

# Patent Publication and the Market for Ideas: Online Supplementary Appendix

## A. Theoretical framework

### A1. Baseline framework

We develop a simple model that considers the benefits and costs of public disclosure, with the goal of understanding AIPA's effects on inventors' decisions on when to license their inventions.

Let  $T_a$ ,  $T_d$ ,  $T_g$ , and  $T$  denote, respectively, the dates for application, publication, grant, and patent expiration. Before AIPA,  $T_d = T_g$  and after AIPA,  $T_d < T_g$ . Let the per-period baseline licensing revenue be  $v$ , which is the average revenue the licensor obtains given the observable characteristics, including the fact that the invention is licensed before both events. Let  $d$  be the effect of public disclosure on the per-period revenue if the licensor waits until the publication event, and  $g$  be the effect of clarifying IP rights if the licensor waits until the grant event. Note that these effects are deviations from the average revenue  $v$  and, thus, can be positive or negative. Disclosure is often accompanied by expropriation risk. Let the probability of inventing around be  $\rho < 1$  if the inventor chooses to voluntarily disclose before publication during the process of searching and negotiating with potential licensees. Let the probability be 1 after publication, which is a simple way of reflecting a higher expropriation risk on public disclosure. Let  $\Delta$  be the expected loss to the inventor each period, given expropriation.

Given the model setup, the following describes the payoffs from licensing at different timings and the decision rules under different disclosure regimes.

#### The licensor's timing decision before AIPA.

Given an invention, the inventor can either license the invention immediately after the application date or wait until the patent allowance date. The payoff from licensing right away is

$$U_a^{\text{before}} = (1 - \rho)vT_g + \rho(v - \Delta)T_g + (v - \Delta)(T - T_g).$$

For periods before patent grant, with probability  $1 - \rho$ , the inventor enjoys per-period revenue  $v$ ; and with

probability  $\rho$ , the revenue is offset by  $\Delta$  because of “inventing around.” After the patent grant date, the invention becomes public, and inventing around happens with probability 1.

The inventor’s payoff from licensing after the patent grant date is

$$U_g^{\text{before}} = (v + d + g - \Delta)(T - T_g).$$

The inventor receives no revenue in the periods before patent grant; after grant, the per-period licensing revenue changes by  $d + g$ , the net effect from publication and the clarification of patent rights. Hence, the inventor licenses the invention immediately if and only if the net benefit from earning licensing revenues for  $T_g$  more periods, while risking information leakage through the negotiation process, is greater than the combined net effect from public disclosure and the clarification of patent rights for the rest of the patent protection period. In other words,

$$(v - \rho\Delta)T_g > (d + g)(T - T_g). \quad (1)$$

The licensor’s timing decision after AIPA.

The inventor chooses among three alternative dates for licensing in the post-AIPA period; the payoffs of the three alternatives are, respectively,

$$U_a^{\text{after}} = (1 - \rho)vT_d + \rho(v - \Delta)T_d + (v - \Delta)(T - T_d),$$

$$U_d^{\text{after}} = (v + d - \Delta)(T - T_d),$$

$$U_g^{\text{after}} = (v + d + g - \Delta)(T - T_g) - \Delta(T_g - T_d).$$

Note that the term  $-\Delta(T_g - T_d)$  in  $U_g^{\text{after}}$  reflects that, once the patent application becomes public, inventing around would depress the inventor’s revenues regardless of the licensing decision.

The inventor licenses immediately after application if neither the benefit from waiting for disclosure nor the benefit from waiting for the clarification of patent rights outweighs the benefits from obtaining a longer period of royalties while risking information leakage from the negotiation process; that is,

$$(v - \rho\Delta)T_d > d(T - T_d) \ \& \ vT_g - \rho\Delta T_d > (d + g)(T - T_g). \quad (2)$$

The inventor licenses after publication if the net benefit from disclosure is greater than the lost net profits

of  $T_d$  period and if the marginal benefit from clarifying intellectual property (IP) rights is less than losing revenues for  $T_g - T_d$  periods; that is,

$$(v - \rho\Delta)T_d < d(T - T_d) \ \& \ (v + d)(T_g - T_d) > g(T - T_g). \quad (3)$$

The inventor waits until patent grant if neither of the above two conditions is met.

