Warrants in the Financial Management Decisions of Innovative Firms

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Abstract

Innovative firms that invest heavily in new technologies and business models have disadvantages when we use assets and earnings data in their financial statements to evaluate them. The reason is, intangible investments are expensed instead of capitalized due to conservatism in the U.S. Generally Accepted Accounting Principles even though those investments generate long-term benefits. As a result, firms with mostly intangible assets are subject to more constraints in using traditional ways of raising capital and need alternatives. I find that innovative firms are more likely to use equity warrants for financing than other firms by developing a novel dataset from a textual analysis of financial statements. Out of 181,425 annual financial statements submitted to the U.S. Securities and Exchange Commission electronically during 1994 – 2018, 10,300 reports discuss the fair value of equity warrants. The proportion of annual reports with the fair value of warrants has increased sharply from 0.4% in 1994 to 8% in 2018. Logistic regressions of equity warrants show that innovation measures such as R&D, proprietary information risk, and financial constraints have significant explanatory power. Industry effects are also significant. Pharmaceutical, computer system design, electromedical, and software industries are more likely to use equity warrants than others.

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1. Introduction

Innovative firms invest heavily in developing new technologies, business models, databases, and other intangible assets. However, most of these investments are not recorded as assets on balance sheets due to accounting conservatism (Lev and Zarowin, 1999; Kothari et al., 2002; Penman and Zhang, 2002; Beaver and Ryan, 2005; Paul and Durbin, 2016; Park, 2019 and 2021).

As a result, the more resources a firm uses to develop intangible assets internally, the reported earnings look worse than actual economic profits because the costs are expensed instead of capitalized, even though intangible investments generate long-term benefits. Therefore, intangible-intensive firms are more likely to be subject to information asymmetry, causing financing frictions when their business needs significant capital investments. Stulz (2020) points out that the increasing importance of intangible assets explains why private equity with specialized knowledge has expanded rapidly while public equity has declined sharply during the last twenty years.

For example, Firm A is a pioneer in e-commerce, developing new business models, cloud computing technologies, and other intangible assets internally. These investments are not capitalized and thus, reported earnings are much lower than added economic values. When their rapidly growing e-commerce needs airplanes to expedite deliveries, they find innovative ways to overcome financial constraints. Instead of buying airplanes by issuing new debt or equity, Firm A enters into a contract with Firm W specializing in air cargo to use their aircraft for delivery and requests that Firm W issue equity warrants to Firm A as part of the agreement. A warrant is a contract giving the holder the right to buy the issuing company's stock in the future at a certain price. If Firm A's innovation in e-commerce leads to rapid growth in sales, the benefit will spill over to Firm W by increases in air cargo. Then

Firm A can claim the benefits by exercising the warrants included in the contract, leading to buying Firm W stocks at a predetermined low exercise price in the contract. If the air cargo business does not grow as fast as expected and Firm W's stock underperforms, the warrants will expire worthless, protecting Firm A from the downside risk of owning expensive idling equipment.

How many U.S. firms use this type of warrants for financing? Unlike call options, this type of warrants is not traded on exchanges, and thus we do not have data available, but public firms disclose their use of warrants in annual reports. Can we use textual analysis to overcome the limitation in available data? Do financial statements show the time series and cross-sectional variation in the usage of warrants by U.S. firms? Do measures of innovation and financial constraints explain the use of equity warrants? The main objective of this paper is to answer these questions. To my knowledge, this paper is the first to analyze equity warrants as an alternative way of financing innovation—understanding how firms finance innovation and growth is one of the most important questions in corporate finance.

Empirical research on equity warrants is rare due to the constraints in data. I overcome this challenge using natural language processing tools that became widely available for empirical finance researchers recently. I analyze financial statement texts publicly traded firms are required to submit to the U.S. Securities and Exchange Commission (SEC) and identify firms that discuss the fair value of equity warrants. Out of 181,425 annual reports submitted to SEC electronically during 1994 – 2018, 10,300 files mention the fair value of equity warrants. The proportion of 10-Ks with warrants has increased sharply from 0.4% in 1994 to 8% in 2018.

I find that users of warrants have higher R&D expenditures and intangible assets than other firms, and the differences are significant at the 1 percent level. Textual analysis results show that intangible-intensive firms use more financially constraining words in their financial statements. Those with a higher proportion of tangibles use less constraining words than others. All regression coefficients are significant at the 1 percent level. Logistic regressions confirm that innovation measures such as R&D and recorded and unrecorded intangible assets explain equity warrants. Industry effect is also significant, indicating that pharmaceuticals, computer system design, electromedical, scientific research, and software industries are more likely to use equity warrants than others. The results are robust to the controls for financial constraints and the proprietary information risk in Bodnauk et al. (2015) and Hoberg and Maksimovic (2015).

The newly developed dataset and empirical findings of this paper will help policymakers, corporate managers, financial analysts, and investors make informed decisions, and Covid-19 shows an example. When the U.S. Treasury Department negotiated financial aid deals with airlines in April 2020 under the Coronavirus Aid, Relief, and Economic Security (CARES) Act, the government requested major air carriers such as Delta Air Lines issue warrants (Shepardson and Rucinsky, 2020). The warrants mean that the government will have the right to buy airline stocks at pre-set price and time, making the U.S. taxpayers large shareholders if the airline stock prices recover from the pandemic before the warrants expire. The government managed the downside risk in this aid because it will not own the stocks if the business does not recover, making the warrants unvested.

The paper proceeds as follows. Section 2 explains the disadvantages of innovative firms concerning accounting conservatism. Section 3 tests the relationship between

intangible assets and financial constraints. Section 4 presents how intangible-intensive firms use equity warrants for financing. Section 5 explains the methods of extracting warrants from financial statement texts. Section 6 is for estimating unrecorded intangible assets in innovative firms. Section 7 presents logistic regressions of warrants on innovation, financial constraints, and proprietary information risk, and Section 8 concludes.

2. Innovative Firms and Accounting Conservatism

Nakamura (2001 and 2003) of the Federal Reserve Bank of Philadelphia estimates that U.S. firms invest at least $1 trillion in intangible assets such as new technologies every year. However, internally developed intangible assets are not recorded as assets on balance sheets according to the U.S. Generally Accepted Accounting Principles (GAAP).

The main reason is that the *Statement of Financial Accounting Standards (SFAS) No. 2 (Accounting for Research and Development Costs, 1974)* required corporations to expense their R&D costs immediately instead of capitalizing them. High uncertainty about the future benefits of R&D expenses is the rationale for the immediate expensing decision (Kothari et al., 2002). SFAS is now *Accounting Standards Codification (ASC)*, and SFAS 2 corresponds to *ASC 730, Research and Development*.

For example, suppose Firm A invests $100 million in tangible assets such as warehouse buildings. In that case, the investment does not reduce its net income because property, plant, and equipment (PP&E) are recorded as assets on the balance sheet. However, when the firm invests the same amount in developing new technologies, the $100 million is not recorded as assets but regarded as operating expenses and thus reduces the net income of Firm A due to accounting conservatism (Beaver and Ryan, 2005; Park, 2019 and 2021). I use R&D in this example, but many other expenses have similar issues, such as marketing

expenses to develop brand names and the costs of building databases for e-commerce. The categories of intangible assets include marketing-related, customer-related, contract-related, technology-related, and other unspecified intangible assets (Castedello and Klingbeil, 2009).

U.S. GAAP for business accounting adopts more conservative approaches and requires immediate expensing of most intangible-related investments. In contrast, the international guidelines for national economic accounting revised in 2008, the *System of National Accounts* (*SNA 2008*), recommend capitalizing R&D expenditures (Rassier, 2014). It took decades for prominent economists' speeches and writings on the issues in intangibles to bring transformations in national economic accounting guidelines.

For example, in 1987, Robert Solow pointed out that we saw the computer revolution everywhere except in the productivity statistics economists developed and used. In 1996, Chairman Alan Greenspan expressed concerns about a staff analysis of productivity trends during a Federal Open Market Committee Meeting. He questioned the accuracy of the consumer price index, pointing out its failure to adequately account for the new or superior goods made possible by the Information Technology revolution (Solow, 1987; Corrado and Slifman, 1999; Corrado et al. 2009; Rassier, 2014). U.S. Bureau of Economic Analysis (BEA) launched the Digital Economy initiative and released preliminary statistics and a report, for the first time, in March 2018, exploring the size and growth of the digital economy to measure its contribution to U.S. GDP (Barefoot et al. 2018; Jolliff and Nicholson, 2019).

Corrado et al. (2012) and Branstetter and Sichel (2017) analyze the tangible and intangible investment as a share of total value added by the U.S. private sector from 1977 to 2014. They find that the percentage of intangible investments had increased from 7.8% to 12.2%. There was a corresponding decrease in the share of tangibles. Thus the total

investments stay around 20%, and the crossover point when intangibles exceeded tangibles occurred around the mid-1990s when the Internet and the digital economy started proliferating (Barefoot et al. 2018).

Rapidly growing intangible investments in the digital economy imply that more U.S. firms report a low net income not because their economic profits are shrinking but because capitalizing intangible investments is not allowed under GAAP. Using Compustat data from 1968 to 2018 fiscal years, I find that the proportion of firms reporting losses is rapidly rising. In 2018, 44.7% (3,406 out of 7,625 companies) reported negative net income, and the ratio was only 7.2% (281 out of 3,894 firms) in 1968, as shown in Figure 1.

