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PATENT TROLLS AS FINANCIAL INTERMEDIARIES? EXPERIMENTAL EVIDENCE

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"Why Do Inventors Sell to Patent Trolls? Experimental Evidence for the Asymmetric Hypothesis"

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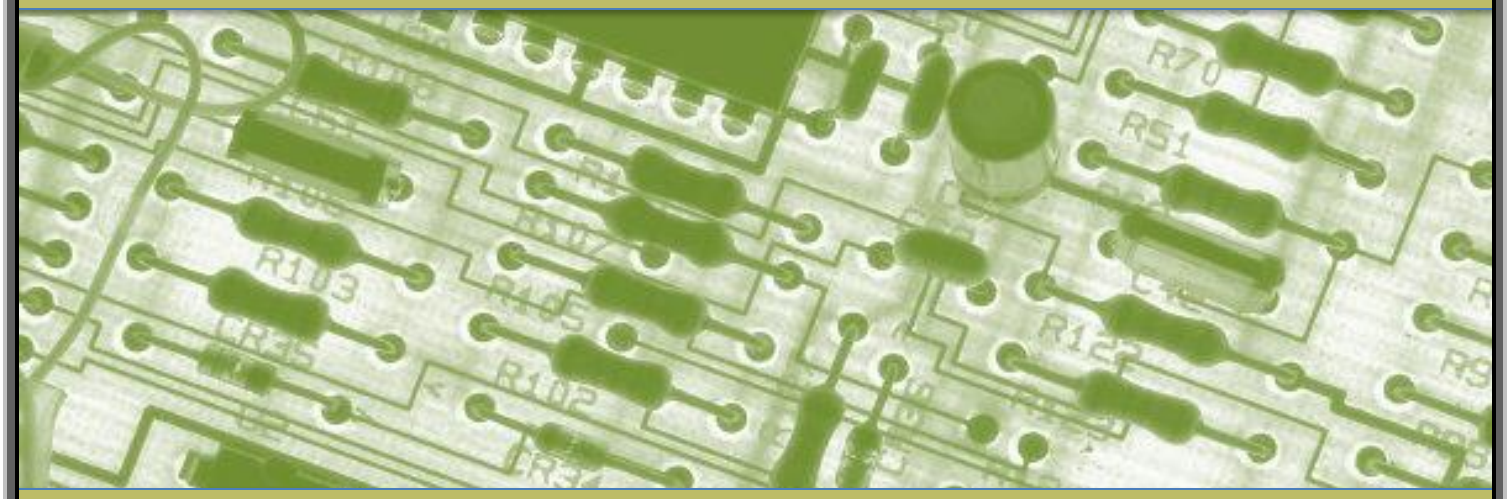

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Why Do Inventors Sell to Patent Trolls?
Experimental Evidence for the Asymmetry Hypothesis

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Abstract: Why do individual patent holders assign their patents to "trolls" rather than license their technologies directly to manufacturers or assert them through litigation? We explore the hypothesis that an asymmetry in financial resources between individual patent holders and manufacturers prevents individuals from making a credible threat to litigate against infringement. First, individuals may not be able to cover the upfront costs associated with litigation. Second, unsuccessful litigation can result in legal fees so large as to bankrupt the individual. Therefore, a primary reason why individual patent holders sell to PAEs is that they offer insurance and liquidity. We test this hypothesis by experimentally manipulating these financial constraints on a representative sample of inventors and entrepreneurs affiliated with academic institutions that are particularly known for their innovative activity: Stanford University and the University of California, Berkeley. We find that in the absence of these constraints, subjects were significantly less likely to sell their patent to a PAE in a hypothetical scenario. Furthermore, treatment effects were significant only for subjects who were hypothesized to be most sensitive to these constraints.

Introduction

The proliferation of Patent Assertion Entities (PAEs), pejoratively known as "patent trolls," has become an important public policy issue. PAEs are specialized firms that purchase patents and then seek licensing revenues from operating companies, typically through litigation or the simply the threat of litigation. These firms are neither producers of intellectual property nor do they produce goods or services that rely on the intellectual property they acquire. The empirical literature about the downstream effects of PAEs on the innovation system remains inconclusive, but one finding appears to be robust: PAEs hold a disproportionately large percentage of the patents filed by individual inventors (Risch 2012).

Why do individuals choose to assign their patents to PAEs rather than license their technologies directly to manufacturers or assert them through litigation? For every patent that PAEs buy, there must be a willing seller. This simple fact implies that PAEs must perform some function in clearing the market for invention. We hypothesize that an asymmetry in financial resources between individual patent holders and manufacturers prevents individuals from making a credible threat to litigate against infringement. First, individual patent holders may not be able to cover the upfront costs associated with litigation. Second, unsuccessful litigation can result in legal fees so large as to bankrupt an individual patent holder. Therefore, a primary reason why individual patent holders sell to PAEs is because they provide insurance and liquidity. That is, from the point of view of the patent holder, PAEs offer a way to guarantee profits from their intellectual property without having to engage in costly litigation.

