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Who's Afraid of the Patent Trolls? Assessing the Market Impact of Landmark Patent Troll Litigation Outcomes

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CLAREMONT McKENNA COLLEGE

**WHO'S AFRAID OF THE PATENT TROLLS? ASSESSING THE MARKET
IMPACT OF LANDMARK PATENT TROLL LITIGATION OUTCOMES**

SUBMITTED TO

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FOR

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Abstract

Patent trolls have changed the innovation and patent policy landscape. This thesis is an empirical event study that focuses on two landmark cases of patent troll litigation, *RIM v. NTP* and *eBay v. Mercexchange*, to determine whether pro-troll litigation outcomes significantly impact the market values of the firms in the high-tech industries they target. I find that the Supreme Court ruling in *eBay v. Mercexchange* did seem to significantly impact a proportion of firms in the market. The decisive factors in distinguishing affected vs. unaffected firms include a firm's R&D to Sales ratio, market value, and NAICS code specification.

Introduction

Since their appearance in the 1990s, patent trolls have created a new dimension in the patent litigation landscape. Patent trolls are a subset of firms called non-practicing entities (NPEs), or firms that innovate and patent but that do not engage in the manufacturing process, such as research universities (Abril and Plant 2007). Patent troll firms in particular are NPEs that amass patent portfolios for the sole purpose of patent infringement litigation to extract costly licensing fees or large monetary damages from firms that may be infringing on a troll-owned patent (Abril and Plant 2007). Patent trolls have restricted their historical operations to firms in the technology and telecommunications industries (Allison, Lemley, and Walker 2011). Their antics have caused a significant degree of media controversy.

Critics of patent trolls have argued that they slow innovation by tying up company resources that could otherwise be used to research new products with costly lawsuits. (Abril and Plant 2007; Shrestha 2010; Federal Trade Commission 2003). Critics also argue that they exacerbate hold-up problems from delaying the production of a good whose patent is in dispute. This causes harm to the consumer in several ways. Delaying the production of a good via litigation (or the threat of litigation) may result in higher royalties paid by the defendant firm, or even royalties paid on improperly granted patents, resulting in higher prices to consumers and deadweight loss (FTC 2003). Companies may also choose to limit their product offering to avoid litigation and hold-up problems (FTC 2003). In response, patent troll defenders argue that the patent troll firms constitute the

next level of patent market evolution, acting as market-makers who also provide capital and bargaining power to independent investors and small businesses (McDonough 2006).

In either case, the emergence of patent trolls has significant implications for the demand for patent system reform in the U.S., as new legislation will now have to account for these new players in the marketplace. Furthermore, the impact of patent trolls on innovation and competition, especially in the hi-tech industry where they mostly operate, is an area of interest for future research.

The success of patent troll litigation has increased significantly in the 21st century, and in recent years there has been an upsurge in empirical research conducted on patent troll behavior, their impact on the industries they prey upon, their impact on innovation and the patent landscape, and their impact on specific companies within relevant industries. However, thus far I have found no publications on the subject of patent trolls in economics journals, only in law reviews. This may be in part due to the lack of data on patent troll firms, which are predominantly private firms, the lack of data on the firms' patent portfolios, the contents of which are kept highly secret by their owners, and the difficulty of accessing patent litigation data over time and across industries. In order to bypass these problems, my thesis focuses on stock prices of litigant firms. My thesis seeks to examine the effect of patent trolls on firms in the technology and telecommunications industry by analyzing whether the success of patent troll litigation in landmark cases impacts the market value of firms in the same industry as their litigants. The two cases I examine are the *RIM v. NTP* case and the *eBay v. Mercexchange* case.

The relevant litigation outcome dates I examine in this thesis are August 5, 2003, and May 15, 2006, respectively.

In Part I, I present background research on patent trolls in the existing literature, which thus far has been more theoretical in focus. In Part II, I describe my methodology. I conduct event studies on key dates of the announcement of successful patent troll litigation outcomes and analyze changes in stock price in a range of 3-5 days surrounding the time of the announcement to see if company stock price changes significantly in response to patent troll success or failure. I describe my data in Part III. This consists of daily stock price data, as well as data on annual research and development (R&D) expenses, net sales/turnover, and market value, for a portfolio of firms created using existing U.S. exchange-listed technology stock indices, as well as databases of firms with similar NAICS codes to patent troll litigants in the cases I examine. In Part IV, I discuss my results. I find that there are no statistically significant results for the *RIM v. NTP* outcome that support my hypothesis. This may be explained by the usage of the wrong date, the lack of information regarding patent trolls in the market, or the lack of significance of the outcome event to investors in the market. The *eBay v. Mercexchange* does seem to have had a statistically significant result on 64% of firms in my sample portfolio. Further analyses of individual firm abnormal returns showed that R&D to Sales ratios, market values, and NAICS code specifications are significant factors in distinguishing firms who are and are not affected by patent troll litigation success in landmark cases.

