Non-Practicing Entities and Patent Transfer

Jong-Rong Chen
National Central University
jrchen@cc.ncu.edu.tw

Chia-Hua Chung
National Taiwan University
javachung@gmail.com

Chih-Hai Yang
National Central University
chyang@mgt.ncu.edu.tw

Abstract

This paper studies the relationship between types of assignees and patent transfer. Specifically, due to the fact that non-practicing entities (NPEs) have recently emerged as sellers in the market for technology trade, we consider the role of NPEs on influencing patent value. Based on the unique transaction price information from the United States (US) patent transfer in seven live auctions hosted by Ocean Tomo over the period between 2006 and 2008, we adopt a two-step approach to implement empirical estimations by considering the sample selection problem with the endogenous treatment. Empirical results of this typical mechanism of patent transfer indicate that the age of a patent is negatively related to the probability of a successful auction and transfer price, while forward citations, patent claim and scope are positively related to it. In addition, the patent's auction price is higher if it is renewed within one year prior to auction. These findings are consistent with those in the related literature. As for the type of assignees, we find that NPEs are positively associated with the probability and the price of patent transfer, implying that patents owned by NPEs are easy to transfer and be sold at a higher price.

Keywords: non-practicing entity, patent transfer, patent auction, patent value

JEL Classifications: O34, G32, G21, L65

1. Introduction

The importance of innovations on sustaining long-run economic growth initiated by the endogenous growth theory has long been recognized. Staring from the aspect of corporate operation, intellectual properties (IPs) not only have become one key competitive advantage, but also an effective weapon to attack competitors in the high-tech industry. For example, patent ligation regarding smart phone-related technologies among Apple Co., Samsung, and HTC is a significant case. In fact, there has been very extensive empirical work in economics using patent data to investigate various issues.[1] One of the critical issues is the economic value of patents, which has attracted wide concern by economists. Various approaches have been adopted to assess the value of patents, such as market value estimations (Hall *et al*. 2005), patent renewals (Schankerman and Pakes, 1986), and citation frequency (Harhoff et al., 1999). However, there has been little work examining what factors determine patent transfers and an individual patent's value in the marketplace. This is mainly due to the fact that patent transactions and transaction price are rarely observable in practice.

From the perspective of social welfare, it is better for inventors to pursue commercialization or to circulate patents to the firms needing the technologies. However, approximately 70% of IPs in the U.S., Japan, and the European Union are sleeping patents, which are not utilized in the industrial sector (Lee and Lee, 2010). This highlights the importance of the utilization of trading platforms to facilitate the exchange of IPs. The knowledge embodied in a patent is generally specific to the inventor. There is significant variation in the expected economic return generated from patents between sellers and buyers. Shared methods of assessing the economic value of this class of assets are lacking (Oriani and Sobrero, 2008). Although the complexity and high cost of related transactions

[1] Nagaoka *et al*. (2010) provide a comprehensive overview of recent researches using patent data.

prevent the development of trade markets for patents, the market for patent auctions initiated by the Ocean Tomo, an intellectual capital merchant bank, in 2006 has successfully facilitated patent transfer. The market mechanism is used to evaluate the financial value of patents. Crucially, the comprehensive information contained in patent auctions enables us to empirically investigate the determinants of patent transfers and patent value, adding evidence to this line of research.

Reitzig (2003) and Nair *et al*. (2011) summarized a variety of characteristics of patents that have been discussed as value determinants in the theoretical literature, e.g., lifetime, breadth, novelty, disclosure, and citations. Recently, Serrano (2010) proposed a model of patent transfers and renewals in a context with the arrival of opportunities for surplus-enhancing transfer, that is, renewals increase the probability of a patent being traded. Crucially, he indicates that the rates of transfer and renewal differ by the type of patentees, highlighting the key role played by the type of patentee on patent transfer and possibly patent price. This is because some latent patent variables are endogenously determined by patentees.

A matter of growing concern in patent studies is non-practicing entities (NPEs), or patent trolls (sharks). Instead of producing a product or selling a service, they generate profits mainly by extracting excess licensing fees or trapping R&D intensive manufacturers in patent infringement situations so as to receive damage awards (Reitzig et al. 2007). As depicted in Figure 1, events of NPE-related patent litigations increased sharply during the 2001-2012 period. Specifically, the number of companies involved in patent litigations with NPEs was 578 in 2001, but this figure climbed sharply since 2004, reaching 5031 in 2011. This shows an average growth rate of 33% for the period between 2004 and 2011. Correspondingly, NEP litigation events increased from 144 per year in 2001 to 1211 in 2011. The 2011 figure doubled compared with that in 2010.

[Insert Figure 1 approximately here]

The increase in NEP-type patent litigation is widely considered to be a serious threat to innovations. Actually, the question of whether NEPs are trolls or market-makers of technology remains debatable. Critics claim that NPEs use vague patents to generate licensing fees or to engage in frivolous infringement litigation, thereby reducing innovation incentives of R&D intensive firms and social welfare (Reitzig et al., 2007, 2010; Bessen et al., 2011; Turner, 2011). Alternatively, some (e.g., Shrestha (2010), Fischer and Henkel (2012)) think that NPEs may help financially constrained inventors to enhance innovation and competition, thereby creating an efficient market for technology trade.

Since NPEs will likely be an enduring phenomenon in the market for technology (Reitzig *et al*. 2010), this study pursues a different route, analyzing the role of NPEs on patent transfers and transaction price. That is, whether there are differences in the probability of successful auction and auction price between NPEs and other types of patentees. Serrano (2010) finds that the probability of a patent being traded is related to the types of patentees. Besides, Shrestha (2010) claims that NPE patents possess characteristics of more generality, forward citations, and higher originality, implying their patents might be more valuable. However, questions concerning the financial value of NPEs' patents have rare been examined in previous studies. NPEs have recently emerged as sellers in the market for patent auctions organized by Ocean Tomo, suggesting that their operation strategy is to gradually facilitate technology trade. The comprehensive price information regarding successful auction deals in Ocean Tomo's auctions enables us to investigate whether NEP patents are more valuable or are weak and vague as the criticisms state. Our results facilitate an empirically based judgment about the patent quality of NPEs.

This study aims to empirically examine the determinants of patent transfers and patent price, paying special attention on the role of NPEs. The novel contribution to this line of research is multifold. First, previous studies have only examined how patent characteristics influence patent transfers or hypothesized patent prices. This work investigates what factors determine an individual patent's trading price and how they influence it. Second, because NPEs have begun to release their patents in the market of patent auctions, we try to examine whether there are considerable differences in the probability of successful trade and trading price for patents of NPEs and other patentees. Third, NPEs can determine the behavior of patent renewals that can affect patent value (Grönqvist 2009), suggesting the existence of an endogenous problem. This paper considers the endogenous problem attributed to NPEs' behavior in relation to empirical estimations, enabling us to obtain robust estimates regarding the difference in financial value of patents between NPEs and other patentees.[2]

The rest of the paper is organized as follows. Section 2 introduces the patent auctions organized by Ocean Tomo and discusses types of patentees and the differences in patent characteristics in the market of patent auctions. Section 3 reviews the literature regarding determinants of patent transfers and patent value. Section 4 presents the empirical model. Section 5 displays and discusses the empirical results. We further implement some robustness checks in this section. Section 6 concludes and summarizes the paper.

