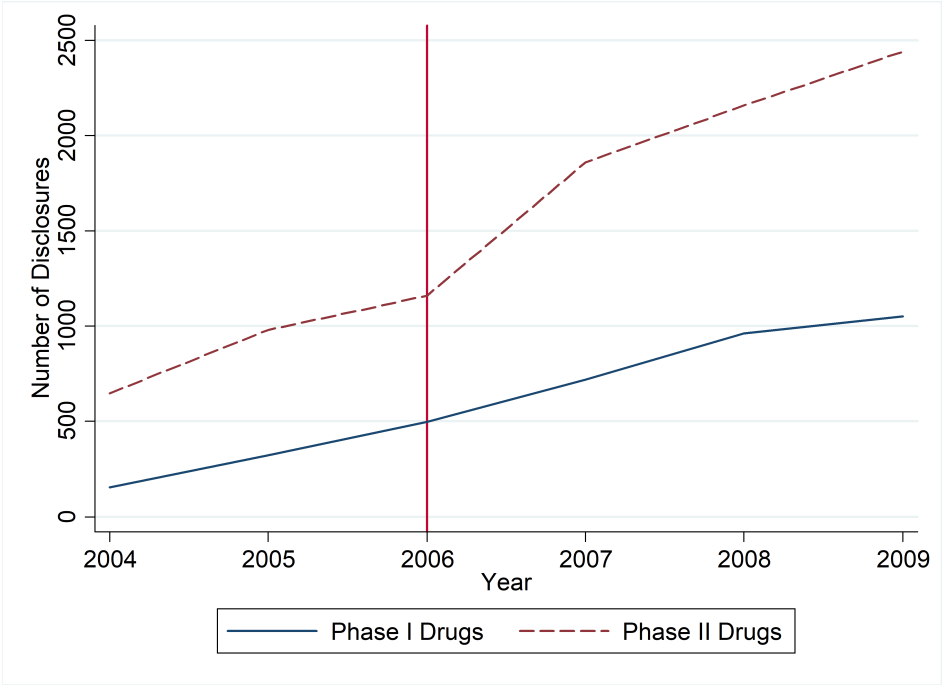
**Figure 1: Disclosures by Project Phase**

The top figure shows the total number of disclosures by private firms of drugs in Phase I compared to drugs in Phase II in the years around the enactment of the FDAAA. The bottom figure shows the differences in the number of Phase I disclosures compared to Phase II disclosures over time.



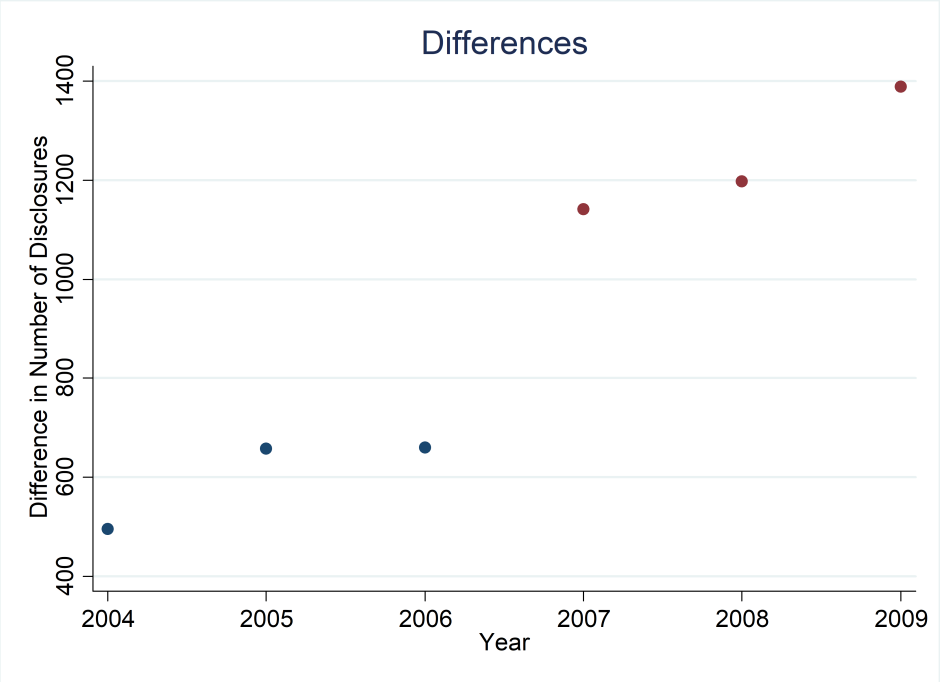
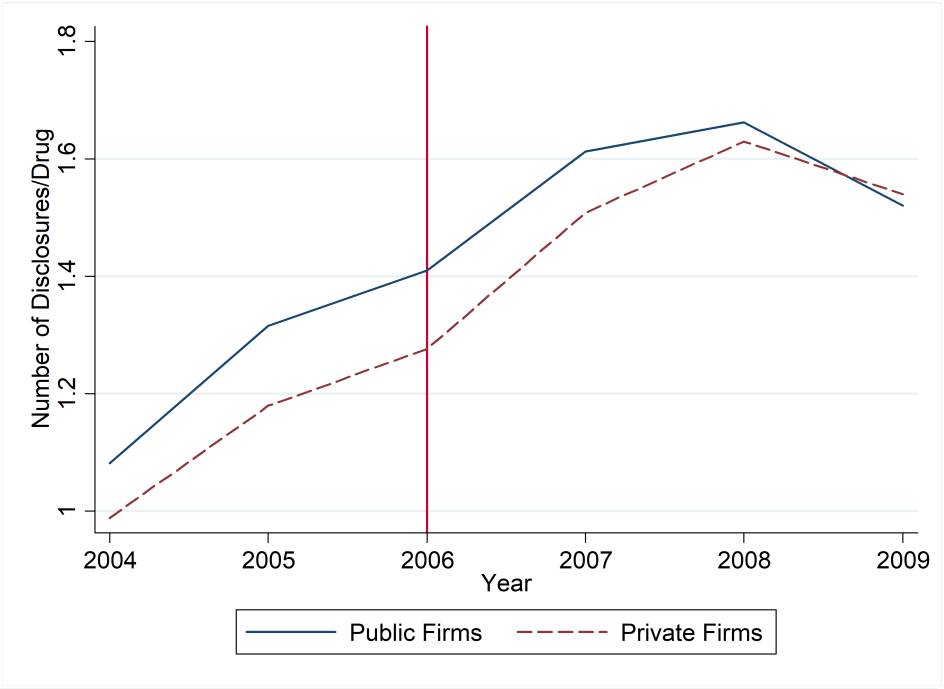