I. Literature Review

The existing literature on patent trolls stems largely from law reviews and law journals. They can be divided into four major topic areas: patent law and court rulings regarding patent troll activity (Magliocca 2007; Shrestha 2010; Diessel 2007), the actual and potential industries patent trolls target and why that is the case (FTC 2003; Allison et al. 2011; Allison, Lemley, and Walker 2009; Shrestha 2010), the effects (whether beneficial or detrimental) of patent trolls (or NPEs) (FTC 2003; Shrestha 2010; McDonough 2006; Reitzig, Henkel and Heath 2007; Magliocca 2007), and empirical studies of whether patent trolling is effective and/or valuable (Allison et al. 2011; Allison et al. 2009). Thus far, I have found no studies conducted on the effect of patent trolls from the market's perspective.

The legal studies on patent trolls concentrate on two landmark cases in the early 21st century. The first case effectively put the phenomenon of patent trolls on the map in 2001, when NTP Inc., a small patent troll firm in Virginia, sued Research in Motion (RIM), the maker of the Blackberry device, for infringement on several patents (Magliocca 2007). NTP won the case at the district level on August 5, 2003, when the court ordered RIM to pay \$53.7 mil in damages and granted NTP a permanent injunction in the infringed-upon patents on email technology (Magliocca 2007). RIM appealed but was ultimately unsuccessful in lifting the injunction, which led it to settle with NTP with an agreement to pay NTP \$612.5 mil in exchange for licensing fees in 2006 (Magliocca 2007). The NTP v. RIM case set a significant legal precedent for the success of patent trolls in utilizing injunctions to sue for exorbitantly large licensing fees (given that case law at this time allowed for plaintiffs to set their own unlimited "reasonable royalty rate"); academics argue that this case is a classic example of how patent trolls stifle

innovation and have a parasitic influence on the patent economy (Magliocca 2007, Shrestha 2010). The second landmark case in the history of patent trolls is the 2006 eBay v. Mercexchange case, where patent troll Mercexchange sued eBay for the infringement of patents in its online auction patent portfolio. Mercexchange won its case on the district level but was unable to secure an injunction, leading it to appeal—ultimately the case reached the Supreme Court, which gave a four factor test in determining whether an injunction was to be issued (Diessel 2007). The Court overturned the Federal Circuit’s ruling that injunctions should always be issued for patent infringement, but failed to support the district court’s ruling that injunctions should not be granted to firms that do not put the litigated patent into practice (Diessel 2007, Magliocca 2007). The Supreme Court ruled in favor of the patent trolls on May 15, 2006 by failing to set a legal precedent in favor of granting injunctions based upon a “market competition requirement”, or the requirement that a firm manufacture a product for competition in the market based upon the litigated patent (Diessel 2007; Magliocca 2007). Diessel notes however that despite this, courts at the district level have adopted the market competition requirement for granting injunctions in the post-eBay environment (2007).

Based upon surveys of patent infringement cases, studies confirm that previous patent troll activity has been restricted to the telecommunications, software, and other such high-tech industries (Allison et al. 2009, Shrestha 2010, Allison et al. 2011; FTC 2003). According to a 2003 FTC report, the drivers of innovation in high-tech industries are competition, patenting, and trade secrecy. Industry specialists agree that the main reasons to patent are to prevent free riding, to negotiate cross-licenses (to enable follow-on innovation), to ensure smooth operations, and to generate revenue via licensing fees

(FTC 2003). Others note that patents, especially on software and business methods, may actually hinder innovation and competition by increasing barriers to entry and introduce the threat of inadvertent patent infringement (FTC 2003).