We test this hypothesis by conducting an experiment to see how the demand for PAEs changes when financial constraints are relaxed. More specifically, we recruited actual inventors and entrepreneurs to consider hypothetical scenarios in which they had to choose between selling

their patent to a PAE and asserting it against a manufacturer through litigation. We leveraged the fact that—from the perspective of the individual patent holder—contingent fee litigation simultaneously eliminates upfront costs as well as the prospect of net losses (Schwartz 2012; Danzon 1983; Shavell 1979).[1] Therefore, we randomly varied whether subjects could hire a lawyer at an hourly rate or on a contingent fee basis. If our hypothesis is correct, then the presence of contingent fee litigation should reduce the demand for PAEs among individual patent holders. This reduction in demand for PAEs should be particularly strong for two sub-groups in our sample: individuals who self-identify as inventors rather than entrepreneurs—because the former tend to be more financially constrained than the latter—and individuals who are especially averse to losses.

The results of our experiment are consistent with the observable implications of our hypothesis. We find that the contingent fee treatment reduced the overall proportion of subjects who chose to sell their patents to PAEs. In addition, we find significant heterogeneity in these treatment effects, which supports our proposed causal mechanism. Treatment effects are statistically significant only for the sub-groups in our sample who should be most sensitive to the upfront costs and potential losses associated with litigation: subjects who either self-identified as inventors or exhibited loss aversion in a follow-up task. These results are robust to both covariate adjustment and alternative model specifications.

We believe that the results of our experiment may have two important implications for understanding whether PAEs help or hinder the rate of innovation. First, PAEs may serve an intermediary role in the market for intellectual property between individual inventors and large

[1] This does not imply that PAEs and contingent fee litigation are perfect substitutes. For example, PAEs can mobilize capital from securities markets and sell bundles of related patents. These characteristics might explain why PAEs dominate the market for assertion. What is relevant to this experiment, however, is that PAEs and contingent fee litigation offer some of the same benefits of liquidity and insurance to an individual patent holder.

manufacturers. Second, in the absence of PAEs, individual inventors might play a more limited role in the innovation ecosystem.

The Asymmetry Hypothesis

The idea that PAEs act as intermediaries to resolve asymmetries between individual patent holders and manufacturers is well established in the literature (Hagui and Yoffie 2013). For example, Golden (2006) posits that resource constraints and the expected cost of litigation cause individual patent holders to settle disputes for substantially less than the full value of their intellectual property. Similarly, McDonough (2006) argues that PAEs improve the liquidity and efficiency of the market for invention because individual inventors rarely have the financial resources to defend their patents in court against large manufacturers. Most recently, Risch (2012) suggests that inventors choose to sell to PAEs rather than enforcing patents themselves because they do not have the resources to pose a credible threat to manufacturers.

The empirical literature on the asymmetry hypothesis has evolved in two different directions. One body of literature attempts to show that an asymmetry exists between individual inventors and large manufacturers. For example, Lanjouw and Schankerman (2004) find that smaller patentees are relatively disadvantaged in enforcing their intellectual property rights, and are thus more likely to litigate than negotiate. Similarly, Ball and Kesan (2009) find that small firms mostly sue other small firms and tend to litigate only their most high-quality patents against large firms.

A separate body of literature documents how the asymmetry between individuals and manufacturers is responsible for an increase in the demand for PAEs. For example, Lamoreaux and Sokoloff (2003) and Lamoreaux et al (2013) show that the period of disruptive technological

change after the Civil War—which was characterized by an increase in the number of individual inventors—coincided with the emergence of patent brokers who intermediated between the shops where invention took place and the large firms that commercialized those inventions. Khan (2014) argues that PAEs have recently reemerged because the United States is once again undergoing a similar process of disruptive technological change. Khan's observation is consistent with the finding by Arora et al (2014) that roughly half of the new products from 2007 to 2009 originated outside of the companies that manufactured them.

Prior empirical tests of the asymmetry hypothesis have been limited by observational data in which the individual patent holder is not the primary unit of analysis.[2] As a result, researchers have not been able to draw causal inferences about the mechanism underlying the decision of individuals to sell their patents to PAEs. A compelling test should focus on individual patent holders as the primary unit of analysis, since they are the actors whose behavior we are trying to understand. Moreover, the test must exploit variation in the dependent variable, which means that the sample must include both patent holders who choose to sell to PAEs and those who do not. Finally, the test should ideally be designed to minimize the confounding effect of unobserved explanatory variables.

Experimental Design

Experimental methods offer a number of distinct advantages over observational data and case studies. First, they allow researchers to clearly identify cause and effect. Second, they allow researchers to manipulate specific features of a complex phenomenon in a controlled environment. Therefore, we designed an experiment to gain more insight into the behavior of

[2] In fact, most of the literature focuses on patents rather than individual patent holders, and then only concentrates on a subset of patents that are held by PAEs—those that are litigated (Fischer and Henkel 2012).

individual patent holders than has been possible in the literature to date. Specifically, we aimed to explore whether reducing the asymmetries discussed above—via contingent fees—would reduce the demand for PAEs among individual patent holders. To our knowledge, this is the first paper to test the asymmetry hypothesis using experimental methods.

