Do patent-trolls cause the high-tech firms to delist?

Sayla Siddiqui[1]

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Abstract

This paper investigates the impact of non-practicing entity (NPE) patent litigation on the delisting of the firms in the U.S. stock market. Using a sample of high-tech and patent intensive firms from the U.S. market between 2000 and 2019, we find that the frivolous patent trolling by the NPEs is positively associated with the delisting decision of the defendant firms. This result is more pronounced when the firms are small, young, under distress and experience negative sentiment in the market. We ensure the causality of this relationship by using the Anti-troll law and American Invents Act targeted to curb the threat of NPE trolls. We also find that this effect is influenced by the cost of NPE litigation and that going private can significantly mitigate the threat of NPE trolls. Our result recommends that policies aimed to ease the threat of the NPE patent trolls is important to safeguard the steadiness of the innovation intensive companies in the U.S. stock market.

Key words: NPE, Patent litigation, Patent trolls and Anti-troll law

JEL classification: G34, K41, O31, O32

[1] Please address all correspondence to Sayla Sowat Siddiqui, PhD Candidate in Finance, The Australian National University; Phone: +61 4 22 393 863; email: saylasowat.siddiqui@anu.edu.au. I would like to thank Nhan Le, Xianming Zhou and Jo Drienko from the Australian National University and Peter Vehoeven from the Queensland University of Technology for their helpful comments.

1. Introduction

In last few decades, there has been a surge in the number of Securities and Exchange Commission (SEC) registered and publicly traded firms that deregister from the SEC. In the year 2000, in the high-tech sector, the U.S. had 1,839 domestically incorporated companies listed on a U.S. stock exchange (see Figure: 1). By 2019, that total number went down by more than half to only 703.

Literature argues that the listed firms enjoy a handful of economic benefits such as, higher access to finance (Saunders and Steffen, 2011), a lower cost of capital (Hail and Leuz, 2006), less information asymmetry with other market participants (Easley, Hvidkjaer, and O'Hara, 2002), higher liquidity, and a larger investor base (Merton, 1987). Jin and Wang (2002) state that according to the 1964 amendment, firms having a substantial amount of asset have to be listed in the stock market e.g., a firm with total assets of at least $10 million must continue to be registered under the Securities Exchange Act if it has at least 300 shareholders of record. In spite of this amendment, firms having way more assets than required got delisted in the U.S. market. For example, companies that deregistered from the market include ACAP Corporation with over 500 beneficial shareholders and $146 million in total assets and United Road Services in 2007 with over 6,000 beneficial shareholders and $97 million in total assets. Provided that the number of beneficial shareholders and total assets of these companies appears to exceed the regulatory minimum for public registration, we wonder why did they delist? Bharath and Dittmar (2010) argue that, firms choose to delist when the costs of listing surpass the benefits of staying public. These costs include not only the direct costs such as; registration fees, underwriting fees, annual listing fees and trading costs but also the indirect costs such as: compliance costs (e.g., auditing and disclosure costs) and agency costs, which arise from conflicts of interest between managers and shareholders. Our paper examines whether the

threat of non-practicing entity (NPE) litigation costs large enough to drive the high-tech public firms from listing in the U.S. stock market.

NPEs or "patent trolls" are the entities who do not own patents for the purpose of producing or selling the goods[1]. They purchase the patent right for the sake of receiving the fee or commission. They exploit this right by sporadically sending demand letters to the patents alike[2]. The characteristics of litigation involving NPEs as plaintiffs are different from those of the litigations where competing firms are the plaintiffs. Because NPE lawsuits are highly expensive[3], the defendant firms usually choose to go for settlement. Bessen and Meurer (2013) argue that NPEs cost defendants around $29 billion in 2011, which is a 400% increase over $7 billion in 2005. In this study, we hypothesize that the huge costs of the litigation by the NPEs may drive the defendant firms to delist from the stock market.

We develop the testable hypothesis based on two strands in the theoretical literature. One stream of the theoretical literature relies on the reputational loss hypothesis, which argue that firms that experience litigations, loss announcement and corporate misconduct etc are supposed to undergo a substantial amount of reputation loss (Armour et al., 2017; Perry and Fontnouvelle, 2005; Deng et al., 2014). For the patent intensive industry like high-tech firms, patent litigation by the NPEs downgrades the stockholders' expectations and beliefs about the defendant firm's quality and reputation. Consequently, the trading behaviour is adjusted leading to a drop in the stock price (Shapira, 2015). This phenomenon is reported in several studies such as, Chen et al. (2019), Henry (2013) and Raghu et al. (2008). Some studies find that a decline in stock price may drive firms to delist from the market (Seguin and Smoller,

[1] Shrestha (2010) states that the NPEs are the firms that rarely or never practice their patents, and instead focus on earning licensing fees.
[2] MPHJ , which is one of the most notorious NPE, sent demand letters to over 16,000 firms between 2012 and 2013, but never filed a lawsuit.
[3] In an event study of 1630 lawsuits on stock prices (4114 events using a five-day window to measure returns), Bessen, Ford and Meurer (2011) find that NPE lawsuits lead to almost half a trillion dollars lost wealth to the defendants from 1990 to 2010 in the US market. During the last four years of this sample period, the gone wealth averaged at least $80 billion per year.

1997; Baker and Kennedy, 2002). Firms decide to exit the stock market if they no longer see any obvious benefits of listing compared with the incurred costs. Using newly listed IPO firms, Seguin and Smoller (1997) find that the 'death rate' is higher for stocks with lower prices. Baker and Kennedy (2002) study stock returns before delisting and find a high mortality rate for the listed companies on the NYSE and the AMEX (both at 40% over 10 years). These firms lost a significant fraction of their value during the period from 10 years to 1 year before delisting. Therefore, a decline in shareholder wealth through NPE induced reputational loss can drive the firms to delist from the stock market.

Another strand in the theoretical literature is related to the transactional cost hypothesis. Extant literature claims that the NPEs cause the underperformance to the defendant firms in regards to the abnormal return (Chen et al., 2019), entrepreneurial and employment activity (Appel, 2019) and various performance measure such as: R&D, sales, cash level and dividend etc (Tucker, 2014; Besson and Meurer; 2008; Bessen et al., 2013). On the other hand, that the costs of maintaining a stock exchange listing are very high as well (DeAngelo et al., 1984). The cost of listing can be both direct and indirect (Martinez and Serve, 2017). Firstly, along with the costs of registration and underwriting fees at the IPO stage, the, listed firms bear some ongoing costs such as annual listing fees obligatory to the stock exchanges and regulatory bodies, and trading costs. Secondly, there can be indirect costs such as: compliance costs (e.g., auditing and disclosure costs) and agency costs. Therefore, if a firm is already underperforming from the threat of NPE litigation, certainly one reason of getting delisted is related to the cost savings from eliminating the stock market listing. Therefore, NPE trolling on the top of existing costs of listing maybe arduous enough to drive the firm out of the market.

We test these hypotheses by examining whether NPE litigation increases the defendant firm delisting. The sample of our study constitutes 21,904 firm-year observations with 3,293 NPE lawsuits from 2000 to 2019. The ordinary least squares (OLS) regressions show that

high-tech firms are more likely to delist from the stock market after experiencing a NPE lawsuit i.e., an increase in NPE lawsuit is associated with an increase in the delisting probability of the defendant firm by around 14.4%. Our result is economically significant as one standard deviation increase in the firm size reduces the delisting probability by 13.7%. Besides, it is coherent with the Broggard et al. (2021) finding of 16.8% probability of delisting on the shareholder litigation analysis. The OLS results are robust to alternative subsamples, alternative estimation models such as, Probit and Cox-hazard model, controlling for governance variables and after exploiting NPE related laws.

Identifying a causal effect of NPE litigation on the firm delisting is challenging. Firms with financial difficulties are more likely to be delisted and can be more vulnerable to the NPE lawsuits. To mitigate this identification challenge, we use the American Invents Act and Anti-troll law act as the natural experiments to establish the causal link between NPE litigation and the decision to delist. The main goal of both the laws was to curb the NPEs discretion of suing the patent intensive firms. The America Invents Act (AIA) switched the U.S. rights to a patent from the previous "first-to-invent" system to a "first inventor-to-file" system for patent applications filed on or after March 16, 2013 whereas, the Anti-troll law allows the state's Attorney General to initiate the legal actions against abusive NPEs. To mitigate the threat of sporadic demand letters sent by the NPEs, under Anti-troll law, courts can check "whether the letters met the requirement of sufficient information, demanded an arbitrary license fee, or demanded payment in an arbitrarily short period of time" while deciding whether a demand letter were sent in bad faith (DeSisto, 2015). If such a requirement is met, the court can oblige the NPE to post bonds equal to the target's expected litigation costs. Besides, the law establishes that if a court finds that a firm which belongs to Anti-troll passed state has been the target of bad faith patent infringement assertions, then the court can award it the following remedies: "(1) equitable relief; (2) damages; (3) costs and fees, including reasonable attorney's

fees; and (4) an exemplary damages amount". To minimize the burden imposed on firms that are targeted by NPEs, the law allows the state's Attorney General to initiate the legal actions against abusive NPEs. Commencing in the state of Vermont from 2013, a total of 34 states had passed anti-troll laws in different years through 2017. We find that this rigorous pleading standards for initiating an NPE lawsuit reduced the propensity of the treated firms to delist relative to the control firms existing outside the Anti-troll law adopting states. We also find that the adoption of both AIA resulted in a drop in the propensity of NPE lawsuits in the corresponding states.

To examine whether reducing the NPE litigation risk inspires the firms to remain listed, we investigate the stock market reactions to the delisting announcements following the adoption of Anti-troll law in different states. Anti-troll law ensures that there remains less incentive to exit the market for the firms because it reduces the propensity of NPE threat. Because Anti-troll makes firm less vulnerable to delisting, only the firms which performs substantially poorly measured by cumulative abnormal returns (CAR) are observed to be delisted. Low CAR around the delisting events means that this delisting phenomenon is shifted towards the low-quality firms. In other words, Anti-troll motivates the better-quality firms to remain listed by ensuring lower litigation risk for them.

To explore which type of firms are mostly vulnerable to NPE induced delisting, we examine the firm characteristics on the delisting. Fama and French (2004) study how the varying characteristics of the new IPO firms affected the firms' survival rate, merger and propensity to be delisted. They find that more than two out of IPO firms are delisted within 10 years for poor performance. Since the poor performance makes the firms vulnerable to delisting, we investigate size, age and leverage of the firms on delisting. We observe that the delisting probability increases to a large extent when smaller, young and distressed (measured by high leverage) are sued by the NPEs. We also study the negative sentiment about the firm

as a proxy for firm vulnerability. Using the composite sentiment score (CSS) for the RavenPack database, we identify firms having negative CSS scores to experience negative sentiment in the market. Our results find that firms having negative sentiment in the market are more vulnerable and more likely to delist when threated by NPE trolls. Both of the results support the idea that under the threat of NPE litigation, the vulnerable firms are more likely to delist than the stronger firms.

Next, we evaluate the underlying mechanism of why NPEs drive the firms to delist. From the transactional cost hypothesis, we project that NPE litigation settlement costs in addition to the listing expenses influence the firms to delist. The idea is driven by the fact that firms may be forced to delist from the market because of the financial distress caused by having to pay a large NPE settlement amount. To estimate the degree to which directs costs may influence a firm to delist, we classify all the delisting cases into forced and voluntary decisions. We investigate that the impact of NPE litigation is significant on both types of delisting with a significantly higher coefficient for the forced delisting. Therefore, the NPE induced firm delisting is driven by both the direct and indirect costs.

The basic intuition of this research is that firms delist from the stock market in order to minimize the NPE litigation risk. In this study, we empirically test whether delisting actually reduces the likelihood of NPE lawsuits. The private firm data is obtained from the Compustat-Capital IQ database, which specifies the firm that had either gone private, not traded in the public stock exchange, subject to a leverage buyout or been traded in the OTC market. As public and private firms exhibit characteristics in a significantly different way, at first, we perform a difference test (t-test) between the characteristics of the public and private firms. We find that the NPE litigation rate against private firms (treated) is significantly lower than the one of the public firms (control group). To confirm this outcome, we conduct a cross sectional regression of the firm's going private (*Private*) on the propensity to be sued by the NPEs (*NPE*).

The negative coefficient of Private confirms our proposition that after going private, the propensity of the firms to be threatened by the NPEs declines.

Finally, as a supplementary test, we investigate whether the NPE litigations that prompt the firms to delist are legitimate or frivolous. The Stanford NPE database identifies only the "Acquired patents", "Corporate heritage" and "Individual inventors" as the patent trolls among all the NPE lawsuits. Among this three, the "Acquired patents" never truly held the patents or invent the products. The other two were the producer or inventor at some points of their business. We find that only the litigations by "Acquired patents-trolls" are positive and significant on defendant firm delisting, implying that it is the frequent trolling against the patents that drives the high-tech companies to exit the market.