I find that firms reporting negative net income have a higher aggregate R&D to sales revenue ratio than firms with positive net income since the mid-1990s when the digital economy emerged. The gap keeps increasing, as shown in Figure 2 and Table I. For example, firms reporting accounting losses in 2018 had 4.15% of sales revenue invested in R&D (104 billion out of 2.5 trillion US$). In comparison, the proportion of those reporting profits was only 2.06% (566 billion out of 27.5 trillion US$). The rapidly growing population of U.S. publicly traded firms with accounting losses is a consequence of evaluating the 21st-century firms in the knowledge-based U.S. economy using the 20th-century profit measures developed mainly for industrial firms whose investments are mostly tangible. Alan Greenspan pointed out a similar issue in the consumer price index in 1996, leading to subsequent transformations in national economic accounting rules on intangible investments, but business accounting rules on expensing intangibles remain the same (Corrado et al. 2009; Rassier, 2014).

3. Financial Constraints of Innovative Firms

I test whether innovative firms that invest heavily in intangible assets subject to more financial constraints than other firms in this section. One of the core questions in corporate finance and economics is understanding how firms finance innovation and what causes financing frictions and constraints. Asymmetric information is the most heavily discussed source (Myers and Majluf, 1984; Krasker, 1986; Miller, 1988; Hennessy and Whited, 2007; Hoberg and Maksimovic, 2015). Moral hazard, cost of contract enforcement, transaction costs, and debt overhang are other sources discussed in the literature. Myers and Majluf (1984) and Krasker (1986) show that asymmetric information leads to equity rationing. Firms with valuable investment opportunities face financial constraints and are forced to underinvest when firms have information investors do not have. Accounting conservatism may make the asymmetric information issue more severe for intangible-intensive firms, but testing the impact of asset tangibility on financial constraints is an empirical question. I test the significance of the impact using the following two steps.

First, I use textual analysis of financial statements to measure financial constraints following prior research. Kaplan and Zingales (1997) and Hadlock and Pierce (2010) manually read annual reports of corporations to identify cases where managers discuss challenges in obtaining external financing. Bodnaruk et al. (2015) extend the idea and apply an automated parsing algorithm to all 10-K annual reports during 1996 – 2011 and develop a list of 184 constraining words. They find that the frequency of constraining words in annual reports predicts future liquidity events better than other constraint measures based on age, size, and accounting ratios. I apply the same textual analysis method to all 10-K reports during 1994 – 2018, match the texts with Compustat data, and Table II presents summary

statistics. There are 109,627 firm-years with 14,127 unique firms in the sample, and the average number of words in cleaned 10-K files is 48,462. The average proportion of constraining words in the 10-Ks is 0.75%, and the 25th and 75th percentiles are 0.62% and 0.88%, respectively.

The second step is regressing the proportion of constraining words in 10-Ks on the corresponding Compustat data on asset tangibility. INTAN is the Compustat data item for intangible assets, PPEGT for property, plant, and equipment, and AT for total assets. I use the ratios of INTAN/AT and PPEGT/AT as measures of asset tangibility. The average proportion of intangible assets, INTAN/AT, is 13%, and the average PPEGT/AT is 44%, as shown in Table II. The regression models in Table III confirm that intangible-intensive firms are more financially constrained, and firms with a higher proportion of tangible assets are subject to less financial constraints than others. The differences are significant at the one percent level (*t*-statistics of 18.75 for INTAN/AT and -15.42 for PPEGT/AT).

I also test whether a text-based asset tangibility measure such as proprietary information risk explains financial constraints after controlling for the Compustat-based INTAN/AT and PPEGT/AT ratios. I measure proprietary information risk, following Hoberg and Maksimovic (2015). They find that companies discuss proprietary information risk in financial statements in either of the following two contexts: the risk of potential damages when proprietary information is revealed or contracts with employees that forbid leaking proprietary information. They identify firms with proprietary information risks as those mentioning protect or safeguard proprietary information, trade secret, or confidential information. I analyze the texts of 109,627 annual reports in the sample and find that 3,668 of them mention "protect(s) or safeguard(s) proprietary information, trade secret(s), or

confidential information." The 3,668 firm-years have the Proprietary Information Risk dummy of one, and the rest have zero. As shown in Table III, firms with Proprietary Information Risk use financially constraining words more often in their annual reports than other companies. The positive relation is significant at the one percent level with a *t*-statistic of 15.97 after controlling for the asset tangibility ratios and the year and industry fixed effects.

These results are consistent with prior research that points out the challenges in financing intangible investments. Almeida and Campello (2007) show that investment-cash flow sensitivities increase with constrained firms' assets' tangibility. They explain that asset tangibility reduces asymmetric information because it is easier to observe tangible assets' payoffs than those of intangibles. Falato et al. (2013) and Rampini and Viswanathan (2013) show that a low collateral rate for intangible capital leads to insufficient lending through collateralized debt contracts. Hall and Lerner (2009) argue that intangible capital is difficult to finance in the free marketplace because of low redeployability, nonexclusiveness, and low liquidity. Lim et al. (2020) point out that high valuation risk and poor collateralizability of some intangible assets discourage debt financing of intangible-intensive firms, but identifiable intangible assets may support debt. They find a positive relation between identifiable intangible assets and leverage, especially in firms whose assets are primarily intangible, using market-based valuations of intangible assets data newly available by changes in accounting standards on business combinations.

4. Using Equity Warrants to Finance Innovation

Intangible-intensive firms seek alternatives to overcome challenges in financing, and employee financing is an example. When a firm invests heavily in intangible capital, it offers

wage contracts that promise higher future compensations (Sun and Xiaolan, 2019). Employees of innovative firms are willing to accept lower wages today if they anticipate higher future compensation. Lower wages free up internal cash flows used in place of traditional debt to finance intangible investment. Michelacci and Quadrini (2009) and Guiso et al. (2013) also present a backloaded wage scheme as an internal financing channel.

In addition to employee financing, innovative firms use equity warrants as an alternative way of financing. A good example is in the company that invests most heavily in R&D. Among all firm-year observations of Compustat in 1994-2018, Amazon's R&D expenditure of $29 billion in 2018 is the largest. Figure 3 presents the top-ten R&D firms in 2018 compared to their net income to show how much higher their accounting profits would be if their investments in technology had not been expensed. As shown in Figure 4, Amazon's R&D expenditures have been increasing exponentially during the past decade, making their accounting net income look much lower than economic profits until their long-term intangible investments start paying off in 2016.

Amazon posts its annual reports on its website since the firm's initial public offering in 1997. The fiscal year ending December 31, 2014, is the first time the annual report mentions equity warrants: "*As part of entering into commercial agreements, we often obtain equity warrant assets giving us the right to acquire stock primarily in private companies." (p. 56).* The holiday season in 2013 was a significant turning point in Amazon's delivery strategy when rapidly increasing online orders overwhelmed their longtime contract carriers such as FedEx, leading to late packages and customer complaints. In response, Amazon started creating its own delivery network, but financing the new initiative was a challenge because its net income was negative (-$241 million) in 2014 while investing over $9 billion in R&D,

as shown in Figure 4. As an alternative source of financing for expedited e-commerce deliveries, Amazon enters into contracts with air cargo companies and obtain equity warrant assets.

For example, Airline T started operating an air network for Amazon in 2015, providing cargo handling and logistic support with five dedicated Boeing 767 freighter aircraft. According to their investment agreement in March 2016, Amazon obtains warrants issued by Airline T, giving Amazon the right to acquire up to 19.9% of the airline's common shares. Amazon has a similar agreement with Airline W, operating twenty Boeing 767 and 737 freight aircraft as of December 31, 2019, giving Amazon the right to purchase up to 39.9% of Airline W's shares, according to the airline's 2019 annual report. See Appendix A for a summary of accounting rules on warrants issued as sales incentives to customers.

This case is an anecdote, and we need a systematic way of developing warrants data for testing the relationship between innovation and equity warrants. However, this empirical analysis is challenging because there is no database available for this type of warrants. Prior research on warrants is mostly on theoretical pricing models or on bank-issued warrants that coexist with classical option markets organized by options exchanges in many European and Asian countries (Chen, 1970; Galai and Schneller, 1978; Bajo and Barbi, 2010; Baule and Blonski, 2015).

Note that bank-issued warrants' underlying assets are not the issuers' shares but various stocks, indexes, or commodities. Thus, they are different from traditional warrants this paper analyzes. Prior empirical research on traditional warrants issued by U.S. firms is either analyzing employee stock options as warrants or the analysis of stock-warrant units, a package of common stock and warrants in initial public offerings and seasoned equity

offerings (Byoun and Moore, 2003; Byoun, 2004; Eberhart, 2005). Gahng et al. (2021) analyze 114 firms that used special purpose acquisition companies (SPACs) for an initial public offering during January 2010 – May 2018 and show that warrant investors outperformed common stock investors in SPACs. See Appendix B for a discussion on warrants in SPACs, which are distinct from what this paper analyzes.

5. Textual Analysis of Equity Warrants Using Financial Statements

I overcome the limited data issue by applying natural language processing (NLP) tools to massive downloads of financial statement texts from the HTTPS file system made possible during late-night hours for research by the SEC's Electronic Data Gathering, Analysis, and Retrieval system (EDGAR). As EDGAR filing began in 1994 after testing in 1992-1993, the sample period is 1994 – 2018. There are 1,028,661 financial statements available for textual analysis, and 181,425 are 10-K annual reports.