An important concern in the design of any lab experiment is external validity, or the extent to which results found in the lab can generalize to behavior outside the lab. External validity may be threatened by the characteristics of either the subject pool or the experimental procedure itself. We address these concerns in two ways. First, we conducted the experiment on individuals who are either active inventors or who are engaged in the process of commercializing inventions. Our sample includes current and former members of incubators and accelerators at academic institutions that are particularly known for their innovative activity: Stanford University and the University of California, Berkeley. Second, we follow standard practice in the social sciences when it is infeasible to require subjects to make binding decisions that affect them in the real world. More specifically, we present subjects with a hypothetical scenario that approximates the decision they would face in their careers as inventors and entrepreneurs.

We invited approximately 1,200 individuals affiliated with five different innovation programs to participate in our study by having their respective program directors send a survey link via email. Subjects were able to complete the survey at their own convenience, and the survey link for each program was active until one week had elapsed without receiving a new response from that program. We received 112 total responses, which corresponds to a response rate of 9.3 percent. We dropped responses from our analysis if respondents either failed an attention check built into our survey, indicated in a comments section that they were interrupted in the course of completing the survey, or if they indicated in the comments section that their

responses would not reflect their behavior in the real world. As a result, our empirical analysis below is estimated on a sample of 103 responses.

Table 1 summarizes basic information about our sample. The average age of individuals in our study was just under 30 years, and more than one-third of subjects identified as female. Nearly 60 percent of these subjects indicated that they had previously filed a patent application. The high proportion of patent filers increases our confidence about the external validity of our findings, especially given that some of the younger respondents in our sample are unlikely to have yet had the opportunity to file a patent.

Table 1
Summary Statistics

	Mean	Min	Max
Filed patent application	.583	0	1
Female	.359	0	1
Age	29.563	19	57
Entrepreneur (vs. inventor)	.583	0	1
Loss averse (vs. loss-neutral)	.621	0	1
Observations	103		

The details of our experiment are as follows (see the Appendix for the full text of the survey instrument). All subjects began the experiment by completing a short writing task that required them to think about a product they use regularly and then propose an improvement to that product, including how they might market this improvement. Once the writing task was completed, subjects were then told to imagine that they had been awarded a patent for this idea that they estimated was worth approximately $1 million. This design element was intended to increase the quality of their responses by simulating the invention process and neutralizing any industry-specific biases from their previous experience with the patent system.

All subjects were then informed that a large corporation saw their idea and decided to infringe the patent without paying for it.[3] Each subject was then randomly assigned to either a control or treatment condition. Subjects in the control condition were given two options: sell their patent to a PAE for a guaranteed $100,000, or hire a lawyer to assert their patent in court for $1,000 per hour with no limit on the number of hours. Subjects in the treatment condition were given the same two options, except that the lawyer worked on a contingent fee basis of one-third of the total award if they won the case and zero dollars otherwise. Therefore, the only feature that varied across groups was that treated subjects were no longer constrained by upfront costs or the prospect of net losses. Subjects were then asked whether they wished to sell their patent to a PAE or hire the lawyer, and the responses to this question served as the dependent variable for our analysis below. Differences in responses to this question across the control and treatment groups allow us to draw inferences about the extent to which financial constraints affect the demand for PAEs.

We then included a comprehension check that asked subjects to indicate the lowest offer they would have accepted from the PAE, regardless of their prior decision to sell or litigate. Choosing to hire the lawyer necessarily implies an indifference point of $100,000 or more, and vice versa. Therefore, we were able to conclude that someone who both chose the lawyer above and provided an answer less than $100,000 either did not understand the main task in the experiment or was not fully paying attention. Respondents who failed this comprehension check—nine in total—were dropped from analysis below.

[3] The purpose of an experiment is to approximate the real world parsimoniously so as to allow researchers to focus only on the parts of a problem that are most relevant to the hypothesis. In practice, many patent holders sell to PAEs before their patent is infringed. In the context of our experiment, we take infringement as given in order to force assertion of the patent. Whether or not an inventor chooses to sell a patent before infringement is a separate question.

We then elicited the risk preferences and loss aversion of subjects by asking them to choose between pairs of hypothetical gambles expressed as coin flips. In the first exercise, subjects chose between a 50 percent chance of winning $2 and zero otherwise, or a guaranteed $1. The expected value of both options is equivalent, which gives us a convenient way to estimate risk preferences. In addition, the denomination of payoffs is purposely trivial because we wanted an unbiased estimate of subjects' risk profile. That is, we did not want answers to this question to be contaminated by their decision in the patent assertion context above.[4] We refer to the subjects who chose the guaranteed $1 as "risk averse" in the analysis below.