Our study is important for several reasons. Firstly, it brings the discussion of the NPEs into the finance literature. Due to the data scarcity, the discussion of NPEs in the finance literature is very limited. Cohen et al. (2019) was the first to report the first large-sample evidence of the behaviour and impact of NPEs on the firm innovation. They argue that NPEs behave as the opportunistic "patent trolls i.e., NPEs sue cash-rich firms unrelated to alleged infringement at almost the same rate as they target cash in firms related to alleged infringement. They also find real negative impact of NPE litigation on the innovation of the targeted firms. Appel et al. (2019) uses the Anti-troll law to examine the impact of NPEs on the start-up employment. They find that Anti-troll law increased the employment of the start-up firm, implying that the NPEs are a threat to the start-up employment. Using a survey of defendants and a database of litigation, Bessen and Meurer (2013) estimate that defendant firms accrued around $29 billion of direct cost to NPEs in 2011. They also add that small and medium sized firms stood the major casualty in this regard. Some of the other literature from the field of law and science such as, Chen (2019), Tucker (2014), Kiebzak (2016) and Chien (2012) also discuss about the detrimental effect of NPEs on the firm and economy. In an unpublished work,

Dayani (2020) discusses about the effect of patent trolls in the market of acquisition. But, the analysis of the propensity of firm delisting from patent trolling is still an open question. Our study tends to fill this gap by using the Stanford NPE database and investigating whether NPE trolling drives firms to deregister from the market. This study is important because it would provide the policymaker the idea about the extent of impairment that NPEs can do to the patent intensive firms and impede the innovation.

Secondly, it adds another reason to the literature of declining number of firms in the U.S. market. For last two decades, the U.S. market is undergoing a constant decline in the number of firms listed in the stock market (Chaplinsky and Ramchand, 2012). Bharath and Dittmar (2010) argue that, firms choose to voluntarily delist when the costs of listing surpass the benefits of staying public. Fama and French (2004) find that more than two out of IPO firms are delisted within 10 years for poor performance. Seguin and Smoller (1997) claims the drop in stock price to be the reason of delisting. Whereas, Charitou *et al.* (2007) suggest that lack of corporate governance drives firms to delist. However, the discussion of patent trolling to the delisting of patent intensive companies such as high-tech firm is absent. The analysis of NPE trolling to the patent intensive firms is undoubtedly a novel addition to the delisting literature.

The remainder of the paper is organized as follows. Section 2 provides the literature review on the reasons of firm delisting and the detrimental effects of NPEs on the defendant firms. Section 3 describes sample construction and reports summary statistics. Section 4 presents our empirical results. Section 5 concludes and summarizes the paper.

2. Relation to literature and theoretical foundation

2.1 Delisting

From the broad spectrum, delisting is referred to as the removal of a publicly listed company from the stock exchange. Based on the initiators of the delisting, Macey et al. (2008) distinguishes the delisting of a company between involuntary and voluntary delisting. A delisting is voluntary if the company itself initiates the delisting whereas it is an involuntary delisting if the stock exchange enforces the firm to exit the market.

2.1.1 Involuntary delisting

Involuntary delisting happens primarily due to the failure of the firm to meet the listing requirements and financial restructuring such as: bankruptcy or liquidation of the firm (Macey et al., 2008). The listing requirements vary depending on the market. In spite of the variances, most of the markets have some minimum listing requirements, such as: certain standard for the stock price and turnover volume, the number of shareholders, dividend, revenue, cash flow and corporate governance requirements. For instance, the NASDAQ has numerical requirements for minimum share price, market value, total assets/total revenues, net income and corporate governance requirements such as the production of financial reports, having a certain number of independent directors and audit committees etc.

A handful of literature that focuses on the reasons for involuntary delisting find that stock price/return and market capitalization to be the key factors that enforce the firms to delist. Seguin and Smoller (1997) examine the stocks listed on Nasdaq between 1974 and 1988 and find that the mortality rate is higher for the lower-priced stocks than for the higher-priced issues. The result remains same for both IPO and non-IPO issues. Baker and Kennedy (2002) investigate the stock return of the NYSE and the AMEX during the period from 10 years to1 year before delisting. They also find that stocks having negative returns a high mortality rate.

Fama and French (2004) study how the varying characteristics of the new IPO firms affected the firms' survival rate, merger and propensity to be delisted. They find that more than two out of IPO firms are delisted within 10 years for poor performance. Since the poor performance makes the firms vulnerable to delisting, some studies focus on the other criteria of performance. For example, Peristiani and Hong (2004) use the information available to investors to forecast the firm survival rate. They find that firms that are delisted usually have low ROA and capitalization (measured by the equity/assets ratio) compared to a control sample. Li and Zhou (2006) argue that the higher the earnings management at the time of the IPO of the firm the lower the quality of the firm, and that this low quality expose the firms to high delisting risk. Their findings show that the aggressive earnings management at the time of the IPO leads the firms to higher delisting risk due to performance failure. Wagner and Cockburn (2010) use patent as a measure of performance. They argue that innovative firms have competitive advantage and less probability of poor performance. Using the Internet and software firms that had completed an IPO on the NASDAQ in the late 1990s, they find that firms without patents reveal poorer performance and a higher chance of involuntary delisting than firms with patents.

Except for the low performance, the other reasons of involuntary delisting that the literature argue is due to the lack of corporate governance. Charitou *et al.* (2007) find that firms with more outside directors and higher levels of insider ownership are less likely to be delisted from the NYSE. They argue that low corporate governance lessens an IPO firm's chance of survival on the stock market. Chancharat *et al.* (2012) examine this on the Australian new-economy listed firms. They investigate that firms with independent boards have higher probability of survival.

2.1.2 Voluntary delisting

A voluntary delisting, which is the delisting initiated by the firm itself can be a with or without subsequent trade. When a listed company is merged with another firm, or is taken over by a public bid, its subsequent trade ceases to exist. Alternatively, a firm can be delisted from one market and transfer its trading to another more or less regulated market. For example, a firm can decide to withdraw from a regulated market, but continue to trade on an unregulated market e.g., over-the-counter (OTC) markets. This type of delisting is referred to as 'going dark' or deregistration. In this case, the firm continues to trade in a different market.

Bharath and Dittmar (2010) argue that, firms choose to voluntarily delist when the costs of listing surpass the benefits of staying public. The cost of listing can be both direct and indirect (Martinez and Serve, 2017). Firstly, along with the costs of registration and underwriting fees at the IPO stage, the, listed firms bear some ongoing costs such as annual listing fees obligatory to the stock exchanges and regulatory bodies, and trading costs. Secondly, there can be indirect costs such as: compliance costs (e.g., auditing and disclosure costs) and agency costs, which arise from conflicts of interest between managers and shareholders, and/or between majority and minority shareholders. DeAngelo et al. (1984) and Lehn and Poulsen (1989) mention that cost saving is a main factor in delisting via LBOs. Therefore, if a firm is underperforming, certainly one reason for getting delisted is to eradicate certain costs that are incurred by a listed firm. Using accounting ratios (operating margin and ROA), Martinez and Serve (2011) to show that before delisting, the delisted firms performed more poorly than the listed firms. In line with this result, Thomsen and Vinten (2014) also show that firms that has gone private are usually lower performers (with negative ROA on average). The results of Pour and Lasfer (2013) and Leuz *et al.* (2008) studying deregistered firms also align with that.

A majority of the literature (e.g. Amihud and Mendelson, 2000; Bolton and Von Thadden, 1998; Boot *et al.*, 2006), demonstrate that liquidity in share trading is one of the most important reasons of the investors' interest in the company and the firm to go public. The volume of transaction or turnover is generally used in the literature as a measure of stock liquidity. It suggests that if the firm's stock liquidity goes down, the firm is highly likely to go private. The result is consensus among the studies on different countries. Engel *et al.* (2007); Bharat and Dittmar (2010) and Mehran and Peristiani (2010) in the USA, Pour and Lasfer (2013) in the UK and Martinez and Serve (2011) in the Continental Europe show a positive relation between the stock illiquidity and the firm's decision to go private.

Firm can also go private if they have low growth prospect and consequently do not require additional funds to finance the future growth opportunities. Literature (Lehn and Poulsen, 1989; Kim and Lyn, 1991; Weir *et al.*, 2008; Weir and Wright, 2006; Thomsen and Vinten, 2014) suggest that delisted firms show lower pre-delisting sales growth than the listed counterparts. Leuz *et al.* (2008) also find that inadequate future growth prospect is a primary driver of the going-dark decision.

From the corporate governance perspective, the agency theory (Jensen and Meckling, 1976) suggests that the separation of ownership and control raises conflicts of interest between managers and shareholders in firms with diffused ownership. As a result, shareholders experience some agency costs. This agency conflict become more severe when the managers of public firms sell a percentage of their ownership to outsiders, and managers are more into extracting private benefits (Jensen and Meckling, 1976). The incentive realignment hypothesis (Martinez and Serve, 2011) recommends that a going private decision can realign the incentives of managers and shareholders back into each other (Kaplan, 1989) and improve the governance structure of the newly delisted firms. Thus, firms may go private when they suffer from ineffective corporate governance. Firms with low institutional ownerships are also considered

to be weakly monitored and thus have deficient corporate governance. Bharath and Dittmar (2010) and Mehran and Peristiani (2010) argue that voluntarily delisted firms are indeed found to exhibit lower institutional ownership and delisting of these firms bring the interests of managers and shareholders back into line with each other.

Overall, this discussion suggests that whether it is stock return, turnover and other performance or an inefficient corporate governance, firms proceed to delist when they are suffering from underperformance.

2.2 Non-practicing entities (NPEs)

NPEs are the "firms that rarely or never practice their patents, and instead focus on earning licensing fees" (Shrestha 2010). The characteristics of litigation involving NPEs are different from those of litigation involving competitors. NPEs aim to quickly recover cash in excess of their investment in the purchase of patents. They usually do not provide any advance notification, and they do not pursue general agreement processes. An NPE first files a patent infringement lawsuit against the related manufacturers and then uses it as leverage in negotiations with individual firms. For a firm with experience in a lawsuit involving an NPE rather than a competitor, it will face more difficulties in their response. Because NPEs are invulnerable to either counter-litigation (as they do not produce the patented good) for infringement or the termination of a business relationship, the establishment of a defense strategy can be challenging for the firms (Reitzig 2004).

Defendants in NPE litigation have only two options: enduring the cost and loss of defending the litigation or settling the lawsuit for less than the expense of defending it. It is unlikely that an NPE would have any other relationship with the infringer because it does not engage in production as a true market competitor (Fischer 2012). Manufacturers may hesitate to go on the offensive in patent disputes for fear of retaliation in other business relationships.

Relationships within the market could reduce the intensity of patent disputes among rivals. When firms have interlocking business relationships, their behaviours in patent disputes may be different from those of NPEs without such ties. As these are absent, patent assertion is an effective strategy for NPEs, which pose a threat to defendants. That is why NPEs are sometimes named as 'patent trolls' in the literature.

2.2.1 The impact of NPE Litigation

The extant literature profoundly analyses about the effect of NPE litigation on the abnormal return, entrepreneurial and employment activity and various performance measure such as: R&D, sales, cash level and dividend etc. The studies mostly report a significantly negative impact of the patent litigation on the firm performance.

One of the most evident effect of the NPE litigation is its impact on the stock return of the defendant firms. In an event study of 1630 lawsuits on stock prices (4114 events using a five-day window to measure returns), Bessen and Meurer (2013) find that NPE lawsuits lead to almost half a trillion dollars lost wealth to the defendants from 1990 to 2010 in the US market. During the last four years of this sample period, the gone wealth averaged at least $80 billion per year. Their sample constituted the technology industry and invested heavily in R&D. As this litigation embodies an inevitable amount of business cost to the high-tech firms, it decreases the profits that these firms could make on innovation. This means NPE lawsuits reduce the incentives to innovate to a large extent. In a supporting study, Chen et al. (2019) compared the spill over effect of the patent litigation brought in by the practicing entities and the NPEs. The probability of an at-risk technology peer being sued by NPEs in the current year increases by 14% if a patent with the similar technologies has been involved in an NPE patent litigation in the previous year. For NPE litigations, potential at-risk peers incur an average loss of $29.8 million per firm in their market capitalization. In contrast, the non-litigated peers incur

an average loss in market capitalization of $25.5 million when a defendant is sued by an NPE. Henry (2013) argues that firm lose 0.85% of their value following a claim that one of their patents is invalid. Using an event study on the stock return, Raghu et al. (2008) also find that the news of patent infringement litigation is unfavourably accepted in the stock market for the defendants.