The main arguments against the practice of patent trolls are that they decrease innovation by wasting resources with frivolous litigation, that they increase the cost of products by charging manufacturers licensing fees, and that they worsen the patent thicket problem (Shrestha 2010; FTC 2003). The patent thickets problem describes the extremely complex and overlapping web of intellectual property rights and claims that makes up the current US patent system (FTC 2003). One of the main criticisms of patent trolls is that they tie up company resources with “bad faith” litigation based upon relatively valueless patents in an attempt to extract licensing fees (Shrestha 2010; FTC 2003; Magliocca 2007). Shrestha argues that this is questionable given the extremely high sunk costs to mounting a litigation suit (plaintiffs require approximately \$2 mil in upfront costs), and that furthermore NPEs tend to own extremely valuable foundational patents that underlie the production of goods across industries and product lines, thus justifying the charge of licensing fees (2010). Critics of patent trolls also claim that they cause hold-up problems by delaying production of a disputed patented good via legal injunctions. This may increase the cost of products or result in a more limited product offering for consumers (FTC 2003). For firms, this may result in inefficiency in that defendant firms are pressured to pay off potentially higher royalty fees to continue production, or to pay licensing fees on potentially irrelevant patents in order to avoid litigation costs (FTC 2003). Critics of patent trolls argue that they unnecessarily complicate the patent thicket problem by further fragmenting the distribution of patent

rights, thus leading to higher prices, lower demand, and a net reduction of overall welfare (FTC 2003). This however, is not a patent-troll specific problem; instead it is a problem that arises out of the current US patent structure (Shrestha 2010).

While most see patent trolls as parasites that play off of the problems of the US patent system, some have argued that they serve an important purpose in the patent economy. McDonough argues that patent trolls “act as a market intermediary in the patent market...provide liquidity, market clearing, and increased efficiency to the patent markets” (McDonough 2006, p. 190; Shrestha 2010). According to McDonough, patent trolls provide an important role in the secondary market for patents by buying patents from inventors, thus providing valuation services for patent-holders who would otherwise have no conception of the worth of their patents (2006; Shrestha 2010). However, there is no incentive for patent trolls to provide the correct valuation information to independent inventors and small business patent-owners if they can quote a lower price to purchase the patents at a discount. McDonough also argues that patent trolls can help mediate patent purchasing between the independent investors and small businesses that create patents, and the large businesses that benefit from patent technology (2006). Patent troll firms help smaller firms who do not have the resources to protect against patent infringement to pursue litigation and secure licensing fees in court (McDonough 2006). However, for every valid patent infringement suit brought against a target firm, there are potentially an equal or greater number of baseless suits filed against firms who would rather pay a royalty fee than deal with costly litigation. Finally, McDonough argues that patent troll firms can act as “patent dealers” who turn the patent market into a “centralized ‘dealer’ market” akin to the NASDAQ, where dealers “hold a patent

inventory and attempt to license to companies seeking a specific technology”, leading to the increased liquidity of patents as commodities (2006, p. 214). However, McDonough overlooks the fact that patent trolls are not incentivized to seek out companies who want their patents and offer them licensing options (because then the potential infringer could switch to an alternative non-patented technology) (FTC 2003). Instead, patent troll firms are incentivized to spring surprise litigation suits (or at least the threat of one) to obtain higher licensing fees (FTC 2003). In fact, Reitzig creates a game theoretic model of patent troll behavior and finds that under the current patent law, the dominant strategy for trolling firms is “being infringed” (2007, p. 150).

There have been several empirical studies on the success and effectiveness of patent trolls that seek to confirm or deny criticisms of the effect of patent trolls on innovation. Among these have been studies on the most litigated (and most valuable) patents and the characteristics of their litigation and settlement processes, as well as the characteristics of their holders. There is some disagreement in regards to whether patent trolls are effective litigants or not. Allison et al found in 2009 that the majority of the most-litigated and most valuable patents are held by NPEs, discrediting the claim that patent trolls waste resources by frivolously pressing lawsuits with weak patents. In 2011, however, the same group of researchers found that repeat patent plaintiffs (mainly patent trolls) are more likely to settle, but that when they do go to trial, they overwhelmingly lose. This stands in contrast to the findings of Shrestha in 2010, which claimed that many NPEs hold high value patents and do not engage in frivolous litigation, and also suggested that NPEs can serve a “valuable role in enhancing innovation by identifying

and acquiring high value patents and thereby funding and encouraging some of the most successful inventors” (p. 128).