Second, we determined whether subjects were averse to losses. Subjects were again asked to indicate which of two hypothetical gambles they would prefer: a 50 percent chance of winning $3 and a 50 percent chance of losing $1, or a guaranteed $1. Once again, the expected value of both options is equivalent, but unlike the first exercise it was now possible to lose money in this gamble. This question therefore better reflects the patent assertion context, where a plaintiff can experience a net loss in the litigation process. We refer to the subjects who chose the guaranteed $1 in this gamble as being "loss averse" in the analysis below.[5]

Finally, we collected background information about our subjects. Most importantly, we asked subjects to self-identify as either an inventor or an entrepreneur, which is used as a proxy for perceived financial constraints in our empirical analysis.[6] Of course, inventors and entrepreneurs may differ in ways other than their degree of financial constraint, and self-

[4] One potential downside of this design choice is that decisions about small denominations might not scale to decisions about larger sums of money. For example, some research suggests that gains are actually valued more than losses in small denominations (Harinck et al. 2007). Therefore, our design yields a relatively conservative measure of loss aversion.

[5] We recognize that "loss aversion" has a specific meaning in the behavioral economics literature, in which losses are valued more highly than gains (Kahneman and Tversky 1979). Our operationalization of this concept is related to that meaning, and the subtle differences are not meaningful in the context of this study.

[6] This assumption is supported both by Levine and Rubenstein (2013), who show that entrepreneurs come from higher income families to begin with and have earnings that are 28 percent higher than otherwise identical salaried employees, as well as an unstructured interviews with individual patent holders.

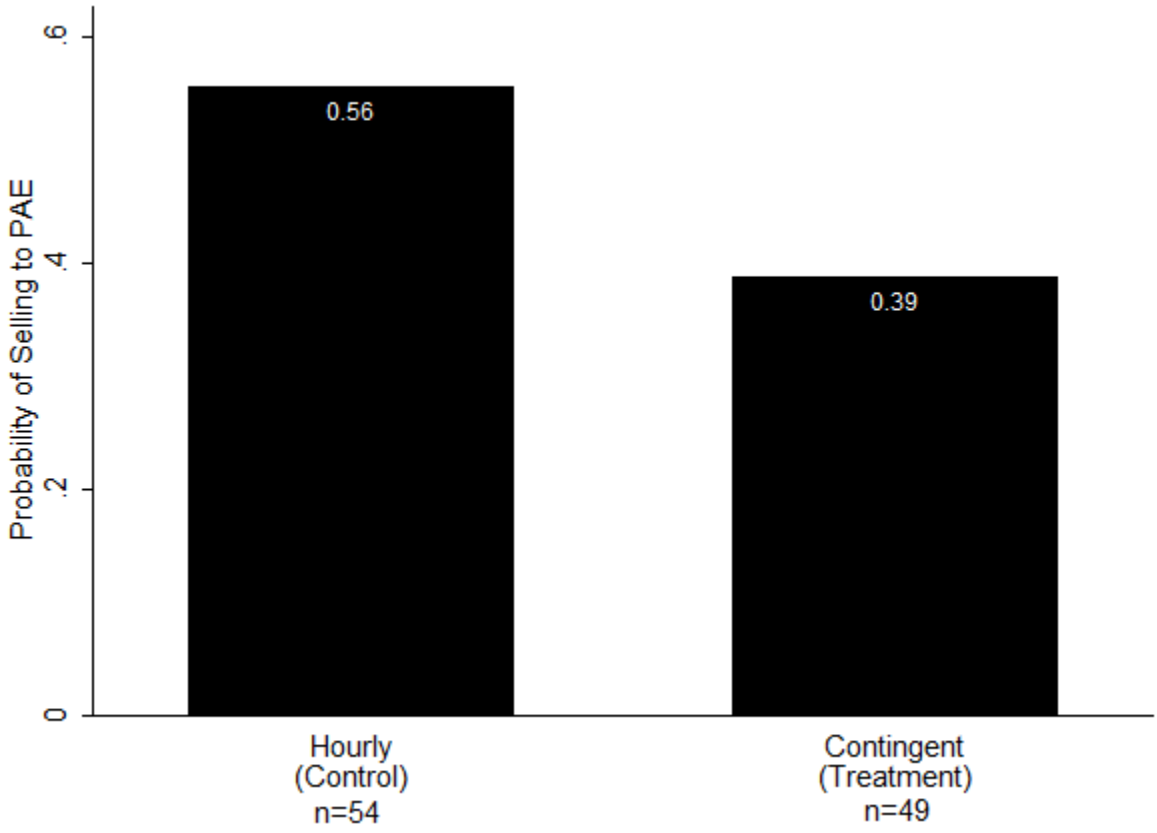
identification may change over time (Spulber 2014). But if those confounding factors dominate differences in financial resources, then we should not detect any meaningful differences in treatment effects for inventors and entrepreneurs when the only manipulation is the cost structure of litigation. We also asked subjects to indicate whether they had previously filed a patent, as this might influence their decision-making in the experiment. Subjects completed the survey by identifying their age, gender, and primary academic field of study.

