Does Innovation Decline Post-IPO?

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Abstract

Bernstein (2015) estimates that innovation quality decreases by 43 percent more post-IPO for firms that successfully go public than firms that file to go public but ultimately withdraw. I document that 54 percent of this magnitude is attributable to a negative survivorship bias from sample selection. In addition, I find no effect when extending his results to 2012, partially attributable to the decline in relevance of his identification strategy. I document an increase in trademark production for firms with completed IPOs which suggests public firms shift their innovative focus towards commercialization. These results cast doubt on the adverse effects of going public on innovation and the recent IPO literature that instruments for IPO completion using the post-filing returns on the Nasdaq stock index.

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While previous research has well-studied the decision of firms to remain private or go public, many of the implications of this decision are not well understood(Aghamolla & Thakor, 2022; Ferreira, Manso, & Silva, 2014; Gao, Ritter, & Zhu, 2013). Of particular importance, is the question of whether going public impacts the quality and output of a firm's innovation output as innovation is the key driver of economic growth and productivity in society (Schumpeter, 1912). This question has important ramifications for how governmental and regulatory authorities incentivize firms towards public or private markets.[1]

Early approaches to examine the impact of the legal ownership structure of firms on innovation lacked comprehensiveness, strong causal identification, and ended their sample period by 2003 due to the National Bureau of Economic Research (NBER) patent data ending in 2006(Hall, Jaffe, & Trajtenberg, 2001). Aggarwal and Hsu (2014) document that venture capital-backed biotechnology firms that go public experience a long-run decline in innovation quality. Acharya and Xu (2017) find that there is heterogeneity in the impact of a firm's legal structure on innovation with public firms in externally finance dependent industries outperforming their private peers, but this study relies largely upon selection on observables and a regression discontinuity design (RDD) that is a causal estimate only for a small number of distressed firms.[2] Bernstein (2015) was the first to causally identify the effect of going public using a large cross-section of IPO filing firms from 1985 to 2003 and an instrumental variable approach that cleverly used the post-filing returns on the Nasdaq as an instrument for the otherwise endogenous IPO completion.[3] Bernstein (2015) documents a decline in innovation quality and originality with no offsetting declines in patented output for firms

[1]For example, consider the more recent trend to allow firms to remain private longer by legal changes in the number of shareholders and improving capital access to private firms through the National Securities Markets Improvement Act of 1996 (Ewens & Farre-Mensa, 2020).

[2]In a related work, Seru (2014) finds that firms in exogenously failed mergers have higher innovation output and novelty than firms ultimately acquired by conglomerates. These exogenously failed mergers are self-defined by Seru (2014) and are based on short-term drops in market valuations.

[3]The post-filing returns on the Nasdaq had been shown within the prior literature to be a statistically significant predictor of IPO withdrawal(Benveniste et al., 2003; Busaba, Benveniste, & Guo, 2001) and could also be argued to be exogenous as the post-filing return on the Nasdaq seems to be outside of a firm's control.

that successfully completed their IPO in comparison to firms that withdrew their IPO filings from 1985 to 2003.[4] His findings and identification strategy have been particularly influential spawning a whole area of research using this instrumental variable of post-filing returns on the Nasdaq to instrument for IPO completion including the effect of going public on: human capital (Babina, Ouimet, & Zarutskie, 2020), stock market participation of individuals in the local geographic area to recent IPO firms (Jiang, Lowry, & Qian, 2022), the geographic expansion of firms (Cornaggia et al., 2021), corporate taxes (Dobridge, Lester, & Whitten, 2021), patent litigation(Caskurlu, 2019), IPO proceeds (Dambra, Gustafson, & Pisciotta, 2021), and firm diversity(Koning & Ferguson, 2019).

In this paper, I reexamine the effect of going public on innovation by extending the analysis of Bernstein (2015) to 2012, analyzing the robustness of Bernstein (2015) to reasonable sample design choices, and integrating trademark filing data to examine whether this initial decline in innovation quality might be explained by a shift in public firms' innovation strategy towards product related innovation. In contrast to Bernstein (2015) I find no adverse effects of going public on innovation when extending his analysis or applying reasonable design choices from the innovation literature. I document five shortcomings of his approach and findings that cast doubt on whether innovation declines post-IPO for the cross-section of firms that ultimately go public.

First, I show that the identification strategy used by Bernstein (2015) is not valid after 2003 due to a loss in relevance of the post-filing returns on the Nasdaq in shifting a firm's likelihood of IPO completion. Prior to 2003, the two-month post-filing returns on the Nasdaq and other forms of this instrument are highly relevant (F-statistic > 40) in shifting a firm's likelihood of IPO completion and also appear to be exogenous(i.e. the post-filing returns on the Nasdaq impact innovation quality only through a firm's legal status). Firms that experience large increases in the post-filing returns on the Nasdaq are significantly more likely to complete their IPO filing while firms exposed to negative returns on the Nasdaq during their IPO filing are much more likely to withdrawal. Post-2003, I

[4]Bernstein (2015) credits this decline in innovation quality of public firms to inventors being less productive and more likely to leave public firms once their stock options vested.

document that the post-filing returns on the Nasdaq no longer explain IPO completion with various intervals of this instrument and samples all resulting in a weak first-stage F-statistic. After 2003, I find that idiosyncratic firm characteristics such as patent quality become important determinants of IPO completion and that in addition to the growth of private capital(Ewens & Farre-Mensa, 2020), have led to a decline in the impact of external market factors.[5,6] I find no effect of going public on innovation quality when extending Bernstein (2015)'s results to 2012. Due to the instrumental variables estimator providing a local average treatment effect (LATE), it is estimated using firm observations in which the post-filing returns on the Nasdaq shift the likelihood of IPO completion. The loss of relevance of this instrument suggests a casual estimate is identified primarily off of firm observations prior to 2003. As many recent papers within the literature rely on this identification strategy, it is important to note that their causal estimates are only valid prior to 2003, and a new identification approach must be applied to have valid causal inference post-2003.[7]

Second, I show that Bernstein (2015)'s finding of a decline in innovation quality for firms that go public from 1985 to 2003 is partially driven by sample selection as his estimates of innovation quality condition on a firm having a patent in the pre- and post-period to be included.[8] This approach leads to a negative bias of finding an effect of going public on innovation quality if firms that successfully go public have a greater likelihood of patenting post-IPO in comparison to firms with withdrawn IPOs. I document that firms that successfully go public have both a higher likelihood to continue patenting post-IPO given they patented pre-IPO in comparison to firms that stay private (79 percent

[5]As documented in Ewens and Farre-Mensa (2020), the passage of the National Securities Market Improvement Act in 1996 led to firms staying private longer which enabled market participants to better evaluate the quality of IPO filing firms.

[6]Additionally, equity markets display stronger mean reversion after 2003, leading to a higher probability of firms experiencing poor returns in the pre-filing period which contributes to a lower probability of IPO completion for a higher post-filing return quintile.

[7]The papers that use this identification approach all use sample periods that include earlier periods when this instrument is highly relevant resulting in the instrument appearing to be unconditionally valid over the entire sample.

[8]The original findings of Bernstein (2015) from 1985 to 2003 are still internally valid. However, his effect sizes represent the effects of going public on innovation quality for firms that do not become innovators post-IPO and avoid a decline in innovative activity post-IPO rather than the cross-section of IPO filing firms.

versus 64 percent), and conditional on having no patents on the pre-period are much likelier to innovate post-IPO (12 percent versus 7 percent).[9] Following Atanassov (2013), I set scaled citations to zero for firm observations that have no patents in the pre- or post-IPO filing window to overcome these sample selection issues. I find no effect of IPO completion on innovation quality post-IPO when accounting for the increase in likelihood of public firms to innovate post-IPO in comparison to their peer firms that stay private. This negative sample selection bias is quite large and correcting it results an effect size decline from 58 percent post-IPO for completed firms to a 26 percent decline.[10]

Third, I find no impact of going public on other measures of patent quality. Two other common measures of patent quality outside of the number of citations it receives is how novel a patent is based on the number of different patent subsections it cites and the generality of a patent measured based on the diversity of patent subsections that cite the focal patent. While Bernstein (2015) finds a decline in innovative originality and no effect on generality for firms that successfully go public, I find no change in either measure.

Fourth, I examine whether this seeming decline in innovation might be driven by a failure to capture a firm's true innovation activity by integrating trademark data for public and private firms. I find that firms with completed IPOs experience significant increases in trademark output in the post-IPO filing period in comparison to firms with withdrawn IPOs. I document large shifts in firms with successful IPOs (in comparison to withdrawn firms) towards trademarks and product-related innovation with a statistically significant IV effect size of 79 percent estimated from 1985 to 2003. These results are consistent with Larrain et al. (2021) which documents a similar shift of public firms towards commercialization in the European IPO market from 1997 to 2017. Similar to Bernstein (2015), I find that going public results in no estimated difference in the quantity of patents output post-IPO in comparison to firms with withdrawn IPOs.

[9]More succinctly, the econometric concern is that by conditioning on an outcome affected by treatment, Bernstein (2015) obtains a biased estimate of the true effect of going public on innovation quality.

[10]Similarly, when applying other reasonable sampling filters such as requiring a firm to have a patent before filing (an ex-ante measure) or including all IPO firms regardless of their patenting output, I find no adverse effect of going public on innovation quality.

Fifth, I examine whether this seeming decline in innovation quality by firms is efficient. I document a correlation of almost zero (0.01) between a patent's economic value using the measure provided by Kogan et al. (2017) and its scaled citations received. I find that patent production is strongly linked to profitability in the post-IPO filing window for firms with completed IPOs, but a firm's citation quality change has no impact on its profitability. Patent and trademark production are strongly linked to stock market outperformance as a one standard deviation increase in a firm's patent production post-IPO increases expected returns by 167 percent over the five-year post-filing period while a one standard deviation increase in trademarks is associated with a 56 percent increase in returns. In contrast, changes in innovation quality post-IPO have no effect on stock market performance. These results in aggregate suggests that firms are rational to pursue quantity and innovative production efficiency rather than patents that might be of little economic value but receive substantial citations consistent with (Abrams, Akcigit, & Grennan, 2013; Hirshleifer, Hsu, & Li, 2013; Kogan et al., 2017).

This paper's main contribution is to the innovation literature–namely the effects of going public on innovation and the broader literature on the effects of legal structure on company activities. My work documents no decline in innovation for public firms when extending the sample period beyond 2003 or including the cross-section of IPO filing firms in a way that mitigates the effects of negative survivorship bias. Consistent with Hirshleifer, Hsu, and Li (2013), I provide supporting evidence that this seeming decline in innovation quality is efficient due to shareholders valuing innovation output over scientific contribution. Additionally, this paper more broadly adds to the literature on the effects of legal structure on firm activity by documenting the breakdown of a commonly used identification strategy. The loss of relevance of the post-filing returns on the Nasdaq as a valid instrumental variable suggests the need for new causal identification to address the effects of a company's legal structure on firm activities after 2003.

This paper also contributes to the question of how a firm's legal structure impacts its innovation strategy. Ferreira, Manso, and Silva (2014) theorize that firms go public when their innovations

shift from exploratory to more focused. Gao, Hsu, and Li (2018) find that the innovations of public firms are more likely to rely on existing technologies and less likely to be exploratory in comparison to private firms. Asker, Farre-Mensa, and Ljungqvist (2015) document that public firms invest substantially less and are less sensitive to investment opportunity shocks using a parametric-based matching approach for identification. Using more focused settings, Gilje and Taillard (2016) find that public firms invest more when analyzing the natural gas industry and Phillips and Sertsios (2017) document a similar phenomenon using data from the medical devices following a shock from Medicare expansion. My results examining differences in the trademark and patented activity of public versus private firms post-IPO contributes an understanding of the increasing focus on commercialization for U.S. public firms. These results are consistent with the work of Larrain et al. (2021) which documents a similar shift of public firms towards commercialization in the European IPO market from 1997 to 2017.

1 Data

1.1 Sample

I collect all IPO filings using Thomson Financial's SDC New Issues database from 1985 to 2012. I include traditional IPO issuances on the Nasdaq, New York Stock Exchange, and American, and SPAC issuances from these three major exchanges and Over-The-Counter markets.[11] Following the IPO literature, I exclude IPO filings of financial firms (SIC between 6000 and 6999), unit-offers, closed-end funds, American depository receipts, limited partnerships, and spin-offs. These filters result in 7,237 traditional, first-time IPO issuances with 5,619 completed IPOs and 1,618 withdrawn

[11]For SPAC IPOs, I aggregate measures of the M&A transaction to the target firm level to ensure comparability with traditional IPOs. For example, the date of the announced merger between the SPAC and the target firm is denoted as the IPO filing date while the effective date of the merger is considered the IPO issuing date. These adaptations of the SPAC filing process to the traditional IPO process allows me to combine these issuances as both directly result in an IPO for a once privately held firm.

IPOs. Following Bernstein (2015), I restrict the main sample to firms with at least one successful patent application over the period from three years before to five years after the IPO filing. These filters result in a sample of 2,681 traditional IPOs of which 2,214 are completed and 467 are withdrawn. Additionally, simple filtering procedures result in 19 total SPAC IPOs (7 completed and 12 withdrawn) leaving me with a final sample of 2,700 IPOs.[12]

The results in Table A.2 display the frequency of IPO filings for firms with a successful patent application in the event window over time. Consistent with Gao, Ritter, and Zhu (2013), there has been a substantial decline in traditional IPO filings post-2000 with an average of 120 IPO filings from 1985 to 2000 and only about 50 filings from 2001 to 2012. Nearly 20 percent of IPO filings of first-time filers are eventually withdrawn with an increasing likelihood of IPO withdrawal occurring in times of market downturn such as 2000 (33 percent withdrawn) and 2008 (68 percent withdrawn). These results also document that SPAC IPOs are a relatively new phenomenon with the first announced deal in the sample occurring in 2006. Consistent with Gahng, Ritter, and Zhang (2021) these deals face a much greater likelihood of IPO withdrawal due to larger underlying agency problems presented by this investment vehicle.[13]

Financial information comes from Compustat when available and is otherwise hand-collected from Form S-1 filings from the SEC's EDGAR database. Stock pricing data is collected from the Center for Research in Security Prices (CRSP). Firm-level information such as venture capital funding and private equity funding is obtained from SDC in addition to information on bankruptcy and acquisitions of firms filing for IPOs. I obtain information on firm age and dual class firms from

[12]See Table A.1 for additional details on the sample filtering along with a comparison to the sample used by Bernstein (2015). The overall correlation across the two samples from 1985 to 2003 is 94.5 percent. We have approximately the same number of withdrawn IPOs (305 vs. 323) while I have significantly more completed IPOs (1,832 vs. 1,478). About 60 percent of this difference in samples of completed IPOs is confined between 1985 to 1988 in which Bernstein (2015) significantly under-represents the number of completed IPOs with patents.

[13]Table A.3 provides the distribution of IPO filings, completion, and principal filing amount across Fama-French 12 industry groupings. The results document that IPO filings are largely concentrated within Business Equipment (42 percent of filings) while Healthcare filings have a much higher likelihood of withdrawal (24 percent) versus the sample average (18 percent).

Jay Ritter's web site. Nasdaq index pricing data comes from Bloomberg while Fama-French 12 and 48 industry portfolio returns are downloaded from Ken French's data repository. All continuous variables are winsorized at the 1st and 99th percentile values.

1.2 Measuring Innovation

Patents are widely viewed as the best proxy for firm innovation within the finance literature (Hall, Jaffe, and Trajtenberg (2001)) and are significant drivers of firm value and future stock performance (Hirshleifer, Hsu, and Li (2013) and Kogan et al. (2017)). Beneficially, patent measures are available for both privately and publicly held firms from the USPTO allowing a measure of the change in innovation within a firm's life and across publicly and privately held firms. The NBER patent database is commonly used within the innovation literature; however this data ends in 2006 and thus cannot be used to study more recent changes in innovation following the growth of private capital. To circumvent this truncation issue, I augment the NBER patent data with patent application filings from the list compiled by Kogan et al. (2017) until 2018 for publicly traded firms while patent application data for withdrawn IPO filings is aggregated to the firm level using the Google Patents Data.[14]

I aggregate all patents granted to the firm to a yearly measure and collect measures of innovation quality (citations), uniqueness (originality), and applicability (generality) based on the patent-level citation information available from the USPTO PatentsView data.[15] The main measure of interest in my study is the average number of citations a firm receives in the three years following the grant date of the patent.[16] Following Hall, Jaffe, and Trajtenberg (2001), I scale the number of citations

[14]Patent applications are manually matched to U.S. public firms in the CRSP database and firms with withdrawn IPOs based on name, location, and industry using the Levenshtein Algorithm (a string matching method) and further manual checking from online searches such as Bloomberg Businessweek. Subsidiaries' patents are assigned to their parent companies based on the subsidiary parent links from Capital IQ.

[15]I thank Po Hsuan-Hsu for this patent data.

[16]I use citations received within the three years after patent grant date as this is highly correlated with long-term patent citations received and mitigates truncation issues with the end of the sample.

received by a firm at the subsection-year level to correct for differences in the number of citations received across patent subsections over time.[17,18] Additionally, I use patent-citation based measures of originality and generality which are based on the distribution of citations received by a patent rather than the citation count. Patent originality reflects the diversity of patent subsections cited in a firm's patent application with higher levels of originality indicating a more novel innovation. Patent generality is a measure of the range of the subsections which cite a firm's patent which proxies for the usefulness of this patent to a broader array of future inventions. Both measures are scaled at the subsection-year level and all citation count measures are available in firm years where a patent application is successfully granted.[19,20]

In addition to patented innovation, a growing literature in finance has begun to realize the value implications and informativeness that trademark filings provide in capturing a firm's product innovation (Hsu et al., 2022; Kooli, Zhang, & Zhao, 2022; Yang & Yuan, 2022). The initial sample of trademark registrations is obtained from the USPTO Trademark Case Files Data set between 1982 and 2017. Trademark assignees are manually matched to U.S. public firms in the CRSP database and firms with withdrawn IPOs based on name, location, and industry using the Levenshtein Algorithm (a string matching method) and further manual checking from online searches such as Bloomberg Businessweek. Subsidiaries' trademarks are assigned to their parent companies based on the subsidiary parent links from Capital IQ.[21]

A key limitation of trademark data is that trademarks are uniquely valued to the granted firm

[17] I scale patent citations at the subsection level rather than the technological used in Bernstein (2015) as technological class measures are only available prior to 2006 while subsection measures are available from 1976 to 2018.

[18] I winsorize scaled citations at the 5th and 95th percentile values following Bernstein (2015), but also experiment with the robustness of the results to other reasonable design choices.

[19] Bernstein (2015) documents that patent data missingness for private firms is unlikely to bias the estimated effect. "In 90% of firm-year observations in the five years after the IPO filing, firms are either independent or acquired and producing a patent under the previous assignee name. In the remaining firm-years firms are acquired and no patents are assigned to them."

[20] In regression analysis, I examine the robustness of the results to setting citation related measures to zero when a firm has zero patents following Atanassov (2013).

[21] I thank Po-Hsuan Hsu for this trademark data.

and it is not possible to proxy the economic value of the product innovation due to trademark applications not requiring citations of related products. The main measure of trademark quality is the renewal rate of the trademark which is required at the six-year and ten-year renewal intervals. To capture the innovation strategy of firms, I model patent and trademark counts over time to explain the variation in a firm's innovation focus over time. I apply one plus the natural log transformation to a firm's trademark and patent production to help normalize the data. These measures provides a formal mechanism to distinguish whether firms' decline in patented innovation might be driven by a substitution effect towards product-related innovation over time.[22] Summary statistics regarding the timing and distribution of successful patent and trademark applications are available in Tables IA.1-IA.5.

1.3 Summary Statistics

Table 1 provides summary statistics for completed and withdrawn firms across measures of innovation, IPO characteristics, and financial performance. Firms with completed IPOs are quite similar across patent production with firms that eventually withdrawal their IPOs with both averaging nearly 6 patents in the [-3,0] year window surrounding a firm's initial IPO filing. Prior to going public, both firms with eventually completed and withdrawn IPOs have patents that will go on to become more highly cited than the average patent within a given-subsection year. Supporting the endogenous timing and quality differences of completed versus withdrawn IPOs, completed firms have patents with significantly higher citations (64 percent higher than the average patent in a given subsection vs 31 percent). Firms with completed IPOs have marginally more trademarks before going public (9.89 versus 8.51), but interestingly renew these trademarks at a much lower rate on average (0.42 versus 0.59). Withdrawn firms are on average younger than completed firms, and also

[22] I construct a measure denoted % Patents which represents the annual, cumulative number of successful patent filings to the sum of successful patent and trademark filings over time. Due to the persistence in this measure, my main tests rely upon modeling the counts separately.

display a greater likelihood to be venture capital backed suggesting these firms might withdrawal for other reasons besides being of lower quality. Lastly, both completed and withdrawn IPO firms display similar likelihoods of being acquired (19 percent vs 23 percent) consistent with the use of the IPO as a mechanism for firms to limit information asymmetries to be acquired(Zingales, 1995).[23]

To further motivate the timing of firms' innovation strategies, Figure 1 examines the likelihood of a firm having a patent or trademark throughout the IPO filing window by event year and IPO completion status. Firms with completed IPOs have a significantly lower likelihood than withdrawn firms of having a patent in the third and second years preceding the IPO but experience a steady increase in the pre-IPO period to outpace withdrawn firms. In the year of the IPO filing, both completed and withdrawn firms reach their peaks (60 percent and 50 percent likelihood, respectively) before gradually declining in the five years following the IPO. The trademark activity of firms with completed and withdrawn IPOs experiences a much stronger pre-trend relationship with both groups increasing from a likelihood of about 40 percent in the third year preceding the IPO while nearly 55 percent in the year of the IPO filing. These likelihoods strongly diverge in the post-period as completed firms suffer only a slight decline in trademark likelihood to 45 percent in the fifth year following the IPO while firms with withdrawn IPOs fall to 25 percent.