II. Theory

To approach the problem of how patent trolls affect the market value of firms in the industries they target, I conduct a series of event studies. The legal literature provides two major events, or two major litigation outcomes, in the history of patent troll litigation, that seem to be turning points in the relative success of patent troll litigation. These are the NTP v. RIM and eBay v. Mercexchange cases. Because these cases have had multiple appeals and court rulings, there are several options in terms of dates to test for statistical significance. These include August 5, 2003, which is the first unexpected pro-troll outcome of the NTP v. RIM case, and May 15, 2006, which is the pro-troll Supreme Court ruling in the eBay v. Mercexchange case. In general, I expect that rulings in favor of patent trolls for injunctions and/or large royalty fees should have a negative impact on the market value (measured by stock price) of the defendant technology firm, as well as other firms in a similar industry. In order to test this hypothesis, I will conduct event studies on the abovementioned case dates to determine whether litigation outcomes significantly impact market value of potential targets for future troll litigation. The methodology for my event studies is derived from Filson and Oweis (2010), which is based on the original event study methodology work by MacKinlay (1997).

First, I construct a portfolio of firms in the industries that patent trolls target. This general portfolio is broken down by NAICS code in the industries of telecommunications, software, and electronics manufacturing, among others. The NAICS

code specifications are based upon the primary NAICS codes of eBay and RIM—I expect that the more closely the portfolio firms approximate the business of the defendant firm in patent troll litigation firms, the more that litigation outcomes will impact their market values. Next, I collect data on the daily returns of the stock prices of the member firms, and calculate the average daily return of the firms for each portfolio (this assumes that the returns of all member firms are weighted equally) (Filson and Oweis 2010). I then estimate a factor model using 250 trading days that end 10 days prior to the event to prevent information leakage contamination (Filson and Oweis 2010). The factor model I use is:

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + \varepsilon_{it}$$

Eqn. 1

where R_{it} is the daily return of portfolio i on day t , R_{ft} is the daily risk-free rate of return (as approximated by 1-month Treasury Bills), α_i is a parameter, R_{mt} is the daily return on the value-weighted market index calculated by the Center for Research on Securities Prices (CRSP), and ε_{it} is the residual, or the “abnormal return” of interest in this case (Filson and Oweis 2010). All data is found from Wharton Research Data Services (WRDS).

Filson and Oweis 2010 note that factor models can include additional factors that assess whether the event effects observed by the market model might be explained by “sources of risk left uncaptured by the market model” (p. 581). These additional factors

are the Fama-French factors and momentum. I have included these in creating a second factor model:

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + \gamma_{i1}SMB_t + \gamma_{i2}HML_t + \gamma_{i3}UMD_t + \varepsilon_{it}$$

Eqn. 2

The additional variables are: γ_1 , γ_2 , and γ_3 as parameters, SMB_t and HML_t as the Fama-French factors (Fama and French, 1993, 1996), and UMD_t as the momentum factor (Carhart, 1997). Data for these variables were also found on WRDS.

Using the coefficients of the estimated factor model and the data surrounding event date (with a range of up to 3 days prior and after the event date), I compute the OLS residuals to estimate the abnormal returns for the days surrounding each litigation outcome (Filson and Oweis 2010; MacKinlay 1997). The “cumulative abnormal returns” (CARs) are found by taking the sum of the OLS residuals across the days surrounding the event in question. A positive CAR indicates that the event resulted in a daily return above what is normally expected, and vice versa for a negative return. I expect pro-plaintiff litigation outcomes to have negative CARs and pro-defendant litigation outcomes to have positive CARs.

Since there are timing issues with event dates and the flow of information to the market, I test a range of windows around the event date in question. I look for CARs specifically on the event date itself, with a range of 1 day after the event date, with a range of 1 day before and after the event date, and with a range of 3 days before and after the event date (Filson and Oweis 2010; MacKinlay 1997). There may be other

confounding variables that cause the CARs I observe in my study, such as other important company or industry events happening at or around my event dates of interest. After conducting a preliminary search using the term “technology” through the Business Wire press releases from *Lexis-Nexis* newswires on my litigation outcome dates, I find no major confounding events. However, as Filson and Oweis note, the overall impact of these events is impossible to assess (2010).

In order to examine the specific characteristics of firms impacted by litigation outcome events, I also examine of annual company R&D expense, net sales/turnover, and market value. I use the first two variables to calculate R&D to Sales ratios for each firm in my portfolio. This is utilized to more accurately portray the amount of R&D expenditure of the firm while accounting for variations in firm size. The R&D to Sales ratio is used as a proxy for the value of a firm’s patent portfolio (private information), and can be used to determine whether firms that rely more on R&D to remain competitive are more susceptible to patent infringement litigation outcomes. This assumes that firms who engage more in R&D spending will tend to have more valuable patent portfolios (which would not be the case if the firm decided to keep their findings as trade secrets). Market value is included as an independent variable to test whether firm size is relevant to whether a firm is adversely affected by pro-troll case outcomes. I hypothesize that smaller firms will be more easily affected by the events in this case, because they have less resources to devote to costly legal battles and are more likely to pay royalty fees to trolls if litigated against in the future. I also hypothesize that firms with higher R&D to Sales ratios will be more adversely affected by the pro-troll litigation outcomes, because firms who engage more in R&D and who presumably rely more on

their patents are more likely to be targeted by patent trolls and experience hold-up problems and other associated problems discussed above (see Part II).