NLP has been used in linguistics, psychology, computer science, and other disciplines since the 1950s, but its history in finance research is short. Loughran and McDonald (hereafter LM, 2011) is a pioneer in NLP of financial statements. They find that the list of positive and negative words developed by psychologists to evaluate sentiments does not work well in finance research because English words have many meanings, and finance, like many other disciplines, has its unique expressions. They develop word lists that reflect the tone in financial statements.

I use the same data source and similar natural language processing tools as in LM (2011) to identify the firms that use equity warrants. I thank Bill McDonald for making sample codes for downloading and processing EDGAR files, cleaned text files, the master dictionary, and the summary data table available for download from the Software Repository

for Accounting and Finance website. See Loughran and McDonald (2016) for a review of textual analysis in accounting and finance and recommendations on future research.

As warrants have many other meanings than equity warrants in English, it is challenging to develop codes for identifying financial statements that use the term only for a specific purpose. For example, according to LM 2018 Master Dictionary that analyzes 86,486 words in over one million financial statements from EDGAR, the proportion of the documents that include the term warrants is 46% (469,305 out of 1,028,661 financial statements). To find a solution for the homonyms issue, I search for financial statements that explain the fair value of equity warrants.

I find that 10,300 out of 181,425 10-Ks in the sample mention the fair value of equity warrants in the annual reports and define them as the firms that use equity warrants. As shown in Figure 5, the proportion of equity warrant users has increased significantly from 0.4% in 1994 to 8.0% in 2018. Next, I match the 10-K texts with Compustat data using the central index key (CIK). The matched sample has 112,988 firm-years with 14,443 unique firms of non-missing sales revenue data. Among them, 7,110 firm-years with 2,494 unique firms use equity warrants. Table IV presents the summary statistics of R&D expenditures (XRD) scaled by sales revenue (SALE) and tangible assets (PPEGT) and intangible assets (INTAN) scaled by total assets (AT) in Compustat. The summary statistics are after winsorization at 1st and 99th percentiles to mitigate the impact of extreme observations. The winsorized sample has 109,627 firm-years, and 6,329 observations use equity warrants. The next section explains how to estimate unrecorded intangible assets to be used in logistic regressions of warrants on innovation measures.

6. Intangible Assets of Firms that Use Equity Warrants for Financing

INTAN is intangibles recorded on balance sheets according to the variable definitions of Compustat. As explained in Section 2, internally developed intangible assets are not recorded on balance sheets due to accounting conservatism. Therefore, I estimate the two components of unrecorded intangibles (UI), knowledge capital (Kcap), and organization capital (Ocap), using the perpetual inventory method following prior research to develop guidelines for national economic accounting.

Kcap is from capitalizing past R&D expenditures, and Ocap is from capitalizing a fraction of past selling, general, and administrative (SG&A) expenditures. Using the same methods, Park (2021) develops an intangible-adjusted high-minus-low (iHML) book-to-market factor and shows that it outperforms the Fama and French (1993) HML factor significantly. Peters and Taylor (2017) use a similar method to adjust Tobin's q when analyzing the impact of intangibles on the relation between corporate investment and market valuation of the firm's assets.

A firm accumulates its knowledge capital by spending on R&D. The idea is to regard the outputs of R&D as capital rather than as intermediate input (Corrado et al., 2009). The following equation shows the accumulation of knowledge capital that parallels the corresponding equation for tangible assets.

Knowledge capital of firm i at fiscal year-end t:

$$Kcap_{i,t} = (1- d_{XRD})* Kcap_{i,t-1} + XRD_{i,t}$$

where d_{XRD} is the depreciation rate of the firm's R&D. I use industry-specific R&D depreciation rates of the U.S. Bureau of Economic Analysis (BEA) as in Li (2012) and Li and Hall (2016). $XRD_{i,t}$ is Firm i's R&D expenditure in Compustat during the fiscal year t.

A firm accumulates its organization capital by spending on selling, general, and administrative expenses (SG&A). Following prior research, I assume that 30 percent of past SG&A accumulates to generate long-term benefits such as brand names, business models, and customer relations, and the remaining 70 percent generates net income for the current period and thus is expensed. The following equation is an accumulation equation for organization capital that parallels the corresponding equations for knowledge capital and tangible assets. I use the SG&A depreciation rate of 20 percent following Falato et al. (2013) and Peters and Taylor (2017).

Firm i's organization capital at fiscal year-end t:

$$Ocap_{i,t} = 0.8* Ocap_{i,t-1} +0.3*SG\&A_{i,t}$$

$SG\&A_{i,t} = XSGA_{i,t} – XRD_{i,t} – RDIP_{i,t}$ if $XSGA_{i,t}$ is greater than $XRD_{i,t}$ because XSGA in Compustat includes both actual reported SG&A expenses and XRD unless XRD is included in the costs of goods sold (COGS). RDIP is in-proces R&D expenses in Compustat.

Total capital (Tcap) is defined as follows: Tcap ≡ AT + Kcap + Ocap – GDWL. GDWL is goodwill in Compustat, and it represents the excess purchase price paid over the estimated fair value of the target company's identifiable net assets in business combinations.[1] I subtract GDWL when defining Tcap because there is subjectivity in estimating goodwill's current fair value, and there are cases of goodwill impairment that are not backed by economic fundamentals (Ramanna and Watts, 2012; Chen et al., 2014; Park, 2021).

[1] Accounting strandards on intangibles was transformed in 2001 when Financial Accounting Standards Board (FASB) issued the Statement of Financial Accounting Standards (SFAS) 141 (Business Combinations) and SFAS 142 (Goodwill and Other Intangible Assets). Acquirers must allocate the purchase prices they pay for targets to the tangible and identifiable intangible assets they acquire for mergers and acquisitions since 2001, and the remainder to goodwill. See FASB (2001a 2007), FASB (2001b), Lim et al. (2020) and Park (2019 and 2021), for more details. FASB standards are now incorporated in the FASB's Accounting Standards Codification (ASC). SFAS 141 can be found under ASC 805 and SFAS 142 is under ASC 350-20-35.

Table IV shows descriptive statistics for the estimated unrecorded intangible assets for the 6,329 firm-years with equity warrants in Panel A and all firm-years of 109,627 observations in Panel B. Note that warrants subsample in Panel A has a higher average ratio of unrecorded intangibles to total capital (UI/Tcap) than all firm-years in Panel B (38% vs. 23%). The average ratios of recorded intangibles (INTAN/AT) and tangible assets (PPEGT/AT) also show that users of warrants are more intangible-intensive than others.

Table V presents formal statistical tests to compare firms with equity warrants and others in R&D expenditures and intangible assets. For analyzing the impact of innovation measures on the use of warrants after adjusting for industry effects, I classify the firm-years into industry subsamples using the Standard Industrial Classification (SIC) code, following the BEA's classification for R&D depreciation rates to estimate unrecorded knowledge capital as in Table 1 of Li and Hall (2016). As shown in Table V, firms with warrants invest 56% of sales revenue in R&D while other firms invest 11% on average, and the difference is highly significant both economically and statistically. Firms with equity warrants also have significantly higher recorded and unrecorded intangible assets than others, and all differences are significant at the one percent level.

Note that intangible-intensive industries such as Pharmaceuticals have significantly higher proportions of warrants firms than other sectors (17.66% vs. 4.27%). Pharmaceuticals also stand out in the number of firm-years with warrants as well as in XRD/SALE ratio. 990 Pharmaceutical firm-years with warrants spend 2.29 times of sales revenue in R&D on average, while the corresponding ratio for other industries is 0.17 times.

Among the three innovation measures presented in Table V, the unrecorded intangible-based ratio is the most significant. In all industries, warrants firm-years have a

higher UI/Tcap ratio than others, and the differences are highly significant. Innovative firms that invest heavily in intangible assets are more likely to use equity warrants for financing than other firms.

7. Logistic Regressions of Warrants on Innovation Measures

For a formal statistical test of the relationship between warrants and innovation measures, I use binary logistic regressions, and the probability modeled is 6,329 equity warrants out of 109,627 firm-year observations. The explanatory variables are R&D to sales revenue ratio (XRD/SALE), intangibles recorded on balance sheets scaled by total assets (INTAN/AT), unrecorded intangible assets scaled by total capital (UI/Tcap) as in Peters and Taylor (2017) and Park (2021), tangible assets scaled by total assets (PPEGT/AT), and industry dummy variables. The optimization method is Fisher's scoring, which maximizes the likelihood by getting successively closer to the maximum by taking another step of an iteration. The convergence criterion of 10^{-8} was satisfied in all models presented in Table VI and Table VII.

The logistic regressions confirm that innovative firms are more likely to use warrants than others. The coefficients of the R&D to SALE ratio, recorded intangibles scaled by total assets (INTAN/AT), unrecorded intangible assets scaled by total capital (UI/Tcap) are all highly significant economically and statistically. In contrast, the tangible assets ratio, PPEGT/AT, has no explanatory power. Among the three innovation measures, the explanatory power of the unrecorded intangible assets is the highest, pointing out the need for financial economists and analysts to take knowledge capital and organization capital missing in financial statements into consideration in their analysis. Note that XRD is the R&D expenditures during a fiscal year while UI is unrecorded intangibles estimated by

capitalizing all past R&D expenditures for knowledge capital and a proportion of previous selling, general, and administrative expenses for organization capital (Eisfeldt and Papanikolaou, 2013; Peters and Taylor, 2017; Park, 2021).