Tucker (2014) investigates empirically how NPE trolling affects the sales of the medical imaging technology. Using the data of 4,829 hospitals across the USA, he finds that relative to similar products not covered by the patents, sales of the imaging software of the medical industry declines by one third when sued by the NPEs.

Recently, a number of studies have focused on assessing the impact of PAE activities on the innovations at firm and country level. Jeruss, Feldman, and Walker (2012) in their study on the NPEs over a period of 2007–2011 find that the percentage of NPE cases among all the patent litigation went up from 22% in 2007 to almost 40% of the cases filed in 2011. In a different study, Bessen and Meurer (2013) investigate that NPEs cost defendants around $29 billion in 2011, which is a 400% increase over $7 billion in 2005. From this cost increase less than 25% of the wealth transfer was allocated to innovation activities with a similar percentage allocated to legal fees and the remainder to other ‘deadweight’ loss or ‘social’ cost. Besson and Meurer (2008) investigate that the litigation costs to defendants counterweight the ROI gained from the patented technology. They find that NPE litigation fees per case can range from $500,000 (through summary judgment) to $4 million or more (through trial). Besson and Meurer (2008) argue that NPEs discourage innovation by heightened costs to the firms and VCs that are launching innovative products to the market as the litigation cost arise after products commercialisation by threatening lawsuits. Thus, NPEs affect return on investment (ROI) and consequently innovation.

A prominent area of the discussion is on NPE's impact on entrepreneurial and employment activity. Kiebzak (2016) find that unlike for regular patent litigation, litigation launched by frivolous litigators or patent trolls has a universally negative effect on VC funding i.e., frequent patent litigation suits deter the entrepreneurial activity. Appel (2019) analyses how frequent patent infringement claims made by NPEs affect the start-ups' ability to grow and create jobs, innovate, and raise capital. On the other hand, Appel (2019) analyse how frequent patent infringement claims made by NPEs affect the start-ups' ability to grow and create jobs, innovate, and raise capital. They exploit the staggered adoption of anti-troll laws in 32 US states. Their findings suggest that anti-troll laws, which restrict the patent infringement claim of bad faith by NPEs, lead to a 4.4% increase in employment at high-tech start-ups—a frequent target of NPEs.

Chien (2012) analysed this more specifically on the small firms and entrepreneurial start-ups. Using a database of 223 technology start-up companies, Chien (2012) examine that 40% of small companies surveyed reported a 'significant operational impact' following NPE litigation. This impact stems from change of product (18%), delayed achievement of milestone (15%), delayed hiring (10%), shut-down of the business line or the entire business (13%), and/or lost valuation (4%). Chien (2012) argue that smaller companies are more affected by NPEs than the companies with over $100 million in revenue although in their sample these large companies were litigated at a significantly higher frequency. Additionally, Chien (2012) mention that smaller companies hold a larger part of their sample than the larger companies. He finds that small and mid-size companies with less than $10 million in annual revenues constitute at least 55% of the unique defendants. Chien (2012) stated that small companies with less than $10 million in annual revenues constitute as a minimum of 55% of defendants, those with below $100 million in annual revenue denote at least 66% of the defendants, and those

with less than $1 billion in annual revenue making up around 89% of the defendants in the NPE litigation.

The above discussion suggests that NPEs are not only detrimental to the stock return and innovation activities, but are also a threat to the job creation and entrepreneurships. On the other hand, in majority of the cases delisting stem from the underperformance of the firms. This leads us to hypothesize and analyse that NPE litigation might lead the defendant firms to delist themselves from the stock market.

2.2.2 NPE related laws

To curtail the threat of NPE trolls, the U.S. federal government introduced two laws such as the America Invents Act (AIA)[4] of 2011 and the State Anti-troll law. The America Invents Act (AIA) of 2011, includes a provision intended to curb abusive patent litigation by making it more difficult to sue multiple defendants in the same patent infringement suit (Bryant 2011). However, evidence suggests the AIA has had limited effect on NPE behavior (CEA, 2016). As a result, Congress has subsequently considered several pieces of legislation aimed at further restricting NPEs and, in particular, their ability to send abusive demand letters. Beginning with Vermont in 2013, states adopted patent reforms that protect local businesses from bad faith infringement claims. The main goal of anti-troll law was to curb the NPEs discretion of sending mass demand letters. To this end, courts can consider "whether the letter had the required information, requested an unreasonable license fee, or demanded payment in an unreasonably short period of time" in deciding whether a patent demand letter was sent in bad faith (DeSisto 2015). If such a determination is reached, the court can compel the NPE to post bond equal to

[4] The America Invents Act (AIA) switched the U.S. rights to a patent from the previous "first-to-invent" system to a "first inventor-to-file" system for patent applications filed on or after March 16, 2013. The law also expanded the definition of prior art used in determining patentability. Actions and prior art that bar patentability under the Act includes public use, sales, publications, and other disclosures available to the public anywhere in the world as of the filing date, other than publications by the inventor within one year of filing (inventor's "publication-conditioned grace period"), whether or not a third party also files a patent application.

the target's expected litigation costs. In addition, the law establishes that if a court finds that a Vermont firm has been the target of bad faith patent infringement assertions, then the court may award it the following remedies: "(1) equitable relief; (2) damages; (3) costs and fees, including reasonable attorney's fees; and (4) exemplary damages in an amount equal to $50,000.00 or three times the total of damages, costs, and fees, whichever is greater." To minimize the burden imposed on firms that are targeted by NPEs, the law allows the state's Attorney General to initiate the legal actions against abusive NPEs. The Vermont law has served as a model for other states, and 34 states had passed anti-troll laws through 2017.

3. Data and sample construction

Our sample comprises high-tech publicly traded U.S. firms in the merged CRSP-Compustat database from 2000 to 2019. We define a firm as being in a high-tech industry based on the classification in Loughran and Ritter (2004). We focus on the high-tech firms because i) the lion's share of innovation takes place in high-tech industries (Brown et al., 2009), and ii) NPE litigations are concentrated in the innovative industries. Examining other industries would most likely result in insufficient variation across the sued and non-sued companies by NPEs. We obtain delisting data and stock prices from the CRSP database. This study follows Doidge et al. (2017) and considers a firm to be delisted in a year when it deregisters and is omitted from the CRSP database.

The NPE litigation data is collected from the Stanford Non-Practicing Entity (NPE) Litigation Database. These NPE-litigation statistics are based on cases coded "830 Patent" in the PACER database, which is maintained by the Administrative Office of the U.S. Courts. In case counts, Stanford NPE database excludes misfiles, nonpatent, false marking and other non-core patent infringement cases. When a case is transferred, Stanford counts it as one case and allocates it to the venue to which it was transferred. When several cases are consolidated into

one, Stanford counts it as one case but with multiple defendants. When a case is severed, Stanford counts it as separate cases. Stanford identifies each patent plaintiff as either a practicing entity or as one of the eleven types of NPEs (discussed in Table 11).

We also use patent information data from Kogan et al. (2017) (henceforth KPSS) which allows us to observe the patenting activity of each firm in our sample based on patents filed at the US Patent and Trademark Office (USPTO) from 1926 to 2010. The dataset provides information on the number of patents, the estimated market value of patents, and the number of citations received by each patent filed with the USPTO.

We match the NPE litigation data with the merged CRSP-Compustat data by matching the names of the companies in the CRSP-Compustat data with the defendant names in the Stanford Non-Practicing Entity (NPE) Litigation Database. All the continuous variables are winsorized at the 1st and 99th percentiles. The final sample comprises 2,543 unique firms and 21904 firm-year observations.

Panel A of Table 1 represents the yearly distribution of the number of listed firms, number of listed firms that are sued by the NPE litigation and number of delisted firms.

Insert Table 1 here

From column (1) we observe that the number of the listed firm decreases consistently every year from the year 2000 to 2019. It is noteworthy that this number is less than half in the year 2019 than that in the year 2000. The NPE% in column (3) equals the number of NPE lawsuits divided by the total number of firms. The average NPE rate in the sample is 15%. The NPE litigation rate peaked in the year 2012 until when the Anti-troll law was not passed. The NPE rate then started to fall gradually from 26% in the year 2013 till 20% in the year 2018 and then

rose a little to 23% in the year 2019. Column (4)-(5) of Table 1: Panel A reports the distribution of the delisted firms for the sample period. The average delisting rate in the sample is 9%.

Panel B of Table displays the distribution of the NPE litigation and delisting of the firms across four-digit SIC industries. In column (2)-(3), we observe that the communication services are the highest target of the NPEs. Computer hardware industry succeeds the communication services industry. Overall, the rate of NPE lawsuit varies from 9% to 53% across different industries. Column (4)-(5) shows the rate of delisting across different industries. We do not observe any meaningful differences in the delisting rates across the industries.

Table 2 reports the number and rate of the delisted firms by categories.

Insert Table 2 here

In columns (2) to (3), delisting cases are classified into voluntary and forced one. The delisting codes are obtained from the CRSP. A delisting is considered as voluntary when the CRSP delist code is either in the class of 'Merger' (codes 200 to 299), or the class of 'Voluntary delisting' (codes 570 to 573). We follow Fama and French (2004) and Doidge et al. (2017) who categorize these codes as delisting for reasons and delisting due to mergers. We categorize delisting due to mergers as voluntary because De Loecker et al. (2020) argue that many small or young but potential start-up firms are keen to merge with another larger bidder in order to be protected under a larger corporation. Column (3) reports that on average 6% of the listed firms went for voluntary delisting during out sample period. The highest voluntary delisting rates is observed in 2000 during the dot-com bubble period. Following Broggard et al. (2021) we consider the categories of 'Exchanges', 'Liquidation', 'Dropped', 'Expirations' or 'Domestic that became Foreign' (with codes from 300 and above and exclude the codes of 570

or 573) as forced delisting. In column (5), the forced delist rate peaked at 8% in 2000, the period of dotcom bubble but stabilized at 1.5% in the 2010's. The all-time highest forced delisting is found in 2002, the period of SOX enactment. In most of the delisting rates, our percentage is a little higher than Broggard et al. (2021), perhaps because we focus only on the high-tech firms and they analyse broad on all the industry.

3.1 Summary Statistics

Figure 1 shows the number of listed firms in the high-tech industry over the year 2000 to 2019. We find that this number is consistently going down every year from 1839 in the year 2000 to 703 in the year 2019. On the other hand, figure 2 reports an upward trend in the percentage of the firms sued by the NPEs. The percentage of the firms sued by the NPEs went steadily upward from the year 2000 to 2012 until it started falling down from 2013 when the Anti-troll law started to be adopted in different states of the U.S. However, from the year 2018 this percentage has again started to go up.

Insert Figure 1 and 2 here

Table 3 reports the summary statistics of the main variable used in this study.

Insert Table 3 here

In our sample, the average delisting rate is 6.9% which is very consistent with Broggard et al. (2021) and Doidge et al (2017). For a sample period of 1996 to 2017 of all the industries, Broggard et al. (2021) find an average delisting rate of 7.3%. Whereas, for the period from 1975 to 2012 Doidge et al. (2017) find this rate to be 7.47%. All of the categories of delisting

i.e., voluntary, forced and going public have a rate between 3.1% and 3.9%. On average the NPE lawsuits in the high-tech industry is 13.5%, which is a bit higher than 8.6% of the NPE litigation (sued by NPEs) in Cohen et al. (2019). However, Cohen et al. (2019) used all the industries in contrast to just high-tech industry. The *NPE intensity* shows that on average a firm is sued at least 1.7 times by the NPEs per year. The average *Market to book ratio* is 2.23 and the *Leverage* rate is 14.8%. The *Firm Size* (natural logarithm of total asset) is 5.75 on average. These values are broadly consistent with Islam and Zein (2020) who report on average *Firm Size* to be 6.62 on high-tech industry.

3.2 Empirical Specification and control variables

To investigate whether exposure to NPE litigation drives firms to delist from the stock market, we estimate the following fixed effect panel regression:

$$Delist_{i,t} = \alpha + (\beta \times NPE_{i,t-1}) + \lambda X_{i,t} + \eta_j + \delta_t + \varphi_{j,t} + \varepsilon_{i,t} \quad (1)$$

where *i* indicates firms, *j* indicates industries and *t* indicates years. The dependent variable $Delist_{i,t}$ is an indicator variable equals one if a firm *i* delists in a corresponding year *t*, and zero otherwise. The independent variable $NPE_{i,t-1}$ is an indicator variable equals one if the firm *i* is sued by an NPE in year *t*, and zero otherwise. In equation (1), we are primarily concerned about the coefficient β. The coefficient β denotes the value and magnitude of the relation between NPE lawsuit exposure and the propensity of the defendant firms to delist. We hypothesize that firms are more likely to delist if they are sued by the NPEs than if they are not.

