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How innovating firms manage knowledge leakage: A natural experiment on the threat of worker departure^{*}

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Abstract

Knowledge protection strategies are crucial to innovating firms facing the risk of knowledge leakage. We examine the threat of worker departure as a key mechanism through which firms choose between patents and secrecy. We exploit a 1998 California court decision that ruled out-of-state noncompetes were not enforceable in California, thereby creating a loophole limiting non-California firms in their enforcement of noncompetes against their workers. When facing a higher threat of worker departure, firms strategically increased patent filings, exchanging legal protection for public disclosure of the invention. These effects were magnified for large-sized firms and for those in complex and fast-growing industries. Further mechanism tests on the possession of trade secrets, inventor migration, saliency of the decision, and independent inventors support our theoretical account.

Keywords: innovation strategy, knowledge management, patents, worker mobility, out-of-state noncompetes

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1 INTRODUCTION

Firms in knowledge-based industries must constantly innovate to create a competitive advantage. To sustain that advantage, firms must also protect their knowledge from leakage to competitors (Agarwal, Ganco, & Ziedonis, 2009; Argote & Ingram, 2000; Campbell, Ganco, Franco, & Agarwal, 2012; Coff, 1997). The ways in which firms protect their knowledge against leakage to competitors, therefore, have received increasing attention in the fields of strategy and innovation (e.g., Cassiman & Veugelers, 2002; Lobel, 2013; Shaver & Flyer, 2000; Oxley & Sampson, 2004; Srikanth, Nandkumar, Mani, & Kale, 2020).

A pivotal decision that innovating firms must make with regard to knowledge protection is whether to rely on patents or alternative protection mechanisms, notably secrecy (Cohen, Nelson, & Walsh, 2000; Hall, Helmers, Rogers, & Sena, 2014; Liebeskind, 1996). Several survey-based studies indicate that this decision is associated with firm characteristics (e.g., firm size) and with characteristics of the knowledge that firms wish to protect (e.g., process versus product innovation) (e.g., Arundel, 2001; Cohen et al., 2000; Levin et al., 1987). Recent studies further suggest that firms dynamically adjust their reliance on patenting or secrecy in response to changes in legislative protection for trade secrets (Contigiani, Hsu, & Barankay, 2018; Png, 2017b).

Taking a step further from extant research, we examine the threat of worker departure as a key driver affecting firms' decisions on patents versus secrecy. Knowledge protection through secrecy is particularly challenging because knowledge is carried by individual workers (Grant, 1996). Innovating firms constantly face the threat that workers who possess valuable knowledge can separate to join competitors or start their own business (Agarwal, Campbell, Franco, & Ganco, 2016; Agarwal, Echambadi, Franco, & Sarkar, 2004; Carnahan, Agarwal, & Campbell, 2012; Starr, Balasubramanian, & Sakakibara, 2018). Even if state legislation provides strong protection for trade secrets, worker departure can become the major source of knowledge leakage and misappropriation. While the established literature suggest that worker departure can cause a substantial threat to firms in the form of knowledge leakage, our understanding is limited as to whether and how this threat of worker departure affects firms' use of patents and secrecy to protect proprietary knowledge.

We argue that firms dynamically change how they protect proprietary knowledge in response to the threat of worker departure. To be specific, if the threat of worker departure is minimal, firms can protect their proprietary knowledge by retaining their workers within firm boundaries (i.e., secrecy). In this case, there is less reason for firms to file a patent, which would bring the concomitant disclosure of inventions and costs of filing, maintaining, and enforcing the patents. However, to the extent that the threat of worker departure increases (i.e., when knowledge protection through worker retention becomes more risky and less effective), firms increase their use of patents as an alternative protective mechanism.

To establish a causal relationship between the threat of worker departure and firms' strategic choices on patenting, we take advantage of a milestone court decision that exogenously changed the threat of worker departure faced by non-California employers. Application Group, Inc. v. Hunter Group, Inc., 61 Cal. App. 4th 881 (1998)—henceforth, Application v. Hunter—provides us with a natural experiment opportunity to test this relationship. In the United States, many firms prevent their employees from joining competitors by requiring employees to sign noncompetition agreements (henceforth "noncompetes"), contracts in which employees agree not to work with a different firm in direct competition with the current employer once their current employment ends (see e.g., Garmaise, 2011; Marx, 2011; Marx, Strumsky, & Fleming, 2009; Prescott, Bishara, & Starr, 2016; Starr, Prescott, & Bishara, 2019). In 1998, the California Court of Appeal decided not to enforce out-of-state noncompetes written between a non-California employer and a non-California employee. This decision set a strong precedent that California courts may not uphold out-of-state noncompetes, even with a choice-of-law provision that a non-California law shall apply. After this decision, non-California workers who were bound by noncompetes could move to California employers because their employers' ability to enforce noncompetes and restrict California-bound workers had become significantly limited. Our in-depth legal analyses confirm that this was a radical decision that unexpectedly and significantly increased the threat of worker departure faced by non-California employers.

Using a difference-in-differences methodology, we compare patent applications of firms in high-enforcing states (treated group) to those in low or non-enforcing states (comparison group), before and after the decision. A key assumption is that, before the decision, noncompetes constrained workers in the treated group from leaving to work for California firms; after the decision, they could move to California firms. In contrast, workers in the comparison group could leave to work for a California firm both before and after 1998, regardless of the decision. We verify this assumption by comparing trends in worker moves to California from high- and low-enforcing states and through interviews with legal experts.

We find that, after *Application v. Hunter*, firms in high-enforcing states increased patent filings by about 5 percent compared to firms in low or non-enforcing states. The effect is even higher—up to 31 percent—for large firms that enjoy the economies of scale in patent application and assertion. The effects are also greater for inventions in complex product industries than in discrete product industries and for fields that are fast-growing rather than stationary. The findings are robust to a stricter comparison group that has industry composition dissimilar to that of California and to a Poisson quasimaximum likelihood estimation. Note that a later court decision, *Advanced Bionics Corp v. Medtronic*, *Inc.*, 29 Cal. 4th 697 (2002) (henceforth, *Advanced Bionics v. Medtronic*), provided a workaround and thus weakened the impact of *Application v. Hunter*, our decision of interest. Our examination of longterm effects confirms that the increase in patent filings began to diminish after 2002.

While *Application v. Hunter* provides an appropriate setting to test the impact of the threat of worker departure, a remaining concern is that there may be other channels such as firms' incentives to invest in R&D and a shift in technological areas, among others, that could affect patent filings. We conduct additional analyses to rule out these alternative explanations. To further verify that the threat of worker departure is the key mechanism driving the results, we also show that the effects are greater for firms that possess trade secrets to protect, that are located in Maryland where the court decision was more salient, and that are in states where the migration rate of high-skilled knowledge workers to California is high. Further, a placebo test on patenting filings by independent inventors—that is, those who did not belong to organizations and thus were not affected by the decision—showed no change in patenting. The findings, taken together, consistently indicate that firms strategically increased patent filings to protect their proprietary knowledge in response to the unexpectedly heightened threat of worker departure to California firms.