After controlling for the three innovation measures, intangible-intensive industry dummy variables are also highly significant in explaining the likelihood of using equity warrants for financing. Pharmaceutical firms have the highest and most significant tendency to use equity warrants for financing, as shown in the industry dummy's largest and significant coefficient.

Pharmaceutical firms invest heavily in R&D than other firms (average XRD/SALE 2.26 vs. 0.07, *t*-statistic = 34.74), making them most profoundly affected by accounting conservatism. To overcome the challenges in financing uncertain intangible investments and the high cost of capital, pharmaceutical firms use equity warrants more often than others. For example, Company K is a biopharma specializing in mental illness treatment and other brain research and drug delivery. It entered into a development and license agreement in May 2000 with Company M, which Company B acquired in August 2012. While Company B and Company Z were jointly developing commercializing Company M's products from August 2012 through January 2014, Company K achieved development and commercialization goals and received milestone payments consisting of cash and warrants for Company M's common stock (2015 10-K report of Company K, p. 14).

Logistic regressions in Table VII test the relationship between warrants and financial constraints, and proprietary information risk measures. Bodnaruk et al. (2015) find that the frequency of constraining words predicts subsequent liquidity events better than other constraint measures such as age and size. The coefficient on the proportion of constraining

words is significantly positive at the one percent level after controlling for R&D expenditures, recorded and unrecorded intangibles, proprietary information risk as in Hoberg and Maksimovic (2015), and the industry effect. These results confirm that financially constrained firms and intangible-intensive firms with proprietary information risk are more likely to use equity warrants for financing than other firms.

8. Conclusions

Financing innovative activities such as R&D is a challenge in a freely competitive market. For addressing the issue, the economics literature focused on policy interventions to prevent underinvestments, such as the intellectual property system, government support of R&D, and R&D tax incentives (Arrow 1962; Hall and Lerner, 2009). This paper sheds light on another challenge in financing innovation in the digital economy, focusing on the impact of accounting conservatism and unrecorded intangible assets. I find that intangible-intensive firms with proprietary information risk are more financially constrained than others and use equity warrants as an alternative way of financing innovation.

I develop a new dataset of warrant users through a textual analysis of 10-K reports submitted electronically to the SEC since the EDGAR file system started in 1994, overcoming the challenges of limited data on equity warrants. Using the new dataset, I show that firms using equity warrants for financing have increased significantly from less than 1% of the U.S. publicly traded firms in 1994 to 8% in 2018. In R&D-intensive industries such as pharmaceuticals, users of warrants are over 17% during 1994-2018.

Using logistic regressions, I show that firms with a higher R&D expenditure to sales revenue ratio are more likely to use warrants for financing and unrecorded intangible assets estimated by capitalizing prior intangible investments have the most significant explanatory

power. Since the rapid growth of the Internet and the digital economy started emerging in the mid-1990s, intangibles exceed tangible investments. This paper contributes to the literature on financing innovation by showing that 20th-century accounting measures developed mainly for industrial firms should be modified when analysts, economists, and policymakers evaluate 21st-century innovation in the digital economy. It also contributes to the derivatives literature by developing new data on warrants using natural language processing of EDGAR files from the SEC and demonstrating the usages of derivatives to finance innovative economic activities.

APPENDIX A. ACCOUNTING RULES ON WARRANTS ISSUED TO CUSTOMERS

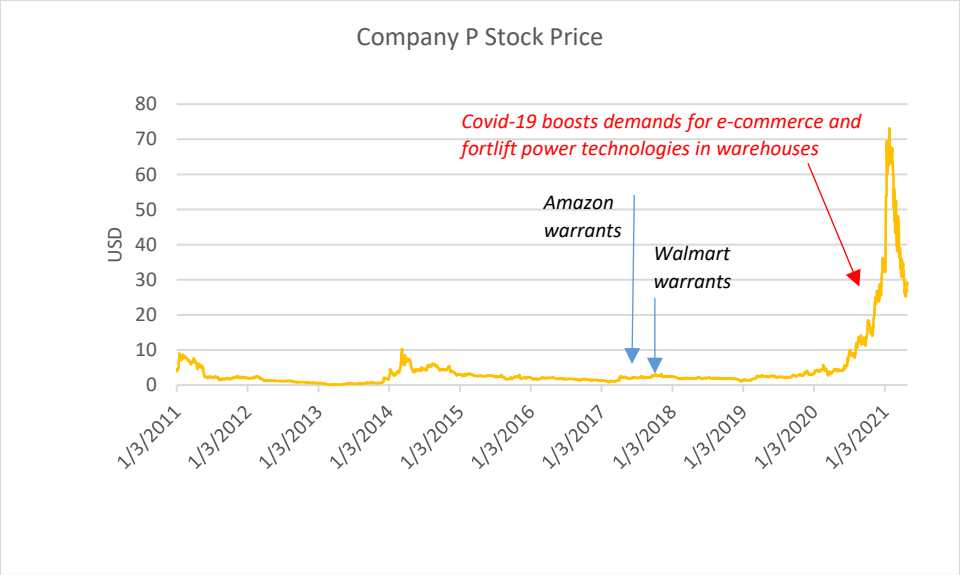
The accounting rules on warrants issued to customers have been transformed significantly in recent years. This appendix is to summarize the changes and to present an example that shows the impacts. The Financial Accounting Standard Board (FASB) clarified accounting rules for warrants issued as sales incentives to customers by issuing Accounting Standard Updates (ASU) No. 2019-08, *Codification Improvements – Share-based Consideration Payable to a Customer*, in November 2019.

This update was necessary as a follow-up of ASU 2018-07, *Improvements to Nonemployee Share-Based Payment Accounting*. ASU 2018-07 expanded the scope of Accounting Standards Codification (ASC) 718, *Compensation – Stock Compensation*, to include share-based payments to nonemployees and amended the guidance in ASC 606, *Revenue from Contracts with Customers*, and made share-based sales incentives reduce revenue. ASU 2018-07 required warrants issued as sales incentives reduce revenues by applying ASC 606, but it was not clear what the measurement date should be.

ASU 2019-08 requires companies to apply ASC 718 to measure and classifiy share-based sales incentives and calculate the fair value of warrants on the grant date when the issuing company and the customer reached a mutual understanding of the terms and conditions of the share-based consideration. See below for a case that shows the impact of the accounting rule changes on the financial statements of a financially constrained innovative firm that has issued warrants as a sales incentive.

Company P is a developer of hydrogen and fuel cell systems that went public in October 1999 and has been through boom and bust cycles over the past two decades. Figure

A1 presents the stock price and trading volume during the past ten years.



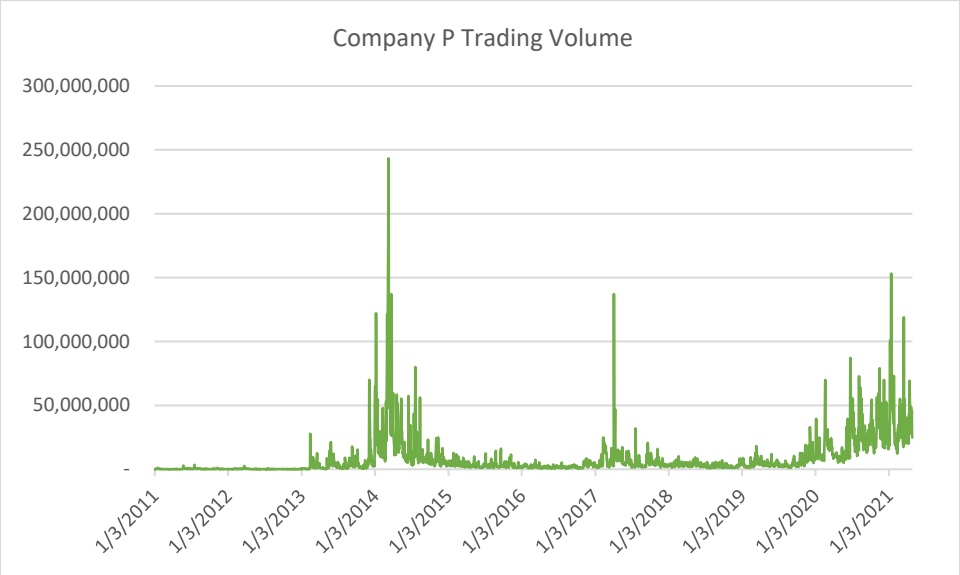


FIGURE A.1

This figure presents the stock price and trading volume of Company P during the past ten years and indicates when they issued equity warrants to customers and the grant date of the warrants under the new accounting rule, ASU 2019-08.

According to the 2017 10-K, 72 percent of Company P's revenue is from Amazon (42.4%) and Walmart (29.4%), providing forklift power in warehouses and other green technology transportation solutions for retailers. The company agreed to issue warrants to

Amazon as a sales incentive on April 4, 2017, when the stock price was $1.30. The agreement allows Amazon to buy over 55 million shares through April 4, 2027, in three tranches when the sales milestones of 600/800/1,200 million dollars have arrived with the exercise prices of $1.1893 per share for the first two trenches. In the case of the third tranche, the exercise price is 90% of the 30-day volume-weighted average share price of the common stock as of the final vesting date of the second tranche. As of December 31, 2019, 20.37 million of the Amazon Warrant Shares had vested, according to the 2019 10-K.