**Figure 2: Disclosures by Private and Public Companies**

The top figure shows the total number of disclosures per drug (the total number of disclosures scaled by the total number of drugs in each group) by private firms compared to public firms in the years around the enactment of the FDAAA. The bottom figure shows the differences in the scaled number of disclosures by private compared to public firms over time.



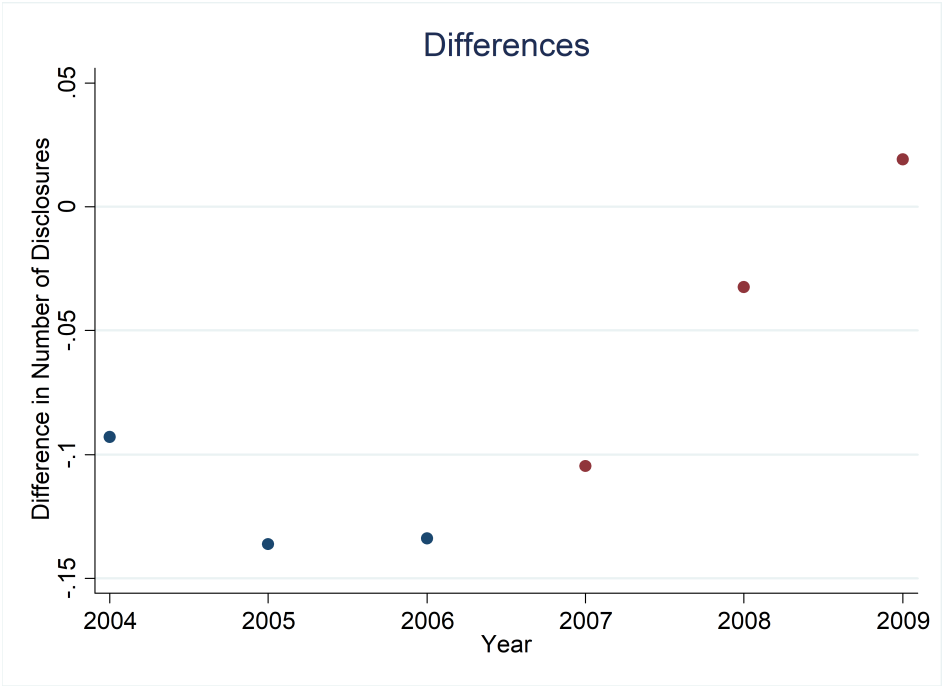



**Figure 3: Parallel Trends for IPOs**

This figure depicts parallel trends for the propensity to initiate an IPO surrounding the enactment of the FDAAA. In each year, the coefficient for the interaction between the treatment variable $PropPhaseII_i$ and the corresponding year dummy is plotted. $PropPhaseII_i$ is defined as the proportion of the firm's drug development portfolio in 2006 that is in Phase II or above (summary statistics are shown for the firm-level). The bars represent 90% confidence intervals. The coefficients are insignificant in all years prior to FDAAA enactment.