This study contributes to a broad stream of strategy and innovation literature. Linking two important streams of research—on worker mobility and on innovation and patenting—we demonstrate that the threat of worker departure can change the relative efficacy of knowledge protection mechanisms and, consequently, can change innovating firms' propensity to patent. This study offers important implications for innovation scholars on the use of patent-based proxies as a measure of knowledge creation activities. The findings suggest that patent-based proxies may not always capture firms' innovation performance because patent filings are not determined solely by firms' knowledge *creation* but also by their knowledge *protection* strategies over time. It is thus important for scholars to carefully validate the use of patents for measuring innovation outcomes.

Furthermore, we propose a robust quasi-experiment that exploits a milestone court decision in California that had substantial influence on the beliefs and behaviors of employers and employees related to worker mobility. Unlike legislative changes, this court decision applied retrospectively to firms and their workers, creating an immediate threat of worker departure and knowledge leakage. In addition, *Application v. Hunter* affected non-California firms' ability to retain workers but not their ability to hire workers. This situation ensured a clean natural experiment on the increased threat of worker departure without affecting firm's hiring abilities Future research can leverage this setting as a natural experiment to study how the threat of worker departure affects different firm behaviors and outcomes. Finally, we show that a court decision on the enforceability of out-of-state noncompetes in California changed the patenting decisions of firms in other states. This finding sheds light on how legal enforcement in one state can have far-reaching consequences outside of the focal state (Marx & Fleming, 2012; Marx, Singh, & Fleming, 2015).

2 THE THREAT OF WORKER DEPARTURE AND PATENTING

Firms have a range of options when it comes to the protection of knowledge: patents, secrecy, leadtime advantages, and the use of complementary assets or capabilities (Anton & Yao, 2004; Cohen et al., 2000; Hall et al., 2014). Patenting is one of the most frequently used options. Patenting provides formal legal protection of knowledge for a limited period—under the US patent law up to twenty years from the date of filing—and prevents others from using the patented knowledge for their own benefit (Agarwal et al., 2009; Gallini, 1992; Gilbert & Shapiro, 1990; Somaya, 2012). A major disadvantage of patenting, however, is public disclosure of the invention. In exchange for formal protection, patent applicants must publicly disclose the technical details of the knowledge that they seek to protect; this closure may trigger imitation and reverse engineering by competitors. In addition, patent registration fees, maintenance fees, payments to patent attorneys, and legal uncertainty are crucial costs for patenting firms (Kitch, 1977; Teece, 1986; Williams, 2013). Thus, in practice, firms use varied knowledge protection strategies and rely on different mechanisms depending on the knowledge that they seek to protect (Arora, 1997; Cohen et al., 2000; Hall et al., 2014; Png, 2017b).

How then do firms choose between patenting and alternative protection mechanisms when protecting their proprietary knowledge? Studies indicate that firms carefully consider the costs and benefits of each option to decide on a knowledge protection mechanism (Cohen et al., 2000; Teece, 1986; Thompson et al., 2022). Recent studies further suggest that these choices are not static but dynamic, and that firms strategically adjust their decisions in response to changes in legal environments that make one option more effective than others (e.g., Contigiani et al., 2018; Png, 2017b). Png (2017b), for example, finds that the enactment of the Uniform Trade Secrets Act, which

increased the legal protection of trade secrets, made firms less reliant on patenting for knowledge protection.

We argue that the threat of worker departure is a key factor that drives firms' choice of knowledge protection mechanisms. Worker departure is one of the most critical sources of knowledge leakage, as individual workers absorb and carry the knowledge created and retained from the innovation process governed by a firm (Arrow, 1972; Grant, 1996; March, 1991; Simon, 1991). As Simon (1991, p. 125) puts it, "All learning takes place inside individual human heads," and organizations learn by "ingesting new members who have knowledge the organization didn't previously have." Proliferating research on "learning-by-hiring" suggests that firms can leverage hiring as an opportunity to absorb external knowledge (e.g., Palomeras & Melero, 2010; Rosenkopf & Almeida, 2003; Song, Almeida, & Wu, 2003). Worker departure to competitors, therefore, is a double loss to a firm as the firm not only loses its proprietary knowledge but also gives an advantage to its competitor (Agarwal et al., 2016; Agarwal et al., 2009; Agarwal et al., 2004; Campbell, Coff, & Kryscynski, 2012; Somaya, Williamson, & Lorinkova, 2008; Wezel, Cattani, & Pennings, 2006). To prevent consequent knowledge leakage, firms must actively manage and respond to the threat of worker departure that arises from the changing business environment.

We predict that firms increase their use of patents when facing a heightened threat of worker departure. First, the threat of worker departure does not undermine the efficacy of patents because the details of knowledge are specified in the patent document and are protected by law. In contrast, other protection mechanisms—for example, secrecy—become much more vulnerable to leakage when workers move between firms (i.e., job-hopping). Thus, firms may decide to file patents for both new knowledge and existing knowledge (that they previously protected via secrecy) to reduce the risk of leakage when the threat of worker departure increases.

Second, the threat of worker departure increases firms' incentives to *preemptively* file a patent under its own name before exiting workers can do so (often with their new employers). Preemptive patenting minimizes misappropriation risks and potential patent infringement litigations that may arise when workers with valuable knowledge leave their employers (Ceccagnoli, 2009; Cohen et al., 2000; Gilbert & Newbery, 1982).

Third, patenting is an effective way to gain bargaining power against workers who possess valuable knowledge. Workers may leverage their knowledge, which was acquired through a firm's innovation processes, and threaten to leave the current employer in an effort to increase their

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bargaining power and demand higher pecuniary or non-pecuniary benefits (Starr, 2019). By obtaining formal protection of its knowledge through patents, a firm can counter workers who try to bargain. These arguments suggest that firms will increasingly use patents to protect their knowledge—even without any changes in fundamental innovation activities—when facing a higher threat of worker departure.

3 EMPIRICAL STRATEGY

3.1 Setting: Application v. Hunter (1998)

We exploit the *Application v. Hunter* decision by the California Court of Appeal as a naturally occurring experiment to empirically test our research question. A correlational study of the threat of worker departure and patenting would be subject to endogeneity problems. An unobservable confounding factor, such as a firm's ability to identify and attract talented workers, may be correlated with both a firm's ability to retain workers and its patenting activities. Reverse causality is another empirical concern. Firms that increase their propensity to patent may consequently exert less effort to retain their workers.

California is known for its strong public policy against the enforcement of restrictive covenants in employment. Since the enactment of California Business and Professions Code Section 16600 ("Section 16600") in 1872, California has consistently not enforced *in-state* noncompetes agreed upon between a California employer and employee. However, *out-of-state* noncompetes—signed by an employer and employee *outside* of California—had been construed as enforceable in California.