2. Literature Review

Although the assessment of patent value has attracted wide concern among economists for years, there is little empirical evidence related to this issue, whether using the hypothesized financial value of patents or a small sample. Studies using observable patent value to examine what factors influence individual patent's value have not yet been observed, with the exception of Odasso and Ughetto (2010) and Nair et al (2011).

[2] It is worth mentioning that the way of identifying whether a company is a NPE in our empirical analysis is through the help from PatentFreedom.com. Further details will be provided in Section 3.

Based on a survey of patent-holders with a set of indicator variables, Harhoff *et al*. (2003) estimated the patent value equation. Their results suggest that the number of references to the patent literature and the citations a patent receives are positively related to its value. Furthermore, patents which are upheld in opposition and annulment procedures and patents representing large international patent families are particularly valuable. Similarly, Reitzig (2003) adopted a questionnaire survey to obtain 127 individual patents from a semiconductor company and then related patent value to a variety of characteristics of patents. The value of individual patents is assessed by one to four technical experts and one marketing representative, rather than using the actual transaction price in the marketplace. The analysis shows that knowledge of technical importance, the position of the patent in a portfolio, its learning value for competitors through disclosure, and the difficulty in inventing all allow for a good approximation of the patent value. However, this study is specific for patents that are used as "bargaining chips" in the semiconductor industry. Gambardella *et al*. (2012) used survey data for a large sample of European patents to estimate the determinants of the value of patent portfolios. They differentiate the influences on the average value of the patented inventions into firm investments in resources and the inventor characteristics. Their findings suggest that not only the investment in resources, but also inventor characteristics like past citations or education, affect the value of a patent portfolio.

Recently, both Odasso and Ughetto (2010) and Nair *et al*. (2011) adopted Ocean Tomo's patent auction price data to explore this question. Nair *et al*. (2011) related patent price to seven latent patent variables. Their estimates reveal that forward citations and foreign filings are positively correlated to price, while the influences of age, technology field, generality, backward citations, and originality are uncertain. In addition to estimate the patent price equation, Odasso and Ughetto (2010) also analyzed the valuation gap of patents that exists between that perceived by the sellers and real market values of a patent.

Their findings suggest that forward citations, patent residual life, and the presence of multiple assignees are positively related to both sellers and bidders valuations. The difference between the patent's expected value is significantly correlated with patent scope, the number of backward citations, the presence of multiple inventors and assignees and the weight of the for-sale patents in the seller's overall patent portfolio.

On the other hand, extant empirical studies of the NPE phenomenon have mainly focused on the litigation issue caused by NPEs (Bessen *et al*., 2011; Fischer and Henkel, 2012; Lerner, 2006; Reitzig *et al*., 2010; Shresta, 2010), while rare examining the role NPEs that play on influencing patent transfers. Serrano (2010) developed a model of patent transfers and renewal and then provided the first evidence on the transfer and renewal of U.S. patents. He classifies patentees into various types and finds that the proportion of transferred patents is large and differs across type of patentees. Moreover, the probability of a patent being traded depends on a number of factors—the age of the patent, the number of citations received by a given age, the patent generality, and whether the patent has been previously traded or not.

Unfortunately, Serrano (2010) does not distinguish NPEs from other types of patentees. More crucially, NPEs are often characterized as relying on low-quality patents, an assessment that, if correct, would imply that NPEs' patents will be evaluated at a lower price by buyers in patent auctions, leading to a lower probability of being successfully traded and lower auction price. This study thus attempts to draw a clear picture of NPEs, by analyzing the performance of NPE patents in the technology transfer market.

3. Data Source, Type of Patentees, and Sample Characteristics

3.1 Data source and type of patentees

Ocean Tomo, an intellectual capital merchant bank, was founded in 2003, for the purpose of establishing a trading platform for technologies through a live patent auction.

The first IP auction held in San Francisco in April 2004 attracted more than 400 professionals. Before Ocean Tomo was merged with ICAP, it held eight auctions in the U.S. and Europe, facilitating the sale of a total of $112 million (Yanagisawa and Guellec, 2009). The IP trading mechanism of live auctions initiated by Ocean Tomo has become a well-functioning marketplace for technology with six years of experience.[3] Crucially, through matching supply and demand of technology in an ascending bid model, a trading price is reached for the successfully auctioned patent. The price that a patent is sold at reflects how much a buyer is willing to pay and is an approximation of its true value. This unique information regarding an individual patent's final price is not available in other assignment data, such as the USPTO Patent Assignment Database utilized by Serrano (2010).

Ocean Tomo's patent auction catalogue contains a rich mine of information regarding the seller (patent holder), potential licensees, the invention, and information on the lots that patents were ultimately sold as well as their final transaction price. It contains patent holder information that can be linked with the USPTO Patent Assignment Database to identify patentee type and other patent characteristics. This study then checks the patentees one by one to clearly classify which patents belong to NPEs and other types of patentees. Therefore, we can analyze the role of NPEs on patent transfer and auction price which has not yet been done in previous studies.

The data used in this study are collected from seven patent auctions held by Ocean Tomo from 2006 to 2008. To ensure that the requirements for patent novelty are consistent and to obtain the same variety of patent characteristics, we concentrate only on U.S. patents and exclude European patents. The sample consists of 465 patent lots that include a total of 976 patents. The sample distribution among the seven auctions is summarized in Table 1.

[3] For a detailed introduction of Ocean Tomo, please see Odasso and Ughetto (2010).

[Insert Table 1 approximately here]

The main purpose of this study is to examine the role of NPEs on patent transfer. We first link the USPTO Patent Assignment Database to identify the patentee for each transfer.[4] Following the classification utilized by Serrano (2010),[5] patentees are classified into various types, distinguishing NPEs from the category of corporations, as shown in Figure 2. Specifically, the sizes of the groups of corporations are classified by the annual number of patents. Large and small innovators denote corporations have more than 100 and less than 5 patents annually. A corporation with annual patents of between 5 and 100 is classified as a medium innovator. To identify whether or not the patent of a lot is owned by NPEs, we have to recognize whether a corporation is a NPE or not first. For this, we checked the website of 176 corporations one by one to see is there any revenue from producing product or selling service. If yes, then the corporation is not a NPE. We ended up with five corporations are NPEs. We then sent those five corporations to PatentFreedom.com for further identification, and eventually left with three NPE corporations.[6] [7]After these processes, we compile the seller information in Ocean Tomo's patent auction catalogue and the NPEs statistics profiled by PatentFreedom.com.[8]

[Insert Figure 2 approximately here]

3.2 sample characteristics

Is there a difference in patent transfer depending on type of patentees? Our analysis starts by describing the probability of being traded and trade price of patents based on type

[4] http://assignments.uspto.gov/assignments/q?db=pat

[5] There are various approaches to classifying patentees in the literature. One is to separate them into corporations and individuals (Grönqvist, 2009; Sneed and Johnson, 2009). The second is based on maintaining entities (Bessen, 2008) which is consistent with the definitions regarding large and small entities used in the USPTO.