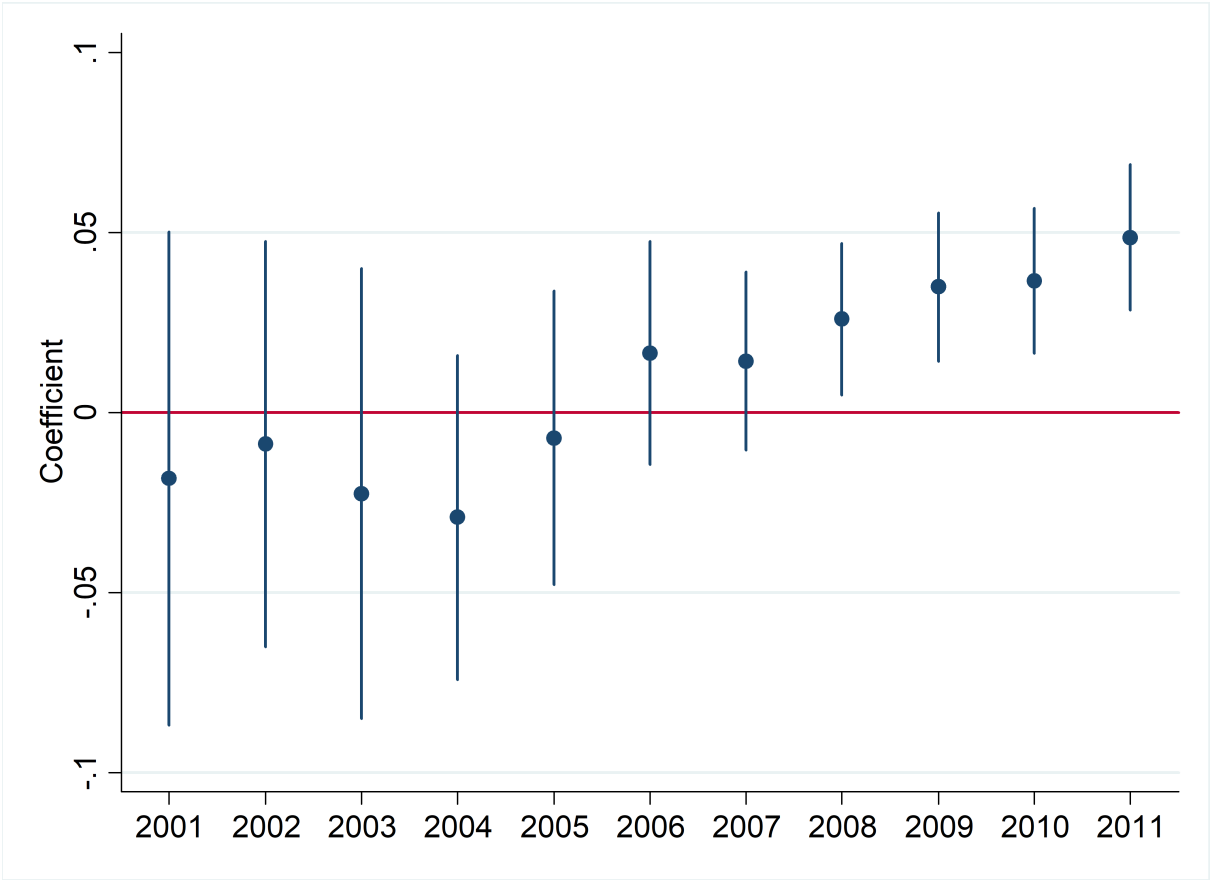


**Table 1: Summary Statistics**

This table contains summary statistics for all variables for the period of our main specification, from 2004 to 2009. $IPO_{i,t}$ is a dummy variable, which takes a value of 1 if the firm has undertaken an IPO, and 0 otherwise. $PropPhaseII_i$ is the proportion of the firm's drug development portfolio in 2006 that is in Phase II or above. $LOA_{i,t-1}$ is the lagged average likelihood of approval for all projects in a firm's drug development portfolio. $NumDrugs_{i,t-1}$ is the lagged total number of drugs in a firm's development portfolio.

| Variable | Obs | Mean | Std. Dev. | Median |
|---|---|---|---|---|
| $PropPhaseII_i$ | 5,181 | 0.593 | 0.427 | 0.745 |
| $IPO_{i,t}$ | 5,181 | 0.028 | 0.165 | 0.000 |
| $LOA_{i,t-1}$ | 4,304 | 0.278 | 0.200 | 0.220 |
| $NumDrugs_{i,t-1}$ | 4,304 | 5.491 | 16.236 | 2.000 |

**Table 2: IPO Propensity Following Increased Disclosure Requirements After FDAAA Enactment**

This table provides results for the main specification, examining the propensity to do an IPO following the increased disclosure requirements introduced by the FDAAA. The dependent variable is $IPO_{i,t}$, which is a dummy variable that takes a value of 1 if the firm has undertaken an IPO, and 0 otherwise. $PropPhaseII_i$ is the proportion of the firm's drug development portfolio in 2006 that is in Phase II or above. $FDAAA_t$ is a dummy variable that takes a value of 1 if the time period is 2007 or later, and 0 otherwise. Control variables include $LOA_{i,t-1}$, which is the average lagged likelihood of approval for all projects in a firm's drug development portfolio, and $NumDrugs_{i,t-1}$, which is the lagged total number of drugs in a firm's development portfolio. Drug portfolio therapeutic category indicators, year fixed effects, and firm fixed effects are included as indicated. The regressions are run from 2004 to 2009. Robust standard errors are in parentheses, and are clustered at the firm level. A constant term is included in all regressions, but not reported. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

| Dependent Variable: $IPO_{i,t}$ | | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $PropPhaseII_i \times FDAAA_t$ | 0.028*** | 0.029** | 0.030*** | 0.021** | 0.024* | 0.026** |
| | (0.008) | (0.009) | (0.009) | (0.010) | (0.014) | (0.011) |
| $PropPhaseII_i$ | 0.014* | 0.014 | 0.014 | 0.012 | 0.012 | |
| | (0.008) | (0.010) | (0.010) | (0.015) | (0.014) | |
| $FDAAA_t$ | −0.001 | −0.003 | | | | |
| | (0.005) | (0.007) | | | | |
| Controls | N | Y | Y | N | Y | Y |
| Year FEs | N | N | Y | Y | Y | Y |
| Firm FEs | N | N | N | N | N | Y |
| Project Portfolio Therapeutic Category Indicators | N | N | N | Y | Y | Y |
| Observations | 5,181 | 4,304 | 4,304 | 5,181 | 4,304 | 4,304 |
| $R^2$ | 0.009 | 0.008 | 0.010 | 0.373 | 0.400 | 0.892 |