Company P had a similar contract with Walmart on July 20, 2017, that allows Walmart to buy up to 55.29 million shares through July 20, 2027. There are three tranches for the sales milestones of 600/800/1,200 million dollars. The exercise price is $2.1231 per share for the first two trenches. The third tranche's exercise price is 90% of the 30-day volume-weighted average share price of the common stock as of the final vesting date of the second tranche. As of December 31, 2019, 5.82 million of the Walmart Warrant Shares had vested.

During the fourth quarter of 2019, Company P adopted ASU 2019-08, with retrospective adoption as of January 1, 2019, and thus warrants reduced their revenue by the fair value of $ measured based on the grant date, according to their 2019 10-K. In contrast, 2017 and 2018 10-Ks reported the fair values estimated on the financial reporting dates based on the expected vesting dates. Under ASU 2019-08, all existing unvested warrants in the first and second tranches use January 1, 2019 as the measurement date. However, the exercise price for the third tranche of 40.74 million shares (20.37 each for Amazon and Walmart), cannot be determined until the sales milestone of $800 million each is reached and the second tranche vests.

As shown in Figure A1, the company's stock price went up sharply during the Covid-19 pandemic from $3.54 on 3/31/20 to $73.18 on 1/26/21 with the rapid growth in online sales boosting demands for their transportation technologies in warehouses. However, the rapid increase in their stock price means the fair values of the warrants they issued to customers rise sharply, wiping out revenues because warrants issued to customers cause revenue reduction under ASU 2019-08.

On March 12, 2021, Company P announced in consultation with its accounting firm KPMG that its 2018 and 2019 financial statements would be restated and their 2020 10-K would disclose a material weakness in the company's internal controls over financial reporting arising from the restatement items. On March 17, 2021, Company P received a notice from NASDAQ stating that they were not in compliance of the listing rule by not filing 2020 10-K yet and disclosed it by filing an 8-K with the SEC. According to the 8-K, Company P has 60 calendar days until May 17, 2021 to file the 2020 10-K with the SEC and the company intends to submit a plan to regain compliance with the NASDAQ rule on or before that date. This example shows the challenges in accounting for warrants in the financial management of innovative firms.

APPENDIX B. WARRANTS IN SPACS

Warrants in special purpose acquisition companies (SPACs) are distinct from what this paper analyzes because SPAC warrants are issued during the initial public offering of private companies in units combined with stocks to be traded separately on exchanges. In contrast, this paper focuses on public company warrants that are not traded on exchanges, and thus a textual analysis of financial statements is the only way to identify them. That is why I discuss SPAC warrants separately in this appendix.

SPAC is a blank check company that has become a popular vehicle for transitioning a private firm to a publicly-traded company, especially during the Covid-19 pandemic. First, a SPAC goes through its own IPO as a shell company without having any operating business. Cash and equivalents are their only assets, and they search for privately-held acquisition targets for many months to complete the merger within one to two years. A SPAC IPO usually offers investors a unit of securities consisting of shares of common stock and warrants. When a SPAC's management called sponsors identifies the acquisition target, they negotiate terms with the target and executes a business combination, if approved by shareholders, as a reverse merger where the operating company merges into the SPAC. The combined company is a publicly traded firm carrying on the target firm's operations.

After a SPAC IPO, sponsors usually file an 8-K with the SEC and issue a press release to let investors know when the common stock and warrants begin trading on an exchange separately. For example, Company M is an insurance firm founded in 2011 to apply data science to personalize auto insurance policies priced and billed by the mile. They announced a business combination with a SPAC on November 24, 2020, and they consummated the merger on February 9, 2021, according to Company M's 2020 10-K filed

with the SEC on March 31, 2021. As of the market close of April 29, 2021, Company M's stock price is $9.19 and the warrants with an exercise price of $11.50 is $2.38 and both the stock and the warrant quotes are from NASDAQ.

The terms of warrants vary greatly across SPACs. Gahng et al.(2021) analyze 114 SPAC warrants issued during January 2010 - May 2018 using the Bloomberg Terminal as the data source. They find that warrant investors have persistently outperformed common stock investors, and the gap increased during the Covid-19 pandemic and the SPAC boom in 2020. The following Bloomberg Terminal functions provide exchanged-traded warrants data: MOST (Most Active Securities) – Security Type: Warrants, WMON (Warrant Monitor), and WSRC (Warrant Search).

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TABLE I

R&D Expenditures (XRD), Net Income (NI) and Sales Revenue (SALE) of U.S. Publicly Traded Firms, 1968 - 2018

Fiscal	All Firms					Firms with Negative Net Income					Firms with Positive Net Income				
Year	Number	SALE	XRD	NI	XRD/SALE	Number	SALE	XRD	NI	XRD/SALE	Number	SALE	XRD	NI	XRD/SALE
1968	3894	733,258	3,089	46,381	0.42%	281	13,690	64	-565	0.47%	3613	719,568	3,026	46,946	0.42%
1973	4817	1,384,901	13,799	81,740	1.00%	429	31,706	131	-1,537	0.41%	4388	1,353,195	13,668	83,277	1.01%
1978	6431	2,811,023	25,816	149,513	0.92%	917	84,880	688	-3,812	0.81%	5514	2,726,143	25,128	153,325	0.92%
1983	7166	4,539,568	53,432	200,837	1.18%	1965	285,403	3,217	-23,554	1.13%	5201	4,254,166	50,215	224,392	1.18%
1988	7850	6,510,913	98,631	343,390	1.51%	2703	465,831	6,729	-42,428	1.44%	5147	6,045,081	91,902	385,818	1.52%
1993	9618	8,604,909	151,383	290,622	1.76%	3150	1,521,788	36,074	-107,695	2.37%	6468	7,083,121	115,309	398,317	1.63%
1998	11445	13,823,697	271,623	691,175	1.96%	4641	1,723,546	64,153	-156,937	3.72%	6804	12,100,151	207,470	848,112	1.71%
1999	11571	15,249,447	283,323	834,899	1.86%	4854	1,221,582	40,737	-151,954	3.33%	6717	14,027,866	242,585	986,853	1.73%
2000	11151	17,284,254	310,279	850,683	1.80%	4946	1,766,592	63,313	-304,076	3.58%	6205	15,517,662	246,967	1,154,759	1.59%
2001	10571	17,450,783	317,222	113,796	1.82%	5199	3,928,413	142,471	-766,583	3.63%	5372	13,522,370	174,751	880,380	1.29%
2002	10175	17,255,256	319,068	81,187	1.85%	4787	4,025,626	125,314	-846,207	3.11%	5388	13,229,630	193,754	927,394	1.46%
2003	9936	18,661,449	340,204	1,077,863	1.82%	4071	2,189,137	65,056	-221,616	2.97%	5865	16,472,313	275,149	1,299,479	1.67%
2004	9744	20,768,997	365,819	1,356,455	1.76%	3633	1,866,776	60,123	-196,612	3.22%	6111	18,902,221	305,696	1,553,067	1.62%
2005	9594	21,459,972	354,278	1,550,398	1.65%	3556	1,457,696	48,014	-230,645	3.29%	6038	20,002,276	306,264	1,781,043	1.53%
2006	9375	23,703,632	406,451	2,018,298	1.71%	3394	1,596,996	71,230	-142,363	4.46%	5981	22,106,636	335,221	2,160,662	1.52%
2007	9037	25,779,488	445,239	1,934,602	1.73%	3581	2,502,850	89,974	-291,911	3.59%	5456	23,276,638	355,265	2,226,513	1.53%
2008	8801	25,966,074	462,985	584,562	1.78%	4297	5,676,088	143,226	-1,105,437	2.52%	4504	20,289,986	319,758	1,689,998	1.58%
2009	8669	23,982,304	419,831	1,279,368	1.75%	4105	3,638,719	87,960	-449,208	2.42%	4564	20,343,585	331,871	1,728,576	1.63%
2010	8636	26,355,304	452,001	1,931,631	1.72%	3515	2,425,771	39,109	-190,908	1.61%	5121	23,929,532	412,892	2,122,539	1.73%
2011	8603	28,671,397	480,255	2,006,675	1.68%	3531	2,701,884	57,297	-252,381	2.12%	5072	25,969,514	422,958	2,259,055	1.63%
2012	9174	29,417,425	499,369	1,863,004	1.70%	4093	2,876,176	72,877	-312,481	2.53%	5081	26,541,249	426,492	2,175,485	1.61%
2013	9247	29,855,642	515,335	2,235,358	1.73%	4233	2,410,003	56,769	-273,596	2.36%	5014	27,445,639	458,566	2,508,954	1.67%
2014	8952	29,650,039	528,259	1,945,578	1.78%	4050	2,745,210	67,983	-270,848	2.48%	4902	26,904,829	460,276	2,216,426	1.71%
2015	8616	27,175,849	537,078	1,447,900	1.98%	4172	3,924,897	81,055	-625,212	2.07%	4444	23,250,952	456,023	2,073,112	1.96%
2016	8346	26,779,158	563,273	1,681,909	2.10%	3903	2,869,189	83,173	-380,467	2.90%	4443	23,909,969	480,100	2,062,376	2.01%
2017	8131	29,312,218	628,786	2,250,353	2.15%	3681	2,505,934	112,980	-294,491	4.51%	4450	26,806,284	515,806	2,544,844	1.92%
2018	7625	30,057,700	670,607	2,335,319	2.23%	3406	2,512,940	104,362	-315,346	4.15%	4219	27,544,761	566,245	2,650,665	2.06%

Note. This table presents the number, total SALE, NI, and XRD of all firms in the Compustat database. The unit of SALE, XRD, and NI is US $ million.