Figure 2 displays the change in patent quality as measured by the average number of scaled citations a firm's patents receive throughout the IPO filing window by event year and IPO completion status. While innovation output exhibits an increase for completed and withdrawn firms until IPO filing and declines gradually afterwards, there is a much more monotonic decline in patent quality for both completed and withdrawn firms over time. Interestingly, there is a growing gap between the pre-filing patent quality measures for completed and withdrawn firms that is largely stable during the post-filing period. The average completed and withdrawn firm has patents that are about 60 percent more highly cited than a patent in a similar subsection-year when the firm is three years prior to its eventual filing date. Firms with completed IPOs have a smaller decline in patent quality

[23]See Table A.4 for summary statistics unconditional on IPO completion status.

for patents filed during the firm's IPO filing year but end the sample period with patents that are only about 20 percent more highly cited than a patent in a similar subsection-year. Withdrawn firms experience a slightly larger decline post-IPO to the point where their patents are slightly less cited than the average patent within the same subsection year group. While these declines in innovation are endogenous, the large magnitude motivates further study to determine the degree to which innovation declines are driven by incentives differing for publicly or privately traded firms or whether declines in innovation are a stylized fact of a firm's life cycle(Klepper, 1996).

2 Empirical Strategy

As shown in the imbalance of observable characteristics, firms that successfully complete their IPOs are systematically different and are of higher quality than those that ultimately withdrawal their IPOs. To overcome this positive selection, I follow the instrumental variable approach of Bernstein (2015) to use the two-month post-IPO filing returns on the Nasdaq stock index as an instrument for IPO completion. While the prior literature relies predominantly upon selection on observables or valid causal inference for a small subset of firms(Acharya & Xu, 2017; Aggarwal & Hsu, 2014), Bernstein (2015) presents the best solution to mitigating the effect of unobservable differences on a firm's innovation quality for a broad cross section of firms.

The baseline specification is as follows:

$$Y_i^{Post} = \alpha_1 + \beta_1 IPO_i + \gamma_1 Y_i^{pre} + v_k + u_t + \varepsilon_{1i} \tag{1}$$

where Y_i^{Post} is the average innovation performance in the five years following the IPO filing, Y_i^{pre} is the equivalent measure in the three years prior and through the IPO filing year, IPO indicates whether a filer goes public or stays private, pre-filing Nasdaq returns, and a firm's location in the IPO wave. Industry fixed effects (v_k) and filing year fixed effects (u_t) are included to control for

any variation in industry across time and industry groupings.[24]

The instrumental variable approach first stage regression is:

$$IPO_i = \alpha_2 + \beta_2 NSDQ_i + \gamma_2 Y_i^{pre} + v_k + u_t + \varepsilon_{2i} \tag{2}$$

where $NSDQ_i$ is the instrumental variable. The second stage regression below identifies the effect of IPO completion on innovation in the post-filing window:

$$Y_i^{Post} = \alpha_3 + \beta_3 \widehat{IPO}_i + \gamma_3 Y_i^{pre} + v_k + u_t + \varepsilon_{3i} \tag{3}$$

where $\widehat{IPO}_i$ represents the predicted values from Equation (2). If the relevance and exogeneity conditions are met for the instrument, β_3 can be thought of as the effect of IPO completion on a firm's future innovation holding firm quality and other unobservables constant.

Notably, this two month period post-IPO corresponds to the period when a target price is selected by investment bankers and the shares of the IPO are allocated to predominantly larger institutional clients. The average firm completes its IPO in just 90 days, and the market returns over this filing window help to ensure the firm is able to secure a reasonable price and sufficient demand for its filing. To satisfy the identification assumptions of the IV estimator, the post-filing returns on the Nasdaq must be both relevant in explaining a significant amount of variation in IPO completion and satisfy the exclusion restriction of impacting a firm's innovation levels only through altering the likelihood of IPO completion.

[24]SDC is missing the venture-capital backed status for all withdrawn IPOs prior to 2003. This information is not available elsewhere, and I experiment with imputation to include this control. Unfortunately, due to the perfect correlation between the missingness of a firm's venture capital backed status and IPO withdrawal, this results in a large suppression of the F-statistic and an inflation of the estimated effect size. I exclude this control from my analysis to avoid these issues, but due to the relative balance for firms' VC status for firms after 2003 and the otherwise balanced characteristics, this exclusion should result in fairly minimal bias.

2.1 Instrument Relevance

Table 2 displays the results of examining the relevance condition of the post-filing return on the Nasdaq on IPO completion over time. Columns 1 and 2 document the strong relationship of the post-filing returns in explaining ultimate IPO completion with an F-statistic of above 30 which exceeds the threshold of 10 specified in Bound, Jaeger, and Baker (1995). A stronger instrument minimizes the level of bias in the eventual two-stage least squares estimator while the R^2 value of 0.14 suggests that IPO completion is quite endogenous as expected. As the two-stage least squares estimator provides a local average treatment effect (LATE) only for complier firms where the instrument is relevant, it is important to determine when and for which firms the estimate is valid. Columns 3 and 4 document that the unconditional first-stage estimate is driven by the period preceding 2003 as the F-statistic is more than 40 prior to 2003 while almost 0 afterwards. Prior to 2003, a firm's patent quality was a statistically insignificant predictor of IPO completion, but afterwards this measure has been an important determinant of IPO completion with a t-statistic of more than 4.5. This shift in relevance suggests an improvement in the information processing of market participants and a change in firm filing attributes that has led to firms being less dependent on external market factors (i.e. the post-filing return on the Nasdaq) for access to capital markets.[25]

The results in Table A.5 provide further support for the increased ability of market participants to evaluate the quality of IPO filing firms after 2003. From 2004 to 2012, there is a significant increase in the size of IPO filing firms as evidenced by the growth in average filing principal amount from about $67 million prior to 2003 to over $150 million afterwards. This result is consistent with the effects of the National Securities Market Improvement Act of 1996 which enabled companies to stay private longer through reducing financing constraints for private firms(Ewens & Farre-Mensa, 2020). Additionally, this change has coincided with an increase in innovation activity prior to firms going public. Prior to 2003, IPO filing firms had about five patents in the three years before going

[25]Figure 3 and Figure A.1 both provide similar support for the time-varying nature of the relationship between post-filing returns on the Nasdaq and IPO withdrawal.

public while post 2003, filing firms had over nine patents. Similar increases occurred in firm's pre-filing trademark activity with a statistically significant increase in trademarks from 9 to 11 trademarks before and after 2003.[26]

Table A.6 verifies the declining relevance of the post-filing return on the Nasdaq after 2003 is not driven by a low-powered test or different lengths of the instrument better explaining IPO withdrawal. The results in Panel A verify that from 1985 to 2003 any arbitrary period of post-filing returns under three months is a strong explanatory variable of IPO completion with a consistent F-statistic above 35.[27] In contrast, the results in Panel B document the declining explanatory power of the post-filing returns over various period lengths and samples. The largest F-statistic generated by any of the potential instrument lengths is just 6.33 while only 2 of the 8 post-filing returns display statistical significance. These instruments from 2004 to 2012 continue to display weak relevance, even when using the full sample of IPO firms that meet all relevant sample filters unconditional on having a patent.[28] In summary, these results suggests the breakdown in relevance is not driven by a low-powered test or a small change in the function of the instrument, but rather a fundamental break between the mechanism of the post-filing return in impacting IPO completion.

To further examine the causes for this decline in the relevance of the Nasdaq post-filing returns in explaining IPO completion, Table 3 displays a transition matrix of the likelihood of a firm's IPO completion given its pre-filing and post-filing Nasdaq return quintile within a given year. Panel A shows the results from 1985-2003 in which the average probability of IPO completion was 86 percent. For sake of reference, a sort on a firm's pre-filing return quintile induces minimal variation in IPO completion as the probability of IPO completion for firms in the bottom quintile of 86 percent rises

[26]Figure A.3 documents a similar pattern from 2004 to 2012 that there is a much larger gap between the pre-filing patent quality measures for completed than withdrawn firms in comparison to the period from 1985 to 2003.

[27]The returns computed over the full post-filing period have weaker explanatory power which is likely driven by the fact that returns over the initial bookbuilding period are of greater importance in impacting IPO completion than returns near the end of the filing period when a firm might not have formally withdrawn yet.

[28]In untabulated regressions, I show that the weakening of this instrument persists until today.

to just 87 percent when moving to the top return quintile. In contrast, the post-filing return on the Nasdaq displays a strong, positive monotonic relationship evidenced by the likelihood of IPO completion rising from 81 percent for firms in quintile 1 to 93 percent in quintile 5. The exogenous nature of this variable in being largely outside of a firm's control, if returns are in fact unpredictable at short intervals, makes this variable particularly compelling.

However, the results in Panel B for IPO filers from 2004 to 2012 document that this monotonic relationship does not persist. During this period, firms in the first quintile of Nasdaq post-filing returns had a 63 percent chance of completing their IPO, and while this probability rises to 78 percent for firms in the third quintile, it declines to just 61 percent for firms in the top quintile. While uninformative in the first panel, sorts on the endogenous variable of Nasdaq pre-filing returns now result in a monotonically increasing pattern of IPO completion likelihood from 66 percent in the bottom quintile to 72 percent for firms in the top quintile.

In combination with improvements in information processing that increases the impact of idiosyncratic rather than external factors on IPO completion, what explains this decline in the instrument relevance of Nasdaq post-filing returns (i.e. Why are firms with high post-filing returns actually more likely to withdrawal their IPO filings)? Table A.7 examines the likelihood of a firm being in a given post-filing return quintile based on its pre-filing returns. If firm IPO filing dates and stock market returns were random, we would expect for the probability of transitioning from a given pre-filing quintile to post-filing quintile to be 20 percent. Prior to 2003, the results in Panel A shows that there is evidence of mean reversion of returns as a firm that falls in the bottom pre-filing quintile has a 30 percent chance of falling in the top post-filing returns quintile. Post 2003, these mean reversion patterns are evens stronger as a firm in the bottom pre-filing return quintile has a 37 percent chance of falling in the top post-filing return quintile. The increase in the mean reversion of equity returns post-2003 results in the Nasdaq post-filing returns being less relevant for explaining IPO completion as the increasing mean reversion renders these firms more likely to be exposed to

poor market returns pre-filing which hinder demand for the eventual issuance.[29]

I also investigate alternative channels for this decline in instrument relevance post-2003 outside of the information environment improving and an increase in mean reversion behavior in equity markets. Table A.8 examines whether firms might be more likely to obtain private venture funding after their IPO filing when post-filing returns are high. Prior to 2003, there is limited evidence of of the post-filing return explaining a firm's decision to receive additional venture capital investment evidenced by firms in the bottom quintile having a 21 percent chance while firms in the top quintile had a 19 percent chance. After 2003, the probability of a firm receiving additional venture funding post-IPO rises significantly from 17 percent for firms in the bottom post-filing return quintile to 25 percent for firms in the top quintile despite both having similar probabilities of IPO completion. Table A.9 examines whether firms with high post-filing returns are more likely to be acquired. After 2003, a firm that falls in the bottom pre-filing quintile has a seven percent chance of being acquired within two years of the IPO filing date while a firm in the top quintile has only an eight percent chance of being acquired rendering this hypothesis unlikely. In summary, improvements in the market information environment, increased equity market mean reversion, and the growth of private capital post-2003 have all contributed to the decline in relevance of the Nasdaq post-filing returns in explaining IPO completion while increasing acquisitions of IPO filing firms has had limited effect.[30]

2.2 Instrument Exogeneity

Additionally, for the post-filing return on the Nasdaq to be a valid instrument, it must satisfy the exclusion restriction of the IV estimator. This assumption implies that the post-filing return

[29] Anecdotally, many firms that fall in the bottom pre-filing return quintile and top post-filing return quintile ultimately cite poor market conditions for their IPO withdrawal. While poor market conditions might be a camouflaged signal to hide that idiosyncratic factors led to a lack of demand for a particular IPO issuance, it is reasonable to conclude that a shock to investor risk aversion, via low pre-filing returns, causes a drop in demand during the IPO bookbuilding period.

[30] For reference, Boeh and Dunbar (2021) document that in the three years post IPO withdrawal, 7 percent of issuers return for a second IPO, 34 percent purse mergers and acquisitions, and 26 percent raise capital privately.

on the Nasdaq must impact a firm's innovation only through its likelihood to complete the IPO. Selecting a shorter Nasdaq post-filing return period length is a helpful feature to reduce concerns over exogeneity due to a smaller chance of the post-filing returns impacting a firm's innovative activity through any other channels.[31] While there is no test to prove this assumption empirically, observing the balance of firm characteristics across the distribution of the instrument, placebo tests, and institutional details can provide evidence for the exclusion restriction.

The results in Table 4 compare the balance of characteristics between firms that experience different realizations of the post-filing returns on the Nasdaq. In general, there are minimal differences in firm characteristics across firms that fall in the bottom 10th percentile versus the top 90th percentile and the bottom 25th percentile versus the 75th percentile of Nasdaq post-filing returns within a given year which provides evidence that the instrument is mostly exogenous to firm observable characteristics. However, the IPO principal amount exhibits statistically significant differences with larger firms being more likely to file in periods that have subsequent low post-filing returns.[32] While firms are unable to directly manipulate the post-filing returns on the Nasdaq, it appears that larger firms are exposed to lower post-filing returns.[33,34] Furthermore, firms that time their issuances to periods of high pre-filing returns appear to have a disproportionately high chance of experiencing relatively good post-filing returns.[35]

[31]For example, specifying an instrument period of nine months (the maximum registration period) results in a chance that a firm's inability to access external capital markets during this IPO filing period might drive a decline in innovative activity through capital frictions rather than its decision to go public versus stay private.

[32]In untabulated regressions, I show these correlations are driven by the period from 1985 to 2003.

[33]This relationship might be due to larger firms being more financially constrained than smaller firms in timing their IPO issuances, smaller firms only going public during periods of increasing market valuation(Baker & Wurgler, 2002), or a type one error driven by the large number of covariate balance tests. Applying the Bonferroni multiple hypothesis testing correction, only the Nasdaq pre-filing returns (both 10th and 25th percentile) and the principal amount(25th percentile) exhibit statistically significant correlations.

[34]Table A.10 shows a similar discrepancy based on the size of firms and IPO completion based on the realization of the Nasdaq post-filing returns. Firms that complete their IPO when the realization of the post-filing return is high and withdrawal when the post-filing return is low (compliers) tend to be larger than firms that withdrawal when the realization of the post-filing return is high and go public when the post-filing return is low (non-compliers).

[35]The lack of mean reversion indicated by this relationship appears to be due to the binary cutoffs as

The results in Panel A of Table 5 support the exogeneity of the post-filing two-month returns by examining the impact of various Nasdaq return windows effect on a firm's future patent quality. If the two-month post-filing returns on the Nasdaq are exogenous and impact a firm's innovation quality only through a firm's ownership structure, the returns over this post-filing period should have the largest impact on a firm's patent quality relative to other arbitrary periods of similar length in a firm's life. I find that the Nasdaq returns over the post-filing period do in fact have the largest impact on a firm's future patent quality. The estimated impact is statistically significant when estimated conditional on the Nasdaq pre-filing return from 1985 to 2003, but the effect size declines in magnitude when extending the results to 2012. Following Bernstein (2015), these tests require that a firm has a patent in the pre-filing and post-filing period to be included and sets scaled citations to missing in which a firm has zero patents.

2.2.1 Sample Selection

A crucial shortcoming of the approach of Bernstein (2015) is that his estimates of the effect of going public on a firm's patent quality condition on a firm having a patent in both the pre- and post-period. This approach leads to a negative bias of finding an effect of going public on innovation quality if firms that successfully go public have a greater likelihood of patenting post-IPO in comparison to firms with withdrawn IPOs.[36] The results in Table A.11 display transition matrices with the likelihood of completed and withdrawn firms patenting across the pre-filing and post-filing period. Firms that successfully go public have both a higher likelihood to continue patenting post-IPO given they patented pre-IPO in comparison to firms that stay private (79 percent versus 64 percent), and conditional on having no patents on the pre-period are much likelier to innovate

equity returns display strong mean reversion when using discretized quintiles within the full sample.

[36]Consider the case in which firms enter public markets to lower the chances of a complete decline in innovation output while firms that remain private are at a much greater risk of failing to innovate post-IPO. If firms that go public have a disproportionate chance of remaining innovative active, but are compared to a small subset of high quality firms that sustain innovation despite remaining private, the estimated effect of going public on innovation will be strongly negatively biased.

post-IPO (12 percent versus 7 percent). These results illustrate both the importance of going public in beginning and sustaining a firm's innovation and sampling in such a way to capture the true effects of going public on innovation quality that avoids a potential negative survivorship bias.

Following the imputation procedure of Atanassov (2013), Panel B of Table 5 considers firm observations with zero patents in the pre- or post-filing period to result in a scaled citation value of zero and includes all firms over the relevant time period.[37] While Atanassov (2013) applies this imputation strategy only to the dependent variable, I apply missing citation counts to zero for firms with either zero patents in the pre- or post-period consistent with the empirical specification of Bernstein (2015) to avoid a negative survivorship bias. The estimated effect size of the post-filing returns on the Nasdaq on a firm's patent quality are almost zero over the period from 1985 to 2003 and 1985 to 2012. In contrast, the Nasdaq returns during the pre-filing period have a large, negative and statistically significant effect on a firm's patent quality post-IPO both over the period from 1985 to 2003 and from 1985 to 2012. The significance of the Nasdaq pre-filing return, which is at least partially endogenous due to a firm's control over their filing timing, in combination with the noted correlation between and pre-post filing returns, suggests the importance of conditioning on the pre-filing Nasdaq returns to remove bias from the post-filing Nasdaq returns and present a conditionally valid IV.[38]

[37] Atanassov (2013) defends this choice of setting observations with zero patent counts to have zero scaled citations to alleviate sample selection concerns of peer comparison firms.

[38] The pre-filing Nasdaq returns over the three months preceding a firm's filing date is an endogenous choice by the firm and is likely correlated with firm sophistication, financial flexibility, or other desirable firm characteristics. The inclusion of the pre-filing returns results in a conditionally valid IV, and it causes only a biased effect for this control variable rather than the exogenous post-filing returns term. The large relationship between the Nasdaq pre-filing returns and a firm's future scaled citations in Panel B of Table 5 is surprisingly large, but does not appear to be connected to lower quality firms entering IPO markets when equity markets are hot given the positive correlation between pre-filing returns and the filing firm's pre-filing patent quality.

3 Results

Thus far, I have shown the post-filing returns on the Nasdaq to be relevant in explaining IPO completion for the period prior to 2003 with a substantial weakening in the period afterward due to improvements in the financial reporting environment, increased access to private capital, and increased mean reversion in equity markets. The post-filing returns on the Nasdaq appear to be exogenous given the relative balance across firm characteristics, and the instrument is valid conditionally on the inclusion of the pre-filing returns on the Nasdaq. In this section, I first extend the analysis of Bernstein (2015) to 2012 to examine whether the effect of going public on innovation has changed in the modern era. Second, I examine the effects of going public on innovation quality when constructing a sample that avoids a negative survivorship bias using all firms with a successful patent within three years before or five years after going public, an ex-ante sample based on whether a firm has a successful patent at the time of its initial IPO filing, and include all IPO firms regardless of their innovation activity. Third, I show that going public has had no impact on other measures of patent quality. Fourth, I integrate trademark data to examine whether going public results in a meaningful increase in commercialization and shift towards product-related innovation rather than patented innovations. Finally, I conclude with a discussion on whether this perceived decline in innovation might be efficient.

3.1 Scaled Citations

Figure 4 provides suggestive evidence that patent quality declines significantly post-IPO for both completed and withdrawn firms. This OLS model, estimated at the patent level, documents a more extreme decline for firms with withdrawn IPOs than completed IPOs when comparing to their pre-trend averages even when including issuer and patent grant year fixed effects.[39] This estimator

[39]Figure A.3 confirms that aggregating the average scaled citations to the firm-year level provides a similar effect size.

fails to correct for the endogeneity of IPO completion status and thus serves as only a motivation for a more thorough causal approach.

Table 6 displays the estimated effect of going public on a firm's average value of scaled citations in the five year window post-IPO. Notably, these models include a measure of the pre-filing innovation measure in event years [-3,0] which serves as a quasi-firm fixed effect but also results in the model being estimated for firms only with a patent in the pre-IPO and post-IPO period in Panel A. Column 1 presents the endogenous effect from 1985 to 2003 that roughly mirrors the positive difference for firms that ultimately complete their IPO in comparison to firms that withdrawal their IPO filings. Column 2 presents the reduced form estimator which suggests that a 100 percent increase in the Nasdaq would result in a decline in a firm's average scaled citations of 0.58 representing a significant decline of 35 percent of the pre-IPO average for completed firms. Column 3 implements the IV estimator and estimates that going public causes a 0.95 decline in scaled citations or a statistically significant decline of 59 percent in comparison to the pre-IPO mean.[40] The F-statistic of nearly 30 suggests that the estimator suffers from minimal bias.[41]

Columns 4 to 6 of Table 6 extend this analysis to 2012 and provide much different implications. The endogenous effect of IPO completion is now estimated to be positive and statistically significant indicating increasing quality differences of firms that elect to complete versus withdrawal their IPOs in the period from 2004 to 2012. Column 5 presents the reduced form effect of the post-filing return on a firm's patent quality which is now estimated to be statistically insignificant and it declines in effect size by nearly 50 percent from the similar estimator from 1985 to 2003. Lastly, the IV estimate in column 6 is statistically insignificant despite the effect size representing a 40 percent effect size decline from the pre-IPO mean of completed firms. Much of this decline in significance

[40]The results in Table A.12 examine the robustness of this estimated relationship to winsorizing scaled citations at various levels. Winsorizing at a level above the 4th and 96th percentile (e.g. the 1st and 99th percentile) results in a statistically insignificant effect size for the reduced form and IV estimator from 1985 to 2003.