**Table 3: IPOs Following the FDAAA, Partitioned by Pre-FDAAA Disclosure Level**

This table provides results examining the propensity to do an IPO following the increased disclosure requirements introduced by the FDAAA, split by the amount of disclosures by firms prior to the FDAAA. The sample is split based on whether a firm made a below-median or above-median annual number of disclosures per drug from 2000 to 2006. The dependent variable is $IPO_{i,t}$, which is a dummy variable that takes a value of 1 if the firm has undertaken an IPO, and 0 otherwise. $PropPhaseII_i$ is the proportion of the firm's drug development portfolio in 2006 that is in Phase II or above. $FDAAA_t$ is a dummy variable that takes a value of 1 if the time period is 2007 or later, and 0 otherwise. Control variables include $LOA_{i,t-1}$, which is the average lagged likelihood of approval for all projects in a firm's drug development portfolio, and $NumDrugs_{i,t-1}$, which is the lagged total number of drugs in a firm's development portfolio. Drug portfolio therapeutic category indicators, year fixed effects, and firm fixed effects are included as indicated. The regressions are run from 2004 to 2009. Robust standard errors are in parentheses, and are clustered at the firm level. A constant term is included in all regressions, but not reported. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable: $IPO_{i,t}$

| Pre-FDAAA Disclosures: | Low # Disclosures per Drug | | High # Disclosures per Drug | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| $PropPhaseII_i \times FDAAA_t$ | 0.017** | 0.034** | −0.002 | 0.0004 |
| | (0.008) | (0.016) | (0.027) | (0.012) |
| $PropPhaseII_i$ | 0.018*** | | −0.009 | |
| | (0.007) | | (0.024) | |
| $FDAAA_t$ | 0.010* | | 0.022 | |
| | (0.005) | | (0.023) | |
| Controls | N | Y | N | Y |
| Year FEs | N | Y | N | Y |
| Firm FEs | N | Y | N | Y |
| Project Portfolio Therapeutic Category Indicators | N | Y | N | Y |
| Observations | 2,800 | 2,447 | 1,610 | 1,420 |
| $R^2$ | 0.011 | 0.853 | 0.003 | 0.960 |

**Table 4: IPOs Following the FDAAA, Partitioned by Pre-FDAAA Competitiveness Level**

This table provides results examining the propensity to do an IPO following the increased disclosure requirements introduced by the FDAAA, split by competitiveness prior to the FDAAA. The sample is split based on whether a firm's drugs have a below-median or above-median number of competing drugs (in the same therapeutic class) in 2006. The dependent variable is $IPO_{i,t}$, which is a dummy variable that takes a value of 1 if the firm has undertaken an IPO, and 0 otherwise. $PropPhaseII_i$ is the proportion of the firm's drug development portfolio in 2006 that is in Phase II or above. $FDAAA_t$ is a dummy variable that takes a value of 1 if the time period is 2007 or later, and 0 otherwise. Control variables include $LOA_{i,t-1}$, which is the average lagged likelihood of approval for all projects in a firm's drug development portfolio, and $NumDrugs_{i,t-1}$, which is the lagged total number of drugs in a firm's development portfolio. Drug portfolio therapeutic category indicators, year fixed effects, and firm fixed effects are included as indicated. The regressions are run from 2004 to 2009. Robust standard errors are in parentheses, and are clustered at the firm level. A constant term is included in all regressions, but not reported. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable: $IPO_{i,t}$

| Pre-FDAAA Disclosures: | Low # of Competing Drugs | | High # of Competing Drugs | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| $PropPhaseII_i \times FDAAA_t$ | 0.013* | 0.021 | 0.040*** | 0.027* |
| | (0.008) | (0.013) | (0.013) | (0.015) |
| $PropPhaseII_i$ | 0.003 | | 0.022 | |
| | (0.008) | | (0.015) | |
| $FDAAA_t$ | 0.006 | | −0.004 | |
| | (0.006) | | (0.008) | |
| Controls | N | Y | N | Y |
| Year FEs | N | Y | N | Y |
| Firm FEs | N | Y | N | Y |
| Project Portfolio Therapeutic Category Indicators | N | Y | N | Y |
| Observations | 2,006 | 1,738 | 3,175 | 2,566 |
| $R^2$ | 0.005 | 0.882 | 0.014 | 0.910 |