TABLE II

Descriptive Statistics for Textual Analysis of Financial Statements, 1994-2018

Variable	Mean	Standard Deviation	Percentiles		
			25th	Median	75th
Financial statement texts					
File size in number of characters	6,618,184	13,978,515	451,531	1,587,881	7.708,663
Number of words	48,462	40,855	25,706	39,046	57,916
Number of unique words	2,872	778	2,348	2,834	3,338
Positive words (%)	0.68	0.17	0.56	0.66	0.78
Negative words (%)	1.60	0.44	1.31	1.59	1.88
Constraining words (%)	0.75	0.20	0.62	0.75	0.88
Compustat data					
XRD / SALE	0.14	0.72	0.00	0.00	0.03
CAPX / SALE	0.11	0.54	0.01	0.03	0.07
XSGA / SALE	0.37	0.89	0.07	0.21	0.38
NI / SALE	-0.32	2.24	-0.05	0.04	0.11
AT / SALE	4.29	6.91	0.78	1.42	3.88
INTAN / AT	0.13	0.19	0.00	0.03	0.19
PPEGT / AT	0.44	0.69	0.07	0.29	0.69

Note. This table presents summary statistics for cleaned 10K annual report texts of US firms submitted during the sample period of 1994 – 2018 and the matching Compustat data of 109,627 firm-years with 14,127 unique firms.

TABLE III

Textual Analysis of Financial Constraints and Asset Tangibility

Dependent variable: Financial Constraints	Model 1	Model 2	Model 3
INTAN / AT	0.06		0.05
	(18.75)***		(17.02)***
PPEGT / AT		-0.01	-0.01
		(-15.42)***	(-13.53)***
Proprietary Information Risk			0.05
			(15.91)***
Year and industry dummy variables	YES	YES	YES
Adjusted R^2 (%)	2.88	2.78	3.27

Note. This table reports the parameter estimates and Adjusted-R^2 from the regressions to test the impact of asset tangibility on financial constraints. *t*-statistics are in the parentheses. The dependent variable is the proportion of financially constraining words obtained from a textual analysis as in Bodnaruk et al. (2015). The explanatory variables are intangible assets (INTAN) and tangible assets such as property, plant, and equipment (PPEGT) scaled by total assets (AT) from Compustat, and a dummy variable measuring proprietary information risk based on textual analysis as in Hoberg and Maksimovic (2015). I also include year and industry dummy variables to adjust for year and industry fixed effects using the industry classification in Li and Hall (2016). ***, **, and * denote that the parameter estimate is statistically significant at the 1%, 5%, and 10% level, respectively.

TABLE IV

Recorded and Unrecorded Intangible Assets of Firm-years with Equity Warrants, 1994 – 2018

Panel A: Firm-years with equity warrants (6,329 observations)

Variable	Mean	Standard Deviation	Percentiles		
			25th	Median	75th
R&D and Recorded Intangibles in Compustat					
XRD / SALE	0.56	1.52	0.00	0.03	0.30
INTAN / AT	0.15	0.21	0.00	0.04	0.24
Tangible Assets in Compustat					
PPEGT / AT	0.40	0.56	0.09	0.24	0.53
Unrecorded Intangibles (UI/Tcap)	0.38	0.27	0.14	0.37	0.59
Knowlede capital (KCap/Tcap)	0.18	0.23	0.00	0.07	0.31
Organization capital (Ocap/Tcap)	0.21	0.18	0.06	0.17	0.31

Panel B: All firm-years (109,627 observations)

Variable	Mean	Standard Deviation	Percentiles		
			25th	Median	75th
R&D and Recorded Intangibles in Compustat					
XRD / SALE	0.14	0.72	0.00	0.00	0.03
INTAN / AT	0.13	0.19	0.00	0.03	0.19
Tangible Assets in Compustat					
PPEGT / AT	0.44	0.69	0.07	0.29	0.69
Unrecorded Intangibles (UI/Tcap)	0.23	0.22	0.02	0.19	0.38
Knowledge capital (Kcap/Tcap)	0.08	0.15	0.00	0.00	0.09
Organization capital (Ocap/Tcap)	0.16	0.16	0.02	0.12	0.25

Note. This table presents R&D scaled by sales revenue (XRD/SALE), tangible assets such as property, plant, and equipment (PPEGT) and intangible assets (INTAN) scaled by total assets (AT) in Compustat and estimated unrecorded intangibles (UI) such as knowledge capital (Kcap) and organization capital (Ocap) scaled by total capital (Tcap) for the 109,627 firm-years matched with 10K texts from EDGAR during 1994 – 2018 for textual analysis of equity warrants. Panel A is for the warrants subsample of 6,329 firm-years, and Panel B shows descriptive statistics for all firm-years.

TABLE V

Comparing Firms with Warrants and Others in R&D Expenditures and Intangible Assets by Industry

Industries (SIC codes)	Number Warrants/ Others (Warrants %)	XRD/SALE			INTAN/AT			UI/TCap		
		Warrants	Others	*t*-stat	Warrants	Others	*t*-stat	Warrants	Others	*t*-stat
Computer & peripheral equipment (3570-9, 3680-9, and 3695)	108/ 1,825 (5.59%)	0.29	0.18	2.04**	0.18	0.11	3.14***	0.43	0.38	2.36**
Software (7372)	361/ 3,400 (9.60%)	0.35	0.25	4.41***	0.21	0.19	1.62	0.54	0.47	5.94***
Pharmaceuticals (2830-1 & 2833-6)	990/ 4,617 (17.66%)	2.29	1.34	9.86***	0.12	0.13	-0.37	0.59	0.50	11.52***
Semiconductor (3661-6 & 3669-79)	351/ 4921 (6.66%)	0.50	0.20	4.63***	0.11	0.11	0.83	0.45	0.36	8.64***
Computer system design (7370-1 & 7373)	544/ 4,026 (11.9%)	0.19	0.12	4.60***	0.28	0.24	3.60***	0.47	0.37	9.69***
Motor vehicles and parts (3585, 3711, 3713 & 3716)	70/ 1,362 (4.89%)	0.22	0.05	2.27**	0.14	0.14	0.09	0.40	0.24	4.80***
Navigational, measuring & control (3812, 3822-3, 3825-6, 3829, 3842 & 3844-5)	337/ 3,626 (8.50%)	0.68	0.21	7.17***	0.14	0.18	-3.41***	0.50	0.38	10.70***
Scientific research (8731)	39/ 285 (12.04%)	0.79	0.76	0.09	0.13	0.17	-1.39	0.53	0.33	4.65***
Other industries	3,529/ 79,236 (4.27%)	0.17	0.02	12.23***	0.14	0.11	6.73***	0.27	0.17	24.51***
All Firm-years	6,329/ 103,298 (5.77%)	0.56	0.11	11.65***	0.15	0.12	9.58***	0.38	0.22	46.01***

Note. This table presents 109,627 firm-year observations in Compustat matched with 10K annual report texts from EDGAR during 1994 - 2018. 6,329 firm-years have equity warrants mentioned in the annual report texts. Firms with warrants are compared with others using innovation measures such as XRD scaled by SALE, recorded intangibles INTAN scaled by total assets (AT), and unrecorded intangibles (UI) scaled by total capital (Tcap). Industry subsamples are also presented following BEI's industry classification for estimating R&D depreciation rates as in Li and Hall (2016). ***, **, and * denote that the difference is significantly different from zero at the 1%, 5%, and 10% level, respectively.

TABLE VI

Logistic Regressions of Warrants on R&D and Intangibles

	Model 1	Model 2	Model 3	Model 4	Model 5
Innovation measures					
XRD/SALE	**0.22*** **				**0.16*** **
Recorded intangibles (INTAN/AT)		**0.44*** **			**0.39*** **
Unrecorded intangibles (UI/Tcap)			**2.38*** **		**2.23*** **
Tangible assets ratio					
PPEGT/AT				**-0.02**	
Industry dummy variables					
Computers and peripheral equipment	0.25**	0.28***	-0.18*	0.28***	-0.17*
Software	0.82***	0.83***	0.17***	0.87***	0.15**
Pharmaceuticals	1.17***	1.57***	0.78***	1.57***	0.54***
Semiconductor	0.42***	0.48***	0.04	0.47***	0.04
Computer system design	1.09***	1.05***	0.62***	1.11***	0.59***
Motor vehicles and parts	0.14	0.13	-0.01	0.14	-0.01
Navigational, measuring, electromedical and control	0.67***	0.71***	0.25***	0.73***	0.22***
Scientific research	0.91***	1.10***	0.68***	1.12***	0.52***
Intercept for other industries	-3.12***	-3.17***	-3.63***	-3.10***	-3.65***
Pseudo-R^2 (%)	5.39	4.56	8.10	4.45	8.62
Likelihood Ratio Test					
Chi-Square	2128	1799	3215	1755	3422
DF	9	9	9	9	11
Pr> Chisq	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Note. This table reports the parameter estimates and pseudo-R^2 from the logistic regression of equity warrants. Explanatory variables are R&D expenditures scaled by sales revenue (XRD/SALE), recorded intangible assets scaled by total assets (Intan/AT), unrecorded intangible assets scaled by total capital (UI/Tcap) as in Peters and Taylor (2017) and Park (2021), tangible assets such as property, plant, and equipment scaled by total assets (PPEGT/AT), and industry dummy variables defined as in Li and Hall (2016). ***, **, and * denote that the parameter estimate is statistically significant at the 1%, 5%, and 10% level, respectively.