Application v. Hunter was the first case to set a strong precedent that California courts may invalidate out-of-state noncompetes based on California law, Section 16600. This case involved Dianne Pike (an employee in Maryland) who was seeking to move from Hunter Group, Inc. (a Maryland company) to Application Group, Inc. (a California company). Pike and Hunter Group, Inc. had signed a noncompete agreement with a choice-of-law provision that Maryland law would govern their contract. In 1998, however, the California Court of Appeal decided not to enforce this out-of-state noncompete agreement, ruling that California law (rather than Maryland law) should apply to their contract despite the choice-of-law provision suggesting otherwise. The decision suddenly denied non-California firms the ability to use noncompetes to prevent their workers' outbound mobility to California and significantly increased the threat of worker departure facing these firms. Our interviews with a California attorney and a leading legal scholar in this field confirm that *Application v. Hunter* was an unexpected decision that significantly increased the threat of job mobility to California by noncompete-bound workers. This decision was final as the appellant's petition for review by the Supreme Court was denied on May 13, 1998. We provide an in-depth legal analysis on the validity and impact of this seminal court decision in Online Appendix A.

Although *Application v. Hunter* offers an opportune setting that enables us to measure an increased threat of worker departure faced by non-California firms, the threat of worker departure may not be the only factor that this decision affected. It may have changed, for example, firms' incentives to invest in R&D, the resources available to inventors, and the direction of invention. These changes, however, come into effect in the relatively longer term, and the threat of worker departure still is the preceding and primary mechanism through which some channels work. For instance, after *Application v. Hunter*, firms may provide more resources to inventors who are likely to move to California, as an incentive to remain in the firm. This alternative mechanism might increase patenting at the firm level, but the main driver for this shift would be firms' expectation of a greater risk of worker departure and knowledge leakage to California. Nonetheless, to further mitigate concerns due to alternative mechanisms, we show in Section 5 that the R&D investment and the qualitative characteristics of patents have not been changed around *Application v. Hunter*.

Three unique advantages of *Application v. Hunter* make it a particularly appropriate setting to test our argument. First, this setting provides an exogenous variation in the threat of worker departure faced by non-California firms. Since *Application v. Hunter* is a court decision (rather than a legislative change), firms or individuals other than the plaintiff and defendant in the case could exert little influence on its decision (Ewens & Marx, 2018). Our legal analysis of *Application v. Hunter* confirms that the decision was made solely based on California's long-standing statutes (Section 16600) and was not based on any prior discussions or public hearings, or on the State of California's promotion of inbound mobility. Even if the court decision were correlated with legal and business environments (e.g., lobbying) in California, we circumvent this endogeneity issue by examining firms located *outside* of California.

Second, a unique feature of *Application v. Hunter* is that it changes non-California firms' ability to retain workers (i.e., restricts outbound mobility), but not their ability to hire workers (inbound mobility). Thus, our research design ensures a clean natural experiment on the threat of worker departure, not confounded by firms' hiring abilities. This advantage is provided by the fact that

Application v. Hunter was a court decision on the enforceability of *out-of-state* noncompetes. In contract, when leveraging court decisions on *in-state* noncompete enforceability as a natural experiment, it is often difficult to disentangle the two effects because such court decisions simultaneously affect a firm's ability to hire and retain workers. For example, Florida's 1996 legislative change that eased restrictions on noncompete enforcement affected not only Florida firms' ability to hire but also their ability to retain employees (Kang and Fleming, 2020).

Third, *Application v. Hunter* is a court decision that applies not only prospectively but also retrospectively to workers who signed the contracts even before the decision. Thus, for firms that had been enforcing noncompetes, the decision immediately introduced a threat that their *existing* workers might leave to join the competing firms in California. This is a unique feature of our setting compared to studies that exploit state-level legislative changes that apply only prospectively (i.e., to those who sign a contract after the effective date of the new law) (Balasubramanian, Chang, Sakakibara, Sivadasan, & Starr, 2020; Ewens & Marx, 2018; Jeffers, 2019; Marx et al., 2009). We provide a more detailed comparison of our research design to that of prior studies on noncompetes in Online Appendix A.4.

These three advantages make the 1998 *Application v. Hunter* decision a suitable setting to test our argument. Yet one important development after *Application v. Hunter* is *Advanced Bionics v. Medtronic*, which dealt with out-of-state noncompete enforceability in California. Although this 2002 case did not overturn the *Application v. Hunter* decision, it provided a work-around for non-California firms to enforce their noncompetes in California using choice-of-venue clauses. Our analysis thus focuses on the period during which *Application v. Hunter* had an uninterrupted impact on out-of-state noncompetes—that is, years through 2002 when *Advanced Bionics v. Medtronic* was decided. We discuss the implications of *Advanced Bionics v. Medtronic* and the longer-term effects of *Application v. Hunter* in Section 4.1 and Online Appendix A.3.

3.2 Methodology

We estimate the difference-in-differences model by exploiting *Application v. Hunter*, which increased the threat of worker departure for non-California firms in 1998. Our focus thus is *not* on firms in California but on firms in all other states in the United States. We compare firms in states that strongly enforce noncompetes (treatment group) with those in states that do not or only weakly enforce noncompetes (comparison group) and do so for four years before and after the year of the decision,

1998. The core idea of the empirical approach is that, in the treatment group, a worker bound by noncompetes could not move to work for a California employer before *Application v. Hunter*; after the decision, however, a worker could move because the decision by the California court denied the use of *out-of-state* noncompetes and choice-of-law provisions. In contrast, in the comparison group, workers could move to a California employer both before and after *Application v. Hunter* as their state law either did not enforce noncompetes or only weakly enforced them. Our interviews with legal experts and analysis of migration trends from high- and low-enforcing states to California support this point.

Many US states enforce noncompetes to some degree, so we have few control states that were not affected by the treatment at all (Garmaise, 2011; Starr, 2019). Since the comparison group was affected in the same way as the treatment group, our research design underestimates and provides the lower bound of the true effects. We thus provide, in Section 4.1 and Online Appendix H, additional tests to check the validity of our comparison group by exploiting the worker migration rate to California before *Application v. Hunter*.

The research design, along with firm- and year-fixed effects, helps us account for unobservable time-varying factors and for time-invariant differences between the two groups. We run the following difference-in-differences estimation:

$$y_{ist} = Enforce_s \cdot Post_t + \delta_{is} + \gamma_t + \epsilon_{ist}$$
(1)

where y_{ist} is the natural log transformation of our outcomes of interest. *Post*_t is an indicator that equals one after 1998. The remaining terms δ_{is} and γ_t are firm-state and year-fixed effects.¹ To determine the state-level enforceability of noncompetes, we combine indices of Garmaise (2011) and Starr (2019). We create a state-level indicator, *Enforce*_s, that takes unity if a state's enforceability is above the mean score in both indices (treatment group) and zero if it is below the mean score in both indices (comparison group). This approach is doubly robust because the two independent indices consistently assigned a high or low score for a state (see Online Appendix B).