III. Data Description

My initial portfolio consists of U.S.-based technology firms that operate in the same industries as target firms for patent trolls during two test periods around the litigation outcome dates of the *eBay v. Mercexchange* and *RIM v. NTP* cases. This covers the years 2002-2003 and 2005-2006. This aggregate list consists of companies with similar Primary NAICS codes as RIM and eBay, 334220 (Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing) and 454111 (Electronic Shopping) respectively. This portfolio also includes companies whose Primary NAICS codes match the Secondary NAICS codes for RIM and eBay. eBay has no Secondary NAICS code, but RIM has the following relevant codes: 423690 (Other Electronic Parts and Equipment Merchant Wholesalers), 511210 (Software Publishers), and 541511 (Custom Computer Programming Services). The portfolio also includes firms in the Mergent Online IT and Telecommunications Sector specification, as well as firms in the following technology stock indexes: the Nasdaq Computer Stock Index (IXCO), the Nasdaq Telecommunications Stock Index (IXTC), the Nasdaq 100 Technology Stock Index (NDXT), and the S&P 500 Technology Sector Index (IXS). After filtering these firms through the CRSP database to retain only the firms with available data during the event study dates, I am left with 412 firms to test for the *RIM v. NTP* case, and 443 firms to test for the *eBay v. Mercexchange* case. See Tables 1 and 2 for summary statistics of portfolios and litigated firms.

In order to examine the characteristics of firms impacted by litigation outcome events, I also collect data from the Compustat database in regards to each company's annual R&D expense, net sales/turnover, and market value for the most recent fiscal year before the litigation outcome takes place. I use the first two variables to calculate R&D to Sales ratios for each firm in my portfolio. See Tables 3 and 4 for summary statistics of portfolios and litigated firms.

IV. Results

After creating the appropriate factor models and finding CARs over a 7 day range for the relevant litigation dates of *RIM v. NTP* and *eBay v. Mercexchange*, I find that none of the CARs for the litigated companies are statistically significant to the 5% (or even 10%) level, meaning that I cannot reject the null hypothesis that the events have no impact (see Tables 5 and 6). Similar results hold after finding factor models and CARs for the general portfolios. Columns 1 and 2 correspond to the equations cited above from MacKinlay and Filson and Oweis (1997; 2010). According to results on the litigated firm level, the impact of patent troll litigation outcomes appear to be economically significant, but these impacts may be due to factors not captured by the traditional model used. However, as predicted, for both cases where the patent troll was victorious, the CARs of the litigated companies were negative on the day of the litigation outcome announcement, and in the 1-2 day range after the announcement. Furthermore, in the case of the *RIM v. NTP* outcome, the litigated firm's [0,0] CAR dropped 56% to -.017 after expanding the date range to [0,1], indicating that information about litigation outcome may have taken time to reach investors such that the impact of the case is seen more on the trading day

after the court's verdict. In general, [0,1] CARs are lower than [0,0] CARs, supporting the hypothesis that the full effects of the event are not experienced until the trading day after its initial announcement, in order to account for the time taken for information to disseminate to investors. As MacKinlay notes, this is to be expected (1997; Filson and Oweis 2010). In any case, it is unclear whether these statistically insignificant results are due to successful patent troll litigation activity, to some other confounding event in the industry, or due to noise in the stock price data.

To assess the significance of individual CARs, I follow the approach given by MacKinlay and Filson and Oweis (1997; 2010). I first find the variance of the OLS residuals during the estimation window, in order to find the variance of daily abnormal returns during the 7 day event window under the null (MacKinlay 1997; Filson and Oweis 2010). The variance of the CARs is computed by "multiplying the estimated variance of daily abnormal returns by the number of days included in the CAR" window (Filson and Oweis 2010, p. 581). Examining residual plots does not reveal significant evidence of heteroskedasticity. The residuals of the factor models show little evidence of autocorrelation. Pair-wise correlation matrices in Excel do not indicate correlation between independent variables of over $\pm.70$ (in fact most are under $\pm.50$).