**Table 5:**
**Robustness: Placebo Test for FDAAA**

This table provides results for a placebo test, examining the propensity to do an IPO following falsely defining the passage of the FDAAA as 2003. The dependent variable is $IPO_{i,t}$, which is a dummy variable that takes a value of 1 if the firm has undertaken an IPO, and 0 otherwise. $PropPhaseII_i{}'$ is the proportion of the firm's drug development portfolio in 2002 that is in Phase II or above. $PlaceboTime_t^{'}$ is a dummy variable that takes a value of 1 if the time period is 2003 or later, and 0 otherwise. Control variables include $LOA_{i,t-1}$, which is the average lagged likelihood of approval for all projects in a firm's drug development portfolio, and $NumDrugs_{i,t-1}$, which is the lagged total number of drugs in a firm's development portfolio. Drug portfolio therapeutic category indicators, year fixed effects, and firm fixed effects are included as indicated. The regressions are run from 2000 to 2005. Robust standard errors are in parentheses, and are clustered at the firm level. A constant term is included in all regressions, but not reported. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable: $IPO_{i,t}$

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| $PropPhaseII_i{}' \times PlaceboTime_t$ | 0.016 | 0.027 | 0.034 | 0.007 | 0.024 | −0.002 |
| | (0.026) | (0.039) | (0.039) | (0.025) | (0.036) | (0.011) |
| $PropPhaseII_i{}'$ | 0.011 | 0.001 | 0.001 | 0.014 | −0.002 | |
| | (0.029) | (0.041) | (0.041) | (0.029) | (0.043) | |
| $PlaceboTime_t$ | −0.003 | −0.012 | | | | |
| | (0.022) | (0.034) | | | | |
| Controls | N | Y | Y | N | Y | Y |
| Year FEs | N | N | Y | Y | Y | Y |
| Firm FEs | N | N | N | N | N | Y |
| Project Portfolio Therapeutic Category Indicators | N | N | N | Y | Y | Y |
| Observations | 2,358 | 1,759 | 1,759 | 2,358 | 1,759 | 1,759 |
| $R^2$ | 0.004 | 0.005 | 0.007 | 0.344 | 0.406 | 0.935 |

**Table 6:**
**Robustness: Excluding the Financial Crisis**

This table provides robustness results for the main specification, examining the propensity to do an IPO following the increased disclosure requirements introduced by the FDAAA, but excluding the years of the financial crisis. The dependent variable is $IPO_{i,t}$, which is a dummy variable that takes a value of 1 if the firm has undertaken an IPO, and 0 otherwise. $PropPhaseII_i$ is the proportion of the firm's drug development portfolio in 2006 that is in Phase II or above. $FDAAA_t$ is a dummy variable that takes a value of 1 if the time period is 2007 or later, and 0 otherwise. Control variables include $LOA_{i,t-1}$, which is the average lagged likelihood of approval for all projects in a firm's drug development portfolio, and $NumDrugs_{i,t-1}$, which is the lagged total number of drugs in a firm's development portfolio. Drug portfolio therapeutic category indicators, year fixed effects, and firm fixed effects are included as indicated. The regressions are run from 2004 to 2009, excluding 2007 and 2008. Robust standard errors are in parentheses, and are clustered at the firm level. A constant term is included in all regressions, but not reported. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable: $IPO_{i,t}$

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| $PropPhaseII_i \times FDAAA_t$ | 0.035*** | 0.037*** | 0.037*** | 0.028** | 0.034** | 0.036* |
| | (0.009) | (0.011) | (0.011) | (0.011) | (0.015) | (0.020) |
| $PropPhaseII_i$ | 0.014* | 0.014 | 0.013 | 0.011 | 0.008 | |
| | (0.008) | (0.010) | (0.010) | (0.011) | (0.014) | |
| $FDAAA_t$ | −0.002 | −0.005 | | | | |
| | (0.005) | (0.008) | | | | |
| Controls | N | Y | Y | N | Y | Y |
| Year FEs | N | N | Y | Y | Y | Y |
| Firm FEs | N | N | N | N | N | Y |
| Project Portfolio Indication Category Indicators | N | N | N | Y | Y | Y |
| Observations | 3,183 | 2,606 | 2,606 | 3,183 | 2,606 | 2,606 |
| $R^2$ | 0.009 | 0.010 | 0.012 | 0.340 | 0.373 | 0.890 |

**Table 7:**
**Robustness: Placebo Test for Portfolio Phase**

This table provides robustness results for the main specification, examining the propensity to do an IPO following the increased disclosure requirements introduced by the FDAAA, but falsely defining the treatment phase threshold. The dependent variable is $IPO_{i,t}$, which is a dummy variable that takes a value of 1 if the firm has undertaken an IPO, and 0 otherwise. $PropPhaseIII_i$ is the proportion of the firm's drug development portfolio in 2006 that is in Phase III or above; companies with drugs in Phase I are excluded. $FDAAA_t$ is a dummy variable that takes a value of 1 if the time period is 2007 or later, and 0 otherwise. Control variables include $LOA_{i,t-1}$, which is the average lagged likelihood of approval for all projects in a firm's drug development portfolio, and $NumDrugs_{i,t-1}$, which is the lagged total number of drugs in a firm's development portfolio. Drug portfolio therapeutic category indicators, year fixed effects, and firm fixed effects are included as indicated. The regressions are run from 2004 to 2009, excluding 2007 and 2008. Robust standard errors are in parentheses, and are clustered at the firm level. A constant term is included in all regressions, but not reported. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