Results

We begin the analysis of our experimental data by conducting a balance test to make sure that the randomization procedure worked properly. A linear regression suggests that none of our covariates significantly predict treatment assignment better than chance alone. This result holds whether we test the null hypotheses individually or jointly ($F=0.48$, $p=0.90$). In other words, the only observable difference between subjects in the treatment and control groups is the contingent fee treatment itself, which allows us to draw causal inferences in the analysis below.

Next, we estimate the average effect of the contingent fee treatment on our entire sample of inventors and entrepreneurs. Figure 1 shows that only 39 percent of subjects in the treatment condition chose to sell to a PAE, compared to 56 percent in the control condition. Removing financial constraints by offering contingent fee litigation therefore reduced the demand for PAEs by 17 percentage points on average, which is statistically significant at the 10 percent level ($\chi^2=2.90$, $p=0.089$).

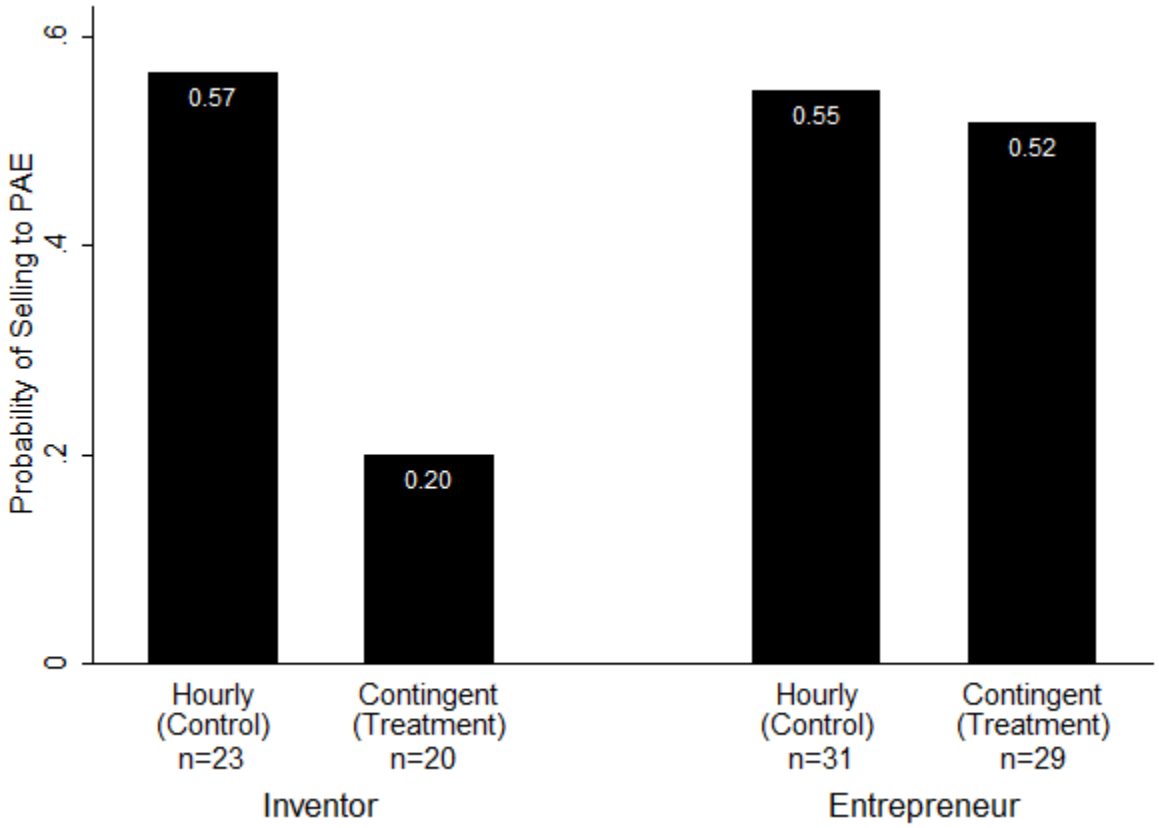
Figure 1. Average Treatment Effects



We then test the hypothesis that the shift in demand for PAEs is driven by individuals who tend to be financially constrained. If this hypothesis is correct, then we should observe relatively larger treatment effects for subjects who self-identify as inventors than for those who self-identify as entrepreneurs.

The results of our experiment confirm our prediction about heterogeneous treatment effects. Figure 2 shows that the contingent fee treatment had an effect only on inventors. The treatment reduced the percentage of inventors who chose to sell to a PAE by nearly three-fold, while the effect on entrepreneurs was trivial.

Figure 2. Treatment Effects by Financial Constraint



We then estimate a series of logistic regressions in Table 2 to determine whether the observed difference between treatment effects for inventors and entrepreneurs is statistically significant. Each of these regressions includes an indicator variable for treatment assignment, an indicator variable for financial constraint that equals 0 for inventors and 1 for entrepreneurs, and a multiplicative interaction term between these two variables. Column 1 displays the estimates of our baseline interaction model. In the presence of the interaction term, the "Contingent Fee" coefficient estimates the effect of the treatment only on inventors, which has the expected negative sign and is highly significant (p=0.019). The coefficient on the interaction term reflects the difference between the treatment effect on entrepreneurs and inventors, which has the expected positive sign and is significant at the 10 percent level (p=0.082).