TABLE VII

Logistic Regressions of Warrants on Financial Constraints and Proprietary Inforamtion Risk

	Model 1	Model 2	Model 3	Model 4
Constraining words (%)	**0.27*** **	**0.66*** **		**0.62*** **
XRD/SALE		**0.15*** **		**0.15*** **
INTAN/AT		**0.33*** **		**0.33*** **
UI/Tcap		**2.33*** **		**2.31*** **
Proprietary Information Risk			**0.59*** **	**0.38*** **
Industry dummy variables				
Computers and peripheral equipment	0.31***	-0.15	0.27***	-0.15
Software	0.90***	0.19***	0.85***	0.19***
Pharmaceuticals	1.58***	0.53***	1.46***	0.47***
Semiconductor	0.49**	0.05	0.45***	0.04
Computer system design	1.13***	0.62***	1.10***	0.62***
Motor vehicles and parts	0.16	0.02	0.14	0.02
Navigational, measuring, electromedical and control	0.76***	0.23***	0.69***	0.20***
Scientific research	1.14***	0.53***	1.10***	0.53***
Intercept for other industries	-3.32***	-4.17***	-3.13***	-4.15***
Pseudo-R^2 (%)	4.49	8.82	4.74	8.94
Likelihood Ratio Test				
Chi-Square	1770	3,507	1868	3,552
DF	9	12	9	13
Pr> Chisq	<0.0001	<0.0001	<0.0001	<0.0001

Note. This table reports the parameter estimates and pseudo-R^2 from the logistic regressions of equity warrants on financially constraining words as in Bodnaruk et al. (2015) and proprietary information risk as in Hoberg and Maksimovic (2015). Control variables are XRD/SALE, INTAN/AT, UI/Tcap, and industry dummy variables. ***, **, and * denote that the parameter estimate is statistically significant at the 1%, 5%, and 10% level, respectively.

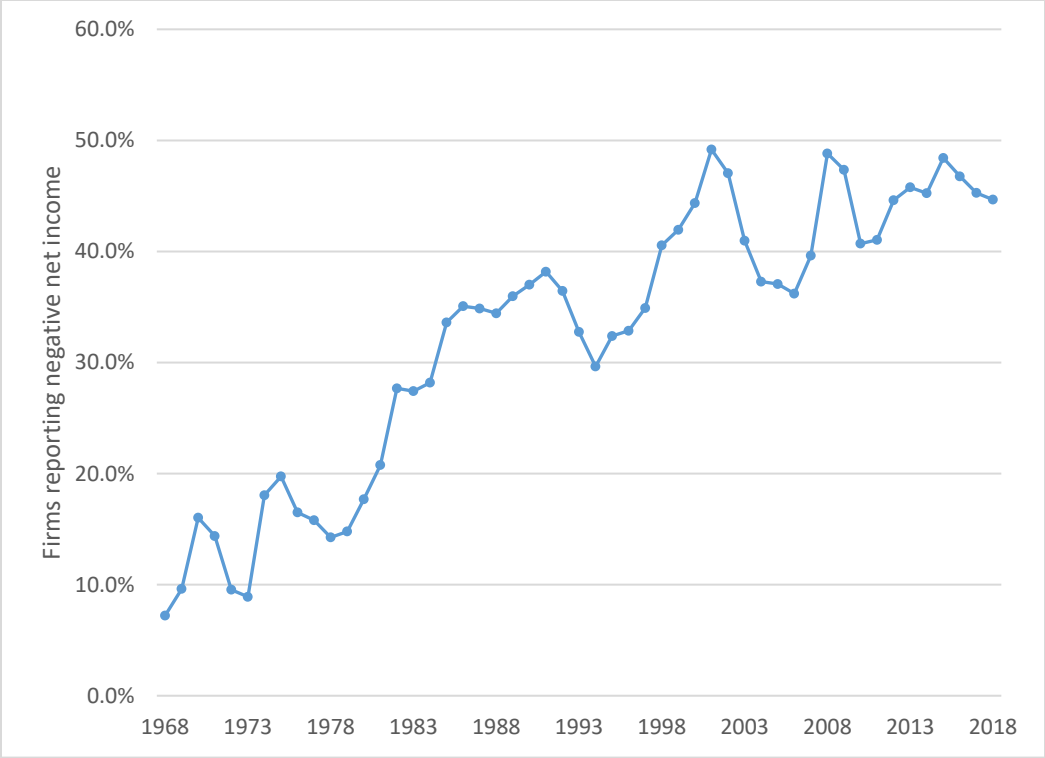

FIGURE 1

The proportion of publicly traded firms reporting negative net income (NI) has been increasing sharply from 7% in 1968 to over 40% in 2018.

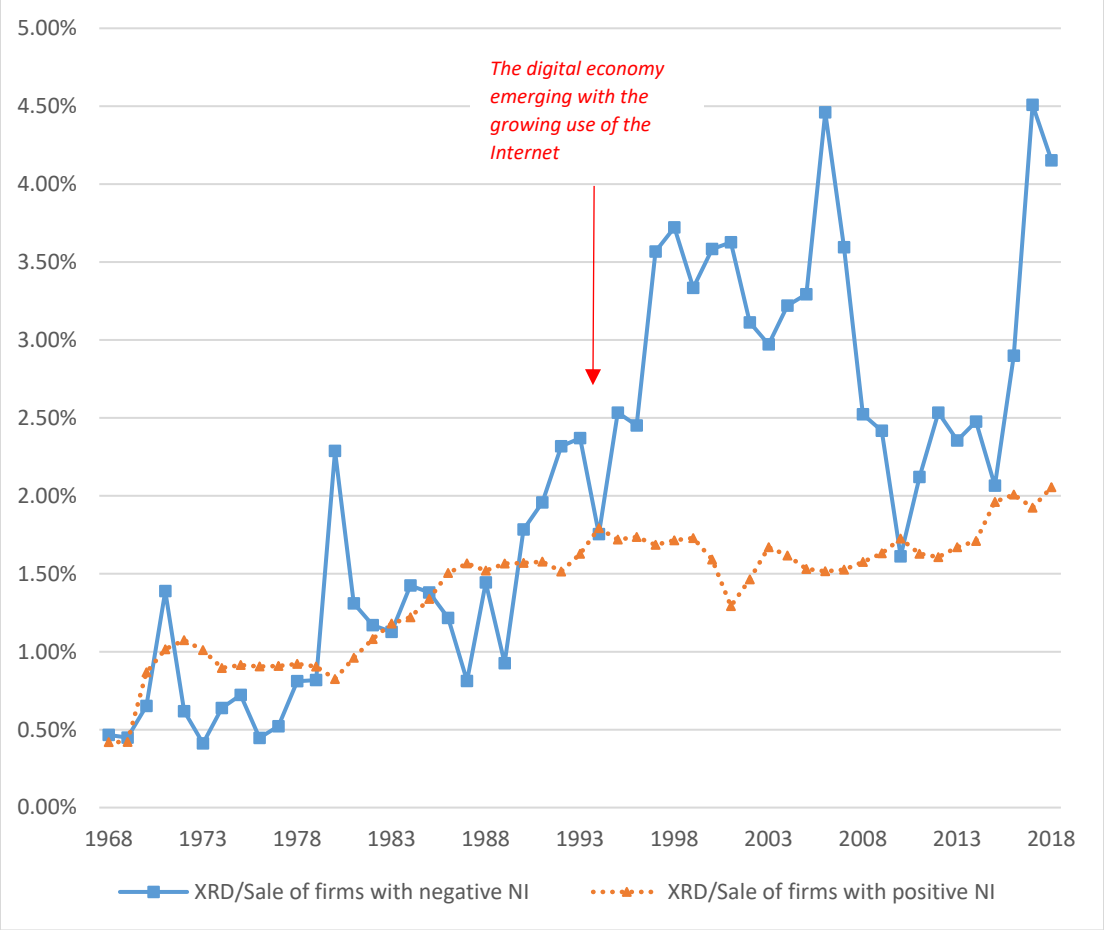

FIGURE 2

Firms reporting negative net income (NI) have a higher aggregate R&D expenditure to sales revenue ratio (XRD/Sale) than firms reporting positive NI since the mid-1990s when the use of the Internet and the digital economy started growing fast. The high R&D expenditures imply that many firms with negative net income may not be underperforming but innovating.