We also conduct more flexible econometric analysis by replacing $Post_t$ with year indicators (distributed leads and lags), omitting a year indicator for 1998 as a baseline. With this event-study approach in Equation (2), we not only explicitly test the parallel trend assumption for pretreatment years (1994–1997) but also examine the dynamic patterns of the effects (e.g., one-time adjustment

¹ Since we exploit differences in state-level enforceability, to treat firms that have the same assignee identifier (but are in different states) as separate businesses, we include firm-state fixed effects.

versus gradual increase) for post-treatment years (1999–2002):

$$y_{ist} = \sum_{k=1994, k \neq 1998}^{2002} Enforce_s \cdot 1\{t=k\} + \delta_{is} + \gamma_t + \epsilon_{ist}$$

$$\tag{2}$$

3.3 Data and Sample

We use PatentsView (December 2020 version), which provides detailed information on patent filing and grant dates, technology classes, claims, assignee firms, and inventors with disambiguated identifiers, their location, and citations. For an analysis of publicly traded firms, we use CRSP/Compustat-Merged data.

Our sample selection begins with the universe of all patent assignees that filed a patent in the United States from 1994 through 2002. We confine our interest to patent-assignee firms that are companies or corporations and exclude government institutions and individual inventors because they have different incentives and are hardly affected by *Application v. Hunter*. We further exclude firms in states that underwent significant changes in noncompete enforceability during our sample period: Florida, Louisiana, and Texas (Garmaise, 2011; Kang & Fleming, 2020). Firms in Alaska and Hawaii are also omitted in the main analysis to account for geographic barriers that restrict ground transportation. Further, we require that firms have at least one inventor during the five years before the decision (1993–1997). This minimal restriction allows us to filter out firms that had no inventor to retain and did not face the threat of worker departure. The resultant sample consists of 23,739 assignee firms with 410,859 patent filings. Table 1 provides descriptive statistics.

- Insert Table 1 Here -

4 RESULTS

4.1 Main Results: Patent Filings

Table 2, column 1, reports the main results of our difference-in-differences estimation on patent filings. After *Application v. Hunter*, firms in the treated group (i.e., high-enforcing states) increased their patent filings by about 5 percent ($e^{0.049}$ –1), compared to those in the comparison group (i.e., low-or non-enforcing states). In 1998, firms in our sample filed an average of 7.3 patents that were eventually granted; the 5 percent increase in patent filings is thus equivalent to 0.37 more patents per year per firm, for every year from 1999 through 2002. In Table 3, column 1, we report the same analysis for publicly traded firms using Compustat data and find an 8.2 percent increase in patent filings after

the decision (see Online Appendix G for further analyses).

- Insert Table 2 Here -

The event-study approach with distributed leads and lags allows for a more flexible and detailed estimation. Figure 1(a) shows that a parallel trend persists until 1998, and the treatment group increased its patent filings by 1.8 percent to 6.2 percent after the decision, compared to the filings in 1998. The gradual increase in patent filings is consistent with the time required from project onset until the filing of patents; surveys indicate that research projects require different time periods to yield patents, 7–12 person-months being the median (Nagaoka and Walsh, 2009, p. 13). Figure 1(b) shows separate event-study estimates for the treated and comparison groups. We confirm the validity of the comparison group as a counterfactual (i.e., the parallel trend for the two groups) and find a diverging trend after the decision in 1998.²

– Insert Figure 1 Here –

Our discussions with legal experts indicate that the effect of *Application v. Hunter* was de facto weakened in 2002 because of the California court's decision in *Advanced Bionics v. Medtronic* regarding enjoining ongoing noncompete litigations in a non-California court (see Online Appendix A.3. for details on the two court decisions). Although this later (2002) court decision limits our ability to estimate the long-term effects of *Application v. Hunter*, it provides us with another opportunity to validate our proposed mechanism. That is, if the threat of worker departure is indeed the key mechanism in play, we should observe the opposite effect (i.e., a decrease in patent filings) around 2002. We show in Figure A.1 in the Online Appendix that during 2003–2006 the number of patent filings gradually declined to the pre-1998 level, bolstering our argument that firms change their patent filings in response to the threat of worker departure.

4.2 Robustness Checks

Stricter comparison group with industries dissimilar to California industries. We refine the comparison group by restricting it to firms in states that have little industry overlap with California. These firms are less affected by *Application v. Hunter* because workers would find it more difficult to

 $^{^2}$ To further deal with the pretreatment trend, we include interaction terms between each firm's outcome variable (in logs) in each year prior to 1998 and a full set of year dummies. This specification absorbs all the pre-1998 differences in patent filings (Cantoni, Dittmar & Yuchtman, 2018). Our results from this strict specification again confirm that the treated firms increased their patent filing by about 7.8 percent after the decision (see Online Appendix D for further details).

move to a California firm in the same industry. Thus, the likelihood of worker departure is even smaller for these firms. We measure industry composition (i.e., share of workers by 2-digit NAICS) for each state and calculate the Euclidean distance (i.e., sum of squared differences of shares in vectors) between the industry composition of California and that of comparison states. We then restrict our comparison group to firms in states that have above-median industry distance to California. The results shown in Table 2, column 2 are consistent with the main findings.

Poisson QMLE. We check the robustness of our model choices. Poisson quasi-maximum likelihood estimation (QMLE) provides an effective way to model the count-dependent variable that has an excess number of zero counts. The findings are robust to the choice of model and to a different set of standard errors (see Online Appendix E).

4.3 Heterogeneity by Firm Size and Industry

Heterogeneity by firm size. We expect that firms will respond differently depending on their size as measured by the number of inventors they employ. Firms with more inventors face a higher risk of worker departure and knowledge leakage. Furthermore, larger firms incur lower marginal costs of patenting, have better access to patent attorneys and other legal resources, and enjoy economies of scale in monitoring patent infringement and enforcement. In contrast, small firms typically do not achieve the economies of scale to access patent attorneys, and they are likely to have already patented their inventions to send quality signals to investors and markets (Agarwal et al., 2009; Conti, Thursby, & Thursby, 2013; Hsu & Ziedonis, 2013). Figure 2 shows the results from split-sample analyses based on five firm-size categories. As predicted, the effects are greater for Large- and Medium-sized firms than for Small and Tiny ones: Large firms filed 31 percent more patents after the decision, equivalent to 4.3 more patents per year per firm; Medium-sized firms increased their patent filings by 11 percent, or 0.7 more patents per year per firm.