Since the delisting of high-tech firms can be driven by common unobserved year and industry effects, we incorporate year, industry and both year-industry fixed effects together (δ_t

, η_j and $\varphi_{j,t}$ respectively) in the models. The industry is defined by four digits SIC codes on Loughran and Ritter's (2004) and standard errors are clustered at the industry level. In the most constricted form of our estimation, we use the industry-year fixed effects ($\varphi_{j,t}$). This fixed effect is used to incorporate all the variables that do not vary within a given year and industry such as, business cycles and industry-wide investment opportunities. It includes VC financing cycles (Ljungqvist et al., 2018), merger waves (Doidge et al., 2017) and industry wide competition (Kahle and Stulz, 2017). All of these could affect a firm's delisting probability (Broggard et al., 2021). This ensures that our study analyses the propensity of firm delisting following NPE lawsuits while absorbing any unobserved heterogeneity that varies across industries and years over time.

The vector $X_{i,t}$ includes time varying firm specific control variables that can affect the probability of firms' delisting such as Market to book ratio, Firm Size, Leverage, ROA and Cashflow volatility.

To account for the fact that low value and low growth firms may decide to exit from the stock market we include *Market to book ratio* and *Firm Size* as controls. Mehran and Peristiani (2011) argues that the *Market to book ratio* can be viewed as a simple proxy for Tobin's q. A low *Market to book ratio* refers to a low-franchise value and less profitable prospects for reinvesting its cash flows to go forward. We measure *Firm Size* by the natural logarithm of the total assets. The extant literature is in a quandary about the effect of firm size and growth on the probability of delisting. One school of thought argues that large and high-growth firms are more focused in the media and therefore more vulnerable to litigation risk (Kim and Skinner, 2002). The cost of staying public is high for large firms which could encourage delisting. The other school of thought claims that the small and low growth firms are less able to exploit the liquidity advantage of public markets compared to the private markets (Doidge et al., 2017; Mehran and Peristiani, 2011).

Pour and Lasfer (2013) argue that access to public markets and greater transparency enable firms to have a superior bargaining power with the banks, ensuing low borrowing restrictions and diversification of sources of finance (Bharath and Dittmar,2006). Some firms finance their growth opportunities with this fund, while other firm go public to rebalance their leverage (Pagano et al., 1998). Aslan and Kumar (2011) find that leverage persuades firms to go private. In Europe, firms go public to enhance their bargaining power with the bankers and to reduce their leverage. Firms that are not able to rebalance their leverage choose to go private (Bancel and Mittoo, 2009). Hence, we expect firms to delist if they are unable to raise equity capital to rebalance their capital structure. We test these arguments by including *Leverage* in the estimation. We expect low growth firms with high leverage and low probability of raising equity capital to be more likely to delist voluntarily.

We control for *ROA* as profitability is one of the key determinants of firm's survival in the U.S. market Bruner et al. (2006). Using the *ROA* as a measurement of profitability, Bruner et al. (2006) observed that at the time of de-listing, the delisted firms have lower profitability in comparison to the staying listed firms. They also find that both voluntary and involuntary delists have negative ROA on average compared to New Lists. Similarly, Sanger (1990) finds that most of the delistings stem from the failure to meet numerical standards; one of which is related to profitability.

We also use *Cashflow volatility* (five-year rolling standard deviation of operating income before depreciation divided by total assets) to control for firm risk, as financial distress may prompt firms to delist (Broggard et al., 2021).

4. Empirical results

4.1 The association between NPE lawsuits and firm delisting – Baseline

We begin by estimating the most basic form of our equation i.e., the impact of NPE lawsuit exposure on defendant firm's propensity to delist. Following Broggard et al. (2021), we employ OLS as our baseline regression on the basis that our estimation holds a large number of fixed effects along with various dimensions. According to Lancaster (2000), using maximum likelihood tests such as Logit or Probit in this regard may cause an incidental problem. In Panel A of Table 4, we use an indicator, NPE, equal to one if a firm experience at least one NPE lawsuit in the prior year, and zero otherwise. In Panel B of Table 4, we use, NPE intensity, which is the number of NPE lawsuits that a firm experiences in the prior year. In Panel A, column (1) uses only the industry fixed effect to absorb the variation of industry in the estimation. Column (2) uses both year and industry fixed effects but separately and column (3) uses industry-year fixed effects altogether.

Insert Table 4 here

We find that high-tech firms are highly likely to delist following the exposure to NPE litigation. In both the panels and in all the specifications in Table 4, the coefficients of NPE and NPE intensity are significantly positive at least at 5%. In the most conservative form of specification where both firm level controls and industry-year fixed effects are considered, an NPE litigation increases the chance of delisting by 14.4%. Moreover, the consistency in the magnitude of the relationship proves that any industry or year fixed effect left behind is unlikely to change the result.

The other significant controls have the expected. In line with Mehran and Peristiani (2009), Doidge et al. (2017) and Bruner et al. (2006), we find that *Market to book value*, *Firm Size* and

ROA are negatively associated with the delisting. Consistent with Broggard et al. (2021) Cashflow volatility is positive associated with firm delisting.

4.2 Other robustness tests of the baseline

Firstly, in Table 5, following Broggard et al. (2021), we estimate the probit and duration model to test whether the outcome is coherent with the baseline. Instead of OLS, we test a probit model in the Column (1) and (2). We do not include year and industry-year fixed effects in the probit model. To control for the larger industry's conditions and economy-wide effects, the variables such as, industry sale growth rate and Real GDP growth rate are incorporated in column (2). In line with the OLS estimate, the coefficient of the probit model is significantly and positively related to delisting propensity. Thus, the probability of delisting elevates following NPE lawsuits. In column (3) and (4), we examine the hazard ratio for the Cox regression. Here the hazard ratio is the probability that a firm will delist in the next year. Survival models account for both the event occurrence and the time to event (Fama and French, 2004). Besides, survival model is the best when examining censored data and the time-series data with different time horizons (Shumway, 2001). Similar to the OLS estimate, the hazard ratio is significantly and positively related to delisting propensity. That said, the probability of delisting raises following NPE lawsuits. In Column (4), we again incorporate the variables of industry sale growth rate and Real GDP growth rate. The coefficient of (SCA) remains robust to this alternative model specification.

Insert Table 5 here

Our general convention says that delisting probability is high when the economy goes through a crisis. To check whether our result still holds even in the non-crisis period, we

exclude the financial and dot com bubble and find similar result. In column 1 of Panel B: Table 5, we exclude the years of financial crisis i.e., 2007-2009 from the sample. In column (2), we remove the dot com bubble i.e., the years 2001-2002 from the sample. Keeping the controls and fixed effects same as the baseline, we find that the coefficient of *NPE* is consistently positive and significant.

A handful of literature discusses about the impact of corporate governance on delisting occasionally. For example, Bajo et al. (2013) find that a large number of institutional investors reduces the probability of delisting. Using 161 firms' data from NYSE between 1998 and 2004, Charitou et al. (2007) find that firm's governance characteristics such as, board of directors and ownership structure has a significant impact on the delisting. Here as a third robustness test, we investigate the impact of governance improvement on the firm delisting decision. We extend the analysis by including Institutional Ownership, Governance index, and Entrenchment index in the baseline regression in Panel C. In all of the specifications, we find that the coefficient of *NPE* is positive and statistically significant at 5%.

Our findings of the robustness tests support that the baseline result holds irrespective of different econometrics specifications to estimate NPE litigation risk.

4.3 The causal relation between NPE litigation and firm delisting

Even though we believe that verifying the robust positive relations between NPE litigation and delisting is adequate, our empirical analysis does not investigate the causal interpretation of the results. We hypothesized that it is the underperformance or low abnormal return of the company that drives the firm to delist. Because, exposure to NPE litigation is a negative shock which leads to underperformance of the company, NPEs in turn drive the firms to deregister from the stock market.

In juxtapose, it might have happened that underperforming firms may be more litigated or trolled by the NPEs and more likely to delist due to financial difficulties. This might have led to a positive association between NPE litigation and firm delisting. This is consistent with the Selected-style hypothesis of Fee et al. (2013). Thus, the association we investigate in the baseline might be led by the selection bias of NPEs to choose underperforming companies. To mitigate this potential selection bias problem, we use some exogenous events that may be associated with the NPE litigation but not with delisting. We use the American Invents Act (AIA) and Anti-troll law act as the natural experiments to establish the causal link between NPE litigation and the decision to delist.

4.3.1 American Invents Act (AIA)

To investigate whether the American Invents Act (AIA) changes the relationship between firm's experience of NPE litigation and delisting we test the interaction between *NPE* and *AIA* on the firms' propensity to delist in Table 6.

To curtail the threat of NPE trolls, the U.S. federal government introduced the America Invents Act (AIA) in 2011. The America Invents Act (AIA) of 2011, includes a provision intended to curb the abusive patent litigation by making it more difficult to sue multiple defendants in the same patent infringement suit (Bryant et al., 2011). The America Invents Act (AIA) switched the U.S. rights to a patent from the previous "first-to-invent" system to a "first inventor-to-file" system for patent applications filed on or after March 16, 2013. The law also expanded the definition of prior art used in determining patentability. Actions and prior art that bar patentability under the Act includes public use, sales, publications, and other disclosures available to the public anywhere in the world as of the filing date, other than publications by the inventor within one year of filing (inventor's "publication-conditioned grace period"), whether or not a third party also files a patent application.

Insert Table 6 Here

Therefore, we can expect that the effect of NPEs would be minimized after the AIA was adopted. Accordingly in column (2), we find that the interaction term between NPE and AIA is significantly negative after the AIA was adopted. In contrast the relation is highly positive and significant before the AIA was adopted (column 1).

4.3.2 Anti-troll law

In response to the concerns that the American Invents Act (AIA) did not sufficiently protect firms from frivolous patent infringement claims, a number of state legislatures stepped forward to another more restrictive law. Beginning with Vermont in 2013, states adopted patent reforms through Anti-troll law that protects local businesses from bad faith infringement claims. The main goal of anti-troll law was to curb the NPEs discretion of sending mass demand letters. To this end, courts can consider "whether the letter had the required information, requested an unreasonable license fee, or demanded payment in an unreasonably short period of time" in deciding whether a patent demand letter was sent in bad faith (DeSisto, 2015). If such a determination is reached, the court can compel the NPE to post bond equal to the target's expected litigation costs. In addition, the law establishes that if a court finds that a Vermont firm has been the target of bad faith patent infringement assertions, then the court may award it the following remedies: "(1) equitable relief; (2) damages; (3) costs and fees, including reasonable attorney's fees; and (4) exemplary damages in an amount equal to $50,000.00 or three times the total of damages, costs, and fees, whichever is greater." To minimize the burden imposed on firms that are targeted by NPEs, the law allows the state's Attorney General to

initiate the legal actions against abusive NPEs. The Vermont law has served as a model for other states, and 34 states had passed anti-troll laws through 2017.

Impact of Anti-troll law

To investigate whether the Anti-troll law changes the relationship between firm's experience of NPE litigation and delisting we test the following difference-in-difference test in Panel A of Table 7:

$$Delist_{i,t} = \alpha + \beta_1 \times NPE_{i,t-1} + \beta_2 \ (NPE_{i,t-1} \times Antitroll\ dummy_{s,t-1}) + \beta_3 \times Antitroll\ dummy_{s,t-1} + \lambda X_{i,t} + \mu_s + \delta_t + \varepsilon_{i,t} \quad (2)$$

where $Antitroll\ dummy_{s,t-1}$ is an indicator variable equal to one if the firm belongs to a state which has adopted the Anti-troll law in the corresponding year. The independent variable $NPE_{i,t-1}$ is interacted by the $Antitroll\ dummy_{s,t-1}$ in order to differentiate the treatment and control firms. As Anti-troll law is a state wise law and is adopted in different years in different state, we use the state fixed effect μ_s to absorb the variable among the states. In addition, because there is variation in years by the states to adopt this law. To incorporate the time variation, we use the year fixed effect δ_t.

Insert Table 7 Here

In column (1) we use only the state fixed effect and in column (2) we use both state and year fixed effect. The results are very similar in both the cases. The coefficient of *NPE* is positive and statistically significant whereas the coefficient of $Antitroll\ dummy$ is insignificant. That means the positive baseline association between *NPE* and firm delisting

exists and anti-troll law alone does not have any significant impact on firm's decision to delist. However, when the *NPE* is interacted by the $Antitroll\ dummy$, we find a largely negative and statistically significant outcome. Therefore, after the Anti-troll law is adopted in a state, the effect of NPE is abated enough to eliminate the positive effect of the NPE on the delisting. To sum up, the baseline results remain robust even after controlling for the potential endogeneity between NPE lawsuits and delisting probability. NPE lawsuits increases the propensity of the firms to delist.