| Dependent Variable: $IPO_{i,t}$ | | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $PropPhaseIII_i \times FDAAA_t$ | −0.005 | −0.007 | −0.008 | −0.004 | −0.004 | 0.004 |
| | (0.011) | (0.012) | (0.012) | (0.012) | (0.014) | (0.013) |
| $PropPhaseIII_i$ | 0.007 | 0.013 | 0.015 | 0.018 | 0.037 | |
| | (0.014) | (0.023) | (0.023) | (0.023) | (0.029) | |
| $FDAAA_t$ | 0.021** | 0.017* | 0.017* | | | |
| | (0.008) | (0.009) | (0.010) | | | |
| Controls | N | Y | Y | N | Y | Y |
| Year FEs | N | N | Y | Y | Y | Y |
| Firm FEs | N | N | N | N | N | Y |
| Project Portfolio Therapeutic Category Indicators | N | N | N | Y | Y | Y |
| Observations | 2,083 | 1,848 | 1,848 | 2,083 | 1,848 | 1,848 |
| $R^2$ | 0.004 | 0.015 | 0.016 | 0.493 | 0.537 | 0.904 |

## Table 8:
## Robustness: Project Composition and IPOs pre-FDAAA

This table provides robustness results examining the propensity to go public based on portfolio composition prior to the enactment of the FDAAA. The dependent variable is $IPO_{i,t}$, which is a dummy variable that takes a value of 1 if the firm has undertaken an IPO, and 0 otherwise. $PropPhaseII_i$ is the proportion of the firm's drug development portfolio in 2000 that is in Phase II or above. $PropPhaseII_{i,t-1}$ is the proportion of the firm's drug development portfolio in the previous year that is in Phase II or above. Control variables include $LOA_{i,t-1}$, which is the average lagged likelihood of approval for all projects in a firm's drug development portfolio, and $NumDrugs_{i,t-1}$, which is the lagged total number of drugs in a firm's development portfolio. Drug portfolio therapeutic category indicators and year fixed effects are included, as indicated. The regressions are run from 2000 to 2006. Robust standard errors are in parentheses, and are clustered at the firm level. A constant term is included in all regressions, but not reported. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

*Panel A: Portfolio Composition at Beginning of Period*

Dependent Variable: $IPO_{i,t}$

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $PropPhaseII_i$ | 0.021 | 0.016 | 0.025 | 0.035 |
| | (0.018) | (0.021) | (0.023) | (0.028) |
| Controls | N | Y | Y | Y |
| Year FEs | N | N | Y | Y |
| Project Portfolio Therapeutic Category Indicators | N | N | N | Y |
| Observations | 3,182 | 2,439 | 2,439 | 2,439 |
| $R^2$ | 0.003 | 0.002 | 0.006 | 0.379 |

*Panel B: Portfolio Composition Over Time*

Dependent Variable: $IPO_{i,t}$

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| $PropPhaseII_{i,t-1}$ | 0.013 | 0.014 | 0.015 | 0.017 | 0.008 |
| | (0.011) | (0.011) | (0.011) | (0.017) | (0.013) |
| Controls | N | Y | Y | Y | Y |
| Year FEs | N | N | Y | Y | Y |
| Firm FEs | N | N | N | N | Y |
| Project Portfolio Therapeutic Category Indicators | N | N | N | Y | Y |
| Observations | 2,439 | 2,439 | 2,439 | 2,439 | 2,439 |
| $R^2$ | 0.001 | 0.078 | 0.003 | 0.377 | 0.911 |

**Table 9:**
**Robustness: Autocorrelation**

This table provides robustness results for the main specification, correcting for potential autocorrelation. The dependent variable is $IPO_{i,t}$, which is a dummy variable that takes a value of 1 if the firm has undertaken an IPO, and 0 otherwise. $PropPhaseII_i$ is the proportion of the firm's drug development portfolio in 2006 that is in Phase II or above. $FDAAA_t$ is a dummy variable that takes a value of 1 if the time period is 2007 or later, and 0 otherwise. Control variables include $LOA_{i,t-1}$, which is the average lagged likelihood of approval for all projects in a firm's drug development portfolio, and $NumDrugs_{i,t-1}$, which is the lagged total number of drugs in a firm's development portfolio. Drug portfolio therapeutic category indicators and year fixed effects are included, as indicated. The regressions are run from 2004 to 2009. Standard errors (in parentheses) are following Newey and West (1987), adjusting for heteroskedasticity and autocorrelation of up to 2 lags. A constant term is included in all regressions, but not reported. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable: $IPO_{i,t}$

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| $PropPhaseII_i \times FDAAA_t$ | 0.027*** | 0.029** | 0.030** | 0.021** | 0.024* | 0.026*** |
| | (0.010) | (0.012) | (0.012) | (0.010) | (0.013) | (0.007) |
| $PropPhaseII_i$ | 0.014* | 0.014 | 0.014 | 0.012 | 0.012 | |
| | (0.007) | (0.009) | (0.009) | (0.010) | (0.013) | |
| $FDAAA_t$ | −0.001 | −0.003 | | | | |
| | (0.006) | (0.008) | | | | |
| Controls | N | Y | Y | N | Y | Y |
| Firm FEs | N | N | N | N | N | Y |
| Year FEs | N | N | Y | Y | Y | Y |
| Project Portfolio Therapeutic Category Indicators | N | N | N | Y | Y | Y |
| Observations | 5,181 | 4,304 | 4,304 | 5,181 | 4,304 | 4,133 |