## A2. Incorporating enforcement

This section incorporates the enforcement of inventors' rights into our theoretical framework, with the goal of understanding how the granting of provisional rights might affect the timing of licensing. Before AIPA, the inventors' right to recoup royalties from infringers started from the grant date of their patents, while after AIPA, pre-grant publication allows inventors to demand royalties from the 18-month publication date (so long as the granted patent application substantially resembles the published application). In order to understand the distinct effects of provisional rights (separate from that of pre-grant publication) on the timing of licensing, we first incorporate enforcement without the grant of provisional rights (that is, even after AIPA, the inventor can only recover the losses from infringement from the grant date). We then add the provisional rights that allow recovering royalties from the publication date.

Recall that “inventing around” reduces the inventor's per-period revenue by  $\Delta$ . Suppose, now, that with probability  $\gamma$ , the inventor recovers the loss through enforcement for periods after patent grant. This implies that, relatively to the framework used in the paper (see Appendix A1 for details), a term  $\gamma\Delta(T - T_g)$  is added to all the payoff functions (regardless of the disclosure regime and the licensing timing). Specifically, the inventor's payoffs before AIPA are:

$$U_a^{\text{before}} = (1 - \rho)vT_g + \rho(v - \Delta)T_g + (v - \Delta)(T - T_g) + \gamma\Delta(T - T_g),$$

$$U_g^{\text{before}} = (v + d + g - (1 - \gamma)\Delta)(T - T_g) + \gamma\Delta(T - T_g).$$

Thus, the inventor licenses after the grant date if and only if

$$(v - \rho\Delta)T_g > (d + g)(T - T_g).$$

After AIPA, the inventor's payoffs are:

$$U_a^{\text{after}} = (1 - \rho)vT_d + \rho(v - \Delta)T_d + (v - \Delta)(T - T_d) + \gamma\Delta(T - T_g),$$

$$U_d^{\text{after}} = (v + d - \Delta)(T - T_d) + \gamma\Delta(T - T_g),$$

$$U_g^{\text{after}} = (v + d + g - \Delta)(T - T_g) - \Delta(T_g - T_d) + \gamma\Delta(T - T_g).$$

The inventor licenses after application if and only if

$$(v - \rho\Delta)T_d > d(T - T_d) \ \& \ vT_g - \rho\Delta T_d > (d + g)(T - T_g),$$

and licenses after publication if and only if

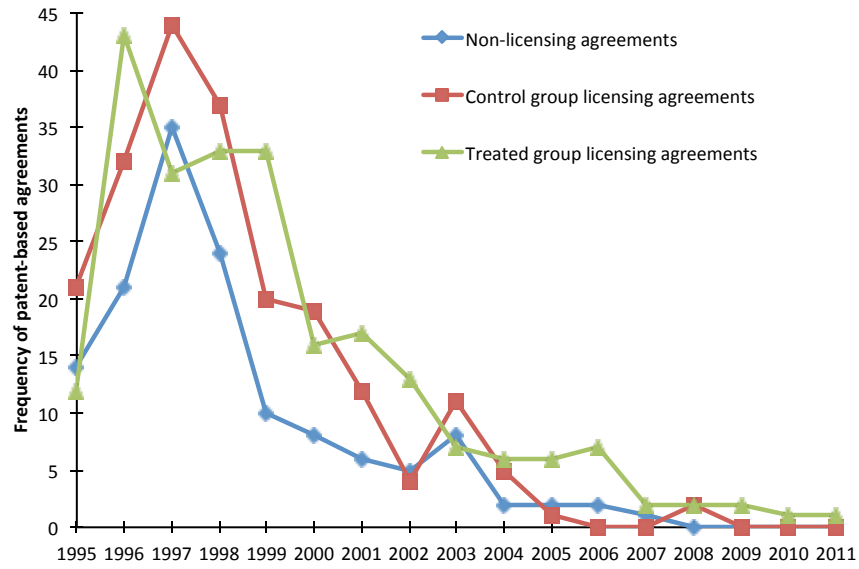
$$(v - \rho\Delta)T_d < d(T - T_d) \ \& \ (v + d)(T_g - T_d) > g(T - T_g).$$

Because the same term is added to all payoffs (and, hence, the relative tradeoffs between licensing timings remain unchanged), the decision rules are the same as what we have in the paper.

We now add provisional rights that allow the inventor to also recover the losses from infringement between the publication and the grant dates. Relative to the above version of the model, this means adding a term  $\gamma\Delta(T_g - T_d)$  to all the three payoff functions in the post-AIPA regime. Similarly, the decision rules do not change. Therefore, comparing the two versions of the framework with enforcement, given that the inventor does not opt out of pre-grant publication, changing the right to recoup the royalty to the publication date alone does not change the timing of licensing. Of course, this result does not mean that provisional rights do not matter. They may matter because the ability to collect royalties after publication may reduce the expropriation concerns overall and, hence, affect the inventor's decision to patent or to opt-out of publication. But once they choose to patent and to publish after 18 months, at least in the simple framework of ours, the provisional rights alone do not seem to affect the relative merits of different licensing timings.