Impact of Anti-troll law on the NPE litigation

In Panel B of Table 7, we investigate whether the Anti-troll law truly reduces the NPE litigations to the high-tech firms as discussed above. We conduct this test by regressing *Antitroll dummy* on *NPE* litigations. Column (1)-(2) use the indicator value of *NPE* litigation and column (3)-(4) use the *NPE intensity* as the dependant variable. The control variables remain the same as that of the baseline regression. Column (1) and (3) use State-Year fixed effect. Column (2) and (4) use the state fixed effect and year fixed effect separately. In all of the specifications, we find the coefficients of *Antitroll dummy* to be significantly negative, implying that a comparative decline in the chance of NPE litigations in the states where Anti-troll law is adopted than those states where it is not adopted. The result confirms the less NPE threats in the Anti-troll law adopted states.

4.3.3 Impact of Anti-troll law on the delisting return

From Panel B of Table 8, we find that Antitroll law's rigorous ruling on the NPEs reduces the frequency of NPE litigation. When NPE trolling is low, high quality (measured by patent) but vulnerable (to NPE litigation) firms can still stay in the market. This effect shifts towards the poorly performing firms that fail to meet the stock exchange requirement. Since poorly

performing firms experience low delisting returns (Engel et al., 2007), the average delisting cumulative abnormal return (CAR) should be even smaller. We suspect this CAR is even more negative following the Antitroll law.

The stock return data is collected from the CRSP and matched to the Compustat Merged-Fundamentals Annual file. We limit the data only to the NYSE, AMEX and NASDAQ traded firms referred to in the CRSP database by exchange code of 10 or 11. The frequency of the return is daily and we winsorize the daily return at the 1st and 99th percentile.

To test whether the adoption of Antitroll law shifts more negative return to the poor performing defendant firms, we investigate the cumulative abnormal return (CAR) of the public defendant firms to the delisting event. We use the Fama and French three-factor model as the benchmark model to estimate the return. The delisting date is the event date. The estimation window is the trading day [-252, 21], where day 0 is the delisting date. The CAR is calculated for various windows from the 5, 9, 13, 17 or 21 days prior to the delisting up to the delisting date. The comparison and test of CAR are reported in Table 8.

Insert Table 8 Here

Panel A of Table 8 compares the CAR of the delisting firms before and after the adoption of Antitroll law. The CAR is calculated for the windows of 5, 9, 13, 17 or 21 days prior to the delisting up to the delisting date. In of the cases, the CAR of the delisting firms declines significantly after the adoption of Antitroll law. For the five days window, CAR falls by 4% after the adoption of Antitroll law.

Panel B reports the cross-sectional regression of the CAR on Antitroll law of all the windows taken into consideration in Panel A. We control for the firm characteristics such as, market to book ratio, firm size, leverage, return on assets and cashflow volatility that may affect

the CAR. Both industry and year fixed effects are used to capture the variation in the industry and between time. As firms may halt filing financial statements years before the delisting, we exploit the earliest financial data available within the current or one year prior to the delisting date. The number of specifications comes down to 912 because of lack of data on stock return and missing control variables. In all of the specifications, we find that the delisting cumulative abnormal returns are significantly negative at 1%. It indicates that the delisting returns deteriorate even further for the firms which belong to the Antitroll states.

4.5 Firm characteristics

4.5.1 Firm vulnerability

Cohen et al. (2019) argue that NPEs are opportunistic, who behave as the "patent trolls. NPEs sue cash-rich firms unrelated to alleged infringement at almost the same rate as they target cash in firms related to alleged infringement. Following Cohen et al. (2019), we proceed to examining which type of firms are most vulnerable to the frivolous NPE lawsuits and prone to delisting. Wernerfelt (1984) and Barney (1991) in their resource-based theory, argue that firm's ability to create and sustain unique resources influences its competitive advantage performance. Following this theory, Esteve-Pérez and Mañez-Castillejo (2008) attempted to identify the determinants of a firm's survival. They claim that older and larger firms and those with better operating performance are likely to have adequate resources to survive longer than the other firms. Therefore, firm size, age and operating performance variables are expected to have negative relationships with the delisting rate. On the other hand, the trade-off theory of capital structure reasons that financial leverage may lead to financial distress and consequently the probability of involuntary delisting (Lamberto and Rath, 2010). This prediction is confirmed by several studies such as, Platt, 1995; Baker and Kennedy, 2002; Li *et al.*, 2006; Demers and Joos, 2007; Yung *et al.*, 2008.

As such, we examine different firm characteristics on delisting and find that leverage and small firm size have significant impact on the association between NPE threat and firm delisting. Column (1) of Table 9 reports the interaction between Leverage and NPE on firm delisting. Firstly, we find that Leverage along is positively related to delisting but it is not significant. Thus, Leverage does increase the financial distress for the firm to delist from the market. However, when interacted with NPE, the coefficient becomes significantly positive, implying that NPE threat substantially increases the risk of delisting for the highly indebted firms. Column (2) exploits the firm size from the concept of resource-based theory mentioned above. Firms are identified as small firms if their total asset size is less than 25 percentile of the sample total asset. We find that small firms are insignificantly positively related to firm delisting. But, when interacted by NPEs, the propensity to delist become higher and significant. This is consistent with Bessen and Meurer (2013) who evidence that small firms are the highest target of the NPEs. In an unreported test, we do not find any plausible relation between firm age and/or operative performance and firm delisting. Finally, column (3) investigates whether young firms are vulnerable to NPE triggering delisting. Firms are identified as young firms in the age of the firm is below 25th percentile of the age of all the sample firms. We find that the coefficient of the *Young firm* is positive and significant. When interacted with *NPE,* the coefficient of the interaction term become double, which indicates that the young firms when sued by the frivolous NPEs are highly vulnerable to delisting.

Insert Table 9 here

This result establishes that high-tech firms which has higher leverage, smaller in size and young in age are more vulnerable to delisting when threatened by patent trolls.

4.5.2 Negative sentiment of the firm news

As an addition to the measure of vulnerability, we investigate how firms' media exposure affect the NPE's opportunistic behaviour. Our conventional wisdom suggests that firms having negative sentiment in the media should be more vulnerable. We collect the media exposure data from the RavenPack database, which provides a composite sentiment score (CSS) for every news held in the database. Firms having negative CSS are identified to have negative sentiment.

Table 10 reports the interaction between NPE and the negative sentiment from the news about the firm on the propensity to delist. In both column (1) and (2), when NPE lawsuits are interacted by the Negative sentiment, we find that the coefficient terms become positive and significant at 5% significance level. This supports our argument that firms having negative sentiment in the market are more vulnerable and more likely to delist when threated by NPE trolls.

Insert Table 10 here

4.6 How do NPE threats drive firms to delist?

Now that we have found enough evidence that NPE litigation drives firms to delist from the stock market, we investigate the mechanism or channel through which this happens. Bharath and Dittmar (2010) argue that firms decide to delist when the costs of listing exceed the benefits of remaining public. In other words, firms look at different trade-offs in their delisting decision, depending on the type of delisting and whether or not they will continue to trade afterwards. By testing the voluntary and forced delisting, we find that the cost of litigation does matter for the firm's decision to delist. Secondly, we investigate whether firms delist in order to protect themselves from the threat of NPE litigations. By comparing the litigation rate of private and

public firms, we find that private firms are considerably less likely to be sued by the NPEs than the public firms.

Cost of NPE litigation

Literature finds at least two costs i.e., direct and indirect costs involved in the NPE litigation. Firstly, when sued by an NPE, the direct cost incurred are so substantial that firms find incurring the similar cost in future is too large to remain listed. The American Intellectual Property Lawyer's Association (AIPLA)[5] issues a bi-annual survey of IP-related costs. For the entire trial, the AIPLA says that for less than $1M at risk, the trial will cost $700,000, while the very high value cases will cost $4M or more.

On the other hand, the indirect cost of NPE litigation involves enforcing a granted property right against infringement, which is associated with costs, such as, time and expenditure of the legal process. Besides, the uncertainty during the dispute leads to high opportunity cost. Differentiating the direct and indirect is not possible from the data available. Therefore, we assess the costs by investigating the motivation for delisting and demerits of NPE troll.

We categorize all delisting cases into forced and voluntary choices. Our general convention suggests that direct (indirect) costs will matter more for forced (voluntary) delisting. If indirect costs do not matter, we will not observe the impact of NPE litigation on the voluntary delisting. To examine this proposition, we restrict our sample into voluntary and forced delists. The results are stated in Table 11.

Insert Table 11 here

[5] https://www.aipla.org/

The magnitude of the effect of *NPE* and *NPE intensity* is significant across all the models, for both forced and voluntary delists. Although the extent on voluntary delists is smaller, indicating the smaller impact of indirect costs as opposed to the one of direct costs, they remain statistically robust and economically meaningful. Besides, this finding helps rule out the concern that our main finding is primarily driven by firms forced to delist because of the financial distress caused by an imminent legal cost. If that is the concern, we should see the litigation effect becomes insignificant to voluntary delisting cases. Nevertheless, that is not the fact.

4.7 Does going private reduce NPE trolling?

The main argument of this paper is that public firms delist from the market out of the threat of NPE trolling. Therefore, it is robust to examine whether going private in fact save them from the NPE threat. To investigate this argument, we regress going private (GPT) or over the counter (OTC) market on the NPE. The GPT data is obtained from the Compustat-Capital IQ database. We identify private firms by the exchange code of 0, 19 or 20. This specifies the firm that had either gone private, not traded in the public stock exchange, subject to a leverage buyout or been traded in the OTC market[6].

Insert Table 12

As public and private firms exhibit characteristics in a significantly different way, we conduct a difference test between the characteristics of the public and private firms in Panel A of Table 12. Columns (1) to (5) report the statistics of the sample between private and public

[6] Private firms have the discretion to voluntarily report financial data when they want to go to IPO in future. Besides, the requirement of SEC reporting is mandatory for OTC firms passing a certain requirement in the firm size or the number of record holders or the existence of public debt issuance. For more discussion on OTC regulatory regimes, please refer to Brueggemann, Kaul, Leuz, and Werner (2018).

firms. Consistent with our expectation, the firm characteristics are statistically and economically significantly different between private and public firms. We also perform a propensity score matching based on market to book ratio, firm age, leverage, return on assets, and cashflow volatility. We match the treated (private) and control (public) firms based on the nearest propensity score with replacement and present the results in Panel A of Table 12. After matching the results in columns from (6) to (10) show that, although there is no systematic difference in the characteristics of control and treated firms, the propensity of NPE litigation is significantly less for the private firms that the public firms. More notably, while other control variables are comparable between the control and treatment groups, the NPE litigation rate against private firms (treated) is significantly lower than the one of the public firms (control group).

Moreover, to confirm this difference test, we conduct a cross sectional regression of the firm's going private (*Private*) on the propensity to be sued by the NPEs (*NPE*). Column (1) reports the OLS regression of the *Private* on *NPE*. Using industry-year fixed effect and firm level controls, we find a negative and significant coefficient of NPE. To confirm the robustness, we use the probit model in column (2) which provides the similar results with higher and more significant coefficient of *Private* on *NPE*. The negative coefficient of Private confirms our proposition that after going private, the propensity of the firms to be threatened by the NPEs declines.

4.8 Trolling or litigation – what matters more

Finally, we aim to investigate whether it is the legitimate litigation against patent or it is the frequent patent trolling that drives the defendant firms to delist from the stock market. The Stanford NPE database distinguishes the NPEs into thirteen types such as, Acquired Patents, University, Failed start-up, Corporate Heritage, Individual Inventor University/Govt/Non-

profit, Start-up, Product Company, Individual, Undetermined, Industry Consortium, IP subsidiary and Corporate Inventor. They define "*NPEs are entities that do not make products or offer services. "Patent trolls"—are NPEs that employ patents primarily to obtain license fees, rather than to support the transfer or commercialization of technology. Patent litigation by patent trolls and other types of NPEs including universities and early-stage startups differs in its purpose and impact on innovation.*"

Stanford NPE database considers only "Acquired patents", "Corporate heritage" and "Individual inventors" to be the true patent trolls. According to their definition "Acquired patents" include any NPE primarily in the business of asserting patents it has acquired from other entities e.g., Acacia and Intellectual Ventures. Therefore, they are not the true inventor of the innovation. "Corporate heritage" entities are firms that were successful producers for a sustained period of years but then transitioned to a PAE business model. Examples include Encyclopedia Britannica, Inc., IMX, Inc., and PDL Biopharma, Inc. "Individual inventors" comprise of firms primarily in the business of asserting patents, where the original inventor of the patents is the founder and/or owner of the NPE. Most "Individual inventors" entities are limited liability companies owned by the inventor(s) of the asserted patents and exist solely to hold and enforce those patents. For example, Ronald A. Katz Technology Licensing, L.L.C.