Next, I perform sign tests to see if successful patent troll litigation outcomes have a significant overall negative impact on the stock prices of the firms they target by assessing the impacts of the events on each individual firm in the portfolio. This is done by calculating the CARs for all firms in a given portfolio and examining them to see if a significant percentage of the CARs are negative, as theory predicts. To perform sign-

testing, I use the simplified factor model (Eqn. 1) for the portfolio of 412 firms for the *RIM v. NTP* case, and 443 firms for the *eBay v. Mercexchange* case. For the *RIM v. NTP* litigation outcome, I find that 198 of 439 firms (the portfolio was again filtered pending available Compustat data for firms for later testing), or 48% of firms, had negative CAR[0,1] effects. For the *eBay v. Mercexchange* Supreme Court decision, 279 out of 439 firms, or 64% of firms, had negative CAR[0,1] effects.

The null hypothesis is one of no event impact, meaning that only 50% of the effects should be negative. MacKinlay and Filson and Oweis provide a test statistic to assess significance, assuming that CARs are taken as independent random draws under the null hypothesis (1997; 2010). This test statistic has a standard normal distribution (Filson and Oweis 2010). This statistic takes the form:

$$\theta = \left[\frac{N^-}{N} - .5 \right] \frac{\sqrt{N}}{.5}$$

Eqn. 3

where N^- is the number of negative abnormal returns and N is the total number of abnormal returns (MacKinlay 1997; Filson and Oweis 2010). The two statistics I calculate are -0.64 (insignificant) and 5.68 (significant at 1%) respectively. Thus we can reject the null for the *eBay v. Mercexchange* outcome but not for the *RIM v. NTP* one. This, taken in combination with the insignificant CARs and positive [0,0] CAR for the portfolio for the *RIM v. NTP* outcome, indicates several possibilities. Firstly, the media and law review researchers could have over-inflated the importance of the *RIM v. NTP* initial outcome as a landmark case for patent trolls. However, this seems rather unlikely

given the legal evidence and post-RIM patent troll litigation trends. Next, it is possible that market participants in 2003 did not understand the full implications of the *RIM v. NTP* ruling—the media had yet to warm up to the sensationalism of patent trolls, so perhaps information about the detriments of future patent troll attacks had not permeated the market. In comparison, this situation had significantly changed by 2006. In fact, most legal researchers began publishing on the subject of patent trolls in 2006 and 2007. Even the 2003 FTC report on patent policy and innovation was published two months after the *RIM v. NTP* August ruling. Finally, if this is not the case, then it is possible that the date tested, August 5, 2003, represented a relatively insignificant step in the legal battle between RIM and NTP. Perhaps the market attributes significance to other portions of the legal back-and-forth (although preliminary testing for the 2006 settlement date as this alternative suggests otherwise).

In any case, the *eBay v. Mercexchange* outcome revealed a statistically significant sign test result over 50%, which coheres with my hypothesis. Perhaps further refinement of the firm portfolio may yield higher sign testing results. Since firms were chosen on the basis of NAICS code similarity with the litigated firms, there is a possibility that unrelated firms that do not patent or that are not affected by patent troll behavior have been included within the portfolio. Furthermore, it is possible that publicly-traded patent troll firms themselves have been included in the portfolio. This is less likely, given that the majority of patent trolls operate on a private basis (Abril and Plant 2007).

Since the *eBay v. Mercexchange* outcome yielded statistically significant results, I further analyze the portfolio for the specific characteristics of firms impacted by litigation

outcome events within the context of annual company R&D expense, net sales/turnover, and market value. I do this by creating a dummy variable for the abnormal returns (1 if negative, 0 if positive) of each firm in the sign test results. Next, I perform the variations of the following OLS regression (linear probability model):

$$D_i = \alpha_i + \beta_i RD_i + \gamma_i MV_i + \delta_i ND_i + \varepsilon_i$$

Eqn. 4

where D_i is the dummy variable for abnormal returns from the sign testing results, α_i , β_i , γ_i , and δ_i are parameters, RD_i is R&D to Sales Ratio for the most recent annual data available prior to May 2006, MV_i is the market value in millions for the same time period, and ND_i is a categorical variable for NAICS codes (I regress at the two digit level of specification in NAICS codes), and ε_i is the residual. My findings are summarized in Table 7. The results indicate that market value is usually significant for negative abnormal returns due to the litigation outcome, while R&D to Sales ratio is sometimes significant. However, this model has significant shortcomings. The residuals from the linear probability model are heteroskedastic, non-linear, and violate the normality of errors assumption of the OLS regression, because the dependent variable is non-continuous and can only take two values. In order to correct for this, I use a probit model to calculate the significance of the independent variables mentioned above (see Eqn. 4). The probit model does not make the OLS regression assumptions about the normality, linearity, and homogeneity of variance of independent variables. Table 8 shows the probit model results.