## B. Figures and Tables

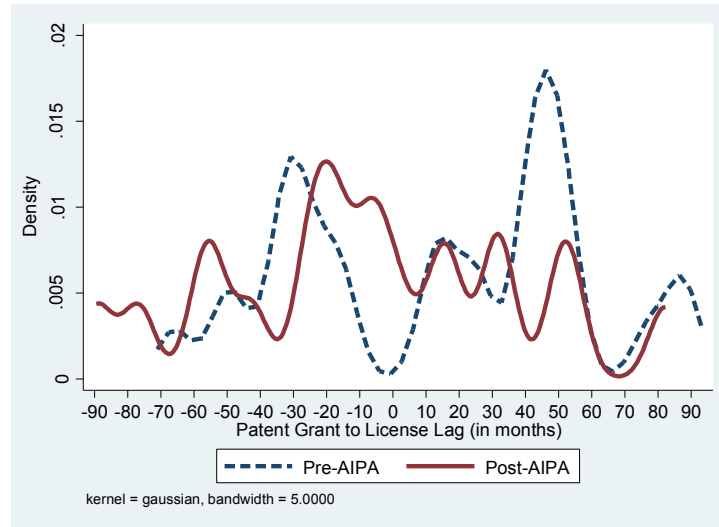
Figure B1: Number of patent-based agreements by patent application year



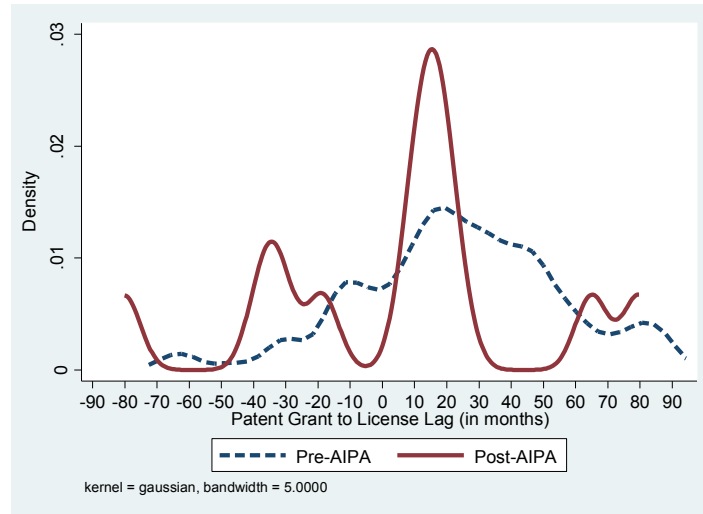
*Notes:* The figure plots the number of licenses by application year for three groups: (1) treatment-group licenses that are based on US patents without foreign equivalent; (2) control-group licenses that are based on either foreign patents alone or US patents with foreign equivalent; and (3) non-licensing agreements of types such as manufacturing, distribution, and marketing that are based on US patents without foreign equivalent.

Figure B2: Distribution of licensing delays from patent grant date for control-group patents