Insert Table 13 here

The above definition suggests that the "Acquired patents" do not truly hold the patents or invent the products. They purchase the patents to sue other patents. The other two categories are inventors of the product. Therefore, "Acquired patents" seems to be the "patent trolls" in the true sense. In table 13, we distinguish the patent trolls into three categories and find that the "Acquired patents" are positive and significant on defendant firm delisting. The other two

categories in column (2) and (3) are positive but not significant. Our result suggests that it is the frequent trolling against the patents that drives the high-tech companies to exit the market because they are too patent intensive.

5. Conclusion

NPEs are named as the 'patent trolls' or 'patent sharks' in the literature as they rarely or never produce the product but purchase the patents on behalf of the other companies for the sole purpose of trolling other similar product producing companies. The recent patent literature highlights the severe effect of NPEs on the innovation intensive companies e.g., innovation, R&D, abnormal return, entrepreneurial and employment activity, cash level, dividend payment, market share and the corporate venture capital (CVC) investments of the defendant firm. Our study adds to the literature by investigating whether the cost of NPE litigation is large enough to drive the defendant firms to delist from the stock market.

Using firm-level controls and industry-year fixed effect, we find a positive association between NPE threat and firm delisting. This association is statistically significant and economically meaningful. This result is robust to controlling for various regression models, alternative subsample periods of time, the endogeneity problem and other governance variables. This relationship becomes stronger for small and young firms and firms in distress such as, highly levered firms. To investigate the firm's vulnerability to NPE opportunism, we examine this association for the firms experiencing negative sentiment in the media. Findings suggest that the firms having more negative sentiment are more likely to delist when sued by the NPE patent trolls. To test the causal effect of NPE threat on delisting, we exploit the American Invents Act and Anti-troll law into our regression. Using both American Invents Act AND Anti-troll law as the natural experiment, we find that after the Anti-troll law is adopted in a state, the effect of NPE is abated enough to eliminate the positive effect of the NPE on the

delisting. We also find a deteriorating abnormal return before delisting in the states where Anti-troll law is adopted.

Finally, to test whether direct or indirect cost leads to the delisting we compare between forced and voluntary delisting. We find forced delisting to be more prominent in driving firms to delist while voluntary delisting to remain significantly positive as well. The results show that direct cost of NPE litigation is more influential to disincentivize firms from remaining listed. To investigate whether escaping from the market really shield the firms from patent trolls, we examine the impact of going private on the propensity of NPE lawsuits. By comparing the litigation rate of private and public firms, we find that private firms are considerably less likely to be sued by the NPEs than the public firms.

In summary, our study contributes to the literature by showing that frivolous NPE trolling is detrimental to the firm's operation. It impedes the high-tech firms' innovation activities and competitiveness in the equity markets. It also suggests that government intrusion on the NPE activities through policy imposition does moderate the excruciating effect of the patent trolling. Our result establishes that such regulations on the NPE trolling is crucial to let the innovative companies pursue in the U.S. stock market.

The main shortcoming of the NPE literature is the unavailability of sufficient public data. If more information were available, we could examine the indirect cost of the NPE litigation on high-tech firm delisting. Further research can add more information to the existing database and invigorate this arena of finance literature.

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Figure 1: **Time series of number of listed firms in the high tech industry:**This figure shows the number of the listed firms in the high-tech industry of the U.S. from the year 2000 to 2019.

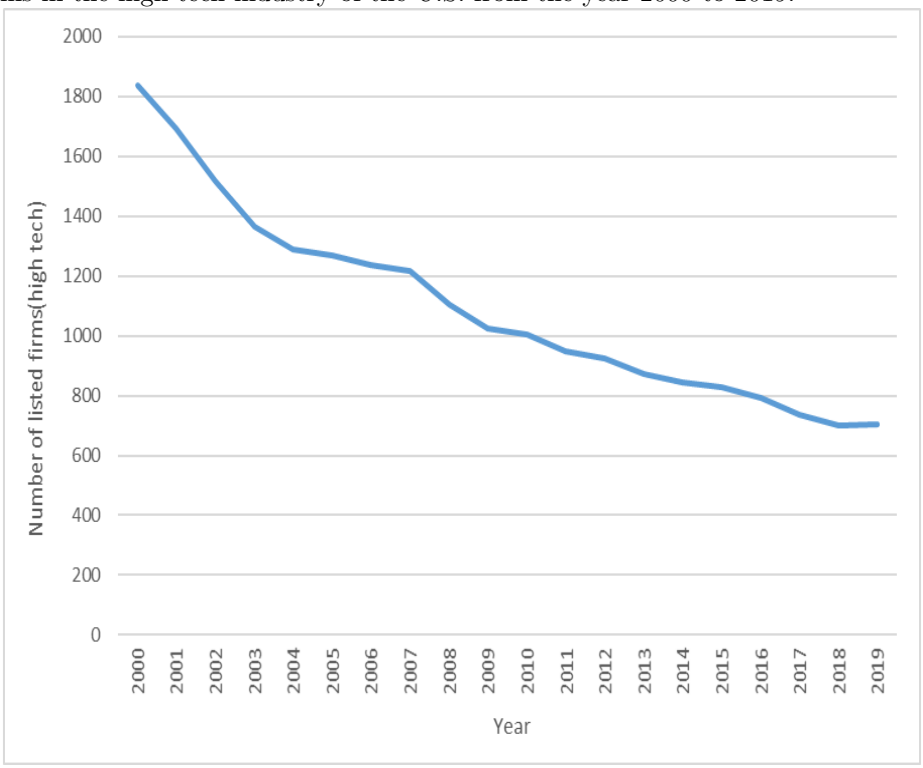
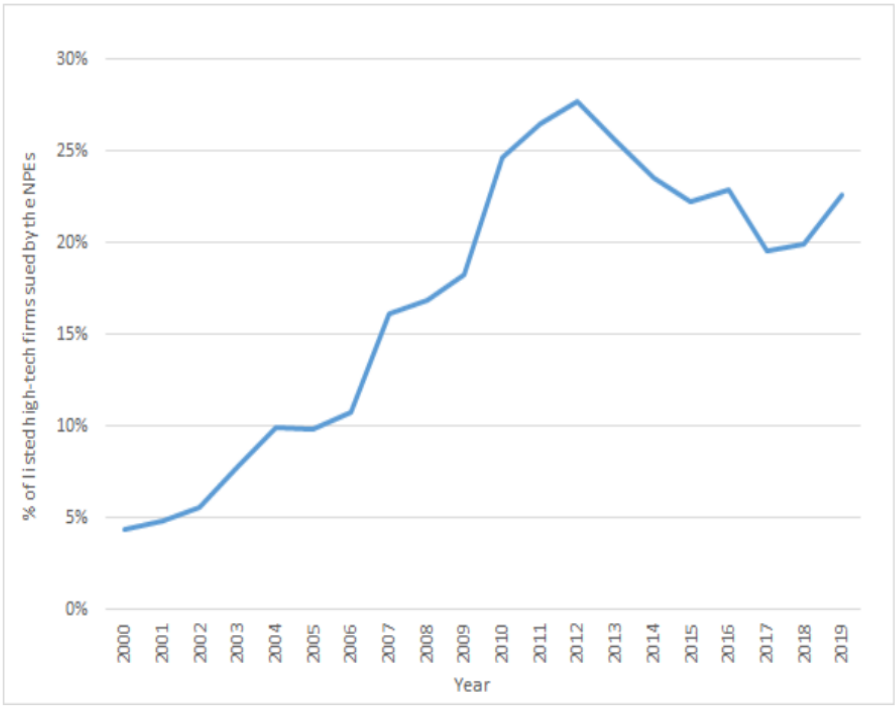


Figure 2: **Time series of the NPE lawsuit intensity to the U.S. high-tech firms:** This figure shows the number of times the U.S. high-tech firms were sued by NPEs over the year 2000-2019.



APPENDIX

Variable description

Variable	Definition	Data source
AIA	Dummy variable equals one if the firm-year is the year after the American Invents Act is enforced.	Compustat
Antitroll dummy	Dummy variable equals one if the firm belongs to a state in which the Anti-troll law has been adopted in the respective year, otherwise zero.	Appel et al. (2016)
Cashflow volatility	The standard deviation of operating income before depreciation divided by total asset over the previous five years.	Compustat-CRSP merged
Delist	A dummy variable equals one if the firm deregisters from the stock exchange in year t, otherwise zero.	CRSP
Entrenchment index	The index measure of the corporate governance structure of a firm through six corporate governance provisions—four constitutional provisions that prevent a majority of shareholders from having their way (staggered boards, limits to shareholder bylaw amendments, supermajority requirements for mergers, and supermajority requirements for charter amendments), and two takeover readiness provisions that boards put in place to be ready for a hostile takeover (poison pills and golden parachutes)—that are associated with economically significant reductions in firm valuation by Bebchuk et al. (2009).	Lucian Bebchuk's home page
Firm Size	Natural logarithm of total asset (adjusted to 2010 values) plus one.	Compustat-CRSP merged
Forced	A dummy variable equals one if the firm is forced to deregister from the stock exchange due to non-compliance with the regulations or financial criteria, otherwise zero.	CRSP
GDP growth	The growth rate of U.S. GDP adjusted to 2010.	BEA
Governance index	The index measure of the corporate governance structure of a firm through merger and acquisition criteria set up by Gompers et al. (2003).	Yale School of Management website
Institutional Ownership	The percentage of ownership of the firm held by other institutions.	WRDS
Industry sales growth	The growth rate of the industry sales.	Compustat-CRSP merged
Leverage	Total debt divided by total assets.	Compustat-CRSP merged
Market to book ratio	Market value of equity divided by book value of equity	Compustat-CRSP merged

Variable description-cont'd

Variable	Definition	Data source
Negative sentiment	The natural logarithm of the number of news about the firm which has negative composite sentiment score (CSS) on the RavenPack data. (nominal).	RavenPack data
Nominal value of Patents	Patent value in millions of dollars (nominal).	KPSS patent data
NPE	A dummy variable equals one if the firm is sued by a Non-practicing entity in the year t-1, otherwise zero.	Stanford NPE Litigation Database
NPE intensity	Natural logarithm of the number of times a firm is sued by an NPE plus one.	Stanford NPE Litigation Database
Patent citations	The number of times the patents of a firm is cited by another firms/individual inventors.	KPSS patent data
Private	A dummy variable equals one if the firm goes private from public	CRSP
Real value of Patents	Patent value in millions of dollars (nominal) converted to real using the CPIAUCNS series (annualized by taking monthly average.	KPSS patent data
R&D	The value of R&D divided by total assets.	Compustat-CRSP merged
ROA	Earnings before interest and taxes (EBIT) divided by total assets.	Compustat-CRSP merged
Small firm	Indicator variable equals to one if the firm size is less than 25 percentile of the firm size of the entire sample, otherwise zero	Compustat
Voluntary	A dummy variable equals one if the firm deregisters from the stock exchange voluntarily, otherwise zero.	CRSP
Young firm	Indicator variable equals one if the age of the firm is below 25th percentile of the age of all the sample firms.	CRSP

Anti-patent troll laws signing dates by states

STATE	DATE
AL	4/02/2014
AZ	3/24/2016
CO	6/05/2015
CT	5/08/2017
FL	6/02/2015
GA	4/15/2014
ID	3/26/2014
IL	8/26/2014
IN	5/05/2015
KS	5/20/2015
LA	5/28/2014
ME	4/14/2014
MD	5/05/2014
MI	1/06/2017
MN	4/29/2016
MS	3/28/2015
MO	7/08/2014
MT	4/02/2015
NH	7/11/2014
NC	8/06/2014
ND	3/26/2015
OK	5/16/2014
OR	3/03/2014
RI	6/04/2016
SC	6/09/2016
SD	3/26/2014
TN	5/01/2014
TX	6/17/2015
UT	4/01/2014
VT	5/22/2013
VA	5/23/2014
WA	4/25/2015
WI	4/24/2014
WY	3/11/2016

Table 1: **Distribution of NPE lawsuits and Delisting**

The table reports the distribution of the NPE lawsuits and the delisting of the public firms of the high tech industry. Panel A reports the yearly frequency of the NPE lawsuits and the delisting of the publicly listed firms for the period from 2000 to 2019. Panel B presents the distribution of the same across 4-digit SIC sectors. In Panel A, the NPE rate in column (3) is the number of NPE lawsuits in column (2) divided by the total number of firms in column (1). In column (5) of Panel A, the Delisting rate is the number of delisted firms in column (4) divided by the total number of firms in column (1). Panel B reports the similar NPE rate and the Delisting rate by industry.