[41]The bias in an IV estimator is calculated by taking the inverse of the F-statistic. This F-statistic suggests a biased estimator of just 3.5 percent which is quite economically insignificant in comparison to the effect size.

for the reduced form and IV effect in the full sample period appear to be driven by the declining relevance of the post-filing returns on the Nasdaq in explaining firm's IPO completion choice and a much stronger endogenous effect to correct. While these causal estimates remain economically significant, the negative effect of going public on innovation previously documented by Bernstein (2015) is much less clear.

To further examine the robustness of these results to other reasonable design choices, Panel B of Table 6 sets firm observations with zero patents to have zero scaled citations for either the pre- or post-period. This imputation strategy following Atanassov (2013) corrects for the negative survivorship bias caused by conditioning on a firm having a patent in the pre- and post-period and accounts for the effect that going public has on innovation quality through allowing a firm to begin or sustain its level of innovation post-IPO. The results in column 1 document that there is a strong, positive endogenous effect of IPO completion on a firm's average scaled citations from 1985 to 2003. The reduced form estimate in column 2 helps to correct for the positive bias in the first estimate but the effect size of -0.20 is only slightly above 15 percent of the pre-IPO mean for completed firms and is statistically insignificant. Continuing to the IV estimator in column 3, there is a large increase in the F-statistic when considering the larger sample, but the estimated effect size is statistically insignificant and only about one-third of the size of the corresponding estimate in Panel A of Table 6. Columns 4 to 6 extend the sample period from 1985 to 2012 but result in effect sizes of almost zero for the reduced form and IV estimator despite the instrument maintaining its relevance.

The results in Table 7 display the estimated effect of going public on innovation quality using other reasonable sampling approaches and document a similar null effect. Panel A of Table 7 conditions on a firm having a patent in the pre-filing period, an ex-ante measure, and documents a strong, positive endogenous effect of IPO completion both from 1985 to 2003 and from 1985 to 2012. The reduced form and IV estimators have effect sizes that represent a decline between 10 to 20 percent of the pre-filing mean for firms with completed IPOs but lack statistical significance as the largest t statistic is only 1.1. Panel B of Table 7 imposes no patent restrictions on the

IPO filing sample which allows for all IPO firms to be considered regardless of their patenting activity before or after their IPO filing. The results confirm that this null effect of going public on innovation quality holds on the broader cross-section of firms regardless of their innovative activity, and that much of the benefits to going public is a firm's increased likelihood of patenting post-IPO in comparison to its private firm peers. In summary, the effects of going public on a firm's patent quality, proxied through scaled citations, is declining in magnitude over time and not robust to various design choices.

3.2 Patent Originality and Generality

It is possible that the effect of going public might have no effect on the number of citations a firm's patents receive post-IPO but instead impacts other measures of innovation quality. To address these concerns, I also analyze the effects on patent originality (the average breadth of patent classes cited by a firm's patents) and generality (the average breadth of patent classes that go on to cite a firm's patents). Figure 5 shows the endogenous effects of going public on patent originality which appears to be similar in magnitude for completed and withdrawn firms. Panel A of Table 8 displays the estimated effects of going public on a firm's patent originality from 1985 to 2003 (columns 1-3) and from 1985 to 2012 (columns 4-6). There is an insignificant effect of IPO completion on a firm's average level of patent originality post-IPO across all specifications and time periods. Interestingly, when the estimator corrects for the endogeneity present in the first estimator, the coefficient estimate is quite stable suggesting minimal bias in the OLS estimator.

Figure 6 shows the endogenous effects of going public on patent generality which is much larger in the post period for completed than withdrawn firms. The results in Columns 1 and 4 of Panel B in Table 8 confirm that the endogenous effect of going public is associated with a significant increase in patent generality. For firms with completed IPOs, the effect size is of only slight economic significance as it represents about 10 percent of the pre-treatment mean. The reduced form estimator

in columns 2 and 5 documents that the bias in the endogenous model is minimal or slightly negative in magnitude as the coefficient estimate increases slightly. The IV estimator in columns 3 and 6 documents an effect size of IPO completion on patent generality of 0.05 or about 10 percent of the pre-filing IPO mean; however, this estimate is no longer significant due to large estimated standard errors. In summary, when defining innovation more broadly to encompass other characteristics of a patent's quality, there is no economic relationship suggesting that estimated declines in innovation post-IPO might be smaller than previously considered.[42]

3.3 Patent and Trademark Output

Despite not finding a consistent, robust effect of going public on patent quality, I examine whether this seeming decline in innovation quality might be driven by a shift in firms' innovation strategy. In Table 9, I examine whether this seeming decline in innovation quality might be driven by public firms increasing patent or trademark production at the expense of innovation quality. The results in Panel A of Table 9 examine the effects of IPO completion on patent production. The endogenous effect of IPO completion on a firm's patent output post-IPO is quite large and economically significant as it results in an estimated increase of 36 percent in a firm's pre-filing patent production. The estimates from the reduced form model in columns 2 and 5 experience slight changes in effect size but large increases in their standard errors resulting in a statistically insignificant relationship. The IV estimators in column 3 of a 59 percent increase post-IPO and column 6 of a 48 percent increase post-IPO from 1985 to 2012 are quite economically significant but lack statistical significance due to large standard errors. The patent gap post-IPO for completed and withdrawn firms displays no meaningful statistical differences, partially attributable to the large variation in patenting rates across firms, and confirms the seeming decline in innovation quality

[42]In contrast to these results, Bernstein (2015) finds a statistically significant effect of going public on a firm's patent originality. Differences in results from 1985 to 2003 might be driven by the fact that Bernstein (2015) scales originality and generality at the technological class level while I scale at the subsection level. I scale at the subsection level as technological class measures are only available from the USPTO prior to 2006.

cannot be explained solely by an increased focus of firms on patent production rather than quality.

Can an increased focus on a firm's trademark activity explain this seeming decline in innovation quality for public firms? The results in Panel B of Table 9 explore whether firms might increasingly focus on commercialization and product innovations captured through measuring trademark activity in the post-IPO period. This shift towards commercialization and product-related is present, at least endogenously. The results in columns 1 and 4 show that firms that complete their IPO in comparison to withdrawn IPOs have a nearly 65 percent increase in trademark filings post-IPO with respect to the pre-treatment mean. The reduced form model in columns 2 and 5 results in an attenuated effect size, but it still results in a meaningful increase in product-related innovation. Implementing the IV estimator in columns 3 and 6 recovers a coefficient of similar magnitude to the endogenous model of a statistically significant increase of 79 percent post-IPO from 1985 to 2003 and a statistically insignificant increase of 65 percent post-IPO from 1985 to 2012. While the standard errors are too large to find a consistent, statistically significant relationship on the effect of trademarks, these large effect sizes provide suggestive evidence that a focus on commercialization for public firms mitigates some of the argued decline in patented innovation quality post-IPO.[43]

3.4 Additional Robustness

While the results of Bernstein (2015) are conducted using a single firm observation due to averaging the dependent variable across the pre-filing and post-filing window, I also provide results using a firm-year panel design that allows for the inclusion of rich fixed effects. The results in Table IA.6 display the instrument relevance for the panel data for the Nasdaq pre- and post-filing returns. Comparable to Table 5, the Nasdaq post-filing return is a strong predictor of IPO completion prior to 2003 though not significant afterwards, while the pre-filing Nasdaq return is slightly significant in the period prior to 2003 while highly significant afterwards. Table IA.7 provides the reduced form

[43]Figure A.4 provides the endogenous estimate of the differences in trademark versus patent production by firms over time.

effect across various measures of patent quality and production, and finds no statistically significant impact of going public across any measures of patent quality or output from either sample period or alternative data filtering procedures. Lastly, Table IA.8 displays the effect of going public on innovation quality with the endogenous effect, reduced form, and IV estimator presented across both sample periods and data filtering procedures. I find no statistically significant effect of going public on innovation quality using an alternative design choice which further supports the null relationship between a firm going public and its future level of innovation.[44]

4 Discussion

4.1 Do Innovation Declines Matter?

Thus far, I have documented a null relationship between going public and a firm's future level of innovation quality when extending the results of Bernstein (2015) to 2012, correcting for a negative survivorship bias, or using other measures of patent quality. I have also shown that firms appear to substitute towards commercialization and product-related innovation after going public which partially explains this seeming decline in innovation quality. In this section, I examine whether these seeming declines in innovation quality are efficient from a firm's perspective. While patent efficiency (Hirshleifer, Hsu, & Li, 2013), patent originality (Hirshleifer, Hsu, & Li, 2018), and trademark efficiency (Hsu et al., 2022) are all associated with higher returns for a firm due to limited attention and continued outperformance, the number of citations a firm's patents receives has no documented theoretical or empirical underlying relationship between a firm's operational or stock price performance.

Firms might be rational to focus on patented innovations with more narrow scientific contributions

[44]Figure IA.1-Figure IA.3 show the estimated effect of going public on innovation quality across various event years. The figures display the estimated difference between completed and withdrawn firms across various models by plotting the interaction of the event year and firm's IPO completion status coefficient.

if these patents serve to insulate existing innovations from outside competitors by building patent thickets (Hsu, Lee, & Zhou, 2022) or the innovations represent an important incremental innovation to an existing technology. Kogan et al. (2017) motivate their measure of patent economic value by arguing that some patents which appear to be of great scientific value are of little economic value.[45] For example, IBM's airplane bathroom queue system which falls in the top 20th percentile of patents granted in 2001 by citation count while the patent was of such minimal value to IBM that the company did not pay the trivial renewal fee and allowed the patent to lapse.

Figure 7 displays the correlation between patent economic value and scaled citations overall and across Fama-French 12 industry groupings. Overall, the patents in this sample have a correlation of just 0.01 between their economic value and the number of scaled citations received in the three years following patent grant date. This small association is not driven by the sample of patents that I analyze in this study for recent IPO firms (the sample includes over 100,000 patents for publicly traded firms) but is consistent across the entire universe of patents for publicly traded firms. Across the full sample of patents granted to publicly traded firms comprised of more than 2 million patents from 1976 onwards, the correlation between these two measures is just 0.02. Notably, firms in the Fama-French 12 industry grouping of Shops is the only group that displays a meaningful positive correlation across the two measures of 0.30.[46]

Additionally, to examine the efficiency implications of this innovation quality decline post-IPO from a firm's perspective, I examine the link between changes in a firm's profitability and stock price performance post-IPO alongside changes in patent and trademark production and patent quality. I construct all covariates as the average difference in the innovation measure post-IPO versus its pre-filing value. Panel A of Table 10 examines the effect of these shifts in innovation quality and output measures on the change in a firm's return on assets (ROA). The unconditional

[45] Their measure is created by using a cumulative abnormal return-like approach surrounding a patent's grant date.

[46] The Fama-French 12 Industry grouping of Energy displays a large negative correlation of about -0.20 between the two measures further illustrating the divide between these two approaches.

results in columns 1 to 3 document that an increase in trademark production and patent production are linked to higher ROA post-IPO while changes in innovation quality have no effect. Column 4 includes all covariates simultaneously, and finds that patent production remains the strongest driver of profit growth post-IPO while the estimated coefficient for the change in innovation quality is actually negative, albeit statistically insignificant.

The results in Panel B of Table 10 examine the association of changes in innovation output and quality post-IPO in explaining variation in stock returns. Innovation production post-IPO is strongly related to a firm's five year buy and hold stock return adjusted by the Nasdaq return. A one standard deviation increase in patents is associated with a 196 percent increase in returns while a one standard deviation increase in trademarks is associated with a 75 percent increase in returns. In contrast, a one standard deviation increase in innovation quality post-IPO is associated with a 7 percent increase in returns. Column 4 includes all covariates simultaneously, and finds similar results to the unconditional specifications with innovation production driving stock market valuation growth rather than innovation quality.

While the results in Table 10 lack a causal identification strategy, the results are suggestive that innovation quality is uninformative in explaining a firm's profitability and stock price performance. In contrast, increases in innovation output such as patents and trademarks are associated with higher profitability and higher return performance. In combination with the minimal correlation between innovation quality and the short-term economic value of a patent, it appears that firms are rational to focus on product innovation and more narrow patenting innovations to support and extend their existing intellectual property rather than pursuing projects solely based on their scientific merit. In aggregate, this behavior might be described as myopic and harmful to the level of innovation in the overall economy; however, a firm's public status beneficially allows for firms to begin or continue to innovate post-IPO. In summary, while much of the prior innovation literature focuses on patent quality, proxied through by citation counts, it appears that this measure has less value in understanding aggregate firm outcomes of interest in comparison to innovation production

measures.

5 Conclusion

This paper reexamines the effects of going public on innovation quality using an extended sample, corrects for the negative survivorship bias present in the empirical specification of Bernstein (2015), and better captures a firm's true innovation by integrating trademark data. The instrumental variable approach from Bernstein (2015) was particularly important as it represented the first approach to address this question for a broad cross-section of firms without relying on a selection on observables strategy.

I document declining relevance of the post-filing returns of the Nasdaq in explaining IPO completion after 2003. The declining relevance of this instrument is caused by improved information processing by market participants, increasing mean reversion in equity returns, and the growth of private capital, and contributes to an insignificant effect of going public on innovation quality when extending the approach of Bernstein (2015) to 2012. The estimated decline in patent quality dissipates almost completely when including a broader cross-section of firms with a reasonable alternative filtering procedure that sets missing firm citation observations to zero following Atanassov (2013). I find no evidence of a decline in innovation quality across other measures of patent quality.

I document an economically meaningful increase in trademark production for firms with completed IPOs which partially explains this seeming decline in patented innovation quality. Additionally, I find minimal evidence that innovation quality proxied for by the scaled citations a patent receives is relevant for explaining changes in profitability or stock return performance post-IPO. In contrast, I find that the growth in patent and trademark output post-IPO are associated with higher profitability and higher returns post-IPO. Future areas of research can identify an instrumental variable or different identification strategy to analyze the broader effects of going public in the United States after 2003. Finally, researchers can explore whether going public changes the likelihood of using

trade secrets to protect patents or trademarks which would help illuminate whether seeming declines in innovation are driven by shifts in firms' intellectual property strategies post-IPO.

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Figure 1: Patent and Trademark Likelihood Surrounding IPO Filing Timing
This figure shows the likelihood of a firm filing for a patent (top panel) and trademark (bottom panel) in the relevant event year for completed and withdrawn IPOs.

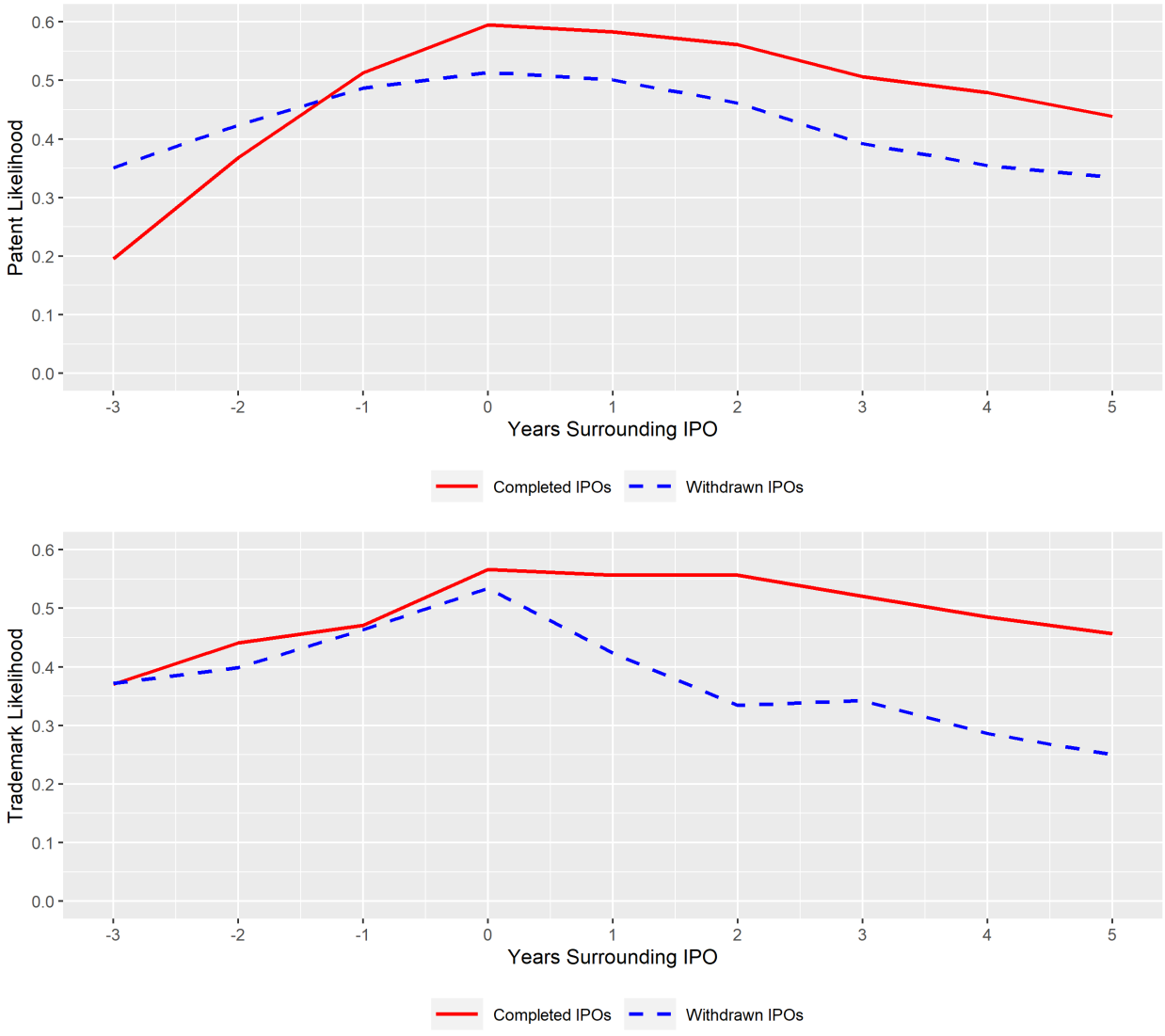

Figure 2: Patent Quality for Completed and Withdrawn Firms Around IPO Filing
This figure shows the average *Scaled Citations* completed and withdrawn firms receive in the years surrounding their IPO filing. *Scaled Citations* is the average citations a firm's patents receives in the subsequent three years following the grant date grouped by the filing year and scaled within a patent's subsection ID.

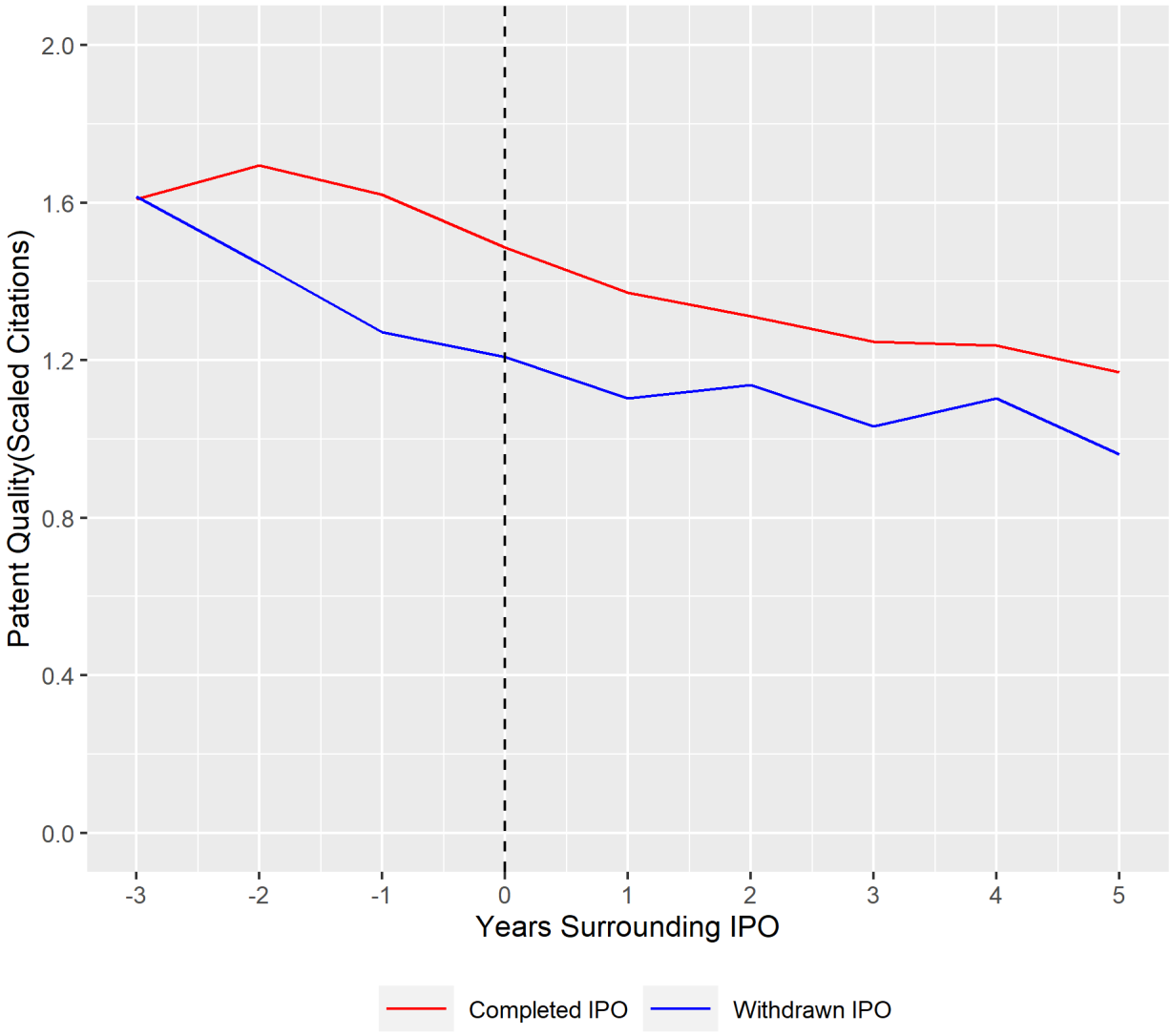

Figure 3: Relationship between IPO Withdrawal and Nasdaq Returns

This figure shows the relationship between IPO withdrawal and Nasdaq fluctuations from 1985 to 2012. The *Full Sample* plot (top panel) contains all IPOs that meet the relevant date and industry filters while the *Patent Sample* (bottom panel) conditions on these filters and the firm filing for a patent in the [-3,5] year window of the IPO.