[6] We thank PatentFreedom.com for the help of identifying NPEs.

[7] We might underestimate the number of NPE corporations by adopting this strictest definition of NPE.

[8] There are more than 640 NPEs profiled by Patent Freedom.

of patentees, as reported in Table 2. Figures in column (2) indicate that corporations are the primary seller in the live patent auction, accounting for 81.66% of the cases, while individuals and others constitute the remaining 18.34%. However, NPEs seem to play a minor role since their auction cases are 14 and account only for 1.43%. Moreover, there is a negative relationship between the number of cases and size of innovators; that is, small innovators (NPEs are generally small) are more aggressive in selling their patents in the auction market. This is because small firms cannot have the wherewithal to exploit new technology and therefore tend to sell patents to potential buyers. As for the probability of a patent being traded, the figures in column (2) suggest that this varies across sizes of innovators rather than types of patentees. The values for probability of patents being sold are 40.32%, 48.95%, and 42.86% for corporations, individuals, and others, respectively. Among the type of corporations, large innovators exhibit a lower auctioned probability of patents, reaching only 21.43%, while the corresponding figure for NPEs is 50.00%.[9]

[Insert Table 2 approximately here]

Crucially, the figures in column (3) suggest that there is a substantial difference in the average value of patents sold across type of patentees. The average value ranges between $51,391 for others to $182,491 for individuals. Overall, patents of small corporations (small innovators and NPEs) and individuals tend to have a higher auction price. Drawn from the above analysis, NPEs' patents tend to exhibit a higher probability of being successfully traded as well as a higher auction price than other types of patentees. This provides preliminary evidence that their patents might not be weak and vague as criticized. In other words, NPEs may facilitate technology transfer by placing patents on the market rather than only engaging in patent licensing and litigation.

Serrano's (2010) model of patent transfer and renewal emphasizes that patent renewal

[9] Patents that have been traded previously are more likely to be traded (Serrano, 2010). Including these statistics, small innovators and NPEs continue to show a higher average number of transfers, while the corresponding value for government agencies (others) is the lowest.

raised the possibility of surplus-enhancing transfer. A patent owner has to decide in each period whether or not to pay a renewal fee to extend the patent's life.[10] This strategy provides a signal regarding the potential value of patents. Specifically, if sellers renew their patents in the year before patents are placed on live auction, this costly signal might induce alternative potential owners to place greater valuation on a patent (Burhop, 2010).[11] Although large entities have sufficient financial capability to maintain their patents and show a higher ratio of patent renewal (Bessen, 2008), as can be seen in column (4) NPEs have a higher ratio of patent renewal than other patentees. This implies that NPEs believe their inventions have potential value worth paying the costly renewal fees. Finally, one surprising phenomenon is that, compared with other types of patentees, NPEs tend to place older patents on the IP market to seek potential buyers. This can partially explain why NPEs have a higher ratio of patent renewals.

4. Empirical Model, Variables and Econometric Problem

4.1 Empirical specification

This study uses a two-step Heckman selection model to implement empirical estimations to analyze the roles of NPEs and patent characteristics on influencing patent value measured by an individual patent's final price in a live auction. This not only enables us to account for the potential sample selection that not all patents are successfully traded, but also examines the less well examined crucial issue of what affects the price of a patent being traded.

Heckman's sample selection model is based on the following two latent variable models:

[10] In the U.S. patent system, patent owners have to pay a renewal fee 3.5, 7.5, and 11.5 years after they file a patent. The renewal fee varies across types of patentees and renewal periods.
[11] Sneed and Johnson (2009) claim the possibility that surplus-enhancing transfer attributed to patent renewal will become lower with the approach of patent expiration.

$$d_{it}^{*} = Z_{it}\gamma_i + u_{1i} \quad ; \tag{1}$$

$$y_{it}^{*} = X_{it}\beta_i + u_{2i} \quad , \tag{2}$$

where *Z* and *X* are vectors of regressors, and the disturbances u_1 and u_2 are assumed to be the zero-mean, bivariate normal distributed with unit variances and a correlation coefficient *ρ*. The two latent variables cannot be observed; d_i=1 if d_i^*>0, and d_i=0 otherwise. The latent variable y_i^* is only observed and equals y_i if d_i=1.

The selection equation (1) explains what factors affect the probability that a patent will be successfully sold. Vector *Z* stands for variables indicating types of patentees and patent characteristics that affect the bidder's decision to acquire a patent. Utilizing the specifications in Nair *et al*. (2011) and the empirical auction literature, the empirical specification is

$$\begin{aligned} Sale = {} & \beta_0 + \beta_1(\,Elapsedm\,) + \beta_2\,(Adjforward) + \beta_3(Backward) + \beta_4\,(Claims) \\ & + \beta_5\,(Scope) + \beta_6\,(Jump) + \beta_7\,(Dinventor) + \beta_8\,(\text{Corp\_nonpe}) \\ & + \beta_9(\text{Corp\_npe}) + \beta_{10}\,(Indiv) + \beta_{11}(Front) + \beta_{12}(Dob) + \beta_{13}\,(US) \\ & + \beta_{14}\,(d2007) + \beta_{15}\,(d2008) + \varepsilon \end{aligned} \quad ; \tag{3}$$

$$\begin{aligned} Sale = {} & \beta_0 + \beta_1(\,Elapsedm\,) + \beta_2\,(Adjforward) + \beta_3(Backward) + \beta_4\,(Claims) \\ & + \beta_5\,(Scope) + \beta_6\,(Jump) + \beta_7\,(Dinventor) + \beta_8\,(Indiv) \\ & + \beta_9(Corp\_small) + \beta_{10}\,(\text{Corp\_medium}) + \beta_{11}(\text{Corp\_large}) \\ & + \beta_{12}\,(\text{Corp\_npe}) + \beta_{13}\,(Front) + \beta_{14}\,(Dob) + \beta_{15}\,(US) \\ & + \beta_{16}\,(d2007) + \beta_{17}(d2008) + \varepsilon \end{aligned} \quad . \tag{4}$$