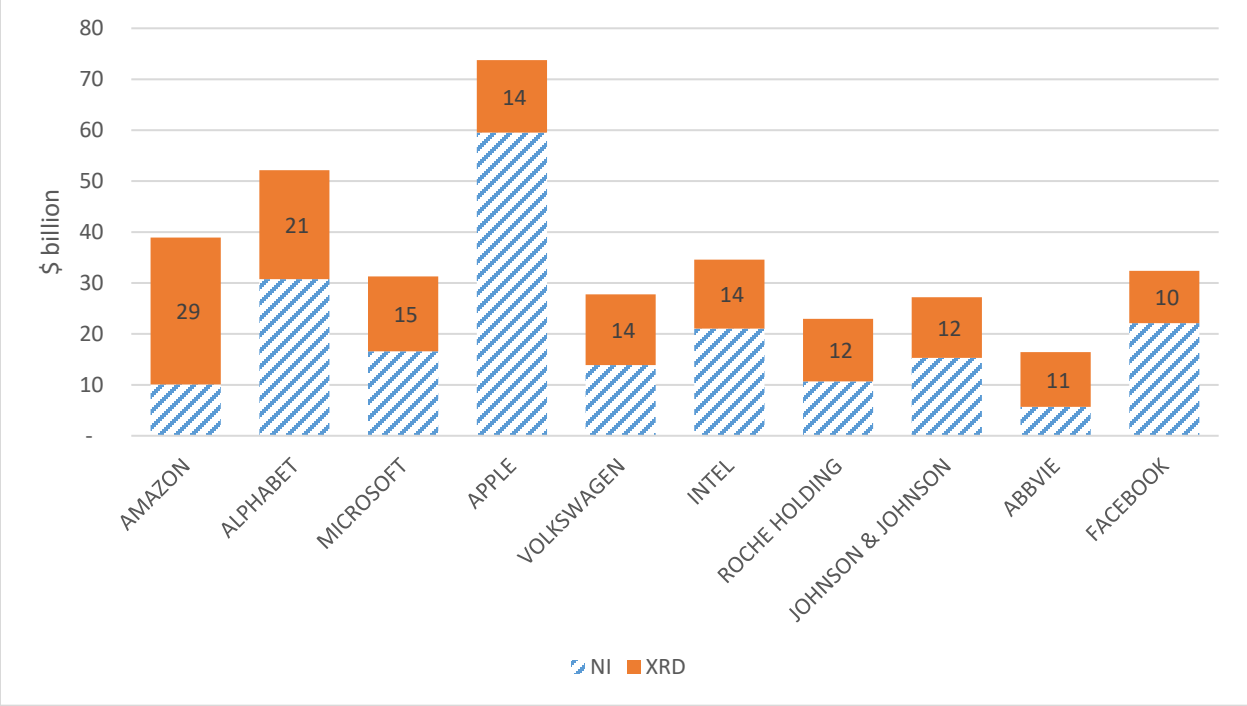

FIGURE 3

This figure presents the top ten firms in R&D expenditures (XRD) during the fiscal year 2018 in the order of the first to the tenth. Their net income (NI) is also included along with R&D to show how high the net income would be without the expensed R&D.

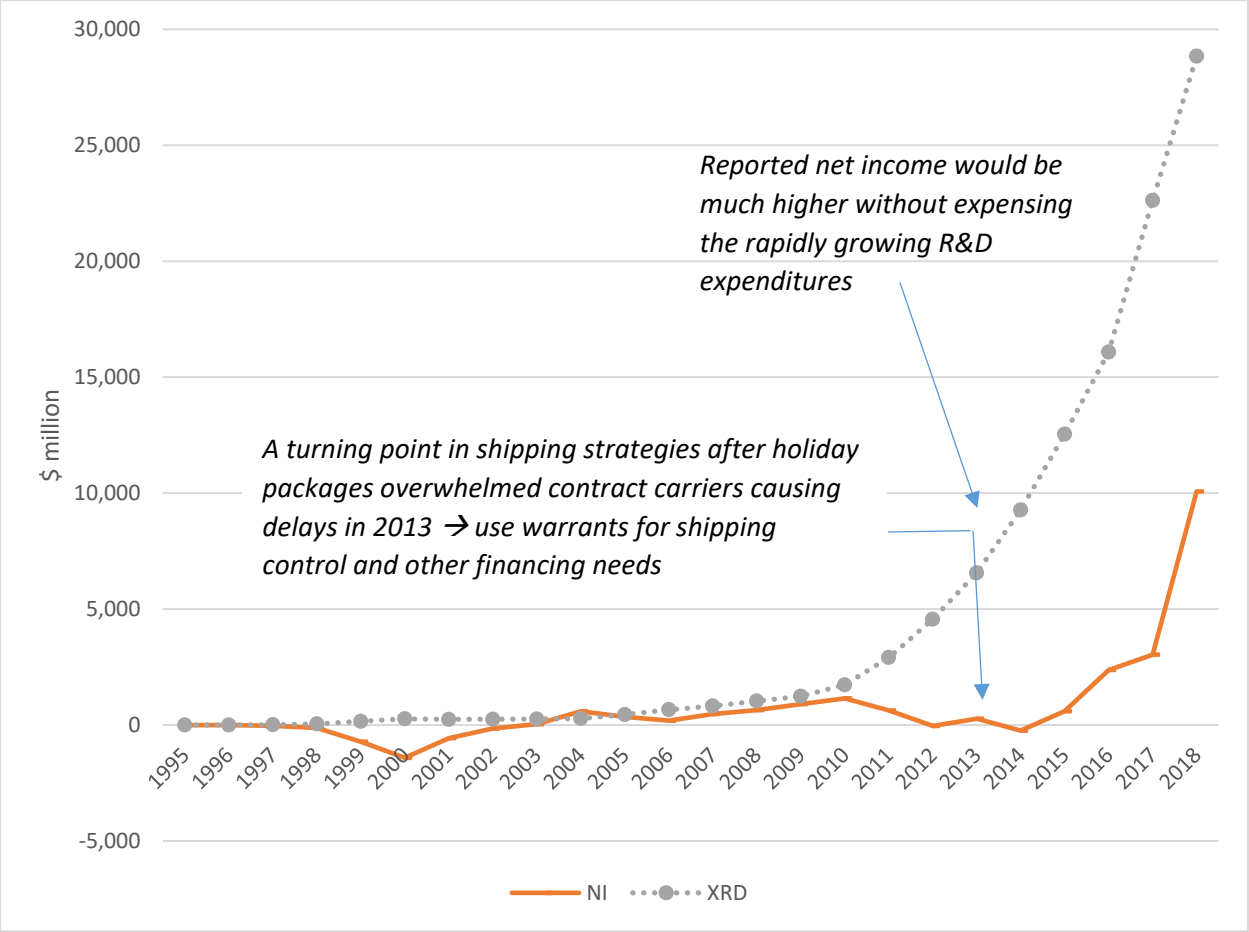

FIGURE 4

This figure presents the entire Compustat record of Amazon's net income (NI) and R&D expenditures (XRD). Long before it started generating positive net income, Amazon invested heavily in R&D.

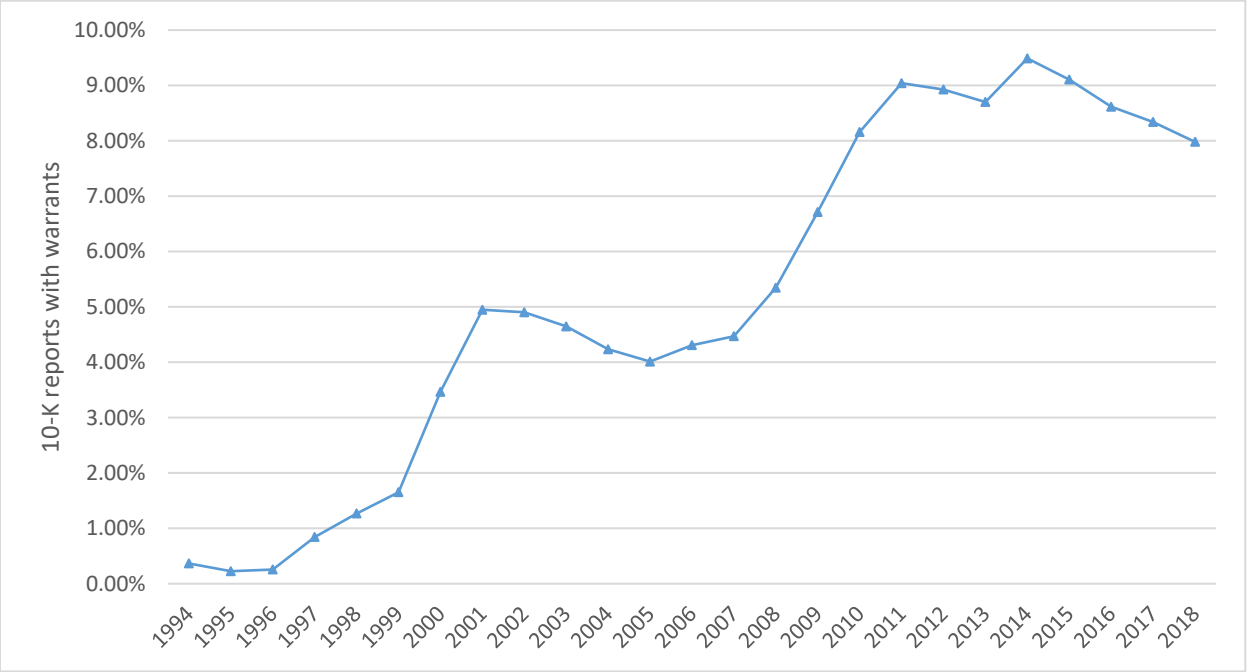

FIGURE 5

The proportion of 10-K reports in EDGAR, mentioning the use of equity warrants, has increased sharply since the digital economy started emerging in the mid-1990s from less than one percent in 1994 to eight percent in 2018.