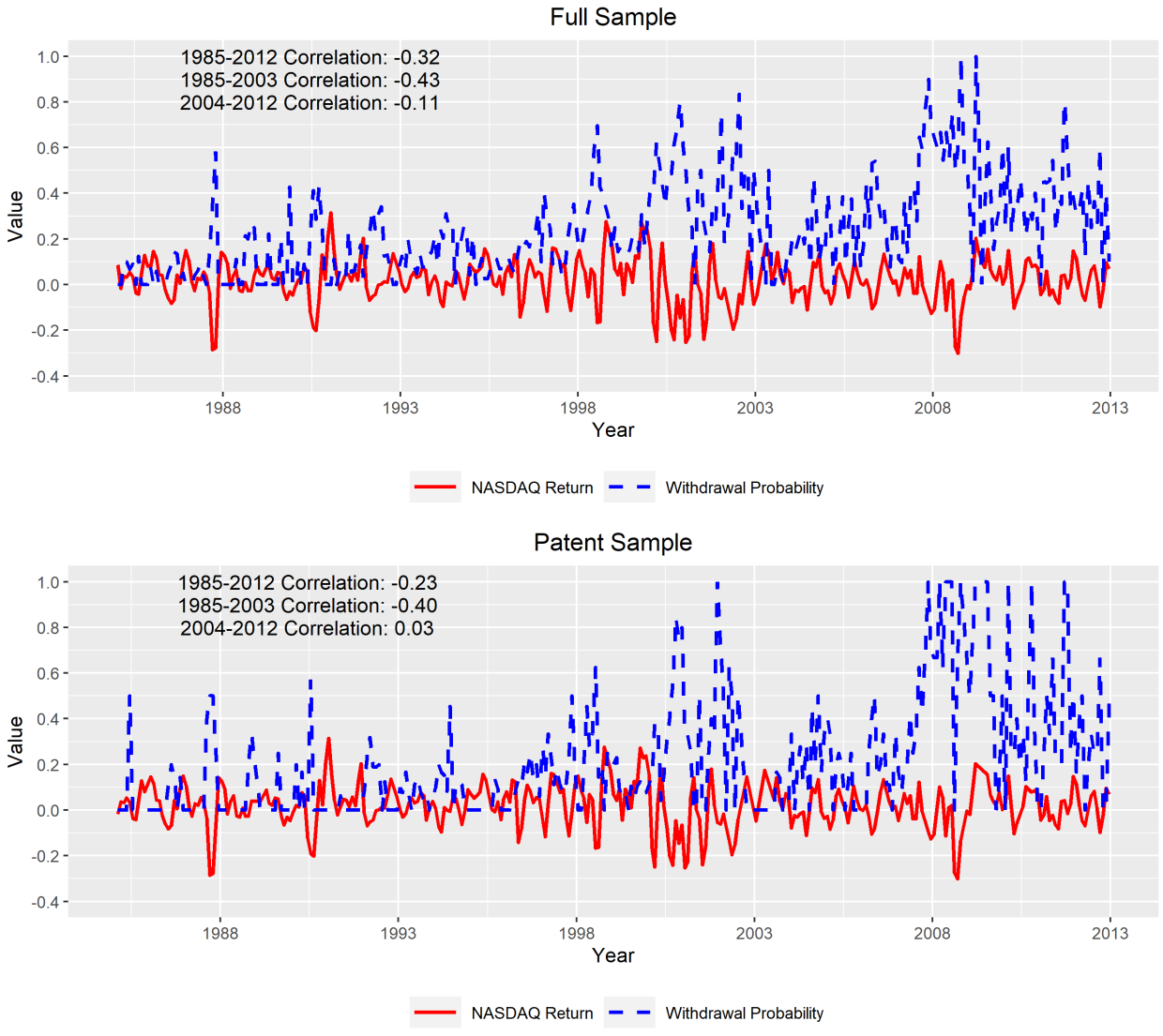

Figure 4: Relationship between Patent Quality and IPO Filing Timing

This figure shows the relationship between IPO completion and patent quality for firms with completed and withdrawn IPOs across the IPO filing year window for IPOs filed from 1985 to 2012. The dependent variable *Scaled Citations* is the average citations a firm's patent receives in the subsequent three years following the grant date grouped by the filing year and scaled within a patent's subsection ID. Regressions are run at the patent level and include issuer and patent grant year fixed effects. Standard errors are clustered at the firm level. All coefficient estimates within completed and withdrawn IPOs are relative to event year 0.

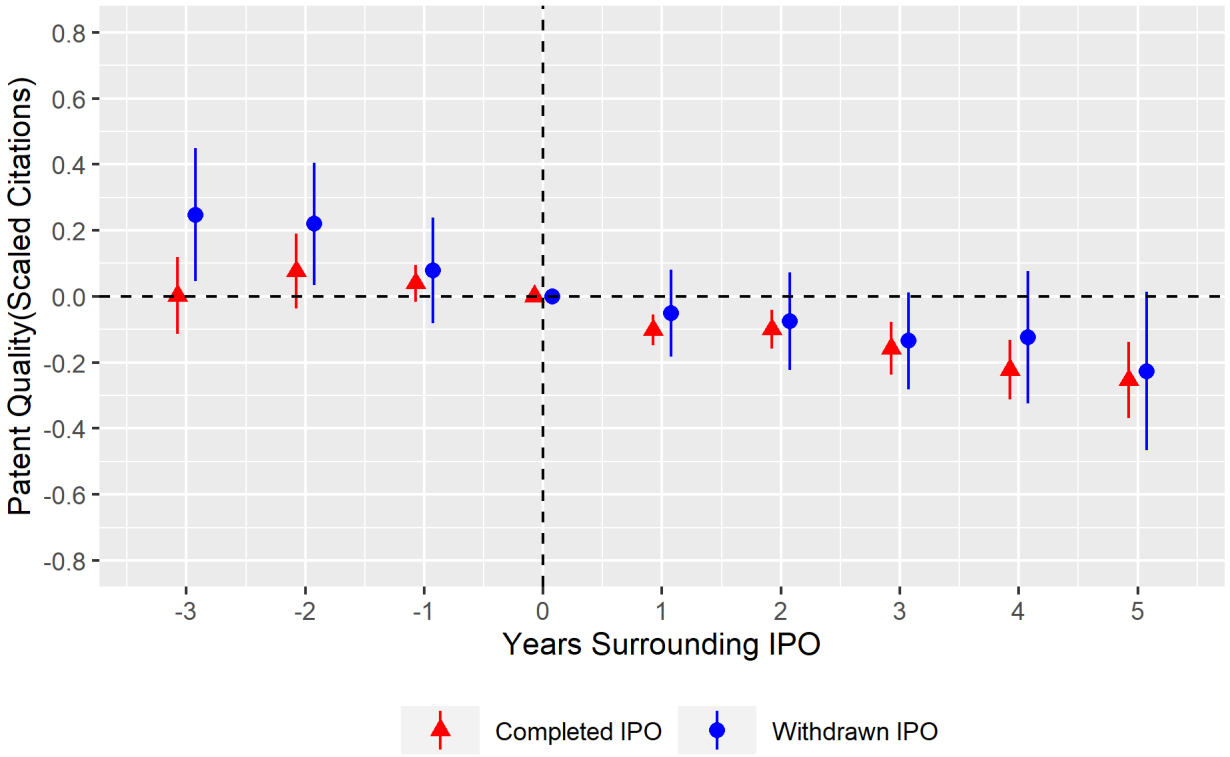

Figure 5: Relationship between Patent Originality and IPO Filing Timing
This figure shows the relationship between IPO completion and patent originality for firms with completed and withdrawn IPOs across the IPO filing year window for IPOs filed from 1985 to 2012. The dependent variable, *Originality*, is the average breadth of patent classes cited adjusted for the patent's subsection ID. Regressions are run at the firm level and include issuer fixed effects. Standard errors are clustered at the firm level. All coefficient estimates within completed and withdrawn IPOs are relative to event year 0.

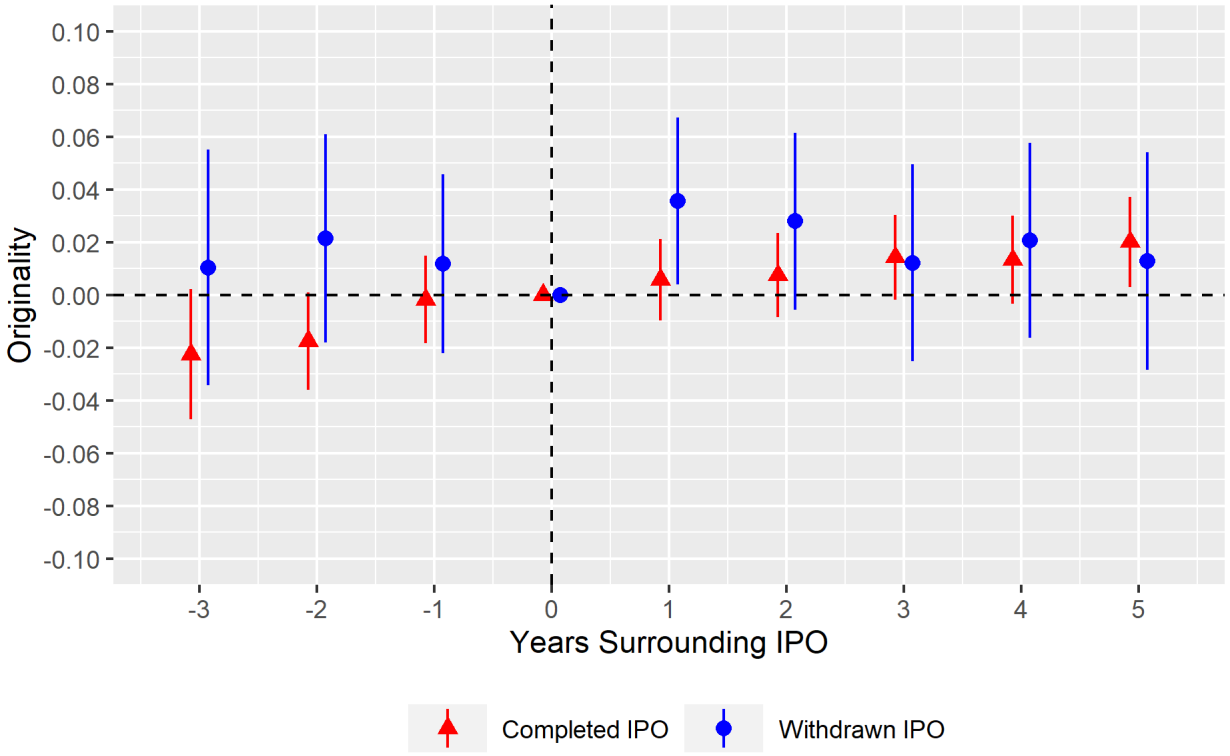

Figure 6: Relationship between Patent Generality and IPO Filing Timing
This figure shows the relationship between IPO completion and patent originality for firms with completed and withdrawn IPOs across the IPO filing year window for IPOs filed from 1985 to 2012. The dependent variable, *Generality*, is the average breadth of patent classes that cite a particular patent adjusted for the patent's subsection ID. Regressions are run at the firm level and include issuer fixed effects. Standard errors are clustered at the firm level. All coefficient estimates within completed and withdrawn IPOs are relative to event year 0.

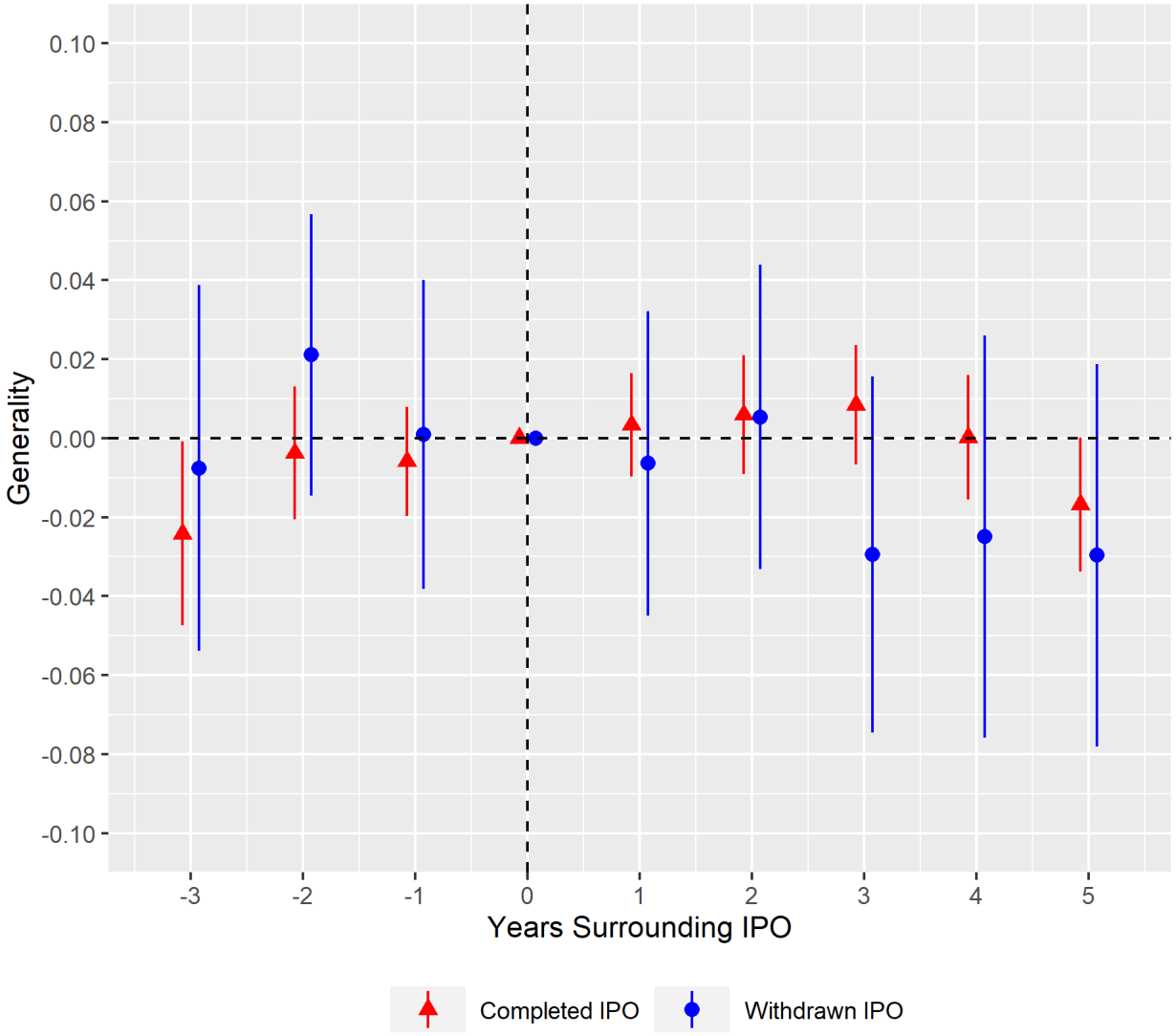

Figure 7: Relationship between Patent Quality and IPO Filing Timing

This figure shows the correlation between a patent's scaled citations received and its economic value overall and within Fama-French 12 industry groupings. Financial firms are excluded based on the sampling filters detailed in Table A.1.

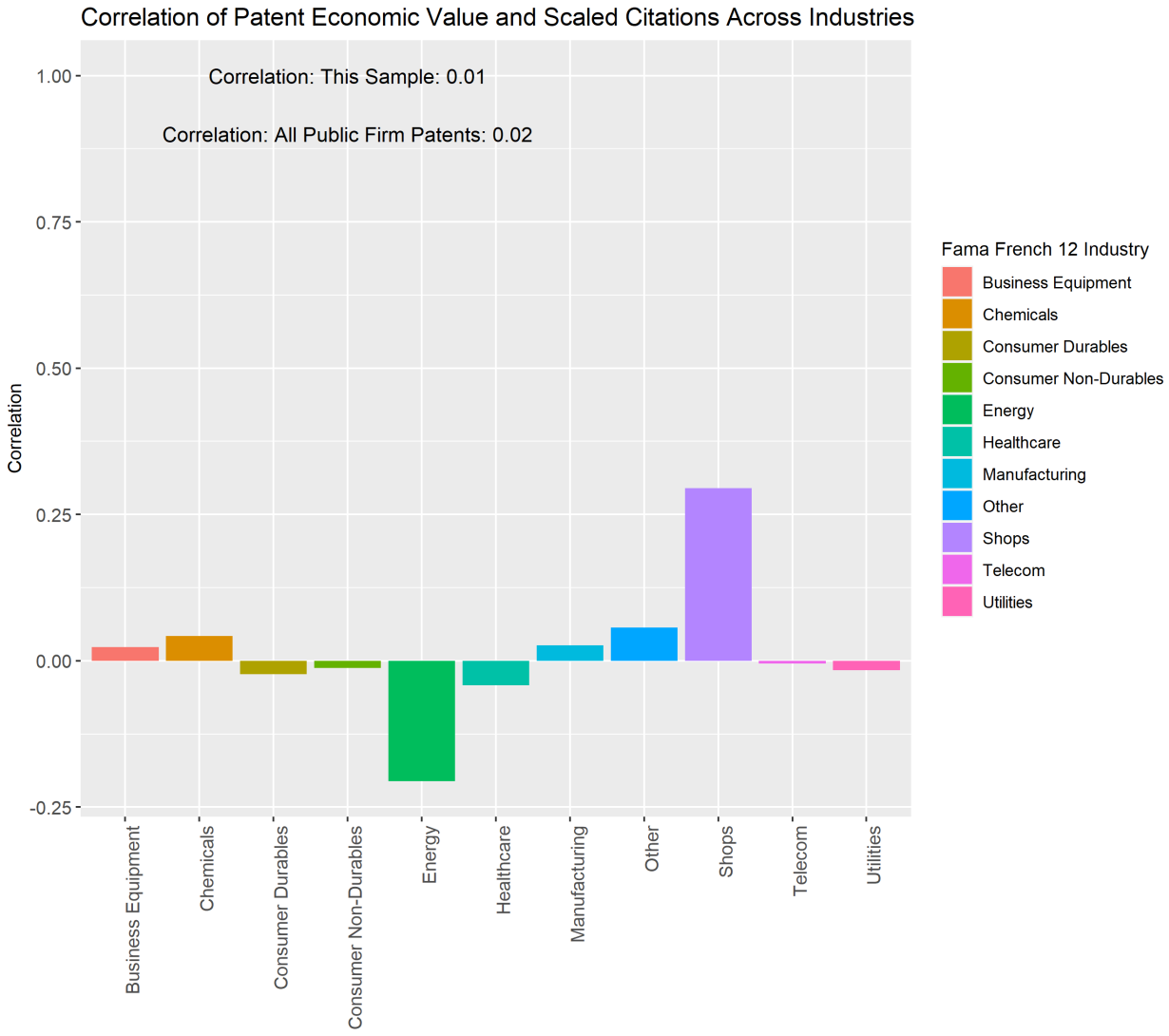

Table 1: Characteristic Comparison Across Completed and Withdrawn IPOs

This table reports the mean, median, and standard deviation across firm characteristics for completed and withdrawn IPOs and the difference in means for IPOs between 1985 to 2012 conditioning on having a patent in the [-3,5] year window surrounding the IPO. ***, **, * correspond to statistical significance at the 1%, 5%, and 10% level, respectively. The Appendix provides detailed variable descriptions.