- Insert Figure 2 Here -

Extremely large corporations that ranked in the top 1 percent in terms of their size show little effect. These huge firms—including Microsoft, Motorola, Boeing, Lockheed Martin, and Whirlpool—have dedicated, in-house patent attorneys for their patent filings, maintenance, and enforcement, helping to maintain a high propensity to patent even before the decision. This non-monotonicity of the firm-size effect is consistent with existing studies that examine the relationship between patenting propensity and firm size. Link and Scott (2018), for example, find that the elasticity of patenting with

respect to R&D is largest for firms of intermediate size.

Heterogeneity by industry product type (discrete vs. complex). The effectiveness of patenting varies across industries according to whether the technological characteristics of products are discrete or complex (Cohen et al., 2000). Theoretically, it is not clear ex ante in which type of industry higher effects will be found. "Complex" technology products (e.g., semiconductors) consist of numerous patentable elements, of which some are patented and others are generally kept as secrets that are embodied in individual workers (Contigiani et al., 2018; Png, 2017a). Consequently, a heightened threat of worker departure creates incentives for firms in complex product industries to file patents for knowledge that was previously kept as secrets. "Discrete" technology products, on the other hand, are composed of relatively few patentable elements (e.g., new drugs). Thus, among firms in discrete product industries, switching from secrecy to patenting may occur less often because these firms are likely to have already patented many of their key inventions (Contigiani et al., 2018; Png, 2017a). However, it is also true that discrete technology products are often more vulnerable to imitation by competitors than are complex technology products. Thus, the threat of worker departure may strongly induce firms in discrete product industries to file patents on any unpatented knowledge.

We empirically test the heterogeneous effects by industry product type. We identify patents in discrete or complex product industries using SIC-patent concordance data from Silverman (2002). Following prior research (e.g., Vonortas and Kim, 2004; Cohen et al., 2000), we categorize industries with SIC codes less than 35 as discrete product industries and those with SIC codes 35 and above as complex product industries. The results in Table 2, columns 3 and 4, show that the increased patent filings come primarily from complex technology products (4.9 percent; p=0.013) rather than from the discrete (1.5 percent; p=0.184), where the null hypothesis of equality is rejected (p=0.012). This supports the argument that complex technology products have more elements that are kept as secrets and are potentially patentable, compared to discrete technology products.

Heterogeneity by technology field dynamism: Fast-growing versus stationary. Fast-growing and expanding industries exhibit a higher rate of innovation, compared to stationary industries. Firms in fast-growing industries thus face higher risks of knowledge leakage via worker departure to competitors and have a greater incentive to protect their knowledge with patents. Firms in stationary industries, on the other hand, have relatively flat and static information and do not compete as fiercely for knowledge. The results in Table 2, columns 5 and 6, show that the increase in patenting for fast-growing industries is greater and more precisely estimated (5.1 percent; p=0.03) than that for

stationary industries (2 percent; p=0.156). We reject the null hypothesis of equality of the two (p=0.024).

5 TESTS OF THE MECHANISMS

In this section, we report on five analyses to verify that the threat of worker departure is the key mechanism driving our results. For example, if our proposed mechanism is true, the increase in patent filings would be larger for firms that possess important trade secrets to protect. We also seek to rule out two alternative mechanisms by which *Application v. Hunter* may cause firms to increase patenting activities: R&D investments and shifts in technological area.

Trade secrets. The possession of trade secrets provides a valuable opportunity to test the mechanism. We expect that firms with trade secrets would respond more strongly to Application v. Hunter because they face a greater risk of knowledge leakage via departing workers. For firms that do not possess trade secrets, in contrast, the risk of knowledge leakage is small even if their workers leave the firm. We identify public firms with trade secrets from their 10-K discussions of trade secrecy and compare the effect between firms with and without trade secrets.³ US Security Act Regulation S-K requires public firms with valuable trade secrets to discuss the risk of trade secret misappropriation in Form 10-K without revealing the nature of the secret (Glaeser, 2018). For example, Intel Corporation stated in its 2020 Form 10-K that "we own and develop significant IP and related IP rights around the world that support our products, services, R&D, and other activities and assets. Our IP portfolio includes patents, copyrights, trade secrets, trademarks, mask work, and other rights." Table 3, columns 2 and 3, shows the results from split-sample analyses. Firms with trade secrets increased patent filings (13.1 percent; p=0.028) more than did firms without (-0.002 percent; p=0.960), supporting the argument that increased patenting is driven by a motivation to protect proprietary knowledge. The interaction model in column 4 confirms that the effect is 11.6 percent higher (p=0.016) for firms with trade secrets, compared to those without.

- Insert Table 3 Here -

High salience of the decision in Maryland. The plaintiff in the case, Hunter Group, Inc., is a Maryland corporation headquartered in Maryland. The defendant, Dianne Pike, was a Maryland resident. We thus expect that *Application v. Hunter* and its implications for worker mobility were more

³ We thank Stephen Glaeser for generously sharing his data on trade secrecy discussions in 10-K filings.

widely understood by and of greater interest to employers and employees in Maryland than in other states. Table 2, column 5, shows the results of a test that included only Maryland firms in the treated group. Maryland firms increased patent filings by about 11.4 percent, more than twice as much as did all firms in the treated group (5 percent). In a model using the full sample with an indicator variable for Maryland firms (column 6), we find that Maryland firms increased patent filings by 6.3 percent more than other treated firms (p=0.000), in addition to a 4.8 percent increase by treated firms in other states (p=0.006). This test strengthens our proposed mechanism by showing that the court decision had a stronger effect on employers that were more likely to be aware of and interested in the decision. *Placebo test with independent inventors.* Since noncompetes are a contract between an employer and an employee, independent inventors who are not affiliated with a firm should remain unaffected by Application v. Hunter. This idea provides an opportunity to run a placebo test. We constructed industry-state-year level data that measures patent filings of independent inventors and ran a regression analysis with industry-, state-, and year-fixed effects. As predicted, we do not find an increase in patent filings by independent inventors. In Table 3, column 7, the estimate is close to zero in magnitude and statistically not distinguishable from zero (0.4 percent; p=0.850). This finding rules out the possibility that our findings are due to state- or industry-level changes that apply to independent inventors.

Migration rate of high-skilled workers to California. If the threat of worker departure is the key mechanism in play, the effects should be larger for firms in states that exhibit a high migration rate to California. We measure the migration rate of high-skilled workers across states by identifying inventors who filed a patent in one state and then filed another in a different state (Marx et al., 2009). Table 3, columns 8 and 9, shows the results of split-sample analyses, respectively, for firms in states that are above and below the median ratio of inventor moves to California to all inventor moves, 1993–1997. The coefficient for firms in states that exhibit a high migration rate to California is larger and more precisely estimated (6 percent, p=0.005) than that for firms in states with a low migration rate (3.8 percent, p=0.018). In an interaction model using the full sample, the coefficient on the interaction term is positive, though not statistically significant (2.2 percent, p=0.193; column 10), and provides suggestive evidence that the threat of worker mobility to California is the key mechanism.⁴

Realized moves. The treatment in our research design is the threat of worker departure, not

⁴ In Online Appendix H, we show the results with the population migration rate to California and physical distance (statute miles) to California.

necessarily the realized moves of workers. Nevertheless, if *Application v. Hunter* indeed increased such threats, we expect job-hopping to California by skilled workers to increase from treated states. We test this idea by measuring realized inventor moves to California based on patent inventor data. The results reveal that realized moves of inventors from treated states (Maryland, in particular) to California significantly increased after *Application v. Hunter*. This analysis provides additional evidence that the threat of worker departure was real and substantial; the decision triggered an imminent increase in worker departure from treated states to California (See Online Appendix C.1 and C.2 for details and a case study).