(a) Foreign patents

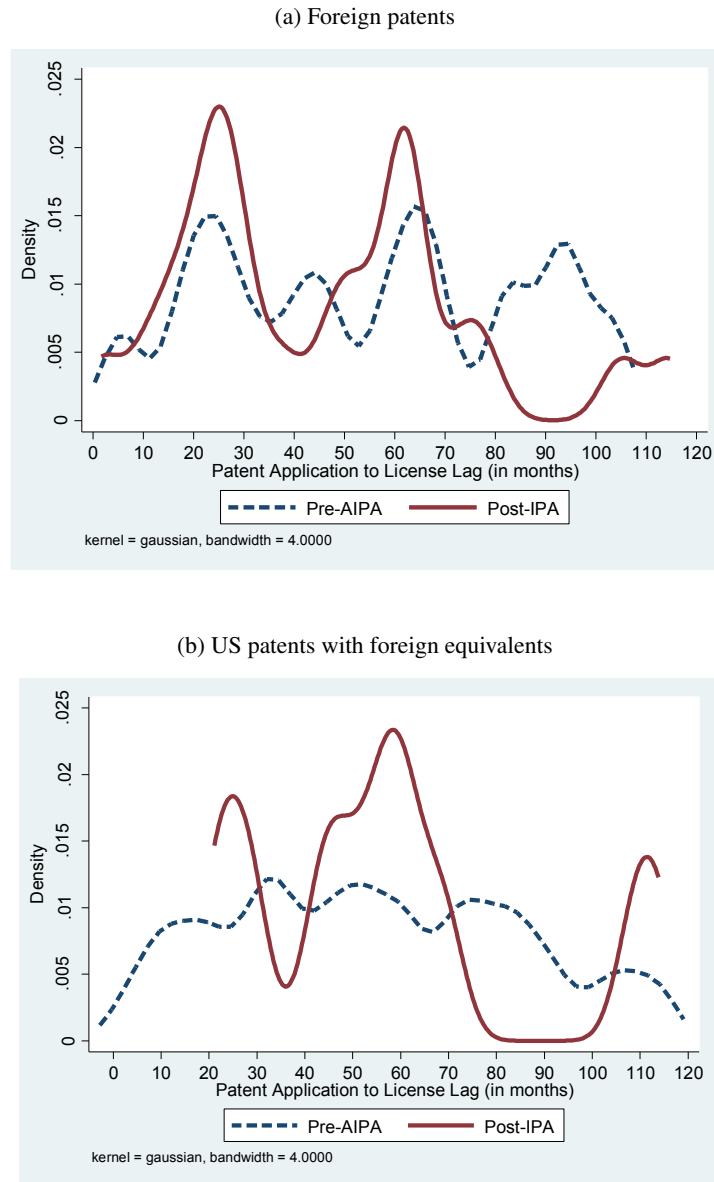


(b) US patents with foreign equivalents



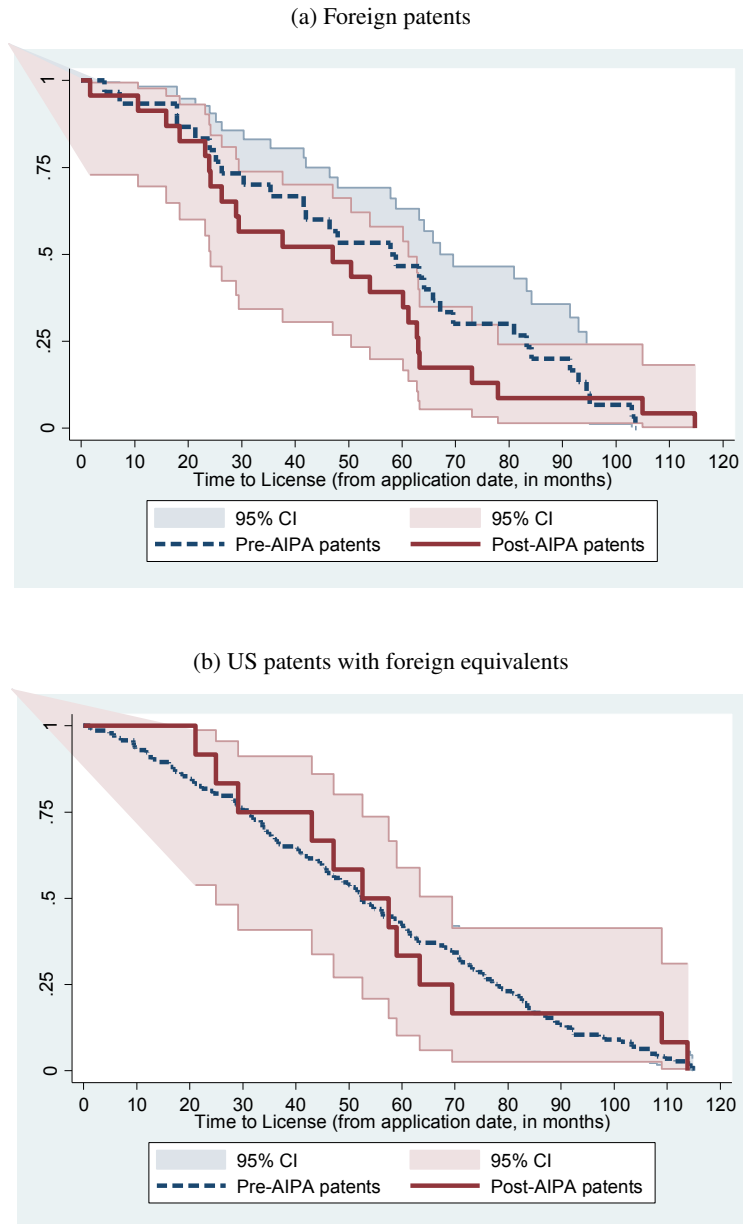
Notes: The figure shows kernel density estimates of the distribution of licensing lags (patent license date—patent grant date) in months for pre-AIPA and post-AIPA patent applications in the control group. Zero on the horizontal timeline indicates that licensing happened in the same month in which the patent was granted. Figure (a) displays density for licenses of pure foreign patents (without US equivalents) and (b) for licenses of US patents with foreign equivalents.