	Completed			Withdrawn			Difference
	Mean	Median	SD	Mean	Median	SD	Mean
Patent Characteristics							
Patent Activity	1.67	1.00	1.30	1.77	2.00	1.34	-0.10
Total Patents	5.94	2.00	8.71	5.87	2.00	8.61	0.07
Scaled Number of Patents	0.62	0.26	1.07	0.60	0.25	1.03	0.02
Total Citations	21.92	6.00	36.06	18.26	4.00	32.95	3.67*
Citation Quality	1.64	1.21	1.40	1.33	1.02	1.23	0.30***
Originality	0.45	0.49	0.26	0.42	0.44	0.27	0.03
Generality	0.44	0.47	0.24	0.36	0.37	0.26	0.07***
Days to Patent Grant	1125.19	1043.00	470.44	1262.86	1114.97	594.93	-137.67***
Trademark Characteristics							
Trademark Activity	1.85	2.00	1.43	1.77	2.00	1.35	0.08
Number of Trademarks	9.89	5.00	13.28	8.51	4.00	11.16	1.39*
Scaled Number of Trademarks	1.56	0.85	2.19	1.21	0.68	1.78	0.35***
Trademark Renewal Rate	0.42	0.38	0.34	0.59	0.67	0.35	-0.17***
Days to Trademark Grant	651.18	612.50	327.71	628.61	586.71	413.50	22.58
% Patents	0.44	0.37	0.37	0.45	0.40	0.36	-0.01
IPO Characteristics							
Principal Amount	84.76	41.25	166.22	86.93	63.75	127.72	-2.17
Ratio of VC to IPO Principal	1.04	0.65	1.31	1.34	1.13	1.04	-0.30**
Firm Age	13.95	7.00	19.01	11.66	7.00	16.17	2.29*
Venture Capital Backed	0.58	1.00	0.49	0.75	1.00	0.43	-0.17***
Private Equity Backed	0.11	0.00	0.31	0.04	0.00	0.19	0.07***
Dual Class	0.06	0.00	0.24	0.08	0.00	0.28	-0.02
Nasdaq Pre-Filing Return	0.06	0.05	0.12	0.03	0.03	0.13	0.02***
Pioneer	0.04	0.00	0.19	0.04	0.00	0.19	0.00
Early Follower	0.02	0.00	0.15	0.03	0.00	0.16	-0.00
Days Registration	90.67	66.00	86.32	266.66	213.00	207.89	-175.99***
Scaled Financials							
R&D/Assets	0.17	0.11	0.22	0.41	0.27	0.43	-0.24***
Sales/Assets	0.80	0.68	0.69	0.75	0.57	0.80	0.05
Net Income/Assets	-0.12	0.01	0.38	-0.51	-0.26	0.73	0.39***
Cash/Assets	0.31	0.24	0.27	0.26	0.21	0.25	0.04
Firm Outcome Characteristics							
Bankruptcy Flag	0.03	0.00	0.16	0.02	0.00	0.13	0.01
Acquisition Flag	0.46	0.00	0.50	0.11	0.00	0.31	0.35***
Acquired Flag	0.19	0.00	0.39	0.23	0.00	0.42	-0.04*

Table 2: Instrument Relevance: IPO completion and Nasdaq Post-Filing Returns

This table reports the OLS regression coefficients and standard errors of the relationship between IPO completion and the post-filing returns on the Nasdaq. Columns (1) and (2) use the full sample of IPOs from 1985 to 2012, columns (3) and (4) from 1985 to 2003, and columns (5) to (6) from 2004 to 2012. The independent variable, *Nasdaq Return* across all specifications is the two month post-filing return on the Nasdaq stock index. Control variables include the three month pre-filing return on the Nasdaq stock index and a firm's location within an IPO wave. Industry and filing year fixed effects are included. ***, **, * correspond to statistical significance at the 1%, 5%, and 10% level, respectively. The Appendix provides detailed variable descriptions.

Sample	Full	Full	Pre-2003	Pre-2003	Post-2003	Post-2003
Instrument	Two Months	Two Months	Two Months	Two Months	Two Months	Two Months
	(1)	(2)	(3)	(4)	(5)	(6)
Nasdaq Post-Filing Return	0.49***	0.53***	0.59***	0.63***	-0.15	-0.15
	[0.09]	[0.09]	[0.09]	[0.09]	[0.30]	[0.31]
Citation Quality Pre-IPO		0.01***		0.01		0.03***
		[0.00]		[0.00]		[0.01]
Scaled Number of Patents		0.01***		0.01***		0.01***
		[0.00]		[0.00]		[0.00]
Nasdaq Pre-Filing Return		0.18**		0.18**		0.16
		[0.07]		[0.07]		[0.29]
Observations	2700	2700	2137	2137	563	563
R^2	0.14	0.15	0.13	0.14	0.11	0.15
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	No	Yes	No	Yes	No	Yes
F-Statistic	30.37	33.22	41.53	44.64	0.24	0.24

Table 3: IPO Completion Likelihood Transition Matrix

This table reports the likelihood of IPO completion given a firm's pre-filing and post-filing Nasdaq return quintile. μ represents the conditional probability of IPO completion given a firm's pre-filing quintile displayed vertically or post-filing quintile displayed horizontally.

Panel A: IPO Completion 1985-2003						
Pre-Filing Quintile	Post-Filing Quintile					
	(1)	(2)	(3)	(4)	(5)	(μ)
(1)	0.77	0.82	0.82	0.88	0.90	0.86
(2)	0.71	0.86	0.79	0.92	0.94	0.85
(3)	0.78	0.83	0.81	0.9	0.96	0.85
(4)	0.82	0.83	0.89	0.85	0.94	0.86
(5)	0.88	0.83	0.89	0.88	0.91	0.87
(μ)	0.81	0.84	0.83	0.89	0.93	0.86
Panel B: IPO Completion 2004-2012						
Pre-Filing Quintile	Post-Filing Quintile					
	(1)	(2)	(3)	(4)	(5)	(μ)
(1)	0.67	0.73	0.71	0.62	0.64	0.66
(2)	0.43	0.87	0.86	0.79	0.63	0.68
(3)	0.66	0.72	0.8	0.67	0.54	0.69
(4)	0.74	0.77	0.77	0.47	0.64	0.70
(5)	0.65	0.74	0.78	0.78	0.00	0.72
(μ)	0.63	0.76	0.78	0.68	0.61	0.69

Table 4: Exclusion Restriction: Orthagonality of Characteristics to Instrument
This table reports the difference in means across firm and IPO characteristics for firms that experience a Nasdaq post-filing return in the bottom decile (compared to the remaining 90% of firms) and quartile (compared to the remaining 75% of firms) within a given year. ***, **, * correspond to statistical significance at the 1%, 5%, and 10% level, respectively. The Appendix provides detailed variable descriptions. The Appendix provides detailed variable descriptions.

Nasdaq Returns Threshold	Bottom 10% (1)	Top 90% (2)	Diff. (3)	Bottom 25% (4)	Top 75% (5)	Diff. (6)
Patent Characteristics						
Patent Activity	1.68	1.76	-0.08	1.69	1.69	-0.01
Total Patents	5.93	5.91	0.02	5.97	5.79	0.19
Scaled Number of Patents	0.62	0.58	0.04	0.63	0.57	0.06
Total Citations	21.35	20.66	0.70	21.51	20.62	0.90
Citation Quality	1.60	1.44	0.16	1.61	1.51	0.10
Originality	0.44	0.43	0.01	0.45	0.43	0.02
Generality	0.42	0.42	0.01	0.43	0.41	0.01
Trademark Characteristics						
Trademark Activity	1.84	1.79	0.05	1.85	1.79	0.07
Number of Trademarks	9.57	10.27	-0.71	9.77	9.31	0.46
Scaled Number of Trademarks	1.49	1.58	-0.09	1.52	1.43	0.09
Trademark Renewal Rate	0.45	0.45	-0.00	0.45	0.46	-0.01
% Patents	0.44	0.45	-0.01	0.44	0.45	-0.00
IPO Characteristics						
Principal Amount	87.03	69.78	17.26*	90.55	69.93	20.62***
Ratio of VC to IPO Principal	1.08	1.16	-0.08	1.06	1.17	-0.11
Firm Age	13.66	13.65	0.01	13.86	13.10	0.76
Venture Capital Backed	0.60	0.63	-0.04	0.59	0.64	-0.05*
Private Equity Backed	0.10	0.09	0.01	0.10	0.07	0.03*
Dual Class	0.06	0.05	0.01	0.06	0.06	0.00
NASDAQ Pre-Filing Return	0.05	0.10	-0.05***	0.04	0.09	-0.04***
Pioneer	0.04	0.03	0.00	0.04	0.03	0.00
Early Follower	0.02	0.04	-0.02	0.02	0.03	-0.00
Scaled Financials						
R&D/Assets	0.18	0.18	-0.01	0.18	0.18	-0.01
Sales/Assets	0.80	0.81	-0.01	0.80	0.81	-0.02
Net Income/Assets	-0.14	-0.14	-0.00	-0.14	-0.14	0.00
Cash/Assets	0.31	0.28	0.02	0.30	0.32	-0.02

Table 5: Exclusion Restriction: Placebo Test

This table reports the OLS regressions coefficients and standard errors of the effect of two-month returns on the Nasdaq at various points relative to a firm's IPO filing date. The included covariates are the two-month return on the Nasdaq stock index over the relevant period(e.g. *Nasdaq One-Year Post-Filing Return* is the two-month return on the Nasdaq calculated beginning one year after a firm's filing date. Control variables include a firm's average scaled citations pre-IPO, average number of scaled patents, and a firm's location in the IPO wave. Industry and filing year fixed effects are included. ***, **, * correspond to statistical significance at the 1%, 5%, and 10% level, respectively. The Appendix provides detailed variable descriptions.

	Panel A: Require Patent Before and After IPO Filing							
	Scaled Citations							
	1985-2003				1985-2012			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Nasdaq Post-Filing Return	-0.45			-0.57*	-0.22			-0.30
	[0.29]			[0.31]	[0.26]			[0.29]
Nasdaq One-Year Post-Filing Return		0.23		0.03		0.17		0.07
		[0.24]		[0.24]		[0.22]		[0.22]
Nasdaq Pre-Filing Return			-0.28	-0.39			-0.25	-0.30
			[0.23]	[0.25]			[0.22]	[0.24]
Observations	1239	1239	1239	1239	1623	1623	1623	1623
R^2	0.20	0.20	0.20	0.20	0.21	0.21	0.21	0.21
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Panel B: All Firms							
	Scaled Citations							
	1985-2003				1985-2012			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Nasdaq Post-Filing Return	-0.05			-0.28	0.10			-0.06
	[0.24]			[0.26]	[0.23]			[0.24]
Nasdaq One-Year Post-Filing Return		-0.00		-0.20		-0.02		-0.12
		[0.21]		[0.21]		[0.19]		[0.19]
Nasdaq Pre-Filing Return			-0.52***	-0.60***			-0.44**	-0.46**
			[0.19]	[0.20]			[0.18]	[0.19]
Observations	2137	2137	2137	2137	2700	2700	2700	2700
R^2	0.05	0.05	0.05	0.05	0.07	0.07	0.08	0.08
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 6: Effect of IPO Completion on Patent Quality

This table reports the OLS regression coefficients and standard errors of the relationship between IPO completion and patent quality. The dependent variable *Scaled Citations* is the average citations a firm receives in the subsequent three years following the grant date for patents filed for in the [1,5] year window following the IPO adjusted for the patents' subsection ID. *IPO* denotes whether a firm successfully completes its IPO and *Nasdaq Return* is the two month post-filing return on the Nasdaq stock index. Columns (1), (2), (4), and (5) are estimated using OLS while columns (3) and (6) are IV regressions using *Nasdaq Post-Filing Return* as the instrumental variable for *IPO*. Control variables include pre-filing returns on the Nasdaq, a firm's location in the IPO wave, and the pre-filing measure of the dependent variable from the [-3,0] year window around the IPO filing year. Panel A requires that a firm has a patent in the pre-filing and post-filing IPO window following Bernstein (2015) while Panel B includes all firms. Industry and filing year fixed effects are included. ***, **, * correspond to statistical significance at the 1%, 5%, and 10% level, respectively.

	Panel A: Require Patent Before and After IPO Filing					
	Scaled Citations					
	1985-2003			1985-2012		
	(1)	(2)	(3)	(4)	(5)	(6)
IPO	0.09		-0.95*	0.15**		-0.66
	[0.08]		[0.53]	[0.07]		[0.60]
Nasdaq Post-Filing Return		-0.58*			-0.32	
		[0.31]			[0.28]	
Observations	1239	1239	1239	1623	1623	1623
R^2	0.20	0.20	0.08	0.22	0.21	0.13
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic	-	-	28.59	-	-	18.72
	Panel B: All Firms					
	Scaled Citations					
	1985-2003			1985-2012		
	(1)	(2)	(3)	(4)	(5)	(6)
IPO	0.22***		-0.32	0.22***		-0.03
	[0.06]		[0.41]	[0.05]		[0.43]
Nasdaq Post-Filing Return		-0.20			-0.02	
		[0.26]			[0.24]	
Observations	2137	2137	2137	2700	2700	2700
R^2	0.06	0.05	0.02	0.08	0.08	0.07
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic	-	-	47 45.72	-	-	35.16

Table 7: Effect of IPO Completion on Patent Quality

This table reports the OLS regression coefficients and standard errors of the relationship between IPO completion and patent quality. The dependent variable *Scaled Citations* is the average citations a firm receives in the subsequent three years following the grant date for patents filed for in the [1,5] year window following the IPO adjusted for the patents' subsection ID. *IPO* denotes whether a firm successfully completes its IPO and *Nasdaq Return* is the two month post-filing return on the Nasdaq stock index. Columns (1), (2), (4), and (5) are estimated using OLS while columns (3) and (6) are IV regressions using *Nasdaq Post-Filing Return* as the instrumental variable for *IPO*. Control variables include pre-filing returns on the Nasdaq, a firm's location in the IPO wave, and the pre-filing measure of the dependent variable from the [-3,0] year window around the IPO filing year. Panel A requires that a firm has a patent in the pre-filing IPO window following Bernstein (2015) while Panel B includes all IPO firms that meet the sampling criteria regardless of their patenting activity. Industry and filing year fixed effects are included. ***, **, * correspond to statistical significance at the 1%, 5%, and 10% level, respectively.

	Panel A: Require Patent Before IPO Filing					
	Scaled Citations					
	1985-2003			1985-2012		
	(1)	(2)	(3)	(4)	(5)	(6)
IPO	0.21***		-0.38	0.23***		-0.27
	[0.05]		[0.38]	[0.04]		[0.41]
NASDAQ Post-Filing Return		-0.22			-0.13	
		[0.20]			[0.19]	
Observations	1609	1609	1609	2112	2112	2112
R^2	0.13	0.13	0.06	0.17	0.15	0.11
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic	-	-	27.32	-	-	19.73
	Panel B: No Patent Requirements					
	Scaled Citations					
	1985-2003			1985-2012		
	(1)	(2)	(3)	(4)	(5)	(6)
IPO	0.10***		-0.08	0.10***		-0.03
	[0.02]		[0.15]	[0.01]		[0.15]
NASDAQ Post-Filing Return		-0.04			-0.01	
		[0.08]			[0.07]	
Observations	5952	5952	5952	7393	7393	7393
R^2	0.33	0.32	0.32	0.34	0.34	0.34
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic	-	-	71.82	-	-	66.97

Table 8: Effect of IPO Completion on Patent Originality and Generality

This table reports the OLS regression coefficients and standard errors of the relationship between IPO completion and patent originality and generality. The dependent variable in Panel A is *Originality* which is the breadth of patent classes cited for patents filed for in the [1,5] year window following the IPO adjusted for the patents' subsection ID. The dependent variable in Panel B is *Generality* which is the breadth of patent classes that cite patents filed for in the [1,5] year window following the IPO adjusted for the patents' subsection ID. *IPO* denotes whether a firm successfully completes its IPO and *Nasdaq Post-Filing Return* is the two month post-filing return on the Nasdaq. Columns (1), (2), (4), and (5) are estimated using OLS while columns (3) and (6) are IV regressions using *Nasdaq Post-Filing Return* as the instrumental variable for *IPO*. Control variables include pre-filing returns on the Nasdaq, a firm's location in the IPO wave, and the pre-filing measure of the dependent variable from the [-3,0] year window around the IPO filing year. Industry and filing year fixed effects are included. ***, **, * correspond to statistical significance at the 1%, 5%, and 10% level, respectively.

	Panel A: Originality					
	1985-2003			1985-2012		
	(1)	(2)	(3)	(4)	(5)	(6)
IPO	0.02		-0.01	0.01		-0.04
	[0.02]		[0.11]	[0.01]		[0.12]
Nasdaq Post-Filing Return		-0.00			-0.02	
		[0.07]			[0.06]	
Observations	1239	1239	1239	1623	1623	1623
R^2	0.31	0.30	0.30	0.33	0.33	0.33
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic	-	-	28.41	-	-	18.52
	Panel B: Generality					
	1985-2003			1985-2012		
	(1)	(2)	(3)	(4)	(5)	(6)
IPO	0.04**		0.05	0.03**		0.05
	[0.02]		[0.09]	[0.01]		[0.11]
Nasdaq Post-Filing Return		0.03			0.03	
		[0.06]			[0.05]	
Observations	1239	1239	1239	1623	1623	1623
R^2	0.46	0.46	0.46	0.46	0.45	0.45
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic	-	-	28.40	-	-	18.65

Table 9: Effect of IPO Completion on Patent and Trademark Output

This table reports the OLS regression coefficients and standard errors of the relationship between IPO completion and patent and trademark production. The dependent variable in Panel A is *Ln(1 + Total Patents)* which is the log transformed number of patents filed for in the [1,5] year window following the IPO. The dependent variable in Panel B is *Ln(1 + Total Trademarks)* which is the log transformed number of trademarks filed for in the [1,5] year window following the IPO. *IPO* denotes whether a firm successfully completes its IPO and *Nasdaq Post-Filing Return* is the two month post-filing return on the Nasdaq. Columns (1), (2), (4), and (5) are estimated using OLS while columns (3) and (6) are IV regressions using *Nasdaq Post-Filing Return* as the instrumental variable for *IPO*. Control variables include pre-filing returns on the Nasdaq, a firm's location in the IPO wave, and the pre-filing measure of the dependent variable from the [-3,0] year window around the IPO filing year. Industry and filing year fixed effects are included. ***, **, * correspond to statistical significance at the 1%, 5%, and 10% level, respectively.

	Panel A: Ln(1+Patents)					
	1985-2003			1985-2012		
	(1)	(2)	(3)	(4)	(5)	(6)
IPO	0.36***		0.59	0.39***		0.48
	[0.08]		[0.45]	[0.06]		[0.49]
Nasdaq Post-Filing Return		0.38			0.26	
		[0.29]			[0.27]	
Observations	2137	2137	2137	2700	2700	2700
R^2	0.34	0.33	0.33	0.37	0.37	0.37
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic	-	-	45.97	-	-	34.85
	Panel B: Ln(1+Trademarks)					
	1985-2003			1985-2012		
	(1)	(2)	(3)	(4)	(5)	(6)
IPO	0.65***		0.79*	0.66***		0.65
	[0.08]		[0.48]	[0.06]		[0.52]
Nasdaq Post-Filing Return		0.50			0.34	
		[0.31]			[0.28]	
Observations	2137	2137	2137	2700	2700	2700
R^2	0.43	0.41	0.43	0.45	0.43	0.45
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic	-	-	46.36	-	-	33.89

Table 10: Innovation Production and Quality Links to Profitability and Returns
This table reports the OLS regression coefficients and standard errors of the relationship between innovation production and quality differences post-IPO on measures of profitability and stock price performance. Panel A displays the effect of changes in innovation on profitability while Panel B displays the effect on adjusted stock returns. The dependent variable in Panel A is Δ *ROA* in computed as the average level of profitability in the [1,5] year window following the IPO minus the firm's profitability in the IPO filing year. The dependent variable in Panel B is *5-Year Nasdaq Adjusted Returns* computed as the firm's buy and hold returns over the five-year period post-IPO minus the Nasdaq stock index return, respectively. The independent variables of interest are Δ *Trademarks Post-IPO* representing the standardized increase in trademarks in the post period versus the pre-period, while Δ *Patents Post-IPO* and Δ *Innovation Post-IPO* are defined analogously for patents and scaled citations, respectively. Control variables include a firm's total assets and IPO principal sought. Results are estimated only for firms with completed IPOs. ***, **, * correspond to statistical significance at the 1%, 5%, and 10% level, respectively.

	Panel A: Profitability			
	Δ ROA			
	(1)	(2)	(3)	(4)
Δ Trademarks Post-IPO	0.04***			0.02
	[0.01]			[0.01]
Δ Patents Post-IPO		0.14***		0.10***
		[0.03]		[0.04]
Δ Innovation Post-IPO			-0.01	-0.01
			[0.01]	[0.01]
Observations	2120	2120	1332	1332
R^2	0.04	0.05	0.05	0.05
Industry F.E.	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes
	Panel B: Stock Price Performance			
	Five Year Nasdaq-Adjusted Returns			
	(1)	(2)	(3)	(4)
Δ Trademarks Post-IPO	0.75***			0.56***
	[0.10]			[0.12]
Δ Patents Post-IPO		1.96***		1.67***
		[0.28]		[0.28]
Δ Innovation Post-IPO			0.07	0.12
			[0.08]	[0.08]
Observations	1625	1625	1094	1094
R^2	0.42	0.42	0.42	0.46
Industry F.E.	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes

Appendix

Variable Definition

Patent Characteristics

Patent Activity. Indicates whether a firm has a patent in a given event year and is aggregated to be the sum of patent activity for firms in the pre-filing window period [-3,0].

Total Patents. The total number of patents for a firm and is aggregated to be the total number of patents for firms in the pre-filing window period [-3,0].

Total Citations. The total number of citations for a firm (that is received within 3 years of the patent grant years) and is aggregated to be the total number of citations for firms' patents in the pre-filing window period [-3,0].

Scaled Citations. The total number of citations for a firm (that is received within 3 years of the patent grant years) scaled at the patent subsection level and is aggregated to be the total number of scaled citations for firms' patents in the pre-filing window period [-3,0].

Originality. The average breadth of patent classes cited scaled at the patent subsection level and is aggregated to be the average of originality for firms' patents in the pre-filing window period [-3,0].

Generality. The average breadth of patent classes that cite a firm's particular patent scaled at the patent subsection level and is aggregated to be the average of generality for firms' patents in the pre-filing window period [-3,0].

Days to Patent Grant. The number of days from patent filing to grant date and is aggregated to be the average number of days in the pre-filing window period [-3,0].

Trademark Characteristics

Trademark Activity. Indicates whether a firm has a trademark in a given event year and is aggregated to be the sum of patent activity for firms in the pre-filing window period [-3,0].

Total Trademarks. The total number of trademarks for a firm and is aggregated to be the total number of patents for firms in the pre-filing window period [-3,0].

Trademark Renewal Rate. Indicates whether a trademark is renewed six years after its grant date by the firm and is aggregated to be the average proportion of trademark renewal in the pre-filing window period [-3,0].