The probit model likelihood ratio is statistically significant, meaning that the model as a whole is also statistically significant against the null. The probit regression coefficients give the change in the z-score or probit index for a one unit change in the predictor, interpretation of the results is limited without further analysis. The probit model indicates that R&D to Sales Ratios, Market Values, and NAICS codes at the 2nd digit level of specification are significant. Perhaps this, taken in combination with the OLS model results, may support my hypotheses that firms with higher R&D to Sales ratios and smaller firms will be more adversely affected by the pro-troll litigation outcomes. These hypotheses do not result in statistically significant results when tested in sub-portfolios using the MacKinley factor model method mentioned above.

Conclusion

In conclusion, while the August 2003 event in the *RIM v. NTP* case did not seem to significantly impact the market, the pro-troll Supreme Court ruling in *eBay v. Mercexchange* did seem to significantly impact a proportion of firms in the market. After conducting factor models tests and CARs analysis, as well as sign testing, OLS regressions with binary dependent variables and probit model analysis, I find that for firms that were affected by the 2006 *eBay v. Mercexchange* ruling, the decisive factors in distinguishing affected vs. unaffected firms include the firm's R&D to Sales ratio, market value, and NAICS code specification. The lack of statistically significant results for the *RIM v. NTP* outcome that support my hypothesis may be due to the usage of the wrong date, the lack of information regarding patent trolls in the market, or the lack of significance of the outcome event to investors in the market.

Further research is needed in grounding the theoretical work conducted thus far in empirical research. Given the general lack of accessibility of patent data and litigation data, researchers should seek to rely more on market statistics for publicly-traded firms. Granted, this imposes a limitation on what can be studied—the behaviors of private patent troll firms, as well as the smaller private firms that they prey upon, will not be included in the data. However, given the general lack of research in this area of law and economics, further event studies should yield interesting results to future researchers. These studies could focus on distinguishing landmark litigation cases brought by patent trolls vs. different types of NPEs, on quantifying the amount of welfare or private costs lost by firms and consumers due to patent litigation, and on telling a historical story of market impacts of patent troll litigation from its inception in the 1990s to the present.

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Table 1: Summary Statistics for Factor Models and CARs Testing for RIM v. NTP

	# Observations per						
	# Firms	Firm	Mean	Min	Max	Std Dev	
Portfolio	455		264	0.00	7.34	-0.85	0.06
Litigated							
Firm	1		264	0.00	0.27	-0.11	0.04

Table 2: Summary Statistics for Factor Models and CARs Testing for eBay v.**Mercexchange**

	# Observations		Mean	Min	Max	Std Dev
	# Firms	per Firm				
Portfolio	444	264	0.00	3.12	-0.64	0.03
Litigated						
Firm	1	264	0.00	0.21	-0.09	0.02

Table 3: Summary Statistics for R&D to Sales Ratio and Market Value for RIM v.**NTP**

	#	Mean	Max	Min	Std Dev
Portfolio - R&D to Sales Ratio	401	0.24	3.41	0.00	0.34
Litigated firm - R&D to Sales Ratio	1	0.13	0.13	0.13	-
Portfolio - Market Value (mil \$)	401	5167.12	293137.3	2.54	24592.8
Litigated firm - Market Value (mil \$)	1	1803.53	1803.53	1803.53	-

Table 4: Summary Statistics for R&D to Sales Ratio and Market Value for eBay v.**Mercexchange**

	#				
	Observations	Mean	Max	Min	Std Dev
Portfolio - R&D to Sales Ratio	401	0.18	9.26	0.00	0.62
Litigated firm - R&D to Sales Ratio	1	0.07	0.07	0.07	-
Portfolio - Market Value (mil \$)	401	5029.49	147738.24	4.78	17938.43
Litigated firm - Market Value (mil \$)	1	60688.79	60688.79	60688.79	-