**Table 10: Project Decisions and IPOs post-FDAAA**

This table provides second-stage instrumental variable (IV) results showing firms' drug project decisions following IPOs induced by the disclosure requirements of the FDAAA. $\hat{IPO}_{i,t}$ is instrumented IPO, using regression (1) in the first-stage to instrument for going public. Outcome variables include $NumDrugs_{i,t}$, the total number of drugs in a firm's development portfolio; $Initiation_{i,t}$, the number of new drug projects that a firm initiates; $Suspension_{i,t}$, the number of drug projects in development that the firm suspends; $Acquisition_{i,t}$, the number of drug projects that the firm acquires from other firms; and $LOA_{i,t}$, the average likelihood of approval for all projects in a firm's drug development portfolio. Control variables include the lagged variables $LOA_{i,t-1}$ and $NumDrugs_{i,t-1}$. Drug portfolio therapeutic category indicators and year fixed effects are included as indicated. The regressions are run from 2004 to 2009. Robust standard errors are in parentheses, and are clustered at the firm level. A constant term is included in all regressions, but not reported. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Dependent Variable: | $NumDrugs_{i,t}$ | $Initiation_{i,t}$ | $Suspension_{i,t}$ | $Acquisition_{i,t}$ | $LOA_{i,t}$ |
| $\hat{IPO}_{i,t}$ | −4.091** | −2.284** | 2.384** | 1.097* | 0.520** |
| | (1.873) | (1.081) | (1.201) | (0.611) | (0.230) |
| Controls | Y | Y | Y | Y | Y |
| Year FEs | Y | Y | Y | Y | Y |
| Project Portfolio Therapeutic Category Indicators | Y | Y | Y | Y | Y |
| Observations | 4,304 | 4,304 | 4,304 | 4,304 | 4,304 |
| $R^2$ | 0.997 | 0.810 | 0.894 | 0.266 | 0.707 |

**Table 11: Project Decisions and IPOs post-FDAAA**

This table provides second-stage instrumental variable (IV) results showing firms' drug project acquisition decisions following IPOs induced by the disclosure requirements of the FDAAA. $\hat{IPO}_{i,t}$ is instrumented IPO, using regression (1) in the first-stage to instrument for going public. Outcome variables include $Risky\ Acquisition_{i,t}$, the number of acquisitions of drugs that are more risky than the firm's current development portfolio; $Less\ Risky\ Acquisition_{i,t}$, the number of acquisitions of drugs that are less risky than the firm's current development portfolio; $Late\ Acquisition_{i,t}$, the number of acquisitions of drugs in Phase II or above; and $Early\ Acquisition_{i,t}$, the number of acquisitions of pre-clinical or Phase I drugs. Control variables include the lagged variables $LOA_{i,t-1}$ and $NumDrugs_{i,t-1}$. Drug portfolio therapeutic category indicators and year fixed effects are included as indicated. The regressions are run from 2004 to 2009. Robust standard errors are in parentheses, and are clustered at the firm level. A constant term is included in all regressions, but not reported. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Dependent Variable: | $Risky\ Acquisition_{i,t}$ | $Less\ Risky\ Acquisition_{i,t}$ | $Late\ Acquisition_{i,t}$ | $Early\ Acquisition_{i,t}$ |
| $\hat{IPO}_{i,t}$ | 0.136 | 0.942* | 0.209* | 0.219 |
| | (0.189) | (0.506) | (0.112) | (0.228) |
| Controls | Y | Y | Y | Y |
| Year FEs | Y | Y | Y | Y |
| Project Portfolio Therapeutic Category Indicators | Y | Y | Y | Y |
| Observations | 4,285 | 4,285 | 4,304 | 4,285 |
| $R^2$ | 0.427 | 0.810 | 0.189 | 0.331 |

# Appendix (For Online Publication)

**Table A1: Project Composition and Project Decisions pre-FDAAA**

This table provides robustness results examining the propensity to go public based on portfolio composition prior to the enactment of the FDAAA. $PropPhaseII_{i,t-1}$ is the proportion of the firm's drug development portfolio that is in Phase II or above. $NumDrugs_{i,t}$ is the total number of drugs in a firm's development portfolio. $Initiation_{i,t}$ is the number of new drug projects that a firm initiates. $Suspension_{i,t}$ is the number of drug projects in development that the firm suspends. $Acquisition_{i,t}$ is the number of drug projects that the firm acquires from other firms. Control variables include $LOA_{i,t-1}$, which is the lagged average likelihood of approval for all projects in a firm's drug development portfolio, and the lagged variable $NumDrugs_{i,t-1}$. Drug portfolio therapeutic category indicators and year fixed effects are included, as indicated. The regressions are run from 2004 to 2006. Robust standard errors are in parentheses, and are clustered at the firm level. A constant term is included in all regressions, but not reported. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