Days to Trademark Grant. The number of days from trademark filing to grant date and is aggregated to be the average number of days in the pre-filing window period [-3,0].

% Patents. The cumulative proportion of patent filings scaled by the sum of trademark and patent filings and is aggregated to be the cumulative average of patents/(patents + trademarks) at event year 0.

Other Characteristics

Pioneer. Indicates whether a firm is the first IPO filing within a Fama-French 48 industry grouping within the last 180 days.

Early Follower. Indicates whether a firm follows a pioneer within a Fama-French 48 industry grouping within the last 180 days.

Figure A.1: Relationship between IPO Withdrawal and Nasdaq Returns

This figure shows the time-varying shift in the relationship between IPO withdrawal and Nasdaq fluctuations from 1985 to 2012. An increase in magnitude indicates a strengthening of the relationship while a reduction indicates a weakening of the relationship. The dotted vertical lines in 1996 and 2007 correspond to the structural breaks in time that result in the smallest Bayesian Information Criterion (BIC). Coefficient estimates of the effect of Nasdaq return fluctuations on the probability of IPO completion are at the monthly level.

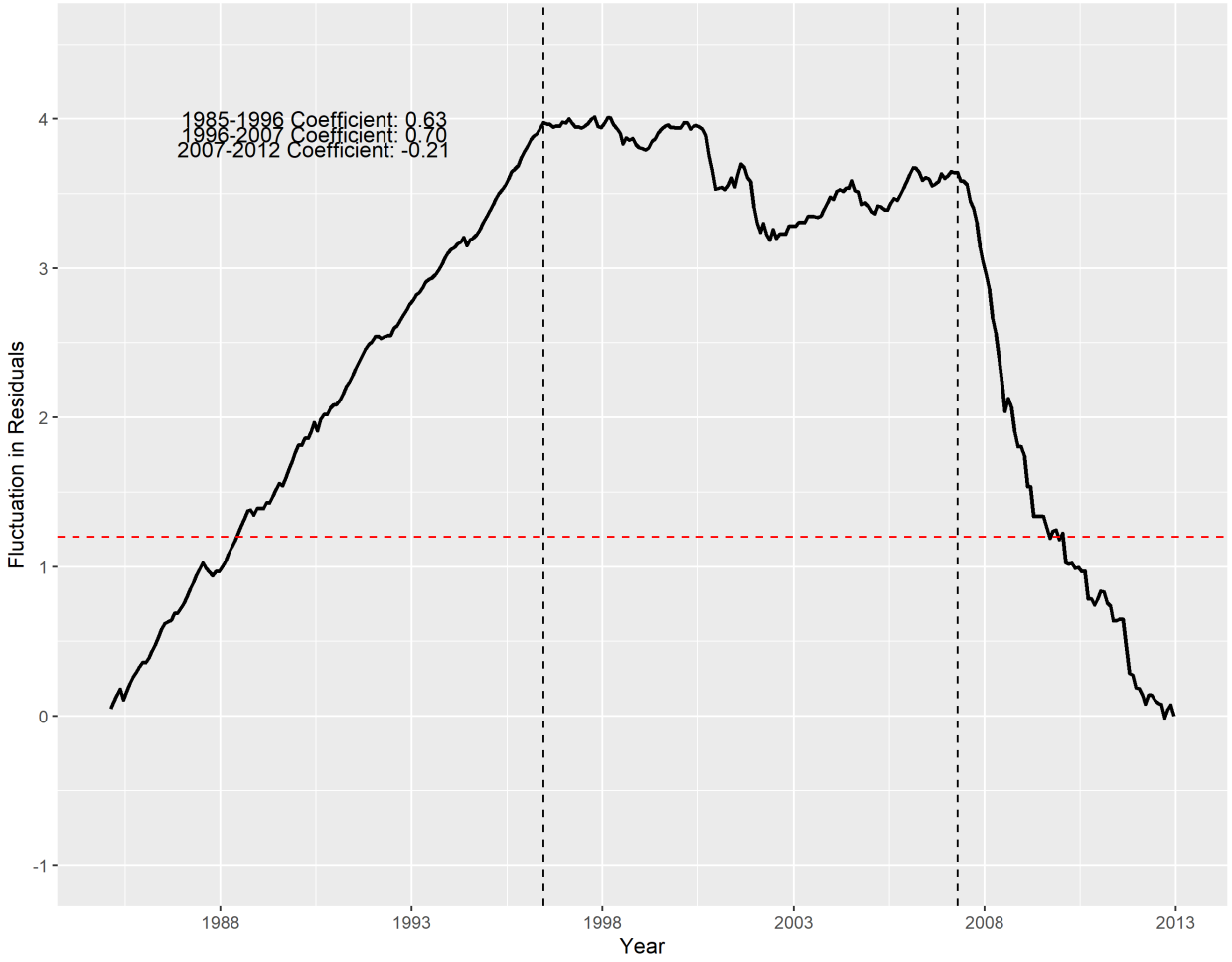

Figure A.2: Patent Quality for Completed and Withdrawn Firms Around IPO Filing
This figure shows the average *Scaled Citations* completed and withdrawn firms receive in the years surrounding their IPO filing for firms. Panel A shows the result for firms filing from 1985 to 2003, and Panel B shows the result for firms filing from 2004 to 2012. *Scaled Citations* is the average citations a firm's patents receives in the subsequent three years following the grant date grouped by the filing year and scaled within a patent's subsection ID.

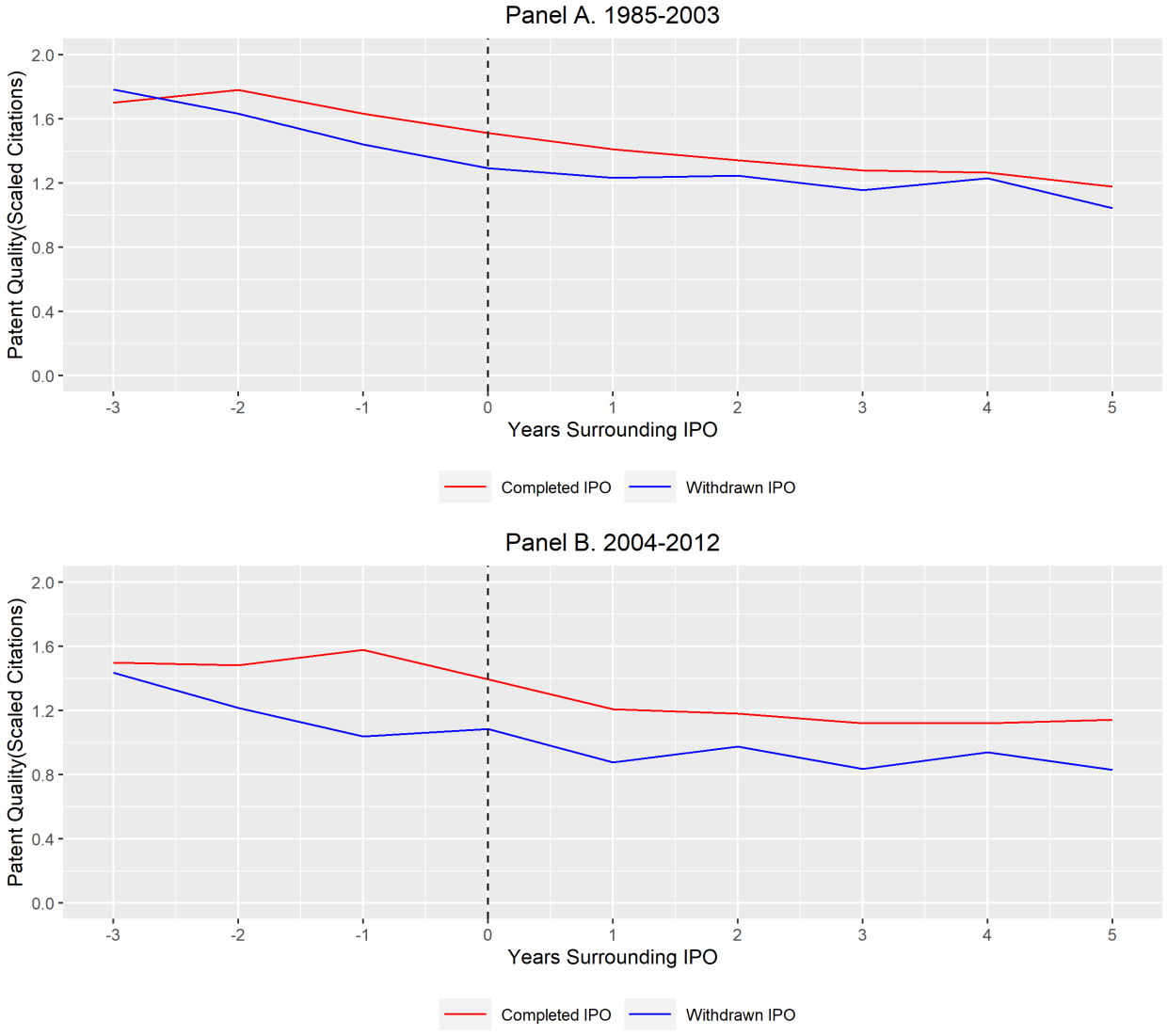

Figure A.3: Relationship between Patent Quality and IPO Filing Timing

This figure shows the relationship between IPO completion and patent quality for firms with completed and withdrawn IPOs across the IPO filing year window. The dependent variable, *Scaled Citations*, is the average citations a firms' patent receives in the subsequent three years following the grant date grouped by the filing year and scaled within a patent's subsection ID. Regressions are run at the firm-event year level and include issuer fixed effects. Standard error estimates are clustered at the firm level. All coefficient estimates within completed and withdrawn IPOs are relative to event year 0.

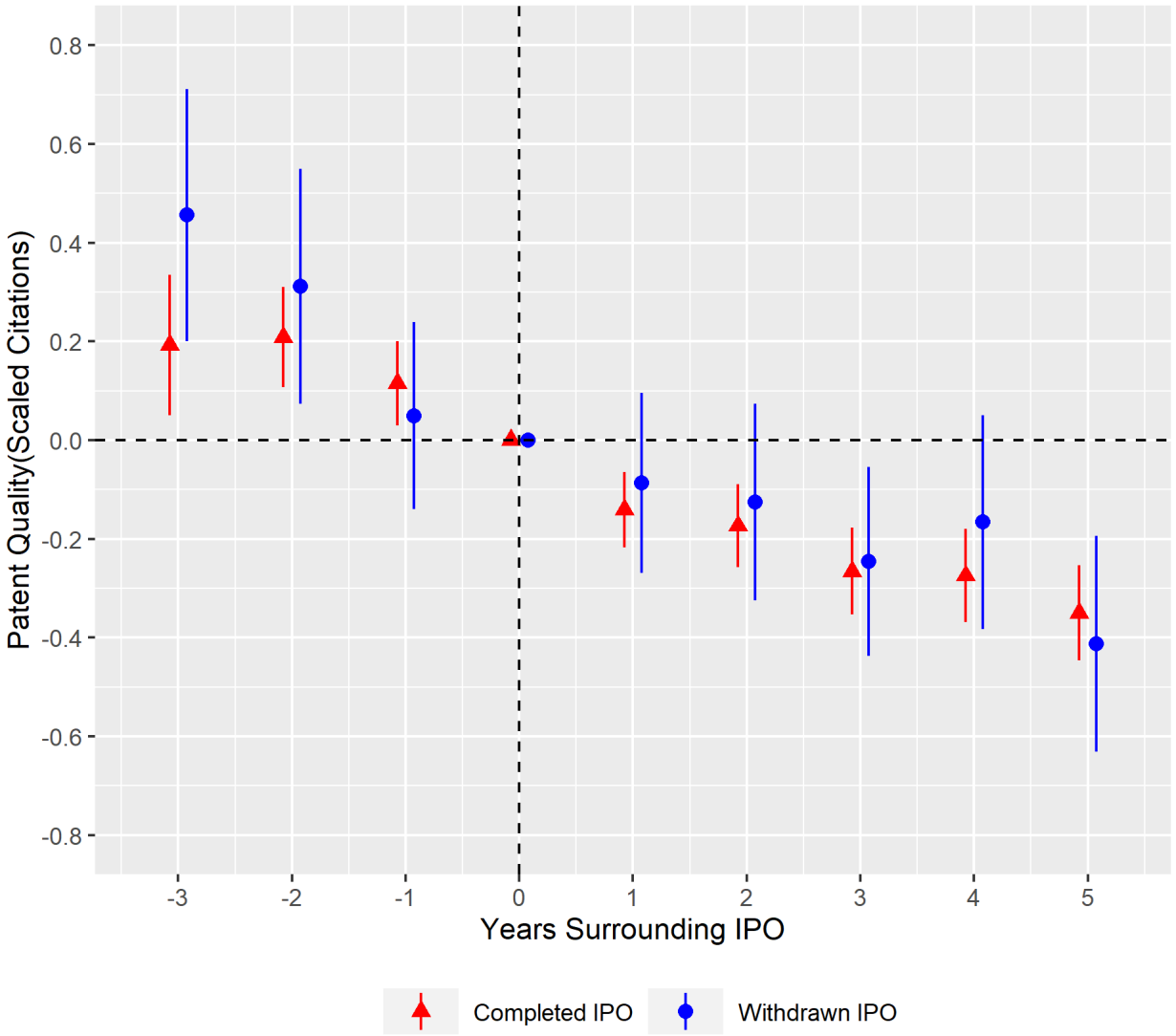

Figure A.4: Relationship between Innovation Strategy and IPO Filing Timing
This figure shows the relationship between IPO completion and a firm's innovation strategy for firms with completed and withdrawn IPOs across the IPO filing year window. The dependent variable, *Trademarks/(Trademarks + Patents)*, is the proportion of trademarks scaled by the cumulative sum of trademarks and patents. Regressions are run at the firm level and include issuer fixed effects. Standard errors are clustered at the firm level. All coefficient estimates within completed and withdrawn IPOs are relative to event year 0.

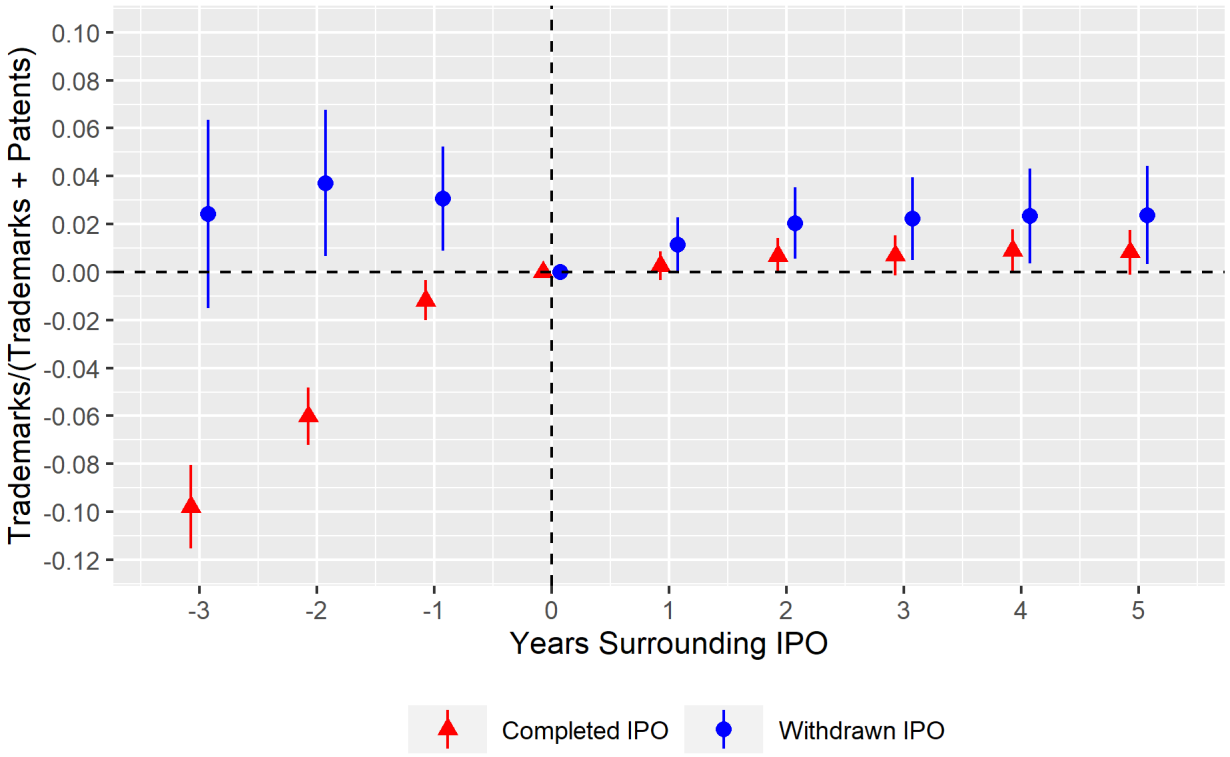

Table A.1: Sample Reconciliation

This table reports the sample reconciliation for traditional IPOs filed from 1985 to 2012 in Panel A, traditional IPOs filed from 1985 to 2003 in Panel B, and SPACs with announced mergers from 1985 to 2012 with the relevant filter and observation counts.

Filter applied	Observations Remaining
	Panel A: Traditional IPOs
(1). Traditional IPO Filing Date Between 1985-2012	12,436
(2). Exclude Financial Firms	9,791
(3). IPO Filed on NASDAQ, NYSE, AMEX	7,821
(4). Exclude REITS, ADRS, and Unit Offers	7,237
(4). Filed for Patent Within [-3,5] Year Window of IPO Filing Date	2,681
	Panel B: Traditional IPOs
(1). Traditional IPO Filing Date Between 1985-2003	9,952
(2). Exclude Financial Firms	7,981
(3). IPO Filed on NASDAQ, NYSE, AMEX	6,257
(4). Exclude REITS, ADRS, and Unit Offers	5,952
(5). Filed for Patent Within [-3,5] Year Window of IPO Filing Date	2,137
	Panel C: SPACs
(1). SPAC Announces Merger Between 1985-2012	156
(2). Target Filed for Patent Within [-3,5] Year Window of M&A Announcement	19

Table A.2: Sample of IPOs

This table reports the total number of traditional IPOs and SPAC IPOs filed, completed, and withdrawn from 1985 to 2012. Columns (1) to (3) report the counts across traditional IPOs while columns (4) to (6) is for SPAC IPOs.

	Traditional IPOs			SPAC IPOs		
	Filed	Completed	Withdrawn	Filed	Completed	Withdrawn
	(1)	(2)	(3)	(4)	(5)	(6)
1985	25	24	1	-	-	-
1986	92	88	4	-	-	-
1987	84	77	7	-	-	-
1988	35	32	3	-	-	-
1989	31	30	1	-	-	-
1990	50	44	6	-	-	-
1991	129	128	1	-	-	-
1992	131	109	22	-	-	-
1993	194	179	15	-	-	-
1994	137	117	20	-	-	-
1995	165	159	6	-	-	-
1996	253	226	27	-	-	-
1997	157	125	32	-	-	-
1998	101	72	29	-	-	-
1999	185	169	16	-	-	-
2000	266	178	88	-	-	-
2001	39	28	11	-	-	-
2002	28	14	14	-	-	-
2003	35	33	2	-	-	-
2004	92	72	20	-	-	-
2005	69	58	11	-	-	-
2006	85	65	20	3	3	
2007	94	55	39	2	1	1
2008	28	9	19	8	1	7
2009	22	16	6	4	1	3
2010	48	35	13	-	-	-
2011	61	39	22	-	-	-
2012	45	33	12	2	1	1
Total	2681	2214	467	19	7	12

Table A.3: Industry Distribution of IPOs

This table reports the distribution of IPO filings, completion, withdrawals, and average principal amount (in millions) across the Fama-French 12 industry classifications excluding financials.

	Filed	Completed	Withdrawn	% Completed	Principal Amount
Business Equipment	1122	959	163	0.85	99.33
Chemicals	58	44	14	0.76	169.77
Consumer Durables	94	85	9	0.90	253.37
Consumer Non-Durables	67	58	9	0.87	201.83
Energy	30	23	7	0.77	390.44
Healthcare	691	527	164	0.76	54.46
Manufacturing	261	222	39	0.85	82.24
Other	218	178	40	0.82	138.98
Shops	76	58	18	0.76	89.73
Telecom	74	59	15	0.80	359.72
Utilities	9	8	1	0.89	253.08
Total	2700	2221	479	0.82	109.22

Table A.4: Summary Statistics All Variables

This table provides summary statistics based on an IPO filing firm's patent history, firm-filing characteristics, and financial performance. All characteristics are reported at the time of the filing year. The Appendix provides detailed variable descriptions.