The outcome equation (2) examines the determinants of the patent's final price, assuming that the patent has been sold. The explanatory variables included are similar to those in the decision equation. The empirical specification is as follows:

$$\begin{aligned} \ln price = {} & \gamma_0 + \gamma_1(\,Elapsedm\,) + \gamma_2\,(Adjforward) + \gamma_3(Backward) + \gamma_4\,(Claims) \\ & + \gamma_5\,(Scope) + \gamma_6\,(Jump) + \gamma_7\,(Dinventor) + \gamma_8\,(\text{Corp\_nonpe}) \\ & + \gamma_9(\text{Corp\_npe}) + \gamma_{10}\,(Indiv) + \gamma_{11}(Front) + \gamma_{12}\,(US) + \gamma_{13}\,(d2007) \\ & + \gamma_{14}\,(d2008) + \gamma(Inverse\ mill\ ratio) + \mu \end{aligned} \quad ; \tag{5}$$

$$\begin{aligned}\ln price = {} & \gamma_0 + \gamma_1(Elapsedm) + \gamma_2(Adjforward) + \gamma_3(Backward) + \gamma_4(Claims) \\ & + \gamma_5(Scope) + \gamma_6(Jump) + \gamma_7(Dinventor) + \gamma_8(Indiv) \\ & + \gamma_9(Corp - small) + \gamma_{10}(\text{Corp\_medium}) + \gamma_{11}(\text{Corp\_large}) \\ & + \gamma_{12}(\text{Corp\_npe}) + \gamma_{13}(Front) + \gamma_{14}(US) + \gamma_{15}(d2007) + \gamma_{16}(d2008) \\ & + \gamma(iInverse\ mill\ ratio) + \mu\end{aligned} \quad . \quad (6)$$

4.2 Variable description

As mentioned previously, a variety of patent characteristics, types of patentees and market characteristics have been included as determinants in both decision and value equations. In the following, we first introduce the dependent variable and then present the main determinants.

4.2.1 Dependent variable

In equations (3) and (4), the dependent variable *s* is a dummy variable equaling unity if a patent placed on the IP market is traded. On the other hand, the empirical specifications of outcome equation in (5) and (6), the dependent variable is the transaction price of auctioned patents. However, the price information contained in Ocean Tomo's patent auction catalogue is by each lot rather than individual patent. We thus use an adjusted transaction price in the sample.[12] As the patent renewal is a critical factor on determining economic value of patents (Burhop, 2010; Serrano, 2010), we adopt the numbers of patent renewals as the weight to calculate each patent's value. Moreover, we also use accumulated payment of renewal fees as the weight to construct the adjusted transaction price in order to implement a robust check.

4.2.2 Independent variable

Independent variables included in decision model of equations (3) and (4) are similar in that they are classified into three categories, namely, patent characteristics, types of

[12] The main reason for using individual patents rather than a lot as the observation is that it is hard to construct various variables of patent and holder characteristics for each lot. Although there might have bias arising from using the adjusted transaction price, it is smaller than that of constructing average patent characteristics for a lot. Moreover, this study has implemented a robustness check.

patentees and market characteristics. The difference in included variables is the classification regarding types of patentees. On the other hand, covariates in patent value equations (5) and (6) are the same as those in the decision model, except instead of the variable *dob* (whether the patentee set the opening bid) the inverse Mill's ratio is used.

Elapsedm denotes a patent's age which is measured by the number of months between issued date and auction. Theoretical models of patent value predict a monotonically positive relation between patent value and its lifetime (Nordhaus, 1967; Matutes *et al*., 1996). An older patent implies a smaller likelihood for commercial exploitation, thus it is less likely to transfer (Serrano, 2010) and has a lower potential value (Reitzoig, 2003; Odasso and Ughetto, 2010). Even though Nair *et al*. (2011) found an insignificant relationship between patent age and patent value, we expect it to have a negative impact on patent transfer and value.

Adjforward and *Backward* represent adjusted forward citation and backward citation, respectively. Forward citation is citations received from subsequent patents and it captures the technological importance of a patent. In the IP market, buyers may assess the potential value of patents through observing their forward citations, thereby implying a positive association between forward citations and the probability of transfer as well as the value of patents. Most previous studies have confirmed this argument (Harhoff et al., 1999, 2003; Nair *et al*., 2011; Odasso and Ughetto, 2010). However, one point worth noting is that the measures of forward citation used in previous studies, the total number of citations or average number of forward citations per year, are biased measures. It is because patents might be issued on various years and the number of forward citation is non-monotonic with time. This study thus adopts the "fixed-effects" approach proposed by Hall *et al*. (2001) to calculate the adjusted number of forward citation.[13] In contrast, backward

[13] Hall *et al*. (2001) proposed two approaches to remedy the measure of forward citation, namely, the fixed-effects approach and the quasi-structural approach.

citation, *Backward*, is the number of citations to other patents. The logic of these references is to present subject matter that is held against the claims of the application (Harhoff et al. 2003). Alternatively, a higher number of citations suggest that the patented technology is well developed and there is no considerable novelty compared with the prior art. These two opposing effects generally induce an insignificant impact, e.g., Nair *et al.* (2011) and Odasso and Ughetto (2010).[14]

Claim is the number of claims of the patent at the patent document. Coping with the increased costs of patent application and protection in the U.S., inventors tend to file only valuable patents with a higher number of claims, implying a positive relationship between claims and patent value (Lanjouw and Schankerman (1997). However, it possibly captures only patent complexity and is not related to patent value (Harhoff and Reitzig, 2004). *Scope* is the number of four-digit IPCs assigned and it has long been considered a measure of the breadth or scope of the patent. Lerner (1994) argued that the value of American biotechnology firms increases with the "scope" of the patents, while Merges and Nelson (1990) indicated that the economics of patent scope are rather complex and have no a clear-cut influence on patent value. Previous studies generally found an insignificant effect on patent transfer (Odasso and Ughetto, 2010) as well as patent value (Harhoff *et al.*, 2003; Nair *et al.*, (2011).

Jump is a dummy variable equaling unity if the patent has been renewed in the year before being placed on the live auction. Serrano (2010) claimed that the probability of an active patent being traded may increase after a renewal date, because the renewed patents imply a higher value. That is, there is a discrete jump in the probability that an active patent will be traded immediately. Burhop (2010) claimed the renewal before transfer is a costly signal, inducing potential buyers to a higher valuation. We expect this variable is

[14] Harhoff *et al.* (2003) and Sneed and Johnson (2009) found a positive and negative correlation between backward citations and patent value, respectively.

positively related to patent transfer and transaction price. *Dinventor* is a dummy variable which is equal to 1 if the patent has only one inventor. As the complexity of developing new technologies is rising sharply along with the technological progress, an invention with higher economic value can generally only be carried out with an R&D team.

As for the variables of the types of patentees, they enter the equation in two different combinations. In equations (3) and (5), we adopt others (government agency) as the base and include three patentee dummies. *Corp_nonpe*, *Corp_npe*, and *Indiv* which represent that patent holders are non-NPEs corporations, NPEs, and individual inventors. *Corp_npe* is one of the main concerned variables in this study. Serrano (2010) argued that small inventors lack sufficient capability to maintain their inventions and tend to put them on the IP market. They thus exhibit a higher probability of being traded. As NPEs are usually small inventors, we expect *Corp_npe* to associate with a positive coefficient in the decision equation, while whether or not NPEs' patents are more valuable is uncertain. In equations (4) and (6), we further separate non-NPE corporations into small, medium, and large innovators, as depicted in Figure 2. Correspondingly, the variable *Corp_nonpe* is replaced by three dummies: *Corp_small*, *Corp_medium*, and *Corp_large*.