Panel A: NPE lawsuits by year

	(1)	(2)	(3)	(4)	(5)
Year	# of firms	NPE		Delisting	
		#	%	#	%
2000	1839	80	4%	190	10%
2001	1693	82	5%	209	12%
2002	1517	84	6%	190	13%
2003	1363	106	8%	147	11%
2004	1287	128	10%	85	7%
2005	1270	125	10%	99	8%
2006	1235	133	11%	113	9%
2007	1215	196	16%	132	11%
2008	1104	186	17%	100	9%
2009	1024	187	18%	83	8%
2010	1005	248	25%	86	9%
2011	947	251	27%	67	7%
2012	923	256	28%	70	8%
2013	872	223	26%	57	7%
2014	846	199	24%	56	7%
2015	828	184	22%	60	7%
2016	794	182	23%	69	9%
2017	737	144	20%	57	8%
2018	702	140	20%	38	5%
2019	703	159	23%	47	7%
Total	**21904**	**3293**	**15%**	**1955**	**9%**

Panel B: NPE lawsuits by industry

	(1)	(2)	(3)	(4)	(5)
Sector	# of firms	NPE		Delisting	
		#	%	#	%
Communication equipment	2037	313	15%	191	9%
Communication services	1339	713	53%	77	6%
Computer hardware	1256	297	24%	117	9%
Electronics	3811	611	16%	238	6%
Measuring controlling devices	1761	179	10%	113	6%
Medical instruments	2547	278	11%	192	8%
Navigation equipment	370	34	9%	22	6%
Software	6771	649	10%	792	12%
Telephone equipment	2012	219	11%	213	11%
Total	**21904**	**3293**	**15%**	**1955**	**9%**

Table 2: **Distribution of types of delisting**

This table reports the types of delisting by years. Column (2) and (4) present the number of delisting that were voluntary and forced respectively. In column (3), the rate of voluntary delisting the number of voluntary delisting in column (2) divided by the total number of firms in column (1). The rate of forced delisting in column (5) is the number of forced delisting in column (4) divided by the total number of firms in column (1).

	(1)	(2)	(3)	(4)	(5)
Year	# of firms	Voluntary Delist		Forced Delist	
		#	%	#	%
2000	1839	143	8%	48	3%
2001	1693	107	6%	102	6%
2002	1517	75	5%	115	8%
2003	1363	77	6%	70	5%
2004	1287	55	4%	30	2%
2005	1270	62	5%	37	3%
2006	1235	84	7%	29	2%
2007	1215	95	8%	37	3%
2008	1104	71	6%	29	3%
2009	1024	49	5%	34	3%
2010	1005	71	7%	15	1%
2011	947	50	5%	17	2%
2012	923	51	6%	19	2%
2013	872	44	5%	13	1%
2014	846	47	6%	9	1%
2015	828	53	6%	7	1%
2016	794	55	7%	14	2%
2017	737	43	6%	14	2%
2018	702	30	4%	8	1%
2019	703	31	4%	15	2%
Total	**21904**	**1293**	**6%**	**662**	**3%**

Table 3: **Summary statistics**

The table reports the summary statistics of the main variables of this study. The sample period is from 2000 to 2019. It considers only the high tech industry defined by Loughran (2004). Variable definitions are provided in the Appendix. We use the NPE litigation data from the Stanford NPE Litigation Database and delisting data from the CRSP. Continuous varibles are winsorized at 1% on both the sides.

	(1) Mean	(2) S.D.	(3) 25th percentile	(4) 50th percentile	(5) 75th percentile	(6) Obs.
Delisting						
Delist	0.069	0.829	0	0	0	15026
Voluntary	0.031	0.552	0	0	0	15026
Forced	0.039	0.620	0	0	0	15026
Private	0.031	0.576	0	0	0	15026
NPE lawsuits						
NPE	0.135	0.342	0	0	0	15026
NPE intensity	1.704	12.694	0	0	0	15026
Antitroll dummy	0.054	0.225	0	0	0	15026
Firm characteristics						
Market to book ratio	2.230	2.614	1.184	1.672	2.545	15026
FirmSize	5.750	2.287	4.028	5.522	7.244	15026
Leverage	0.148	0.279	0	0.041	0.231	15026
ROA	0.061	0.440	0.037	0.074	0.095	15026
Cash Volatility	0.062	0.068	0.019	0.043	0.082	15026
R&D	0.125	0.161	0.042	0.088	0.154	12837
FirmAge	2.348	0.932	1.792	2.398	2.996	14957

Table 4: **The impact of NPE litigation on firm delisting**

This table presents the baseline model of the impact of the NPE litigation on firm delisting. It reports the fixed effect panel regression of the *NPE* on *Delist*. The dependent variable *Delist* is an indicator variable equals one if the firm deregisters from the stock market in a given year and zero otherwise. In Panel A, the independent variable is the *NPE*, which is an indicator variable equals one if the firm (defendant) is sued by a Non-practicing entity in the prior. In Panel B, the independent variable is the *NPE intensity*, which is the natural logarithm of the number of times a firm (defendant) is sued by an NPE in the prior year. The control variables are defined in the Appendix. Standard errors are clustered at the industry level and t-stats are repored in the parentheses. Statistical significance at the 1%, 5% and 10% are indicated by ***, ** and * respectively.

Panel A: NPE lawsuit indicator

	(1)	(2)	(3)
NPE	0.198**	0.171**	0.144*
	(2.76)	(2.35)	(1.99)
Market to book ratio	-0.049***	-0.058***	-0.056***
	(-5.12)	(-4.99)	(-4.69)
Firm Size	-0.043	-0.060*	-0.056
	(-1.20)	(-1.72)	(-1.61)
Leverage	-0.179	-0.201	-0.196
	(-0.39)	(-0.45)	(-0.43)
ROA	-0.966**	-0.991**	-0.994**
	(-2.58)	(-2.71)	(-2.69)
Cashflow volatility	0.123	0.134*	0.126*
	(1.67)	(1.86)	(1.87)
Year FE	No	Yes	No
Industry FE	Yes	Yes	No
Industry Year FE	No	No	Yes
Observations	15026	15026	15026
Adjusted R-squared	0.010	0.012	0.018

Panel B: NPE intensity

	(4)	(5)	(6)
NPE intensity	0.142***	0.135**	0.120**
	(2.88)	(2.66)	(2.52)
Market to book ratio	-0.049***	-0.058***	-0.057***
	(-5.20)	(-5.07)	(-4.75)
Firm Size	-0.050	-0.068**	-0.064*
	(-1.51)	(-2.06)	(-1.92)
Leverage	-0.175	-0.196	-0.192
	(-0.38)	(-0.44)	(-0.42)
ROA	-0.959**	-0.984**	-0.987**
	(-2.57)	(-2.70)	(-2.69)
Cashflow volatility	0.124	0.135*	0.127*
	(1.68)	(1.87)	(1.88)
Year FE	No	Yes	No
Industry FE	Yes	Yes	No
Industry Year FE	No	No	Yes
Observations	15026	15026	15026
Adjusted R-squared	0.011	0.013	0.018

Table 5: **Other robustness tests**

This table shows different estimated effects of the NPE lawsuits on a firm's propensity to delist. The dependent variable *Delist* is the indicator variable equals one if the firm deregisters from the stock market in a given year and zero otherwise. In Panel A, we examine the probit and Cox models. Panel B reports the regressions on various subsample periods. In column (1), we remove period 2007-2009 around financial crisis. In column (2) we remove the period around dot com bubble. Panel C investigates the interactions between the governance variables and NPE lawsuits on the firm delisting. The control variables are defined in the Appendix. Standard errors are clustered at the industry level and t-stats are reported in the parentheses. Statistical significance at the 1%, 5% and 10% are indicated by ***, ** and * respectively.

Panel A: Probability models

	Probit model				**Cox model**	
	(1)		(2)		(3)	(4)
	Coeffecient	Marginal	Coeffecient	Marginal		
NPE	0.212*	0.004	0.211*	0.004	0.601*	0.558*
	(1.73)		(1.71)		(1.94)	(1.77)
Market to book ratio	-0.113***	-0.002	-0.112***	-0.002	-0.243***	-0.250***
	(-3.68)		(-3.64)		(-4.05)	(-4.16)
Firm Size	-0.0949***	-0.002	-0.0958***	-0.002	-0.410***	-0.408***
	(-4.23)		(-4.26)		(-6.53)	(-6.51)
Leverage	-0.0785	-0.001	-0.0813	-0.001	0.0769	0.0758
	(-1.02)		(-1.05)		(0.65)	(0.64)
ROA	-0.372***	-0.007	-0.373***	-0.007	-0.235***	-0.258***
	(-5.65)		(-5.65)		(-2.79)	(-2.88)
Cashflow volatility	0.0756	0.001	0.0759	0.001	0.517	0.604
	(0.79)		(0.79)		(1.49)	(1.59)
Industry sales growth			0.0438**	0.001		0.0835***
			(2.09)			(3.02)
GDP growth			83.91***	1.512		28.49**
			(4.07)			(2.17)
Observations	14441		14441		14383	14383
Log pseudo likelihood	-547.069		-545.084		-843.676	-839.93

Table 5 cont'd

Panel B: Subsamples

	Excluding Financial Crisis (1)	**Excluding dot com** (2)
NPE	0.003*	0.308**
	(1.75)	(2.25)
Market to book ratio	-0.001***	-0.110***
	(-4.47)	(-3.08)
Firm Size	-0.001	-0.156**
	(-1.28)	(-2.77)
Leverage	-0.006	0.106
	(-0.55)	(0.15)
ROA	-0.023**	-1.746***
	(-2.71)	(-4.95)
Cashflow volatility	0.003*	0.223**
	(1.97)	(2.20)
Year FE	Yes	Yes
Industry FE	Yes	Yes
Observations	11882	13754
Adjusted R-squared	0.015	0.009

Panel C: Governance variable

	(1)	(2)	(3)
NPE	0.343**	0.344**	0.341**
	(2.36)	(2.35)	(2.33)
Institutional Ownership	-1.020**		
	(-2.25)		
Governance index		0.018	
		(0.93)	
Entrenchment index			-0.024
			(-0.40)
Market to book ratio	-0.115***	-0.115***	-0.115***
	(-4.98)	(-5.00)	(-4.98)
Firm Size	-0.120*	-0.124*	-0.119
	(-1.72)	(-1.75)	(-1.68)
Leverage	-0.401	-0.401	-0.401
	(-0.45)	(-0.45)	(-0.45)
ROA	-1.982**	-1.981**	-1.983**
	(-2.71)	(-2.71)	(-2.71)
Cashflow volatility	0.267*	0.268*	0.268*
	(1.86)	(1.86)	(1.86)
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	15026	15026	15026
Adjusted R-squared	0.012	0.012	0.012

Table 6: **Effect of American Invents Act**

This table reports the impact of the American Invents Act (AIA) on the firm's propensity to delist. The dependent variable *Delist* is the indicator variable equals one if the firm deregisters from the stock market in a given year and zero otherwise. The independent variable NPE is interacted by *Before AIA* and *After AIA*. *Before AIA* defines the time period before AIA was enacted and *After AIA* defines the time period after AIA was enacted. The control variables are defined in the Appendix. Standard errors are clustered at the industry level and t-stats are reported in the parentheses. Statistical significance at the 1%, 5% and 10% are indicated by ***, ** and * respectively.

	Without AIA effect	**With AIA effect**
	(1)	(2)
NPE	-0.0815	0.0459
	(-0.50)	(0.38)
NPE * Before AIA	0.763**	
	(2.04)	
NPE * After AIA		-0.102**
		(-2.26)
Market to book ratio	-0.115***	-0.114***
	(-5.00)	(-4.98)
Firm Size	-0.119*	-0.103
	(-1.72)	(-1.49)
Leverage	-0.398	-0.403
	(-0.44)	(-0.45)
ROA	-1.980***	-1.987***
	(-2.71)	(-2.72)
Cashflow volatility	0.271*	0.268*
	(1.88)	(1.85)
Industry year FE	Yes	Yes
Observations	15026	15026
Adjusted R-squared	0.012	0.012

Table 7: **The effect of Anti-troll law**

This table reports the impact of the Anti-troll law on the firm's propensity to delist. The dependent variable *Delist* is an indicator variable equals one if the firm deregisters from the stock market in a given year and zero otherwise. Panel A shows how the interaction between various measures of NPE lawsuits and the Antitroll dummy effects the firm's propensity to delist. *Antitroll dummy* is the indicator variable equals one if the firm belongs to a state-year which has adopted Anti-troll law. Panel B estimates *NPE* on the *Antitroll dummy* keeping the controls same as panel A. The control variables are defined in the Appendix. Standard errors are clustered at the industry level and t-stats are reported in the parentheses. Statistical significance at the 1%, 5% and 10% are indicated by ***, ** and * respectively.