Table 2
Treatment Effects by Financial Constraint

Dependent Variable: Sell to PAE	(1) Baseline	(2) Controls	(3) Fixed Effects
Contingent Fee	-1.649	-1.789	-1.997
	(0.703)	(0.752)	(0.799)
Entrepreneur	-0.0682	-0.161	-0.235
	(0.557)	(0.596)	(0.617)
Contingent Fee * Entrepreneur	1.523	1.675	1.887
	(0.875)	(0.928)	(0.983)
Constant	0.262	-0.481	0.514
	(0.423)	(1.075)	(1.284)
Observations	103	103	103
Pseudo R^2	0.057	0.095	0.108
Controls	No	Yes	Yes
Fixed Effects	No	No	Yes

Standard errors in parentheses

Since our financial constraint variable was not experimentally manipulated, our baseline results may be biased in either direction by omitted variables that are correlated with self-identification as either an inventor or entrepreneur. Therefore, we control for potential confounders including age, gender, prior patent filing, and our estimates of both risk aversion and loss aversion in order to produce more unbiased estimates of treatment effects.[7] Column 2 displays the coefficients of interest from this modified regression, with the coefficients on our control variables suppressed.[8] We observe that covariate adjustment increased both the magnitude and statistical significance of our estimated treatment effects on inventors (p=0.017),

[7] Despite the presence of non-randomly assigned explanatory variables in our model, some researchers may still object to any covariate adjustment in the analysis of experimental data. We note that covariate adjustment allows us to estimate treatment effects more precisely regardless of random assignment, and that this technique does not fundamentally bias our estimates since our model has greater than 20 degrees of freedom (Gerber and Green 2012).
[8] None of the control variables enter the regression as statistically significant at conventional levels.

as well as the magnitude and significance of the difference in these treatment effects across inventors and entrepreneurs (p=0.071).

One might imagine that there may be unobserved differences in perceived financial constraints across the five different incubators and accelerators represented in our sample. Therefore, we add indicator variables for all but one of these innovation programs to the previous model. Column 3 displays the results of this fixed effects model, which further increases the magnitude and statistical significance of both the main effect on inventors (p=0.012) as well as the interaction effect (p=0.055).[9] We believe that this specification yields the most precise and unbiased estimates of the heterogeneous effects of the contingent fee treatment across different levels of perceived financial constraint.

These regression coefficients do not, however, provide an intuitive interpretation of the magnitude of these effects. We therefore compute the marginal effect of the contingent fee treatment on inventors and entrepreneurs separately, using the full specification with both controls and fixed effects. We find that the contingent fee treatment decreased the predicted probability of selling to a PAE for inventors by more than 40 percentage points (p=0.003), while the effect for entrepreneurs was both negligible and statistically insignificant. Taken together, these findings provide empirical support for our hypothesis that the demand for PAEs is positively and non-trivially related to perceived financial constraints.

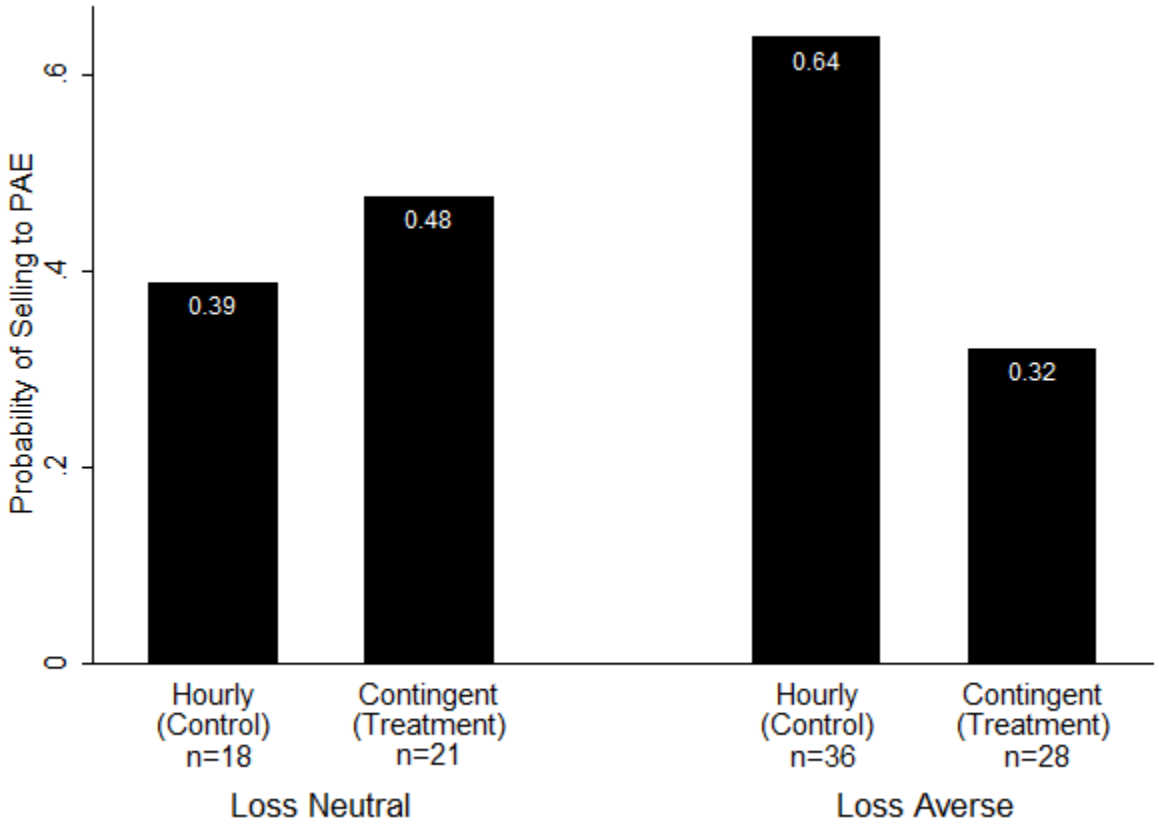
Our results reported in Figure 2 and Table 2 also provide empirical support for the validity of our self-identification variable as a proxy for financial constraint. If our results were driven by some other factor, then we would expect to see significant differences between