The third category of variables is market characteristics, namely, *Front*, *Dob*, and *US*. *Front* is a dummy variable which is equal to 1 if the previous lot is successfully traded. This variable captures whether or not the atmosphere of a live auction is animated. The animated atmosphere may raise the probability of a lot being traded, even inducing a higher price. *Dob* is dummy variable equaling unity if the seller sets an opening bid for a lot and is included only in equations (3) and (4). Generally, a patent holder sets a lower opening bid, stimulating a potential buyer to bid a lot. Thus, it might positively relate to the probability of a patent being traded. *US* is a regional dummy which is equal to 1 if the live auction is held in the U.S. This variable can differentiate whether there are differences in probability of trade and patent value between US and European auctions. Finally, two year dummies (*d2007* and *d2008*) are also included. Table 3 summarizes definitions and basic statistics of variables.

[Insert table 3 approximately here]

4.3 Econometric problem

This study focuses mainly on the role of NPEs on patent transfer and its subsequent transaction price. However, this variable may suffer the endogenous problem. Table 2 shows that NPEs have fewer patents for auctions in the IP market organized by Ocean Tomo, while their patents experience a higher probability of being successfully traded and a higher average transaction price. Moreover, NPEs exhibit higher ratios of patent transfer and patent renewals relative to other types of patentees, but their patents are generally older than patents provided by other patentees in the market of live auction. The above observations suggest that NPEs might endogenously determine the behavior of maintaining patents, in order to facilitate patent transfer and raise transaction price through the costly signal.

To deal with this endogenous problem, we use the renewal fees to construct an instrument variable of NPEs. As noted in Serrano (2010), the mandatory renewal fees in the U.S. patent system are not due annually, creating some interesting testable implications on the relationship between patent renewal and the probability of a patent being traded. For example, patents with the same age should have a substantial difference in value in different auction years. Specifically, the mechanism of renewal fees has been revised several times in the USPTO. For example, as depicted in Figure 3, the renewal fee mechanism for small entities changed every five years during the 1995-2011 period. The expense for the first time renewal (3.5 years) increased 73.85% from US$325 in 1998 to US$565 in 2011, while the corresponding renewal fee in the 11.5th year increased sharply from US$990 to US$2,365, approximately 2.39 times. Therefore, this study adopts the accumulated payment of renewal fees before a patent being placed on the IP market

(*Renewalfee*) as an instrumental variable for the NPE's variable.

[Insert figure 3 approximately here]

5. Empirical Results and Discussions

5.1 Empirical Results

Table 4 reports a series of estimations from equations (3) and (5). That is, patentees are classified into non-NPE corporations, NPEs, individuals, and others. Panel A reports estimates obtained with consideration of the endogenous problem by using accumulated renewal fees as an instrumental variable of NPEs, while the estimates in Panel B are obtained without considering the endogeneity. Despite both estimations reaching similar results, the estimated magnitude on coefficients of patentee types and some variables exhibit a substantial difference.

[Insert table 4 approximately here]

Elaspedm captures a patent's age and it is as expected to associate with a significant coefficient in equations of patent transfer and transaction price. An older patent denotes a shorter residual life, thereby possessing less value for commercial exploitation. Thus, potential buyers have a lower willingness to bid on the patent. Even though the lot has been traded, it receives a lower valuation, *ceteris paribus*.

Estimates of the adjusted number of forward citations (*Adjforward*) show that the technological importance of a patent indeed increases the probability of being traded and the transaction price. This result is consistent with findings obtained in previous studies, e.g., Harhoff *et al*. (2003), Nair *et al*. (2011), and Odasso and Ughetto (2010). The magnitude of the effect indicates that an increase in one adjusted forward citation would lead to an increase of about 0.03 percent in successful trade and 0.12 percent in patent value. One point worth mentioning is the estimated value elasticity of forward citation is much higher if the endogenous problem of NPEs is not dealt with. On the other hand, the estimated coefficient of backward citation is not significant in all estimations. This is because the number of backward citation might denote two opposing effects influencing patent transfer, thereby resulting in an insignificant impact.

Both variables of patent breadth and scope (*Claims* and *Scope*) are not associated with a significant coefficient in most specifications. As mentioned in Harhoff *et al*. (2003), the economics of patent scope are rather complex, thereby generally leading to unclear relation in empirical estimations, such as Nair *et al*., (2011) and (Odasso and Ughetto, 2010). Interestingly, renewing a patent before placing it on the IP market does not induce a significant increase in the trade probability. That is, the "jumping effect" claimed by Serrano (2010) is not witnessed in this study. In contrast, the behavior of patent renewal contributes positively and significantly to raising transaction price, supporting Burhop's (2010) point that renewal before transfer is a costly signal. Moreover, the estimated coefficient on *Dinventor* is expected to have a significant negative effect in estimations considering the endogenous problem (Panel A).

Turning to the main variables we are concerned with, types of patentees, we find that the significance and magnitude of these effects are much stronger after dealing with the endogenous problem. Compared with patents owned by others (government agencies), patents owned by individual inventors, non-NPEs corporations, and NPEs are more likely to be traded as well as receiving a higher valuation. In particular, the estimated magnitude of NEPs variable point out, NEPs' patents have a higher probability of 5.69% to being traded and assuming patents are traded, their transaction price is 23.16% higher than other patents held by the base group (government, university and research institute). As shown in Table 2, the average price of NPEs' patents is about three times higher than that of the base group. These finding lend insightful implications for the role of NPEs on the IP market. NPEs are widely criticized as patent trolls and cause welfare loss by discouraging innovations of R&D intensive manufacturing firms. However, our results show that, given

NPEs emerge in the IP market; their patents seem to be appreciated by some potential buyers and received a higher valuation. This supports the standpoints of Shrestha (2010) and Fischer and Henkel (2012) that NPEs may enhance innovation and competition through focusing on R&D rather than manufacturing and thereby create an efficient market for patent trade.

As for the influence of market characteristics, *Front* is not expected to associate with a significantly positive coefficient after considering the endogenous problem. While an animated atmosphere can stimulate buyers' willingness to bid, buyers are serious on determining whether or not to bid a patent, as patents are specific and high price commodities. Consistent with empirical auction studies, setting an opening bid (*Dob*) for a lot is helpful for raising the probability of a patent being traded. Moreover, compared with auctions held in Europe, patents auctioned in the U.S. are more likely to be traded and exhibit a higher transaction price. Finally, both year dummies have a significantly positive coefficient, suggesting that the probability of a patent being traded and transaction price increase along with time passing. That is, the market of patent live auction has gradually become a more active market.

When we separate patentees into five types and implement empirical estimations, results are reported in Table 5. Compared with results shown in Panel A of Table 4, the results are almost the same but there is one point worth mentioning. Drawn from estimates on types of patentees, our finding supports Serrano's (2010) argument, that there are some differences in the rate of transfer. Small-innovators and private inventors are the most active sellers of patents whereas government agencies are the least. Crucially, the key finding not explored in Serrano (2010) is that NPEs are more active sellers than other small-innovators and private inventors.

[Insert table 5 approximately here]

5.2 Robustness Check

As in the aforementioned discussion, Ocean Tomo's patent auction catalogue provides price information for each lot rather than individual patents. In our sample, we use the number of patent renewals as the weight to calculate each patent's price. In this section, we would like to implement the robustness check by using alternative weights to calculate their values. Using the accumulated payment of renewal fees as the weight to construct the adjusted transaction price, the empirical estimates are reported in Table 6.