| Dependent Variable: | $NumDrugs_{i,t}$ | $Initiation_{i,t}$ | $Suspension_{i,t}$ | $Acquisition_{i,t}$ |
|---|---|---|---|---|
| $PropPhaseII_{i,t-1}$ | 0.027 | 0.082 | 0.119 | −0.016 |
| | (0.086) | (0.099) | (0.093) | (0.040) |
| Controls | Y | Y | Y | Y |
| Year FEs | Y | Y | Y | Y |
| Firm FEs | Y | Y | Y | Y |
| Project Portfolio Therapeutic Category Indicators | Y | Y | Y | Y |
| Observations | 1,573 | 1,573 | 1,573 | 1,573 |
| $R^2$ | 0.9998 | 0.968 | 0.966 | 0.747 |

**Table A2: IPOs Following the FDAAA, Split by Pre-FDAAA Orphan Drug Designations**

This table provides results examining the propensity to do an IPO following the increased disclosure requirements introduced by the FDAAA, split based on whether a firm has a drug in development designated as an orphan drug in 2006. The dependent variable is $IPO_{i,t}$, which is a dummy variable that takes a value of 1 if the firm has undertaken an IPO, and 0 otherwise. $PropPhaseII_i$ is the proportion of the firm's drug development portfolio in 2006 that is in Phase II or above. $FDAAA_t$ is a dummy variable that takes a value of 1 if the time period is 2007 or later, and 0 otherwise. Control variables include $LOA_{i,t-1}$, which is the average lagged likelihood of approval for all projects in a firm's drug development portfolio, and $NumDrugs_{i,t-1}$, which is the lagged total number of drugs in a firm's development portfolio. Drug portfolio therapeutic category indicators, year fixed effects, and firm fixed effects are included as indicated. The regressions are run from 2004 to 2009. Robust standard errors are in parentheses, and are clustered at the firm level. A constant term is included in all regressions, but not reported. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable: $IPO_{i,t}$

| Pre-FDAAA Disclosures: | No Orphan Drug | | Orphan Drug | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| $PropPhaseII_i \times FDAAA_t$ | 0.018** | 0.018* | 0.022 | 0.032 |
| | (0.008) | (0.009) | (0.019) | (0.037) |
| $PropPhaseII_i$ | 0.011 | | −0.003 | |
| | (0.008) | | (0.028) | |
| $FDAAA_t$ | 0.008 | | 0.043** | |
| | (0.005) | | (0.020) | |
| Controls | N | Y | N | Y |
| Year FEs | N | Y | N | Y |
| Firm FEs | N | Y | N | Y |
| Project Portfolio Therapeutic Category Indicators | N | Y | N | Y |
| Observations | 3,903 | 3,114 | 1,278 | 1,190 |
| $R^2$ | 0.007 | 0.919 | 0.009 | 0.920 |

**Table A3: Project Decisions and IPOs post-FDAAA**

This table provides two-stage least squares results showing firms' drug project decisions following IPOs induced by the disclosure requirements of the FDAAA. Column (1) provides first-stage results using $PropPhaseII_i$ to instrument for $IPO_{i,t}$, while columns (2) through (5) provide second-stage results for project decisions due to having done an (instrumented) IPO. $IPO_{i,t}$ is a dummy variable that takes a value of 1 if the firm has undertaken an IPO, and 0 otherwise; $\hat{IPO}_{i,t}$ is instrumented IPO. $PropPhaseII_i$ is the proportion of the firm's drug development portfolio in 2006 that is in Phase II or above. Second-stage outcome variables include $NumDrugs_{i,t}$, the firm's total number of drug-indications currently under development; $Initiation_{i,t}$, which is the number of new drug projects that a firm initiates; $Suspension_{i,t}$, which is the number of drug projects in development that the firm suspends; and $Acquisition_{i,t}$, which is the number of drug projects that the firm acquires from other firms. Control variables include $LOA_{i,t-1}$, which is the average lagged likelihood of approval for all projects in a firm's drug development portfolio, and $NumDrugs_{i,t-1}$, which is the lagged total number of drugs in a firm's development portfolio. Drug portfolio therapeutic category indicators and year fixed effects are included as indicated. The regressions are run from 2007 to 2009. Robust standard errors are in parentheses, and are clustered at the firm level. A constant term is included in all regressions, but not reported. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | First-stage | Second-stage | | | |
| Dependent Variable: | $IPO_{i,t}$ | $NumDrugs_{i,t}$ | $Initiation_{i,t}$ | $Suspension_{i,t}$ | $Acquisition_{i,t}$ |
| $PropPhaseII_i$ | 0.032** | | | | |
| | (0.015) | | | | |
| $\hat{IPO}_{i,t}$ | | −4.983** | −3.114** | 1.466 | 1.071 |
| | | (2.373) | (1.527) | (1.178) | (0.736) |
| Controls | Y | Y | Y | Y | Y |
| Year FEs | Y | Y | Y | Y | Y |
| Project Portfolio Therapeutic Category Indicators | Y | Y | Y | Y | Y |
| Observations | 2,731 | 2,731 | 2,731 | 2,731 | 2,731 |
| $R^2$ | 0.542 | 0.998 | 0.841 | 0.933 | 0.379 |