	N	Mean	SD	Min	p25	Median	p75	Max
Patent Characteristics								
Patent Activity	2700	1.69	1.31	0.00	1.00	1.00	3.00	4.00
Total Patents	2700	5.92	8.69	0.00	1.00	2.00	7.00	33.00
Scaled Number of Patents	2700	0.62	1.06	0.00	0.05	0.26	0.70	6.92
Total Citations	2700	21.27	35.55	0.00	0.00	5.00	23.00	135.50
Citation Quality	2112	1.58	1.37	0.00	0.60	1.15	2.16	5.26
Originality	2112	0.44	0.26	0.00	0.25	0.48	0.64	1.00
Generality	2112	0.42	0.24	0.00	0.23	0.46	0.61	0.89
Days to Patent Grant	2112	1,150	498	397	794	1,053	1,394	3,004
Trademark Activity	2700	1.83	1.41	0.00	1.00	2.00	3.00	4.00
Scaled Number of Trademarks	2700	1.50	2.12	0.00	0.18	0.82	1.93	12.86
Trademark Renewal Rate	2053	0.45	0.35	0.00	0.13	0.44	0.75	1.00
Days to Trademark Grant	2053	647	345	0.00	427	608	821	1,753
% Patents	2503	0.44	0.37	0.00	0.09	0.38	0.79	1.00
Principal Amount	2650	85.11	160.60	3.60	23.25	43.40	82.50	1,247
Ratio of VC to IPO Principal	1063	1.09	1.28	0.01	0.30	0.72	1.42	8.32
Firm Age	2475	13.66	18.68	1.00	4.00	7.00	13.00	99.00
Venture Capital Backed	2525	0.60	0.49	0.00	0.00	1.00	1.00	1.00
Private Equity Backed	2700	0.10	0.30	0.00	0.00	0.00	0.00	1.00
Dual Class	2282	0.06	0.24	0.00	0.00	0.00	0.00	1.00
Pioneer	2700	0.04	0.19	0.00	0.00	0.00	0.00	1.00
Early Follower	2700	0.02	0.15	0.00	0.00	0.00	0.00	1.00
Days Registration	2681	121	135	6.00	51.00	73.00	127	826
Total Assets	2239	301.18	957	1.74	26.01	59.08	139	7,067
Total Revenue	2234	252	824	0.00	8.16	34.22	106	6,087
Net Income	2234	0.54	52.30	-181	-10.47	0.24	5.66	342
R&D Expense	1925	14.47	35.13	0.00	2.36	5.93	13.24	286
Cash	2151	37.60	79.49	0.00	3.20	13.06	36.26	609
Negative Profit	2234	0.49	0.50	0.00	0.00	0.00	1.00	1.00
R&D/Assets	1925	0.18	0.24	0.00	0.05	0.11	0.20	1.55
Sales/Assets	2234	0.80	0.70	0.00	0.21	0.68	1.21	3.44
Net Income/Assets	2234	-0.14	0.41	-2.30	-0.23	0.00	0.08	0.36
Cash/Assets	2151	0.31	0.27	0.00	0.06	0.23	0.49	0.94
Bankruptcy Flag	2700	0.02	0.15	0.00	0.00	0.00	0.00	1.00
Acquisition Flag	2700	0.39	0.49	0.00	0.00	0.00	1.00	1.00
Acquired Flag	2700	0.19	0.39	0.00	0.00	0.00	0.00	1.00

Table A.5: Characteristic Comparison Across IPOs Before and After 2003

This table reports the mean, median, and standard deviation across firm characteristics for all IPOs and the difference in means for IPOs filed between 1985 to 2003 and 2004 to 2012 conditioning on having a patent in the [-3,5] year window surrounding the IPO. ***, **, * correspond to statistical significance at the 1%, 5%, and 10% level, respectively. The Appendix provides detailed variable descriptions.

	1985-2003			2004-2012			Difference
	Mean	Median	SD	Mean	Median	SD	Mean
Patent Characteristics							
Patent Activity	1.53	1.00	1.25	2.31	2.00	1.36	-0.79***
Total Patents	5.09	2.00	7.91	9.09	4.00	10.60	-4.00***
Scaled Number of Patents	0.57	0.23	0.99	0.79	0.36	1.27	-0.21***
Total Citations	19.87	5.00	33.95	26.58	7.00	40.66	-6.71***
Citation Quality	1.64	1.23	1.37	1.39	0.97	1.38	0.25***
Originality	0.44	0.48	0.26	0.45	0.48	0.25	-0.01
Generality	0.46	0.49	0.23	0.32	0.32	0.25	0.13***
Days to Patent Grant	1041	949	439	1501	1442	516	-460***
Trademark Characteristics							
Trademark Activity	1.81	2.00	1.40	1.91	2.00	1.44	-0.10
Number of Trademarks	9.26	4.00	12.56	11.12	5.00	14.22	-1.87**
Scaled Number of Trademarks	1.51	0.86	2.13	1.44	0.73	2.10	0.07
Trademark Renewal Rate	0.46	0.45	0.35	0.43	0.40	0.33	0.03
Days to Trademark Grant	653	615	338	625	579	370	28.50
% Patents	0.42	0.33	0.37	0.53	0.52	0.35	-0.11***
IPO Characteristics							
Principal Amount	67.56	36.00	138.05	150.47	86.25	213.34	-82.91***
Ratio of VC to IPO Principal	0.97	0.64	1.15	1.49	1.00	1.56	-0.52***
Firm Age	13.42	7.00	18.58	14.47	8.00	19.01	-1.05
Venture Capital Backed	0.59	1.00	0.49	0.65	1.00	0.48	-0.06*
Private Equity Backed	0.08	0.00	0.27	0.15	0.00	0.36	-0.07***
Dual Class	0.05	0.00	0.22	0.09	0.00	0.29	-0.04*
NASDAQ Pre-Filing Return	0.07	0.06	0.13	0.01	0.02	0.08	0.05***
Pioneer	0.03	0.00	0.16	0.07	0.00	0.26	-0.05***
Early Follower	0.02	0.00	0.13	0.05	0.00	0.22	-0.03***
Days Registration	103	64	119	194	132	166	-91***
Scaled Financials							
R&D/Assets	0.17	0.10	0.23	0.23	0.13	0.27	-0.06***
Sales/Assets	0.82	0.71	0.70	0.72	0.59	0.69	0.10**
Net Income/Assets	-0.13	0.01	0.40	-0.20	-0.04	0.45	0.07**
Cash/Assets	0.30	0.23	0.27	0.34	0.27	0.26	-0.04**
Firm Outcome Characteristics							
Bankruptcy Flag	0.02	0.00	0.15	0.02	0.00	0.15	0.00
Acquisition Flag	0.42	0.00	0.49	0.31	0.00	0.46	0.11***
Acquired Flag	0.19	0.00	0.39	0.20	0.00	0.40	-0.01

Table A.6: Instrument Relevance: Post-Filing Returns and IPO Completion

This table reports the OLS regression coefficients and standard errors of the relationship between IPO completion and the post-filing returns on the Nasdaq at various intervals and firms. Panel A reports the results for firms filing from 1985 to 2003 while Panel B is from 2003 to 2012. Columns (1) to (4) include firms meeting all the sample filtering criteria from Table A.1 besides having a patent in the pre-filing window while columns (5) to (8) require all sample filtering criteria from Table A.1. The independent variable, *Nasdaq Returns* is the post-filing return on the Nasdaq for the specified interval length. Full denotes that the *Nasdaq return* is the holding period return over a firm's entire filing period and is defined only for firms with a filing period under 270 days. Control variables include a firm's average value of patent quality in the pre-filing period, number of patents pre-filing, the three month pre-filing return on the Nasdaq stock index and a firm's location within an IPO wave. Industry and filing year fixed effects are included. ***, **, * correspond to statistical significance at the 1%, 5%, and 10% level, respectively. The Appendix provides detailed variable descriptions.

Panel A: 1985-2003

	All Firms				Patent Sample			
Instrument	One Month	Two Months	Three Months	Full	One Month	Two Months	Three Months	Full
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Nasdaq Returns	0.62***	0.52***	0.37***	0.02	0.78***	0.63***	0.56***	0.16***
	[0.09]	[0.06]	[0.05]	[0.03]	[0.13]	[0.09]	[0.08]	[0.05]
Observations	5952	5952	5952	5443	2137	2137	2137	1993
R^2	0.14	0.14	0.14	0.12	0.13	0.14	0.13	0.12
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic	53.21	71.08	47.39	0.48	36.62	45.70	45.99	10.67

Panel B: 2004-2012

	All Firms				Patent Sample			
Instrument	One Month	Two Months	Three Months	Full	One Month	Two Months	Three Months	Full
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Nasdaq Returns	0.11	0.18	0.40**	0.09	0.01	-0.16	0.34	0.29*
	[0.25]	[0.19]	[0.16]	[0.11]	[0.41]	[0.32]	[0.26]	[0.16]
Observations	1441	1441	1441	958	563	563	563	426
R^2	0.09	0.09	0.09	0.10	0.14	0.14	0.14	0.18
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic	0.18	0.99	6.33	0.72	0.00	0.26	1.68	3.28

Table A.7: Nasdaq Returns Transition Matrix

This table reports the transition matrix likelihood of firms based on their pre-filing return quintile. Panel A displays the results from 1985 to 2003 while Panel B displays the results from 2004 to 2012. Entries report the probability that a firm in one of the listed quintiles of Nasdaq return performance in the pre-filing period is in the listed quintile of Nasdaq returns in the post-filing period.

	Panel A: Transition Matrix 1985-2003				
Pre-Filing Quintile	Post-Filing Quintile				
	(1)	(2)	(3)	(4)	(5)
(1)	0.06	0.10	0.25	0.29	0.30
(2)	0.14	0.23	0.26	0.21	0.16
(3)	0.24	0.2	0.18	0.17	0.21
(4)	0.32	0.22	0.17	0.14	0.15
(5)	0.29	0.25	0.13	0.19	0.14
	Panel B: Transition Matrix 2004-2012				
Pre-Filing Quintile	Post-Filing Quintile				
	(1)	(2)	(3)	(4)	(5)
(1)	0.07	0.09	0.20	0.26	0.37
(2)	0.21	0.14	0.13	0.22	0.32
(3)	0.30	0.22	0.22	0.16	0.11
(4)	0.25	0.24	0.24	0.16	0.10
(5)	0.24	0.31	0.21	0.21	0.02

Table A.8: Additional Investment Post-IPO Likelihood Transition Matrix

This table reports the likelihood of a firm receiving additional investment post- IPO filing year given a firm's pre-filing and post-filing Nasdaq return quintile. μ represents the conditional probability of a firm receiving additional investment given a firm's pre-filing quintile displayed vertically or post-filing quintile displayed horizontally.

Panel A: 1985-2003						
Pre-Filing Quintile	Post-Filing Quintile					
	(1)	(2)	(3)	(4)	(5)	(μ)
(1)	0.19	0.18	0.21	0.11	0.18	0.17
(2)	0.17	0.20	0.19	0.19	0.19	0.19
(3)	0.21	0.15	0.18	0.16	0.17	0.17
(4)	0.21	0.11	0.19	0.20	0.26	0.19
(5)	0.22	0.22	0.02	0.25	0.20	0.20
(μ)	0.21	0.17	0.17	0.17	0.19	0.18
Panel B: 2004-2012						
Pre-Filing Quintile	Post-Filing Quintile					
	(1)	(2)	(3)	(4)	(5)	(μ)
(1)	0.00	0.00	0.29	0.16	0.20	0.17
(2)	0.00	0.20	0.07	0.17	0.34	0.18
(3)	0.23	0.28	0.08	0.28	0.23	0.22
(4)	0.26	0.23	0.15	0.12	0.18	0.20
(5)	0.23	0.26	0.35	0.17	0.00	0.25
(μ)	0.17	0.23	0.20	0.18	0.25	0.20

Table A.9: IPO Acquisition Likelihood Transition Matrix

This table reports the likelihood of a firm being acquired within two years given a firm's pre-filing and post-filing Nasdaq return quintile. μ represents the conditional probability of a firm being acquired given a firm's pre-filing quintile displayed vertically or post-filing quintile displayed horizontally.

Panel A: 1985-2003						
Pre-Filing Quintile	Post-Filing Quintile					
	(1)	(2)	(3)	(4)	(5)	(μ)
(1)	0.12	0.16	0.12	0.09	0.04	0.09
(2)	0.10	0.04	0.06	0.06	0.07	0.06
(3)	0.08	0.05	0.09	0.05	0.04	0.06
(4)	0.02	0.06	0.08	0.05	0.06	0.05
(5)	0.06	0.06	0.06	0.05	0.09	0.06
(μ)	0.06	0.06	0.08	0.06	0.06	0.07
Panel B: 2004-2012						
Pre-Filing Quintile	Post-Filing Quintile					
	(1)	(2)	(3)	(4)	(5)	(μ)
(1)	0.11	0.00	0.12	0.12	0.07	0.09
(2)	0.00	0.00	0.14	0.17	0.06	0.07
(3)	0.11	0.12	0.08	0.00	0.15	0.09
(4)	0.07	0.04	0.08	0.06	0.18	0.07
(5)	0.08	0.06	0.04	0.04	0.00	0.06
(μ)	0.07	0.05	0.09	0.09	0.08	0.08

Table A.10: Complier Summary Statistics

This table reports the means and differences in means for firms defined as compliers and non-compliers in two different time periods. Compliers are firms that complete (withdrawal) their IPO when the post-filing return on the Nasdaq stock index is above (below) the 25th percentile within a given year. Non-compliers are firms that withdrawal (complete) their IPO when the post-filing return on the Nasdaq stock index is above (below) the 25th percentile within a given year. ***, **, * correspond to statistical significance at the 1%, 5%, and 10% level, respectively. The Appendix provides detailed variable descriptions.

Sample Period	1985-2003			2004-2012		
	Compliers	Non-Compliers	Diff.	Compliers	Non-Compliers	Diff.
Group %	69.3%	30.7%		60.2%	39.8%	
Patent Characteristics						
Patent Activity	1.51	1.56	-0.05	2.34	2.27	0.07
Total Patents	5.09	5.09	0.01	9.02	9.20	-0.18
Scaled Number of Patents	0.59	0.53	0.06	0.78	0.81	-0.03
Total Citations	19.77	20.12	-0.36	28.01	24.42	3.59
Citation Quality	1.64	1.63	0.01	1.52	1.19	0.34**
Originality	0.44	0.45	-0.01	0.45	0.45	0.01
Generality	0.46	0.45	0.01	0.33	0.31	0.02
Trademark Characteristics						
Trademark Activity	1.82	1.81	0.01	1.96	1.83	0.13
Number of Trademarks	9.32	9.11	0.21	12.05	9.72	2.33*
Scaled Number of Trademarks	1.53	1.47	0.06	1.56	1.27	0.29
Trademark Renewal Rate	0.45	0.49	-0.04*	0.40	0.47	-0.07*
% Patents	0.42	0.42	0.00	0.53	0.53	-0.00
IPO Characteristics						
Principal Amount	72.61	55.87	16.74**	172.18	117.33	54.85***
Ratio of VC to IPO Principal	0.96	1.00	-0.04	1.45	1.54	-0.09
Firm Age	13.70	12.69	1.00	15.15	13.44	1.71
Venture Capital Backed	0.57	0.64	-0.08**	0.64	0.65	-0.01
Private Equity Backed	0.09	0.05	0.04***	0.18	0.11	0.07*
Dual Class	0.06	0.04	0.01	0.10	0.07	0.03
NASDAQ Pre-Filing Return	0.06	0.08	-0.03***	0.01	0.01	0.00
Financial Characteristics						
Total Assets	151.92	156.33	-4.41	291.63	238.82	52.81
Total Revenue	126.32	128.45	-2.14	234.54	195.90	38.63
Net Profit Margin	-1.10	-1.23	0.13	-1.21	-1.38	0.17
R&D/Assets	0.17	0.17	-0.01	0.21	0.26	-0.05
Sales/Assets	0.82	0.83	-0.01	0.72	0.72	-0.01
Net Income/Assets	-0.12	-0.14	0.01	-0.18	-0.24	0.06
Cash/Assets	0.29	0.31	-0.02	0.33	0.35	-0.02

Table A.11: Patent Activity Likelihood Transition Matrix

This table reports the transition matrix likelihood of firms having a patent in the post-IPO filing window given their pre-IPO filing patent activity from 1985 to 2012. Panels A and B require a firm has a patent during the IPO filing window while Panels C and D only require that a firm meets all other sample filtering criteria besides having a patent. Entries report the probability that a firm in one of the discrete, pre-filing patent activity buckets does or does not go on to have a patent in the post-IPO filing window.

	Panel A: Patent Likelihood for Completed Firms 1985-2012	
	Sample: Require Patent in IPO Filing Window	
Pre-Filing Patent Activity?	Post-Filing Patent Activity	
	(0)	(1)
(0)	0	1
(1)	0.21	0.79
	Panel B: Patent Likelihood for Withdrawn Firms 1985-2012	
	Sample: Require Patent in IPO Filing Window	
Pre-Filing Patent Activity?	Post-Filing Patent Activity	
	(0)	(1)
(0)	0	1
(1)	0.34	0.66
	Panel C: Patent Likelihood for Completed Firms 1985-2012	
	Sample: All IPO Firms	
Pre-Filing Patent Activity?	Post-Filing Patent Activity	
	(0)	(1)
(0)	0.88	0.12
(1)	0.21	0.79
	Panel D: Patent Likelihood for Withdrawn Firms 1985-2012	
	Sample: All IPO Firms	
Pre-Filing Patent Activity?	Post-Filing Patent Activity	
	(0)	(1)
(0)	0.93	0.07
(1)	0.34	0.66

Table A.12: Robustness of Reduced Form and IV Estimator to Winsorization

This table reports the effect of IPO completion on patent quality post-IPO at various levels of winsorization. Panel A displays the reduced form estimator while panel B displays the IV estimator from 1985 to 2003. The dependent variable *Scaled Citations* is the average citations a firm receives in the subsequent three years following the grant date for patents filed for in the [1,5] year window following the IPO adjusted for the patents' subsection ID. The superscripts denote the level of winsorization used for the pre-filing and post-filing measures of *Scaled Citations*. The covariate of interest in the reduced form model in Panel A is *Nasdaq Return* which is the two month post-filing return on the Nasdaq stock index. In Panel B, *IPO* denotes the estimated effect of whether a firm successfully completes its IPO using *Nasdaq Return* as an instrumental variable. Control variables include pre-filing returns on the Nasdaq, a firm's location in the IPO wave, and the pre-filing measure of the dependent variable from the [-3,0] year window around the IPO filing year. ***, **, * correspond to statistical significance at the 1%, 5%, and 10% level, respectively.

Panel A: Reduced Form Estimator 1985-2003											
	$SC^{0:100}$	$SC^{1:99}$	$SC^{2:98}$	$SC^{3:97}$	$SC^{4:96}$	$SC^{5:95}$	$SC^{6:94}$	$SC^{7:93}$	$SC^{8:92}$	$SC^{9:91}$	$SC^{10:90}$
NASDAQ Return	−0.64	−0.48	−0.48	−0.59	−0.61*	−0.59*	−0.56*	−0.53*	−0.50*	−0.48*	−0.46*
	(0.55)	(0.48)	(0.43)	(0.36)	(0.33)	(0.31)	(0.29)	(0.28)	(0.26)	(0.25)	(0.24)
Observations	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239
R^2	0.21	0.21	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Panel B: IV Estimator 1985-2003											
	$SC^{0:100}$	$SC^{1:99}$	$SC^{2:98}$	$SC^{3:97}$	$SC^{4:96}$	$SC^{5:95}$	$SC^{6:94}$	$SC^{7:93}$	$SC^{8:92}$	$SC^{9:91}$	$SC^{10:90}$
IPO	−1.07	−0.79	−0.80	−0.97	−1.00*	−0.97*	−0.93*	−0.87*	−0.82*	−0.79*	−0.76*
	(0.94)	(0.79)	(0.72)	(0.61)	(0.57)	(0.53)	(0.51)	(0.48)	(0.46)	(0.44)	(0.42)
Observations	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239
R^2	0.13	0.15	0.14	0.10	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Internet Appendix

Figure IA.1: Relationship between Patent Quality and IPO Filing Timing
This figure shows the relationship between IPO completion and patent quality across the IPO filing year window for IPOs filed from 1985 to 2012. The dependent variable, *Scaled Citations*, is the average citations a firm's patent receives in the subsequent three years following the grant date grouped by the filing year and scaled within a patent's subsection ID. Regressions are run at the patent level and include issuer and grant year fixed effects. Standard error estimates are clustered at the firm level. All coefficient estimates (computed as the difference in patent quality between firms with completed IPOs and withdrawn IPOs) are relative to the estimated coefficient in event year 0.

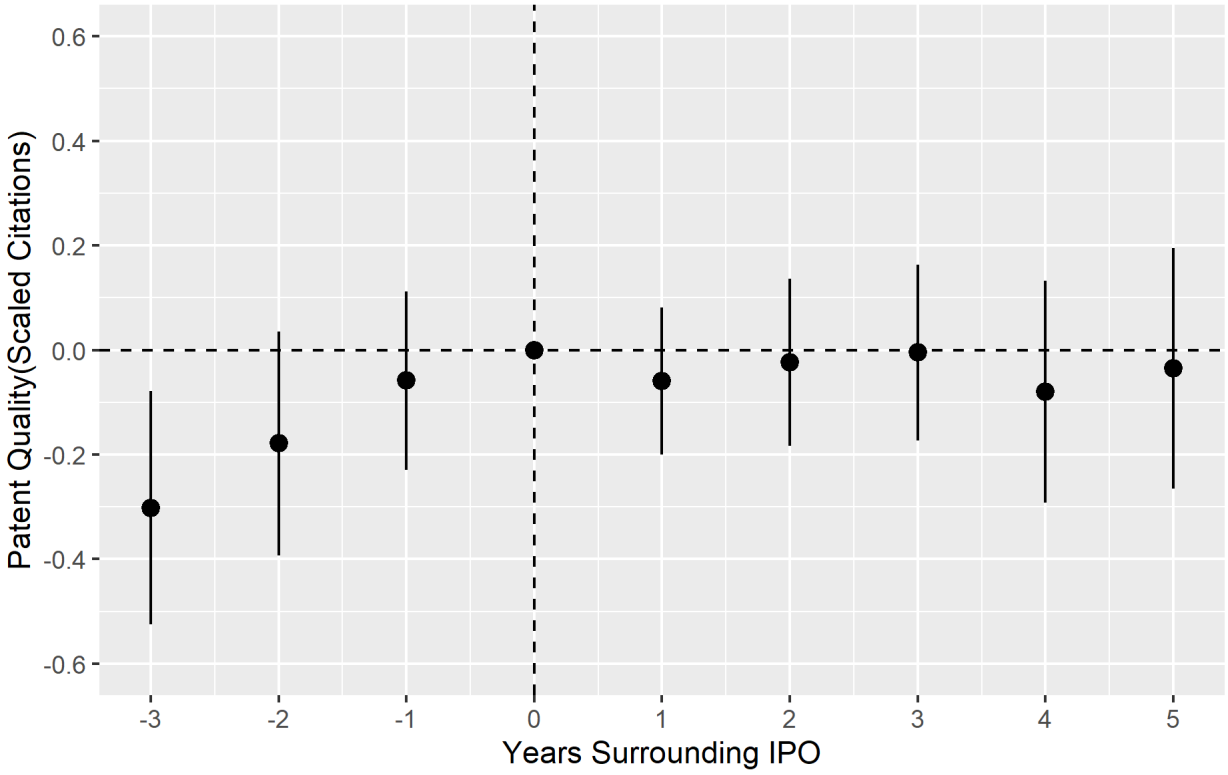

Figure IA.2: Reduced Form Estimate: Patent Quality and IPO Filing Timing
This figure shows the relationship between IPO completion and patent quality across the IPO filing year window for IPOs filed from 1985 to 2012. The dependent variable, *Scaled Citations*, is the average citations a firm's patent receives in the subsequent three years following the grant date grouped by the filing year and scaled within a patent's subsection ID. Reduced form regression estimates are plotted of the interacted coefficient estimates of the post-filing return on the Nasdaq and the event year. Regressions are estimated at the patent level and include issuer and grant year fixed effects. Standard error estimates are clustered at the firm level. All coefficient estimates (computed as the difference in patent quality between firms with completed IPOs and withdrawn IPOs) are relative to the estimated coefficient in event year 0.