[Insert table 6 approximately here]

We only focus on estimates in the value equation, since the results of first-stage estimations are the same. There are three points worth mentioning. First, the estimated coefficient of *Claims* turns out to be significantly positive at the 10% statistical level, lending to weak support to findings in Lanjouw and Schankerman (1997) that there is a positive relationship between the number of claims and patent value in the U.S. Second, all estimated coefficients on variables of patentee types remain significantly positive, but the magnitudes of these effects are considerable lower. For example, the coefficient magnitude of NEPs decreases 15.44% from 19.9334 to 16.8558, suggesting that a more precise measure for individual patent within a multi-patent lot is needed. Third, in contrast, the estimated magnitude of regional and year dummies increase relative to those in Table 5.

6. Concluding Remarks

Along with the development of the live auction held by Ocean Tomo, the IP market has gradually become more active to facilitate technology transfer. NPEs, the debatable innovators, not only continue to generate profits from patent licensing and infringement, but also emerge as sellers in the IP market of live patent auctions. Do patents owned by NPEs exhibit considerable difference in the probability of being auctioned and the transaction price relative to those of other patentees? This study investigates the determinants of patent transfer and patent value by focusing on the role of types of patentees. Based on the unique price information contained in Ocean Tomo's patent auction catalogue, we examine what factors affect an individual patent's real market value.

Using a two-step approach to control for the sample selection problem and adopting an instrumental variable approach to deal with the endogenous problem of NPEs, the findings are summarized as follows. First, among various patent characteristics, patent age, forward citation, and whether a patent has only a single innovator are significantly related to the probability of a patent being trade as well as transfer prices. However, due to the complexity that patent breadth and scope capture, there seems to be no clear-cut relation with patent value, as argued in Harhoff and Reitzig (2004).

Second and crucially, as claimed in Serrano (2010), the proportion of transferred patents is large and differs across types of patentees. Specifically, we find that NPEs patents are much more likely to be transferred than other's patents. Controlling for the endogenous problem,, the estimation of patent value equation indicates that NPEs' patents receive a much higher valuation by buyers relative to patents owned by other types of patentees. A robustness check has also confirmed this finding. This result lends light to the debate regarding whether NEPs are trolls or market-makers of technology. Under this typical mechanism of patent transfer, NPEs are positively associated with the probability and the price of patent transfer. The implication is that NPEs can help financially constrained inventors to enhance innovation and competition, as claimed in Shrestha (2010), through facilitating patent transfer.

In addition, a patent's auction price is higher if it is renewed within one year prior to auction, supporting the hypothesis of a jumping effect proposed in Serrano (2010). If patentees make the opening bid, their patents have a higher likelihood of being successfully traded. Finally, the market of the live patent auction turns out to be more active, as the magnitudes of year effects increase gradually. This development is encouraging from the standpoint of awakening sleeping patents.

There is one limitation worth mentioning. In reality, the number of NPEs patents accounts for only a small share (1.43%) of all Ocean Tomo live auction patents and they are owned by 3 NPEs. Compared with the total number of sellers in our data which is 176, or the existing number of more than 640 NPEs, according to PatentFreedom.com, further studies using more NPEs patents to implement empirical estimations are needed.

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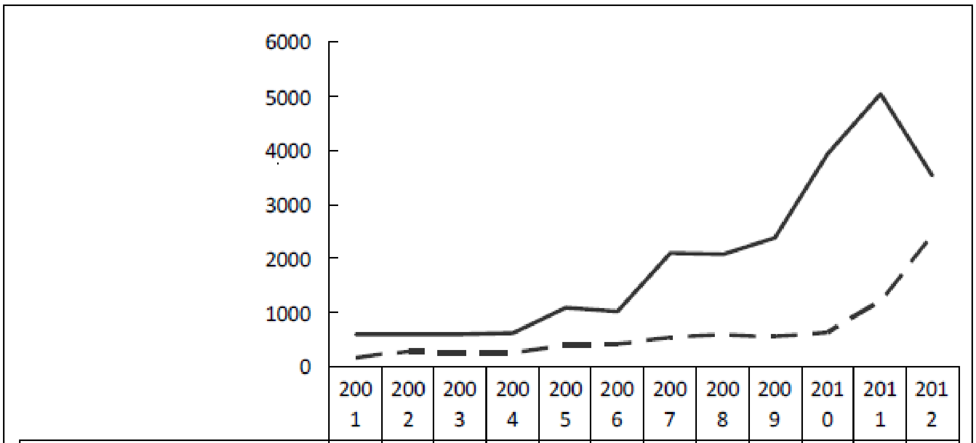
Figure 1 Non-Practicing Entities (NPEs) and Patent Litigations



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
number of companies involved in NPEs lawsuits	578	593	584	611	1079	1014	2089	2074	2371	3921	5031	3538
number of NPEs lawsuits	144	259	237	235	381	390	519	558	545	620	1211	2414

Data Source: Patent Freedom © 2012. Data captured as of July 13, 2012.