R&D investments. One alternative explanation is that firms may have incentives to change their R&D expenditure in response to the threat of worker departure. If this is the case, our main finding—that firms increased patenting—could be due to a higher input in the innovation processes, rather than to a change in the motivation to protect proprietary knowledge from worker departure. We thus examined whether an increase in patenting was accompanied by an increase in R&D expenditure for public firms. Table 3, column 1, reports that treated public firms increased patent filings by about 8.2 percent (p=0.060) and those possessing trade secrets increased filings up to 13.1 percent (p=0.028). However, we do not find evidence that these firms meaningfully increased R&D expenditure, which is consistent with Garmaise (2011). As reported in Table G.2 in Online Appendix G, this is estimated as 7 percent, which is not distinguishable from zero (p-value=0.168). The main results, therefore, are not likely driven by changes in R&D input. This conclusion is more convincing provided that the R&D expenditure item of 10-K filings includes costs associated with patent filings and wages paid to R&D personnel because these labor and patenting costs would increase the R&D expenditure even if there were no increase in fundamental research activities (Hall and Lerner, 2010).

Patent characteristics. Another alternative mechanism may be due to firms shifting away from technological areas in which they expect greater competition from California competitors who, after *Application v. Hunter*, are better positioned to attract high-quality talent. In this case, an increase in patenting may be due to a change in the firm's area of technological focus. We test this possibility indirectly by examining changes in the qualitative characteristics of patents. Yet we do not find strong evidence of such qualitative changes in patent filings (see Online Appendix F).

6 DISCUSSION AND CONCLUSION

We study and highlight the threat of worker departure and subsequent knowledge leakage as a key

driver that shapes how innovating firms manage their knowledge. To causally identify the effects, we take advantage of a milestone court decision in California that created a loophole limiting non-California firms' enforcement of noncompetes. When facing a higher threat of worker departure, firms relied more on patents for knowledge protection although it meant public disclosure of the invention. The effects were greater for medium- to large-sized firms and for inventions in fast-growing fields or complex product industries. Tests on the possession of trade secrets, on high salience of the decision in Maryland, on independent inventors, and on the migration rate of skilled workers to California all provide consistent support for our theoretical account that the threat of worker departure plays a crucial role in firms' patenting decisions.

Our empirical analysis adopts a novel identification strategy that merits further discussion. When using an event in California as a naturally occurring experiment to study its impact on firm outcomes, one may be concerned that confounding factors that affect the event may also influence the outcomes of interest. Our empirical approach mitigates this endogeneity concern by comparing outcomes of firms *outside* California, which are unlikely to be correlated with factors that affect a California court's decision. In addition, the decision changed non-California firms' ability to retain workers without affecting their ability to hire workers, providing an opportunity to study the threat of worker departure. Another advantage is that we use a court decision that is applied retrospectively to existing workers, creating an immediate threat of worker departure. Future research could leverage this naturally occurring experiment to study how an immediate threat of worker departure affects different firm behaviors and outcomes.

This study provides several important implications outside of academia as well as further research opportunities. First, we show how legal enforcement in one state has far-reaching consequences outside of the focal state. That is, business environments that shape firm strategies are not limited to the local environment but include broader policy and legal institutions and environments (Marx et al., 2015). State governments frequently engage in competition to attract and retain businesses in their jurisdictions by providing favorable business and legal environments—notably by permitting strong enforcement of in-state noncompetes—which often leads to a "race to the bottom" (Glynn, 2008). Our results based on the *Application v. Hunter* decision show that one state's ability to enforce noncompetes is yet heavily affected by another state's decision to honor *outof-state* noncompetes. Business managers and policymakers should thus carefully consider how local policies and laws spill over borders.

Second, our finding that firms patent strategically implies that patent counts may not always capture firms' fundamental innovation activities accurately. Studies that use patent-based proxies to measure innovation rely on an implicit assumption that patent filings are primarily determined by knowledge *creation* considerations such as R&D investments. Our findings, however, show that knowledge *protection* considerations can also significantly affect patenting decisions. We suggest that researchers measuring innovation based on patent data carefully examine the validity of such measures. Further, our result that public firms did not meaningfully change their R&D expenses in the short-term, after *Application v. Hunter*, calls for future study. A fruitful research avenue would be to delve into how the threat of worker mobility affects the interplay between R&D investments and patents in the long term. Studies using granular R&D data on private as well as public firms can provide more comprehensive insights on this question.

Last, but not least, our finding that firms increased their propensity to patent suggests that innovating firms seek legal protection although it means public disclosure of the invention. An interesting future avenue would be to investigate how such disclosures due to legal changes affect the rate and direction of follow-on innovations (Galasso & Schankerman, 2014). We hope that this study connects the research on worker mobility and innovation and contributes to a better understanding of how innovating firms create, acquire, and protect proprietary knowledge while coping with the threat of worker mobility that they face in a competitive business environment.

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Figure 1. The threat of worker departure and patent filings: Distributed leads and lags (a). Flexible difference-in-differences approach

(b). Separate event-study approach



Notes. Panel (a): The graphs illustrate the results from two different econometric estimations. First, the blue dots represent estimates in the flexible difference-in-differences model interacted with year indicators (event-study approach). The blue vertical lines represent the 95% confidence interval. Second, the red horizontal lines represent estimates in the difference-in-differences model with aggregated indicators for pre- and post-1998 periods. The red-shaded area round the horizontal lines represents the 95% confidence interval. Panel (b): Each series is from a separate event-study regression. The red solid line represents the estimates for the treatment group; the yellow dashed line represents the estimates for the comparison group. In both panels, the year of the court decision, 1998, is used as a baseline (an omitted category). Standard errors are clustered at the state level.