Panel A: Impact of Anti-troll law

	(1)	(2)	(3)
NPE	0.416**	0.370*	0.410*
	(2.03)	(1.81)	(1.79)
NPE *Antitroll dummy	-0.941**	-0.803*	-0.891*
	(-2.02)	(-1.74)	(-1.99)
Antitroll dummy	0.375	-0.195	-0.168
	(1.04)	(-0.46)	(-0.38)
Market to book ratio	-0.080**	-0.099**	-0.099**
	(-2.11)	(-2.18)	(-2.22)
FirmSize	-0.143**	-0.159**	-0.182***
	(-2.18)	(-2.50)	(-3.58)
Leverage	-0.078	-0.094	-0.155
	(-0.10)	(-0.12)	(-0.19)
ROA	-1.583**	-1.637***	-1.650***
	(-2.66)	(-2.72)	(-2.75)
Cashflow volatility	-0.493	0.062	-0.070
	(-0.28)	(0.03)	(-0.04)
State FE	Yes	Yes	Yes
Year FE	No	Yes	Yes
Industry FE	No	No	Yes
Observations	12310	12310	12310
Adjusted R-squared	0.011	0.013	0.014

Panel B: Impact of Antitroll law on the exposure to NPE

	(1)	(2)	(3)	(4)
	NPE	NPE	NPE intensity	NPE intensity
Antitroll dummy	-0.782***	-0.016*	-1.755*	-0.025*
	(-25.50)	(-1.78)	(-1.73)	(-1.87)
Year FE	No	Yes	No	Yes
State FE	No	Yes	No	Yes
State year FE	Yes	No	Yes	No
Controls	Yes	Yes	Yes	Yes
Observations	12761	12917	12761	12917
Adjusted R-squared	0.173	0.174	0.193	0.200

Table 8: **Cumulative abnormal return following Anti-troll law**

This table represents the *CARs* for the delisting events with the data available. Panel A shows the *CARs* for the stocks before and after Anti-troll law adoption. Panel B reports the fixed effect panel regression on different *CAR* window. *Antitroll dummy* is an indicator variable equal to one if the state to which the firm belongs to has adopted the Anti-troll law. The control variables are defined in the Appendix. Standard errors are clustered at the industry level and t-stats are reported in the parentheses. Statistical significance at the 1%, 5% and 10% are indicated by ***, ** and * respectively.

Panel A: Pre and post Anti-troll law

Window	Pre Anti troll	Post Anti troll	Difference	t-stat
[-5,0]	-0.044	-0.083	-0.040*	1.69
[-9,0]	-0.063	-0.090	-0.027**	1.78
[-13,0]	-0.068	-0.089	-0.021**	1.82
[-17,0]	-0.071	-0.076	-0.005***	2.81
[-21,0]	-0.074	-0.086	-.012**	2.11

Panel B: Cross sectional regression

	CAR [-5,0]	CAR [-9,0]	CAR [-13,0]	CAR [-17,0]	CAR [-21,0]
Antitroll dummy	-0.051***	-0.072***	-0.162***	-0.174***	-0.165***
	(-6.75)	(-5.77)	(-8.08)	(-7.34)	(-7.01)
Market to book ratio	0.005	0.004	0.043	0.050	0.050
	(0.64)	(0.28)	(1.78)	(1.83)	(1.68)
FirmSize	-0.004	0.002	-0.003	-0.005	-0.004
	(-1.45)	(0.45)	(-0.26)	(-0.40)	(-0.32)
Leverage	0.020	0.084	0.201*	0.209*	0.202*
	(1.43)	(1.58)	(2.28)	(2.27)	(2.26)
ROA	0.021	0.013	-0.028	-0.033	-0.039
	(1.50)	(0.56)	(-0.39)	(-0.41)	(-0.47)
Cashflow volatility	-0.028	0.140	0.164	0.093	0.109
	(-0.61)	(1.39)	(0.92)	(0.41)	(0.51)
Year FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Observations	912	912	912	912	912
Adjusted R-squared	0.005	0.003	0.002	0.002	0.002

Table 9: **Firm vulnerability**

This table reports the interaction between *NPE* and some firm characteristics on the propensity to delist. The extent and the magnitude of the interaction terms define which firms are most vulnerable to delisting. The dependent variable *Delist* is an indicator variable equals one if the firm deregisters from the stock market in a given year and zero otherwise. The independent variables are different measurements of performance which are interacted by *NPE*. *NPE* is the indicator variable equals one if the firm (defendant) is sued by a Non-practicing entity in the prior year . All the variables are defined in the Appendix. Standard errors are clustered at the industry level and t-stats are reported in the parentheses. Statistical significance at the 1%, 5% and 10% are indicated by ***, ** and * respectively.

	(1)	(2)	(3)
Leverage	0.324		
	(0.44)		
Leverage * NPE	2.431**		
	(2.02)		
Small firm		0.223	
		(0.37)	
Small firm * NPE		0.338*	
		(1.72)	
Young firm			0.462***
			(2.99)
Young firm * NPE			0.862*
			(1.95)
NPE	-0.101	0.172	0.0310
	(-0.40)	(1.05)	(0.14)
Industry-year FE	Yes	Yes	Yes
Control	Yes	Yes	Yes
Observations	15157	15100	13556
Adjusted R-squared	0.018	0.011	0.011

Table 10: **Negative sentiment of the firm news**

This table reports the interaction between NPE and the negative sentiment from the news about the firm on the propensity to delist. The dependent variable *Delist* is an indicator variable equals one if the firm deregisters from the stock market in a given year and zero otherwise. The independent variable *NPE* is the indicator variable equals one if the firm (defendant) is sued by a Non-practicing entity in the prior year. The *Negative sentiment* is the natural logarithm of the number of news expressing negative sentiment. All the variables are defined in the Appendix. Standard errors are clustered at the industry level and t-stats are reported in the parentheses. Statistical significance at the 1%, 5% and 10% are indicated by ***, ** and * respectively.

	(1)	(2)
NPE	-0.0985	
	(-0.65)	
NPE * Negative sentiment	0.197**	
	(2.06)	
NPE intensity		-0.0209
		(-0.25)
NPE intensity * Negative sentiment		0.0901**
		(2.09)
Negative sentiment	-0.0461	-0.0807
	(-0.63)	(-1.20)
Market to book ratio	-0.051***	-0.052** *
	(-2.70)	(-2.66)
FirmSize	-0.133**	-0.141*
	(-1.96)	(-1.90)
Leverage	1.040	1.059
	(1.69)	(1.72)
ROA	-1.383***	-1.382***
	(-2.50)	(-2.50)
Cashflow volatility	-0.274	-0.339
	(-0.25)	(-0.30)
Year FE	Yes	Yes
Industry FE	Yes	Yes
Observations	10344	10344
Adjusted R-squared	0.011	0.012

Table 11: **Types of delisting**

This table reports the multinomial logit estimates of the effect of NPE lawsuits on the types of delisting whether voluntary or forced. In column (1) and (2) the dependent variable is Delisting types where *Voluntary delisting* is a dummy variable equals one if a firm's CRSP delist code is within the range of 200-299 or is 570 or 573, otherwise zero. The *Forced delisting* is a a dummy variable equals one if a firm's CRSP delist code is 300 or above and not 570 or 573. The independent variable *NPE* is an indicator variable equals one if the firm (defendant) is sued by a Non-practicing entity in the year t-1. The control variables are defined in the Appendix. Standard errors are clustered at the industry level and t-stats are reported in the parentheses. Statistical significance at the 1%, 5% and 10% are indicated by ***, ** and * respectively.

	(1) Coeff.	(2) Marginal	(3) Coeff.	(4) Marginal
Base model - Active firms				
Forced delists				
NPE	0.528***	0.002		
	(2.65)			
NPE intensity			0.024***	0.000
			(2.2)	
Market to book ratio	-0.673**	-0.002	-0.666*	0.000
	(-1.80)		(-1.79)	
FirmSize	-0.300***	-0.001	-0.261***	-0.001
	(-2.88)		(-2.72)	
Leverage	-0.002	0.000	-0.013	-0.001
	(-0.01)		(-0.09)	
ROA	-0.390***	-0.001	-0.404***	-0.001
	(-2.88)		(-3.01)	
Cashflow volatility	0.083	0.000	0.081	0.001
	(0.34)		(0.34)	
Voluntary delists				
NPE	0.308***	0.001		
	(1.94)			
NPE intensity			0.014***	0.000
			(3.61)	
Market to book ratio	0.005	0.000	0.005	0.000
	(0.52)		(0.56)	
FirmSize	0.006	0.000	0.053	0.002
	(0.06)		(0.59)	
Leverage	-1.636*	-0.005	-1.91*	-0.006
	(-1.69)		(-1.91)	
ROA	0.630	0.002	0.744	0.002
	(0.73)		(0.83)	
Cashflow volatility	1.714	0.005	1.61	0.005
	(0.94)		(0.9)	
Industry FE	No		No	
Year FE	Yes		Yes	
Observations	15026		15026	

Table 12: **NPE litigation of the Private firms**

This table examines whether firm's going private impacts it's exposure to NPE litigation. Panel A reports the comparison of the firm characteristics, litigation rate and delisiting rate for Public and Private firms before and after the propensity score matching. Panel B reports the cross sectional regression of firm's going private on exposure to NPE litigation. The independent variable *Private* is a dummy variable equals one if the firm went from public to private and zero otherwise. The dependent variable *NPE* is the indicator variable equal to one if the (defendant) firm is exposed to NPE litigation, otherwise zero. The control variables are defined in the Appendix. Standard errors are clustered at the industry level and t-stats are reported in the parentheses. Statistical significance at the 1%, 5% and 10% are indicated by ***, ** and * respectively.

Panel A: Comparison of the sample before and after propensity score matching

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Averages -		Entire	Sample			Matched	Sample	
Variable	**Pvt.**	**Pub.**	**Diff.**	**t**	**Pvt.**	**Pub.**	**Diff.**	**t**
Market to book ratio	1.144	1.127	0.017	0.048	1.067	1.076	-0.008	-0.16
FirmSize	6.304	5.687	0.618***	7.993	6.315	6.318	-0.003	-0.02
Leverage	0.129	0.148	-0.019***	-2.237	.157	.169	-0.011	-0.57
ROA	0.168	0.065	0.103***	6.702	-.134	-.165	0.032	0.75
CashflowVolatility	0.664	0.141	0.524***	16.262	.397	.285	0.112	1.32
NPE	0.063	0.130	-0.067***	-7.323	.044	.092	-0.048***	-2.65

Panel B: Cross-sectional analysis

	OLS	Probit
	(1)	(2)
	NPE	**NPE**
Private	-0.038*	-0.641**
	(-1.94)	(-2.43)
Market to book ratio	0.004*	0.021***
	(1.77)	(4.67)
FirmSize	0.055***	0.267***
	(6.85)	(32.51)
Leverage	-0.002	-0.004
	(-0.08)	(-0.05)
ROA	-0.022**	0.047
	(-2.18)	(0.70)
Cashflow volatility	0.001	0.026
	(0.31)	(0.60)
Year FE	No	Yes
Industry FE	No	Yes
Industry year FE	Yes	No
Observations	14993	14933
Adjusted R-squared	0.154	
Pseudo R-squared		0.193

Table 13: **The types of the NPEs**

This table reports the impact of different types of NPEs on the firm's propensity to delist. The dependent variable *Delist* is an indicator variable equals one if the firm deregisters from the stock market in a given year and zero otherwise. The independent variables from column (1) to (3) are different types of NPEs where *NPE* is an indicator variable equals one if the firm (defendant) is sued by a Non-practicing entity in the prior year. The control variables are defined in the Appendix. Standard errors are clustered at the industry level and t-stats are reported in the parentheses. Statistical significance at the 1%, 5% and 10% are indicated by ***, ** and * respectively.

	(1)	(2)	(3)
Acquired patents	0.248*		
	(1.99)		
Corporate heritage		0.430	
		(0.42)	
Individual-inventor-started company			0.115
			(0.42)
Market to book ratio	-0.722	-0.707	0.267
	(-1.04)	(-0.78)	(0.23)
Firm Size	-0.0293	0.0134	0.0113
	(-0.42)	(0.15)	(0.18)
Leverage	0.894	0.821	-1.277*
	(1.37)	(0.84)	(-1.87)
ROA	-3.338	-3.375**	-1.355
	(-1.69)	(-2.36)	(-1.49)
Cashflow volatility	-2.515	-2.403	-0.504
	(-1.39)	(-1.58)	(-1.45)
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Observations	2183	2183	2382
Adjusted R-squared	0.002	0.001	0.006