Table 5: Factor Models and CARs Testing for RIM v. NTP

Variable	Portfolio		Litigated Firm	
	Eqn (1)	Eqn (2)	Eqn (1)	Eqn (2)
Factor Model				
Coefficients:				
	0.0017**	0.0013**	0.0013	0.0014
Constant	(.00055)	(.00029)	(.0022)	(0.0022)
Market excess return	0.98** (.036)	0.91** (.032)	1.32** (.15)	0.88** (.25)
SMB (the small-minus-big Fama-French factor)		0.89** (.054)		0.32 (.41)
HML (the high-minus-low Fama-French factor)		0.36** (.070)		-.075 (.55)
UMD (the Carhart momentum factor)		-0.60** (.041)		-1.13** (.32)
# Observations	250	250	250	250
R-squared	.75	.93	.24	.27
Cumulative abnormal returns (CARs):				
				-0.0074
CAR[0,0]	0.00073 (0.022)	-0.19 (.023)	-0.092 (.21)	(.015)
CAR[0,1]	-0.014 (0.016)	-0.029 (.016)	-0.12 (.15)	-0.016 (.011)

				-0.013
CAR[-1,1]	-0.019 (0.013)	-0.027 (.013)	-0.08 (.12)	(.0086)
				-0.028
CAR[-3,3]	-0.032 (0.0085)	-0.031 (.0086)	0.16 (.078)	(.0056)

Note: ** denotes significance at 1%; standard errors in parentheses; covariances are 0

because the null assumes that consecutive observations are iid (Filson and Oweis 2010)

Table 6: Factor Models and CARs Testing for eBay v. Mercexchange

Variable	Portfolio		Litigated Firm	
	Eqn (1)	Eqn (2)	Eqn (1)	Eqn (2)
Factor Model				
Coefficients:				
	0.00089**	0.00076**	-0.00032	0.000070
Constant	(.00024)	(0.00017)	(.0014)	(.0014)
Market excess return	0.94** (.039)	0.73** (.035)	1.5** (.23)	1.60** (.29)
SMB (the small-minus-big Fama-French factor)		0.67** (.049)		-0.29 (.41)
HML (the high-minus-low Fama-French factor)		-0.26** (.078)		-1.38* (.65)
UMD (the Carhart momentum factor)		-0.064 (.049)		-0.10 (.41)
# Observations	250	250	250	250
R-squared	.69	.86	.15	0.18
Cumulative abnormal returns (CARs):				
CAR[0,0]	-0.012 (0.019)	-0.0081 (0.12)	-0.0061 (.042)	-0.014 (.046)
CAR[0,1]	-0.014 (0.013)	-0.010 (.0086)	-0.034 (.030)	-0.038 (.032)
CAR[-1,1]	-0.016 (0.011)	-0.012 (0.0070)	-0.031 (.024)	-0.040 (.026)
CAR[-3,3]	-0.032 (0.0072)	-0.024 (0.0046)	0.015 (.016)	0.013 (.017)

Note: ** denotes significance at 1%; standard errors in parentheses; covariances are 0

because the null assumes that consecutive observations are iid (Filson and Oweis 2010)

Table 7: OLS Regression Models with Binary Dependent Variable for eBay v.**Mercexchange**

Variable	(1)	(2)	(3)	(4)
	0.64**			
Constant	(.028)	.65** (.025)	0.67** (.029)	0.75** (.054)
R&D to Sales Ratio	0.065 (0.44)		0.061 (.04)	-0.022* (.013)
Market Value (mil \$)		-4.3E-06** (1.2E-06)	-4.9E-06** (1.5E-06)	0.061 (.043) -5E-06** (1.5E-06)
NAICS Code				06)
# Observations	313	385	301	301
R-Squared	0.007	0.033	0.042	0.042

Note: ** denotes significance at 1%; * denotes significance at 10%; standard errors in parentheses

Table 8: Probit Models for eBay v. Mercexchange

Variable	(1)
Constant	-6.14** (.57)
R&D to Sales Ratio	1.51* (.78)
	-1.6E-11** (5.87E-
Market Value (\$)	12)
NAICS=32	-4.90** (.92)
NAICS=33	-5.75** (.58)
NAICS=42	-6.28** (.74)
NAICS=45	-6.96** (.86)
NAICS=51	-5.94** (.59)
NAICS=52	-
NAICS=53	-5.37** (.85)
NAICS=54	-6.12** (.64)
NAICS=56	-
NAICS=62	-
NAICS=81	-
# Observations	301
Log Likelihood	
(Convergence)	354.538
Likelihood Ratio (Chi2)	33.527**

Note: ** denotes significance at 1%; * denotes significance at 5%; standard errors in parentheses