Figure 2. The threat of worker departure and patent filings: Heterogeneity by firm size

Notes. This bar plot illustrates estimates from five separate difference-in-differences models by firm size, measured by the five-year inventor stock during 1993–1997. We use firm-size classes by the US Bureau of Labor Statistics. We merge size class 3 (10-19 employees) and class 4 (20-49 employees) due to the small number of firms in each class. We expand size class 5 (50-99 employees) to include firms with 100-106 employees and add a Top 1% category (107 or more employees) for outliers. Vertical lines represent one standard error from the mean. Standard errors are clustered at the state level. The regression estimates, standard errors (in parentheses), and *p*-values (in brackets) are 0.009, (0.016), and [0.555] for Tiny firms (29,721 observations); 0.033, (0.021), and [0.132] for Small firms (9,797 observations); 0.099, (0.037), and [0.011] for Medium firms (10,325 observations); 0.272, (0.108), and [0.018] for Large firms (1,732 observations); and 0.039, (0.114), and [0.739] for Top 1% firms (1,908 observations).

Variables	Description	Mean	SD	Min	Max
Full sample					
Patent filings	Patent filings The average number of eventually granted patent applications by firms		71.85	0.00	4,439.00
	i). in the discrete product industry	2.21	12.59	0.00	492.00
	ii). in the complex product industry	6.27	62.80	0.00	4,090.00
	iii). in the fast-growing fields	6.70	68.16	0.00	4,350.00
	iv). in the stationary fields	2.15	9.71	0.00	468.00
	v). Maryland firms	6.27	20.06	0.00	263.00
	vi). independent inventors (unaffiliated)	1.57	1.42	0.00	32.00
Industry dynamism (industry level)	The compound annual growth rate of patent filings at the 3-digit CPC industry level for 1993–1997		0.07	-0.07	0.53
Migration rate to CA: high-skilled workers (state level)	The average ratio of each state's outflow moves of patent inventors to California to the state's entire cross-state inventor moves from 1993– 1997		0.08	0.00	0.42
Public firm sample (Comp	ustat)				
Patent filings	The average number of eventually granted patent applications by public firms	20.48	140.91	0.00	4,417.00
Trade secrets	An indicator variable that takes the value of 1 if a firm reported having trade secrets in its 10-K filing during 1993–1997 and zero otherwise	0.52	0.50	0.00	1.00

Table 1. Main variables and summary statistics

Notes. This table reports summary statistics for variables used in the analyses from 1994 through 2002.

	Dependent variables: patent filings (log)						
	All	All:	By industry	v product type	By industry	v dynamism	
		Strict control	Discrete	Complex	Fast-growing	Stationary	
	(1)	(2)	(3)	(4)	(5)	(6)	
Enforce×Pos	0.049	0.056	0.015	0.048	0.050	0.020	
t	(0.016)	(0.015)	(0.011)	(0.018)	(0.015)	(0.014)	
	[<i>p</i> =0.005]	[p=0.001]	[<i>p</i> =0.184]	[<i>p</i> =0.013]	[<i>p</i> =0.003]	[<i>p</i> =0.156]	
Unit FE	Firm	Firm	Firm	Firm	Firm	Firm	
Time FE	Year	Year	Year	Year	Year	Year	
Wald test	-	_	$\chi^2(1)=6.262, p=0.012$ χ		$\chi^2(1)=5.0$	$\chi^2(1) = 5.069, p = 0.024$	
R^2	0.810	0.814	0.804	0.819	0.815	0.786	
Adjusted R ²	0.660	0.666	0.649	0.676	0.668	0.616	
Observations	53,483	50,490	53,483	53,483	53,483	53,483	

Table 2. The threat of worker departure and patent filings: Main results and additional tests

Notes. This table reports regression coefficients from six regressions based on Equation (1). The sample includes all patent assignees that had at least one inventor from 1994 through 1997. The dependent variable consists of the number of patent filings: all (column 1); all with a stricter comparison group consisting of firms in states that have above-median distance to California in terms of industry composition; patents in discrete product industries (column 3); in the complex product industries (column 4); in the fast-growing technology fields (column 5); and in the stationary technology fields (column 6). For columns 3 and 4, following Vonortas and Kim (2004) and Cohen et al. (2000), we code industries with SIC codes less than 35 as discrete product industries; those with SIC codes 35 and above were coded as complex product industries. We identified patents in discrete versus complex product industries using Silverman's (2002) IPC-US SIC concordance. For columns 5 and 6, we calculated the compound annual growth rate of patent filings at the 3-digit CPC level for 1993–1997. Technology fields above the median growth rate (5.1%) were coded as fast-growing technology fields, and below the median as stationary. For columns 3–4 and 5–6, the Walt test row provides the $\chi^2(1)$ test statistic and the p-value for testing the quality of the estimates for two different outcomes of interest. Standard errors, clustered at the state level, are provided in parentheses. *p*-values are provided in brackets.

		Dependent variable: patent fillings (log)								
					•		Placebo			
	All	Trade	secret (publi	c firms)	Salience	MD firms	test	Migratio	n rate to CA:	High-skilled
	(public	Split-s	sample	Internation	Subsampla	Interaction	Individuala	Split	-sample	- Interaction
	firms)	Yes	No	Interaction	Subsample	Interaction	maiviauais	High	Low	Interaction
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Enforce×Post	t 0.079	0.123	-0.002	0.042	0.108	0.047	0.004	0.058	0.037	0.037
	(0.042)	(0.056)	(0.035)	(0.061)	(0.014)	(0.016)	(0.022)	(0.018)	(0.018)	(0.017)
	[<i>p</i> =0.060]	[<i>p</i> =0.028]	[<i>p</i> =0.960]	[<i>p</i> =0.496]	[<i>p</i> =0.000]	[<i>p</i> =0.006]	[<i>p</i> =0.850]	[<i>p</i> =0.005]	[<i>p</i> =0.051]	[<i>p</i> =0.044]
Enforce×Post ×Indicator	t –	-	-	0.110 (0.046) [<i>p</i> =0.016]	-	0.061 (0.009) [<i>p</i> =0.000]	-	-	-	0.022 (0.016) [<i>p</i> =0.193]
Sample	Compustat	Compustat	Compustat	Compustat	Patent	Patent	Patent	Patent	Patent	Patent
Unit FE	Firm	Firm	Firm	Firm	Firm	Firm	Industry, State	Firm	Firm	Firm
Time FE	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year
R^2	0.530	0.582	0.521	0.530	0.808	0.811	0.296	0.810	0.811	0.811
Adjusted R ²	0.446	0.497	0.429	0.445	0.634	0.660	0.244	0.659	0.652	0.660
Observations	12,798	8,187	7,689	12,790	15,213	53,483	2,195	36,077	31,306	53,483

Table 3. The threat of worker departure and patent filings: Testing the threat of worker departure as a key mechanism

Notes. This table reports regression coefficients from ten regressions based on Equation (1). The baseline sample includes all patent assignees that had at least one inventor from 1993 to 1997. The dependent variable consists of the number of patent filings: by public firms in Compustat (columns 1 and 4); by public firms in Compustat that do or do not possess trade secrets (columns 2 and 3); with only Maryland firms in the treatment group (column 5); by all firms and with an indicator for Maryland firms (column 6); by independent US and foreign inventors without affiliation at the 3-digit CPC industry-state-year level (column 7); by firms in states that exhibit high and low migration rate to California for high-skilled workers (columns 8 and 9); and by all firms and with an indicator for treated states that exhibit high migration rate to California for high-skilled workers. For columns 8–10, we measured inventor moves by identifying inventors who filed a patent with a new employer in a new state. Standard errors, clustered at the state level, are provided in parentheses. *p*-values are provided in brackets.