[9] Our results also hold after running a conditional fixed-effects logistic regression. This econometric technique, unlike adding indicator variables for specific programs, mitigates the degree of incidental parameter bias in logistic regressions with small samples.

inventors and entrepreneurs in the control condition. Instead, we find that the responses of inventors and entrepreneurs who did not receive the contingent fee treatment are nearly identical.

The fact that the proportion of subjects who chose to sell to the PAE in the treatment condition does not fall to zero implies that there are factors other than financial constraints that also shape the demand for PAEs. Recall that the asymmetry hypothesis also posits that individual patent holders sell to PAEs because of the prospect of net losses. If this hypothesis is correct, then we should also expect treatment effects to be larger for subjects who exhibited loss aversion in our coin flip exercise. Figure 3 shows that the contingent fee treatment appears to have an effect only on loss-averse subjects, which is consistent with our hypothesis. The treatment cut in half the percentage of loss-averse subjects who chose to sell to a PAE, while the demand for PAEs among loss-neutral subjects edged up slightly. In addition, we note that loss-neutral subjects were substantially more likely to sell to the PAE in the control condition.

Figure 3. Treatment Effects by Loss Aversion



We estimate another set of logistic regressions in Table 3 to determine whether treatment effects for loss-averse and loss-neutral subjects are significantly different. The difference between Table 2 and Table 3 is that we now interact the contingent fee treatment with an indicator variable for loss aversion, rather than with perceived financial constraint. The structure of the table remains the same: Column 1 reports our baseline interaction model, Column 2 includes control variables, and Column 3 includes program-level fixed effects.[10] The "Contingent Fee" coefficient now tells us the main effect of the contingent fee treatment only for loss-neutral subjects. This coefficient is consistently positive but not statistically significant in any model, as expected. The coefficient on the interaction term now tells us whether the

[10] Once again, our results hold after running conditional fixed-effects regressions to avoid the potential incidental parameters problem.

difference between treatment effects on loss-averse subjects and loss-neutral subjects is significant. This coefficient consistently has the expected negative sign and is significant at the 5 percent level in all three specifications (p=0.048, 0.033, 0.034).

Table 3
Treatment Effects by Loss Aversion

Dependent Variable: Sell to PAE	(1) Baseline	(2) Controls	(3) Fixed Effects
Contingent Fee	0.357	0.387	0.427
	(0.655)	(0.696)	(0.729)
Loss Averse	1.023	1.174	1.178
	(0.598)	(0.679)	(0.778)
Contingent Fee * Loss Averse	-1.674	-1.887	-2.026
	(0.846)	(0.885)	(0.958)
Constant	-0.452	-1.871	-1.211
	(0.486)	(1.132)	(1.402)
Observations	103	103	103
Pseudo R^2	0.050	0.101	0.111
Controls	No	Yes	Yes
Fixed Effects	No	No	Yes

Standard errors in parentheses

We then compute the marginal effect of the contingent fee treatment on both loss-averse and loss-neutral subjects. We find that contingent fees decreased the predicted probability of selling to a PAE for loss-averse subjects by 35 percentage points (p=0.002), while the marginal effect for loss-neutral subjects was actually positive but not statistically significant. Taken together, the regression results indicate that the demand for PAEs is positively and non-trivially related to loss aversion.