Figure 2 Types of Patentees

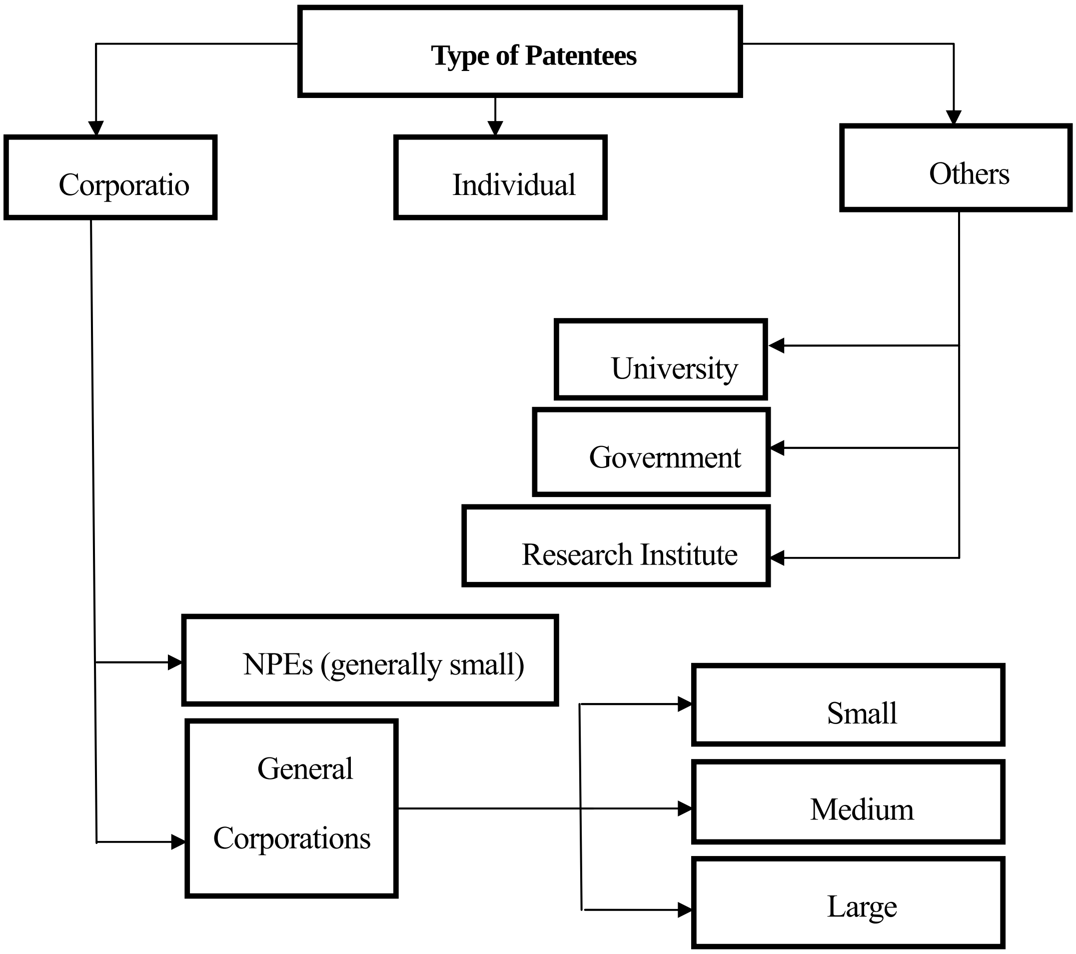
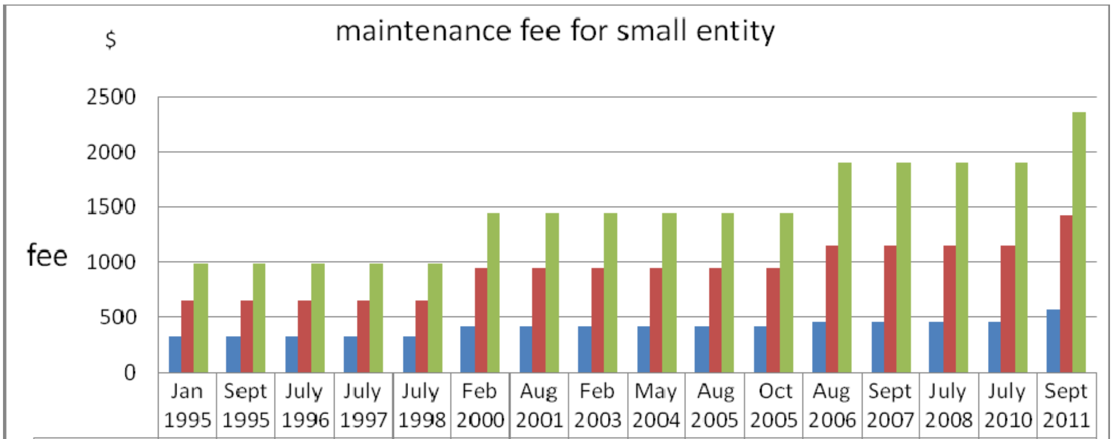


Figure 3 Maintenance Fees for Small Entities



	Jan 1995	Sept 1995	July 1996	July 1997	July 1998	Feb 2000	Aug 2001	Feb 2003	May 2004	Aug 2005	Oct 2005	Aug 2006	Sept 2007	July 2008	July 2010	Sept 2011
3.5 year	325	325	325	325	325	415	415	415	415	415	415	450	450	450	450	565
7.5year	655	655	655	655	655	950	950	950	950	950	950	1150	1150	1150	1150	1425
11.5 year	990	990	990	990	990	1455	1455	1455	1455	1455	1455	1900	1900	1900	1900	2365

Table 1 Sample Distribution in Various Live Auctions

Date	*Place*	*Number of patents bid on*	*Number of auctioned patents*
2006/10/26	New York	238	39
2007/04/19	Chicago	133	80
2007/06/01	London	87	25
2007/10/25	Chicago	138	65
2008/04/02	San Francisco	114	71
2008/06/26	Amsterdam	101	59
2008/10/30	Chicago	165	76
Total		976	415

Source: Ocean Tomo, LLC.

Table 2 Patentee Distribution of Patent Transfers in the Sample

	Type of Patentee	(1) Number and share of patents	(2) Number and share of those sold	(3) Average patent price Sale value($)/patents	(4) Ratio of Renewal	(5) Time from patent issue to auction (month)
Corporation	Large(>100)	98 (10.04%)	21 (21.43%)	2,042,590/21 =97,266.19	74.49%	69.868
	Medium (5~100)	165 (16.91%)	57 (34.55%)	5,025,090/57 =88,159.47	67.27%	69.511
	Small(<5)	420 (43.03%)	196 (46.67%)	33,792,967/196 =172,413.10	64.52%	71.122
	NPEs	14 (1.43%)	7 (50.00%)	1,089,000/7 =155,571.43	78.57%	108.56
Individual	Patents owned by individual assignees	237 (24.28%)	116 (48.95%)	21,168,841/116 =182,490.01	64.14%	70.398
Others	Government, University, and research institute	42 (4.30%)	18 (42.86%)	925,045/18 =51,391.39	73.81%	63.599

Source: summarized by authors.

Table3 Variable Definition and Basic Statistics

Name	Definition	Mean	Standard Dev.	Minimum	Maximum
lnprice	Logarithm of weighed transaction price	11.24558	1.244543	7.970649	14.86633
Sale	Dummy variable: 1=a patent is successfully traded	0.425205	0.494628	0	1
Elapsedm	Patent age: the number of months between issued date and auction.	70.7612	48.03775	1.466667	220.8333
Adjforward	Adjusted number of forward citation	1.018701	1.719788	0	16.87413
Backward	The number of backward citation	17.36066	22.68019	0	179
Claims	The number of claims	20.51639	17.09202	0	184
Scope	The number of four-digit IPCs assigned	3.776749	2.923775	1	38
Jump	Dummy variable: 1= the patent has been renewed in the year before being placed on the live auction.	0.163934	0.370406	0	1
Indiv	Dummy variable: 1= the seller is an individual inventor	0.242828	0.429012	0	1
Corp_small	Dummy variable: 1= the seller is a small corporation inventor (excluding NPEs)	0.430328	0.495376	0	1
Corp_medium	Dummy variable: 1= the seller is a medium corporation inventor (excluding NPEs)	0.169057	0.374995	0	1
Corp_large	Dummy variable: 1= the seller is a large corporation inventor (excluding NPEs)	0.100410	0.300671	0	1
Corp_nonpe	Dummy variable: 1= the seller is a corporation (excluding NPEs)	0.699795	0.458582	0	1
Corp_npe	Dummy variable: 1= the seller is an NPE	0.014344	0.118966	0	1
Dinventor	Dummy variable: 1=a patent has a single inventor	0.507172	0.500205	0	1
US	Dummy variable: 1= the live auction is held in the U.S.	0.807377	0.394562	0	1
D2007	Dummy variable: 1= the live auction was held in 2007.	0.366803	0.482180	0	1
D2008	Dummy variable: 1= the live auction was held in 2008.	0.389344	0.487852	0	1
Dob	Dummy variable: 1= a lot sets the opening bid	0.071721	0.258158	0	1
Front	Dummy variable: 1=the previous lot is successfully traded	0.426230	0.494782	0	1
Renewalfee (IV of NPEs)	Accumulated renewal fees between filed dates and auction (including delayed fine) (US$ thousand)	1.213412	1.630282	0	7.1