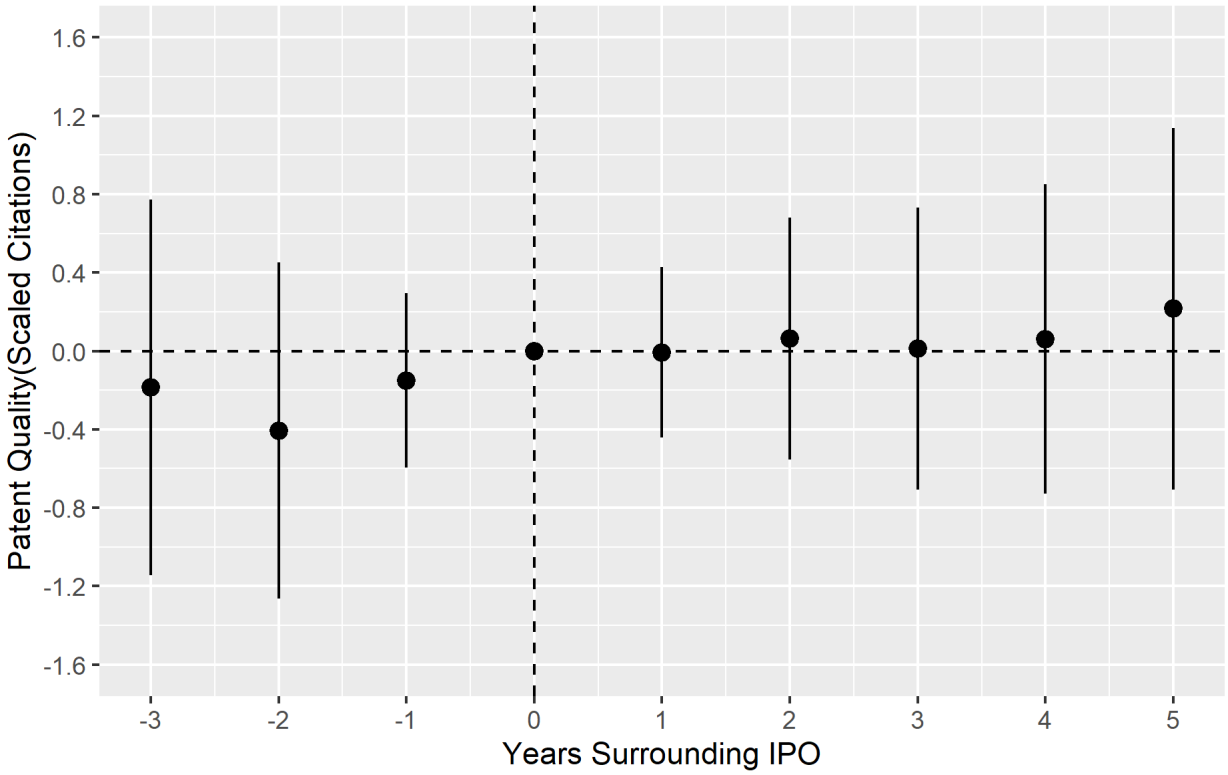

Figure IA.3: Instrumental Variables Estimate: Patent Quality and IPO Filing Timing
This figure shows the relationship between IPO completion and patent quality across the IPO filing year window for IPOs filed from 1985 to 2012. The dependent variable, *Scaled Citations*, is the average citations a firm's patent receives in the subsequent three years following the grant date grouped by the filing year and scaled within a patent's subsection ID. Instrumental variable regression estimates are plotted using the interaction of the post-filing return on the Nasdaq interacted with the event year. Regressions are estimated at the patent level and include issuer and grant year fixed effects. Standard error estimates are clustered at the firm level. All coefficient estimates (computed as the difference in patent quality between firms with completed IPOs and withdrawn IPOs) are relative to the estimated coefficient in event year 0.

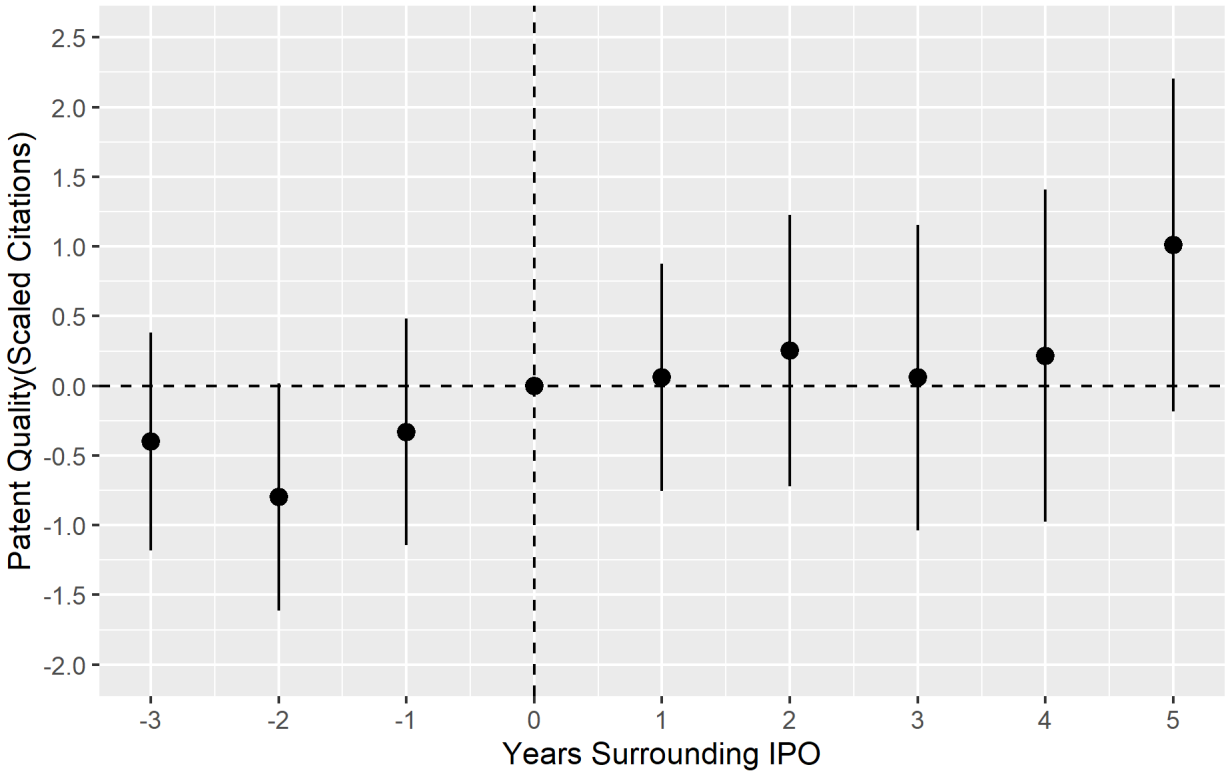

Table IA.1: Sample Coverage

This table reports the distribution of firm-year observations over time and the coverage of patent and trademark filing activities for firms within the [-3,5] year window surrounding their IPO filing date. *Firm-Year* is the total number of observations across different years, *Patent-Year* is the number of observations with a patent filing in the relevant year, *Trademark-Year* is the number of observations with a trademark filing in the relevant year. *% Patent* is the proportion of firm observations with a patent filing in the relevant year while *% Trademark* is the proportion of firm observations with a trademark filing in the relevant year.

	Overall Count			Proportion Observations	
	Firm-Year	Patent-Year	Trademark-Year	% Patent	% Trademark
1982	25	2	3	0.08	0.12
1983	117	10	32	0.09	0.27
1984	201	35	66	0.17	0.33
1985	236	68	78	0.29	0.33
1986	267	97	91	0.36	0.34
1987	317	110	123	0.35	0.39
1988	446	137	176	0.31	0.39
1989	577	185	231	0.32	0.40
1990	771	264	348	0.34	0.45
1991	883	335	384	0.38	0.43
1992	956	390	436	0.41	0.46
1993	1125	448	516	0.40	0.46
1994	1247	581	597	0.47	0.48
1995	1317	696	652	0.53	0.50
1996	1452	707	778	0.49	0.54
1997	1589	735	807	0.46	0.51
1998	1497	754	811	0.50	0.54
1999	1331	667	716	0.50	0.54
2000	1229	609	684	0.50	0.56
2001	1156	578	573	0.50	0.50
2002	972	453	446	0.47	0.46
2003	903	430	385	0.48	0.43
2004	898	412	376	0.46	0.42
2005	749	357	319	0.48	0.43
2006	509	271	253	0.53	0.50
2007	518	281	270	0.54	0.52
2008	551	280	244	0.51	0.44
2009	563	288	247	0.51	0.44
2010	471	260	215	0.55	0.46
2011	402	230	161	0.57	0.40
2012	314	179	126	0.57	0.40
2013	218	141	98	0.65	0.45
2014	182	106	78	0.58	0.43
2015	156	79	71	0.51	0.46
2016	108	51	49	0.47	0.45
2017	47	20	73 19	0.43	0.40
Total	24300	11246	11459	0.46	0.47

Table IA.2: Patent Applications and Grants for IPO firms

This table reports the distribution of firm-year observations over time and the coverage of patent filing and granting activities for firms within the [-3,5] year window surrounding their IPO filing date for completed and withdrawn firms. On average, patent approval takes about 24 months.

Panel A: Distribution by Year						
	IPO Filings		Patent Applications		Patent Grants	
Year	Complete	Withdrawn	Complete	Withdrawn	Complete	Withdrawn
1982	-	-	3	0	0	0
1983	-	-	13	0	0	0
1984	-	-	117	11	1	1
1985	24	1	188	11	29	4
1986	88	4	277	22	82	11
1987	77	7	346	34	181	13
1988	32	3	455	56	284	28
1989	30	1	658	62	409	49
1990	44	6	956	85	445	56
1991	128	1	1229	108	627	66
1992	109	22	1453	115	984	85
1993	179	15	1870	223	1210	118
1994	117	20	3004	214	1436	143
1995	159	6	4777	396	1650	123
1996	226	27	4394	289	2466	182
1997	125	32	6071	385	3348	260
1998	72	29	6809	517	4628	350
1999	169	16	7453	584	5233	368
2000	178	88	7064	579	5431	437
2001	28	11	7235	541	5972	498
2002	14	14	6441	468	6021	475
2003	33	2	5407	394	6047	449
2004	72	20	3922	418	5908	400
2005	58	11	2743	373	4988	312
2006	68	20	2254	289	4984	414
2007	56	40	2951	362	3369	343
2008	10	26	3726	364	2838	294
2009	17	9	4026	416	2436	262
2010	35	13	3493	438	2938	347
2011	39	22	3845	417	3756	388
2012	34	13	4181	345	4436	452
2013	-	-	3954	202	5199	515
2014	-	-	3302	118	5448	525
2015	-	-	2869	95	5226	402
2016	-	-	1006	55	3932	234
2017	-	-	652	4	3676	148
Total	2221	479	109144	8990	105618	8752

Table IA.3: Patent Filings by Fama-French Industry Groups and USPTO Subsections
This table reports the distribution of patent filings across Fama-French 12 industry groupings and USPTO subsections for firms with completed and withdrawn IPOs.

	Panel B: Distribution by Industry	
Industry	Complete	Withdrawn
Business Equipment	59.30%	37.40%
Chemicals	1.10%	7.50%
Consumer Durables	13.30%	2.70%
Consumer Non-Durables	0.50%	2.40%
Energy	0.20%	3.40%
Healthcare	14.00%	31.50%
Manufacturing	4.80%	4.30%
Other	3.50%	5.50%
Shops	0.60%	1.50%
Telecom	2.60%	3.70%
Utilities	0.10%	0.00%
	Panel C: Distribution of Patents Across Patent Subsections	
Subsection	Complete	Withdrawn
Chemistry	7.00%	18.40%
Electricity	35.40%	22.20%
Fixed Constructions	0.70%	1.30%
General New Technology	2.50%	3.60%
Human Necessities	10.90%	23.80%
Mechanical Engineering	5.80%	1.50%
Performing Operations/Transporting	8.80%	7.80%
Physics	28.80%	21.20%
Textiles/Paper	0.10%	0.10%

Table IA.4: Trademark Applications and Grants for IPO firms

This table reports the distribution of firm-year observations over time and the coverage of trademark filing and granting activities for firms within the [-3,5] year window surrounding their IPO filing date for completed and withdrawn firms. On average, trademark approval takes about 18 months.

Panel A: Distribution by Year						
	IPO Filings		Trademark Applications		Trademark Grants	
Year	Complete	Withdrawn	Complete	Withdrawn	Complete	Withdrawn
1982	-	-	3	0	0	0
1983	-	-	23	0	1	0
1984	-	-	82	4	13	0
1985	24	1	145	7	81	3
1986	88	4	199	9	110	9
1987	77	7	251	6	203	3
1988	32	3	321	33	195	8
1989	30	1	980	16	315	26
1990	44	6	1018	64	458	16
1991	128	1	1138	46	640	21
1992	109	22	1806	71	1246	62
1993	179	15	1699	95	1341	59
1994	117	20	2158	108	1520	66
1995	159	6	2805	240	1638	86
1996	226	27	4203	373	2232	122
1997	125	32	4009	661	2861	276
1998	72	29	3976	509	3793	364
1999	169	16	4102	654	3587	558
2000	178	88	4717	982	3676	489
2001	28	11	3154	652	3855	614
2002	14	14	2060	615	5098	979
2003	33	2	1806	602	3310	772
2004	72	20	2024	276	2179	636
2005	58	11	1521	353	1996	520
2006	68	20	1656	302	2014	287
2007	56	40	1532	464	1777	361
2008	10	26	1341	430	1904	354
2009	17	9	1565	268	1468	509
2010	35	13	961	392	1371	387
2011	39	22	1315	246	1527	326
2012	34	13	1020	121	1189	327
2013	-	-	996	128	1225	168
2014	-	-	670	84	996	201
2015	-	-	556	62	862	108
2016	-	-	233	13	610	94
2017	-	-	148	11	518	60
Total	2221	479	56193	8897	55809	8871

Table IA.5: Trademark Filings Across Fama-French 12 Industry Groupings
This table reports the distribution of trademark filings across Fama-French 12 industry groupings for firms with completed and withdrawn IPOs.

	Panel B: Distribution by Industry	
Industry	Complete	Withdrawn
Business Equipment	42.00%	30.10%
Chemicals	4.60%	2.80%
Consumer Durables	5.70%	1.70%
Consumer Non-Durables	6.60%	21.80%
Energy	0.60%	0.60%
Healthcare	17.80%	21.80%
Manufacturing	7.40%	5.80%
Other	8.30%	3.90%
Shops	2.60%	1.60%
Telecom	4.30%	9.90%
Utilities	0.10%	0.00%

Table IA.6: Panel Relevance: Effect of Nasdaq Post-Filing Returns on Innovation

This table reports the OLS regression coefficients and standard errors of the relationship between IPO completion and the various returns on the Nasdaq. Columns (1) and (2) use the sample of IPOs filed from from 1985 to 2003 while columns (3) and (4) use the sample of IPOs filed from 2004 to 2012. The independent variables include *Post-Filing Nasdaq Return* which is the two month post-filing return on the Nasdaq stock index and *Pre-Filing Nasdaq Return* which is the three month pre-filing return on the Nasdaq stock index. Fixed effects include firm, event year, Fama-French 12 × year, and filing month × post. ***, **, * correspond to statistical significance at the 1%, 5%, and 10% level, respectively. The Appendix provides detailed variable descriptions.

	IPO			
	1985-2003		2004-2012	
	(1)	(2)	(3)	(4)
Post-Filing Nasdaq Return × Post	0.81***		0.12	
	[0.09]		[0.30]	
Pre-Filing Nasdaq Return × Post		0.17**		0.73***
		[0.07]		[0.27]
Observations	19220	19220	5059	5059
R^2	0.89	0.89	0.80	0.80
Firm F.E.	Yes	Yes	Yes	Yes
Event Year F.E.	Yes	Yes	Yes	Yes
FF12 × Year F.E.	Yes	Yes	Yes	Yes
IPO Month × Post F.E.	Yes	Yes	Yes	Yes
F-Statistic	86.20	6.03	0.15	7.98

Table IA.7: Panel Instrument Relevance: IPO completion and Nasdaq Post-Filing Returns

This table reports the OLS regression coefficients and standard errors of the relationship between IPO completion and a firm's average patent quality. Panel A requires that a firm-year observation has a patent to be included in columns (1) to (4) while Panel B includes all firm-year observations within the relevant sample period. The independent variable, *Nasdaq Post-Filing Return* is the two month post-filing return on the Nasdaq stock index. Fixed effects include firm, event year, Fama-French 12 × year, and filing month × post. ***, **, * correspond to statistical significance at the 1%, 5%, and 10% level, respectively. The Appendix provides detailed variable descriptions.

	Panel A: Require Patent in Panel Year for Columns (1) to (4)					
	Scaled Citations		Originality	Generality	Ln(1+Patents)	Ln(1+Trademarks)
Sample Period	1985-2003	1985-2012			1985-2012	
	(1)	(2)	(3)	(4)	(5)	(6)
Nasdaq Post-Filing Return × Post	-0.24	-0.38	0.02	0.00	-0.07	0.01
	[0.38]	[0.33]	[0.05]	[0.05]	[0.14]	[0.13]
Observations	7954	10625	10270	10059	24284	24284
R^2	0.50	0.51	0.63	0.66	0.62	0.54
Firm F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Event Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
FF12 × Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
IPO Month × Post F.E.	Yes	Yes	Yes	Yes	Yes	Yes
	Panel B: All Firm-Year Observations					
	Scaled Citations		Originality	Generality	Ln(1+Patents)	Ln(1+Trademarks)
Sample Period	1985-2003	1985-2012			1985-2012	
	(1)	(2)	(3)	(4)	(5)	(6)
Nasdaq Post-Filing Return × Post	-0.05	-0.11	0.01	-0.00	-0.07	0.01
	[0.16]	[0.15]	[0.05]	[0.04]	[0.14]	[0.13]
Observations	19220	24284	24284	24284	24284	24284
R^2	0.35	0.37	0.46	0.46	0.62	0.54
Firm F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Event Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
FF12 × Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
IPO Month × Post F.E.	Yes	Yes	Yes	Yes	Yes	Yes

Table IA.8: Panel Effect of IPO Completion on Patent Quality

This table reports the OLS regression coefficients and standard errors of the relationship between IPO completion and the post-filing returns on the Nasdaq. The dependent variable of interest is *Scaled Citations* which is the average citations a firm's patents in the subsequent three years following the grant date grouped by the filing year and scaled within a patent's subsection ID. Panel A requires that a firm-year observation has a patent to be included while Panel B includes all firm-year observations within the relevant sample period. Columns (1) and (4) present the endogenous regression, columns (2) and (5) the reduced form regression, and columns (3) to (6) are the instrumental variables regression. The exogenous variable used as the covariate in columns (2) and (5) and instrument in columns (3) and (6), *Nasdaq Post-Filing Return* is the two month post-filing return on the Nasdaq stock index. Fixed effects include firm, event year, Fama-French 12 × year, and filing month × post. ***, **, * correspond to statistical significance at the 1%, 5%, and 10% level, respectively. The Appendix provides detailed variable descriptions.

Panel A: Require Patent in Panel Year						
	Scaled Citations					
	1985-2003			1985-2012		
	(1)	(2)	(3)	(4)	(5)	(6)
IPO × Post	-0.04		-0.38	0.01		-0.77
	[0.10]		[0.60]	[0.08]		[0.70]
Nasdaq Return × Post		-0.24			-0.38	
		[0.38]			[0.33]	
Observations	7954	7954	7954	10625	10625	10625
R^2	0.50	0.50	–	0.51	0.51	-0.02
Firm F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Event Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
FF12 × Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
IPO Month × Post F.E.	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic	-	-	30.58	-	-	18.84
Panel B: All Firm-Year Observations						
	Scaled Citations					
	(1)	(2)	(3)	(4)	(5)	(6)
IPO × Post	0.08*		-0.06	0.06*		-0.15
	[0.04]		[0.20]	[0.04]		[0.20]
Nasdaq Return × Post		-0.05			-0.11	
		[0.16]			[0.15]	
Observations	19220	19220	19220	24284	24284	24284
R^2	0.35	0.35	-0.00	0.37	0.37	-0.00
Firm F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Event Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
FF12 × Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
IPO Month × Post F.E.	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic	-	-	86.20	-	-	75.76