We consider two potential threats to inference for our results about loss aversion. First, we may simply be picking up aversion to risk: individual patent holders may be more averse to the uncertainty associated with litigation, rather than the prospect of net losses. We address this concern by substituting our measure of risk aversion in the interaction model above to see whether treatment effects are greater for subjects who are relatively more risk-averse (results not shown). Our results yielded the expected sign on the interaction term, but none of the coefficients of interest were statistically significant. This suggests that the demand for PAEs is not simply due to the fact that they offer guaranteed profits, but rather because they protect the patent holder from experiencing net losses due to unlimited hourly fees.

Second, it is possible that the loss-averse subjects in our sample are disproportionately inventors, which would imply that these are not two separate sources of heterogeneity in treatment effects. We therefore estimate a bivariate regression which confirms that self-identifying as an inventor and loss aversion are independent characteristics: inventors were not significantly more likely than entrepreneurs to exhibit loss aversion in our sample (results not shown). In fact, the correlation coefficient between self-identification as an inventor and exhibiting loss averse is weakly negative.

Conclusion

Why do individuals choose to assign their patents to PAEs rather than license their technologies directly to manufacturers or assert them through litigation? We hypothesize that an asymmetry in financial resources between individual patent holders and large manufacturers prevents individuals from credibly threatening to litigate against infringement. First, individuals may not be able to cover the upfront costs associated with litigation. Second, unsuccessful

litigation can result in legal fees so large as to bankrupt the individual. Therefore, PAEs offer a way for individual inventors to guarantee profits from their patents without having to engage in costly litigation.

We tested this hypothesis by conducting a survey experiment to see how the demand for PAEs changes when these two financial constraints are relaxed. More specifically, we recruited actual inventors and entrepreneurs to consider hypothetical scenarios in which they had to choose between selling their patent to a PAE and asserting it through litigation. Our experimental design leveraged the fact that—from the perspective of the individual patent holder—contingent fee litigation simultaneously eliminates upfront costs as well as the prospect of net losses. Therefore, we randomly varied whether subjects could hire a lawyer at an hourly rate or on a contingent fee basis.

The results of our experiment were consistent with the observable implications of our hypothesis. We showed that the contingent fee treatment reduced the overall proportion of subjects who chose to sell their patents to PAEs. In addition, we found significant heterogeneity in these treatment effects, which supports our proposal causal mechanism. Treatment effects were significant only for the sub-groups in our sample who should have been most sensitive to the upfront costs and potential losses associated with litigation: subjects who either self-identified as inventors (rather than entrepreneurs) or exhibited loss aversion in a follow-up task. Furthermore, we demonstrated that these results were robust to both covariate adjustment and alternative model specifications.

Our findings may have two important implications for the larger public policy debate about the patent system. First, our results suggest that PAEs may serve an intermediary role in the market for intellectual property between individual inventors and large manufacturers.

Second, empirical support for the asymmetry hypothesis suggests that in the absence of PAEs, individual inventors might play a more limited role in the innovation ecosystem. Future research should explore whether, in the absence of PAEs, individuals who are financially constrained or loss-averse would drop out of the innovation ecosystem altogether.

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Appendix: Survey Instrument

Think about a product or service that you use on a regular basis. Please write two (2) sentences about how you would improve this product or service and how you would market the new and improved version.

Imagine that you have been awarded a patent for this idea that you estimate is worth approximately $1 million.

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Experimental Conditions:

Control

A large corporation called Technology Titans saw your idea and has decided to infringe your patent without paying for it.

You now have two options:

1) Sell your patent to a firm called Ideas Incorporated for a guaranteed $100,000, and Ideas Incorporated will now deal with Technology Titans directly.

2) Hire a lawyer to defend your patent against Technology Titans in an attempt to secure your $1 million. The lawyer charges $1,000 per hour and there is no limit to the number of hours billed for this case.

What would you like to do?

- ○ Sell your patent
- ○ Hire the lawyer

Treatment

A large corporation called Technology Titans saw your idea and has decided to infringe your patent without paying for it.

You now have two options:

1) Sell your patent to a firm called Ideas Incorporated for a guaranteed $100,000, and Ideas Incorporated will now deal with Technology Titans directly.

2) Hire a lawyer to defend your patent against Technology Titans in an attempt to secure your $1 million. The lawyer charges a contingent fee of one-third of your total winnings only if you win the case.

What would you like to do?

- ○ Sell your patent
- ○ Hire the lawyer

****

Your decision has been recorded and cannot be changed. Next, please answer the following question *regardless* of your choice on the previous screen.

What is the lowest offer for which you *would have* been willing to sell your patent rather than hire the lawyer?

(Your answer should be *less* than $100,000 if you sold your patent and *greater* than $100,000 if you hired the lawyer.)

Which of the following gambles on a fair coin flip would you prefer? (Question 1 of 2)

Heads: You win $2 Tails: You win $0	Heads: You win $1 Tails: You win $1
○	○

Which of the following gambles on a fair coin flip would you prefer? (Question 2 of 2)

Heads: You win $3 Tails: You lose $1	Heads: You win $1 Tails: You win $1
○	○