Figure B3: Distribution of licensing delays from patent application date for control-group patents



Notes: The figure shows kernel density estimates of the distribution of licensing lags (patent license date—patent application date) in months for pre-AIPA and post-AIPA patent applications in the control group. Zero on the horizontal timeline indicates that licensing happened in the same month in which the patent was applied for. Figure (a) displays density for licenses of pure foreign patents (without corresponding US equivalents) and (b) for licenses of US patents with corresponding foreign equivalents.

Figure B4: Survivor function of licensing for control-group patents



*Notes:* The figure plots the Kaplan-Meier survivor function of licensing for pre-AIPA and post-AIPA patents in the control group. Figure (a) displays density for licenses of pure foreign patents (without corresponding US equivalents) and (b) for licenses of US patents with corresponding foreign equivalents.

Table B1: Probit estimates of the probability of licensing (panel-structured data; control group)

Def. of the publication window Sample	18-28 months		18-30 months		18-32 months	
	72-month sample		72-month sample		72-month sample	
	(1)	(2)	(3)	(4)	(5)	(6)
Application window	0.02 [0.01]*	0.01 [0.01]	0.02 [0.01]*	0.01 [0.02]	0.02 [0.01]*	0.01 [0.02]
Publication window	0.01 [0.01]	0.00 [0.01]	0.01 [0.01]	-0.00 [0.01]	0.01 [0.01]	-0.00 [0.01]
Post AIPA × Application window	-0.01 [0.01]	-0.02 [0.02]	-0.01 [0.01]	-0.02 [0.02]	-0.01 [0.01]	-0.02 [0.02]
Post AIPA × Publication window	0.01 [0.01]	0.01 [0.01]	0.01 [0.01]	0.02 [0.01]	0.01 [0.01]	0.01 [0.01]
Post AIPA	0.01 [0.00]**	0.01 [0.01]	0.01 [0.00]**	0.00 [0.01]	0.01 [0.00]**	0.00 [0.01]
log(duration)	0.02 [0.00]**	0.02 [0.01]**	0.02 [0.00]**	0.02 [0.01]**	0.02 [0.01]**	0.02 [0.01]**
U.S. patent with foreign equivalent	-0.01 [0.00]+	-0.01 [0.01]	-0.01 [0.00]*	-0.01 [0.01]	-0.01 [0.00]*	-0.01 [0.01]
U.S. patent with foreign equivalent × Publication window	-0.01 [0.01]	-0.02 [0.01]	-0.01 [0.01]	-0.02 [0.01]	-0.01 [0.01]	-0.02 [0.01]
U.S. patent with foreign equivalent × Application window	-0.01 [0.01]	-0.02 [0.01]	-0.01 [0.01]	-0.02 [0.01]	-0.01 [0.01]	-0.02 [0.01]
Other controls	Y	Y	Y	Y	Y	Y
Observations	11,129	5,604	11,129	5,604	11,129	5,604
Pseudo R2	0.08	0.08	0.08	0.08	0.08	0.08
Log likelihood	-956	-621	-955	-621	-956	-621

*Notes:* The table presents Probit estimates (marginal effects) for licensing probability using a panel-structured data for control-group licenses, containing monthly observations for each license starting from the corresponding patent's application date until license date. The dependent variable equals 1 if licensing happens in any given particular month, and 0 otherwise. "Application window" equals 1 if the month is between patent application date and 18 months from application, 0 otherwise. "Publication window" equals 1 if the month is within 12 (or 14) months after 18-month publication, that is, 18 to 30 (or 32) months from application date. Other control variables included are the same as those used for the specifications reported in Column (2) of Table 4, including the number of patents, pendency, number of prior licensee deals, number of prior licensor deals, number of prior joint deals, for-profit licensor, knowhow transfer, exclusive license, number of potential buyers, potential buyers missing (dummy), and dummies for top therapeutic areas and technology classes. All models report robust standard errors clustered by licensor; \*\* p < 0.01, \* p < 0.05, + p < 0.1.