Table 4 Empirical Results (with vs. without endogenous treatment)

	Panel A (with endogenous treatment)					Panel B (without endogenous treatment)				
Dependent variable	I. Sale			II. lnprice		I. Sale			II. lnprice	
	Coef.	marginal effect	Z	Coef.	t	Coef.	marginal effect	z	Coef.	z
Elapsedm	-0.0057***	-0.0022***	-3.32	-0.0053***	-3.63	-0.0021**	-0.0008**	-2.31	-0.0043	-0.79
Adjforward	0.0875***	0.0340***	3.24	0.1228***	3.83	0.0756***	0.0294***	2.83	0.2613*	1.88
Backward	-0.0037	-0.0014	-1.56	-0.0033	-0.89	-0.0024	-0.0009	-1.00	-0.0086	-0.63
Claims	-0.0040	-0.0015	-1.08	0.0029	0.77	0.0028	0.0011	1.11	0.0212*	1.64
Scope	0.0104	0.0041	0.59	0.0256	1.13	-0.0064	-0.0025	-0.38	-0.0152	-0.18
Jump	0.1157	0.0453	1.00	0.6420***	4.62	0.1143	0.0448	0.99	0.9294*	1.68
Dinventor	-0.2401**	-0.0933**	-2.36	-0.5133***	-4.51	-0.1269	-0.0493	-1.39	-0.6359	-1.40
Indiv	**3.9530*****	**0.8797*****	**2.71**	**7.3094*****	**8.48**	**0.4219***	**0.1659***	**1.71**	**2.6044****	**2.33**
corp_nonpe	**4.0371*****	**0.8385*****	**2.66**	**7.0057*****	**7.86**	**0.3674**	**0.1394**	**1.50**	**1.9407***	**1.84**
corp_npe (IV)	**14.6354*****	**5.6943*****	**2.69**	**23.1595*****	**7.13**	**1.1354*****	**0.4100*****	**2.79**	**4.4058***	**1.91**
Front	0.1558	0.0607	1.39	-0.2897	-1.57	0.3301***	0.1284***	3.74	0.7703	1.18
Dob	1.4311***	0.4934***	3.48			0.5518***	0.2174***	2.98		
US	0.2600**	0.0988**	2.27	0.3234**	2.06	0.1751	0.0671	1.60	0.5879	0.96
d2007	1.3583***	0.5025***	5.51	1.2316***	3.65	0.8606***	0.3310***	6.48	2.7704*	1.83
d2008	1.6892***	0.6013***	5.60	1.9651***	5.20	1.0424***	0.3954***	7.66	3.6799**	2.13
Mills (lambda)				1.4192**	2.52				5.0539**	2.20
constant	-5.2377***		-3.37	1.8704**	2.01	-1.5238***		-4.83	1.0460	0.26
R2(Adj R2)				0.3252(0.2998)						
Wald chi2(p>chi2)								12.09(0.5991)		
Number of observation		972		415			972		415	

Note：***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 5 Empirical Results: Six Types of Patentees (with endogenous treatment)

Dep. variable	Sale			lnprice	
	Coef.	marginal effect	z	Coef.	t
elapsedm	-0.0054***	-0.0021***	-3.05	-0.0044***	-2.97
adjforward	0.0851***	0.0331***	3.13	0.1430***	4.37
backward	-0.0035	0.0013	-1.42	-0.0025	-0.67
Claims	-0.0037	-0.0014	-0.99	0.0049	1.26
Scope	0.0099	0.0038	0.56	0.0226	1.00
Jump	0.1253	0.0491	1.08	0.7145***	4.97
dinventor	-0.2477**	-0.0961**	-2.44	-0.5676***	-4.80
Indiv	**3.7429****	**0.8681*****	**2.43**	**6.4705*****	**6.81**
corp_small	**3.8416****	**0.9449*****	**2.42**	**6.2401*****	**6.50**
corp_medium	**3.8508****	**0.8092*****	**2.37**	**5.7184*****	**5.48**
corp_large	**3.5838****	**0.7204*****	**2.16**	**5.7724*****	**4.97**
corp_npe (IV)	**13.7882****	**5.3610****	**2.39**	**19.9304*****	**5.49**
Front	0.1672	0.0651	1.48	-0.1388	-0.70
Dob	1.3846***	0.4830***	3.22		
US	0.2765**	0.1048**	2.33	0.3023*	1.85
d2007	1.2978***	0.4829***	4.86	1.4492***	4.31
d2008	1.6294***	0.5842***	4.96	2.1869***	5.78
mills (lambda)				2.1088***	3.29
Constant	-5.0054***		-3.02	1.7982*	1.94
R2(Adj R2)				0.3378(0.3095)	
Number of observation	972			415	

Note：***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 6 Robustness Check

Dependent variable	Sale			lnprice	
	Coef.	marginal effect	z	Coef.	t
Elapsedm	-0.0055***	-0.0021***	-3.05	-0.0039***	-2.65
Adjforward	0.0851***	0.0331***	3.13	0.1631***	4.96
Backward	-0.0035	0.0013	-1.42	-0.0027	-0.74
Claims	-0.0037	-0.0014	-0.99	0.0072*	1.84
Scope	0.0099	0.0038	0.56	0.0198	0.87
Jump	0.1253	0.0491	1.08	0.7829***	5.42
Dinventor	-0.2477**	-0.0961**	-2.44	-0.6163***	-5.18
Indiv	**3.7429****	**0.8681*****	**2.43**	**5.6973*****	**5.97**
corp_small	**3.8416****	**0.9449*****	**2.42**	**5.4429*****	**5.64**
corp_medium	**3.8508****	**0.8092*****	**2.37**	**4.8031*****	**4.58**
corp_large	**3.5838****	**0.7204*****	**2.16**	**4.7417*****	**4.06**
corp_npe	**13.7882****	**5.3610****	**2.39**	**16.8558*****	**4.62**
Front	0.1672	0.0651	1.48	0.0276	0.14
Dob	1.3846***	0.4830***	3.22		
US	0.2765**	0.1048**	2.33	0.3707**	2.26
d2007	1.2978***	0.4829***	4.86	1.6331***	4.84
d2008	1.6294***	0.5842***	4.96	2.4128***	6.34
mills (lambda)				2.7032***	4.19
Constant	-5.0054***		-3.02	1.6957*	1.82
LR chi2(p>chi2)	154.69(0.0000)				
R2(Adj R2)				0.3391(0.3108)	
Number of observations	972			415	

Note：***, **, and * denote statistical significance at the 1%, 5%, and 10% leves, respectively.