How innovating firms manage knowledge leakage: A natural experiment on the threat of worker departure

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A Application v. Hunter

A.1 Litigation timeline

California is known for its strong public policy against the enforcement of restrictive covenants in employment, including the enforcement of voluntarily entered non-competes (we use the term "non-competes" to refer to non-compete clauses/agreements). The most relevant statute is California Business & Professional Code Section 16600 ("Section 16600"), which states that "except as provided in this chapter, every contract by which anyone is restrained from engaging in a lawful profession, trade, or business of any kind is to that extent void."

Since the 1872 enactment of Section 16600, California has consistently refused to enforce *in-state* non-competes, that is, non-compete agreements between a California employer and employee. However, *out-of-state* non-competes, which are signed by an employer and employee *outside* of California, have been construed as enforceable under California law (for a review, see Wu, 2003).

Application Group, Inc. v. Hunter Group, Inc., 61 Cal. App. 4th 881 (1998)—henceforth, *Application v. Hunter*—was the first legal case to establish that out-of-state non-competes are also not enforceable in California, even with the presence of a "choice-of-law" provision in which the contracting parties specify that any dispute arising under the contract shall be determined under the law of a particular jurisdiction (for a detailed review of this case, see Kahn, 1999).

In 1992, Dianne Pike, a consultant in computerized human resources management systems, resigned from Hunter Group Inc. ("Hunter") to take a position at a competing firm in California, known as Application Group, Inc. ("AGI"). Pike had signed a non-compete agreement with Hunter prohibiting her from working for a competing firm for one year after the termination of her employment. Their contract also included a "choice-of-law" provision, which specifically stated that the contract should be "governed by and construed in accordance with the laws of the State of Maryland." As such, this provision allowed Hunter to contend that legal disputes on the contract, including its non-compete agreement, must be

decided by a court in Maryland, a state where non-competes are enforceable.

Both firms took instant but separate actions after Pike resigned from Hunter to join AGI. In 1992, Hunter sued both Pike and AGI in the Maryland Circuit Court for a breach of contract and unlawful interference. AGI, on the other hand, filed a complaint to California courts for a declaratory judgement, arguing that California's Section 16600 rather than Maryland law should be applied to this case. The Maryland Circuit Court favored AGI in its decision, noting that Hunter did not provide enough evidence to claim damages. This decision allowed California courts to proceed with their requests with AGI's declaratory relief, which was pending Maryland Court's decision.

In January 1995, the case proceeded to California trial courts. In trial court, Judge Norman originally issued a statement of decision that denied AGI's claims for declaratory relief (January 30, 1995). However, in response to AGI's objections, Judge Norman issued a revised statement of decision that, for the most part, ruled that California law applies to AGI's hiring of Hunter employees (April 5, 1995). On June 15, 1995, the trial court's judgment was entered that California law should indeed apply to the hiring of Pike. The final decision was made by the California Courts of Appeal in February 1998. The decision affirmed the trial court's decision that enforcing out-of-state non-competes in California would violate the state's public policy, even if the contract was signed between a Maryland firm and a Maryland resident and included a choice of law provision (*Application v. Hunter*, 1998).

A.2 Application v. Hunter as a strong legal precedent

It is essential to establish that *Application Group, Inc. v. Hunter Group, Inc.*, 61 Cal. App. 4th 881 (1998) ("*Application v. Hunter*") was a truly precedent setting. We conduct an in-depth legal analysis to verify that *Application v. Hunter* set a strong precedent for future courts, and that it substantially increased the threat of worker departure and knowledge leakage faced by noncompete-enforcing firms. We find both quantitative and qualitative evidence that future courts, practitioners, and legal scholars frequently cite this decision as a seminal case regarding the enforceability of *out-of-state* noncompetes in California.

Quantitative citation analysis

One of the most straightforward ways to examine the significance of a court decision is to examine the number of times a case is cited (forward citations) in subsequent court decisions and other legal sources, including law reviews, law practitioner's guidelines, etc. We used Lexis+, a leading provider of legal research tools, to compare the number of times that Application v. Hunter was cited to the number of times that all other noncompete-related court decisions made in the same year (392 cases) were cited. Table A.1. summarizes the procedure (in notes) and results of this analysis.

	Application v.	Other decisions in 1998 (<i>N</i> =392)			
	Hunter	Mean	Median	S.D.	
Cited by court decisions	165	17.9	4	83.5	
Cited by other sources	604	20.7	5	51.9	
Total	769	38.6	10	121.8	

Table A.1. Quantitative citation analysis of Application v. Hunterand other decisions made in 1998

Notes. Data was collected around January 15, 2021 from Lexis+, a well-established, extensive, legal research tool widely used by legal researchers and practitioners. As a comparison group, we searched for all decisions containing the words *non competition, covenant not to compete, non compete, non compete clause, non compete covenant* (including all possible combinations with hyphens) in their document. We found 393 such cases and excluded the *Application v. Hunter* case from this category.

Application vs Hunter was cited 769 times by 165 court decisions and 604 times in other legal documents (476 court documents, 70 law reviews, 46 treatises, 9 other citations, and 3 statutes). This number is significantly higher than that of other court decisions, suggesting that *Application v. Hunter* indeed had a very strong influence on future court decisions, legal scholarship, and law practices. In fact, *Application v. Hunter* is the third-most-cited decision in this group (out of 393), exceeded only by two court decisions unrelated to *inter-state* enforceability of noncompetes.¹

¹ The two other cases that are cited more than *Application v. Hunter* are *McDonald's Corporation v. Robertson*, 147 F.3d 1301 (1,969 times) and *Kolani v. Gluska*, 64 Cal. App. 4th 402 (880 times). These cases are not related to the enforceability of out-of-state noncompetes.

Qualitative citation analysis

We also qualitatively analyzed the content of the 165 court decisions that cite *Application v*. *Hunter* to understand how *Application v*. *Hunter* affected future court decisions. *Application v*. *Hunter* set a strong precedent that California courts can apply California law to determine the enforceability of noncompetes in an "agreement between an employee who is not a resident of California and an employer whose business is based outside of California, when a California-based employer seeks to recruit or hire the nonresident for employment in California" (*Application v*. *Hunter*, 1998), even when there is a choice-of-law provision suggesting otherwise (i.e., "to be governed by and construed in accordance with the laws of the State of Maryland," *Application v*. *Hunter*, 1998).

Our qualitative analysis of 165 cases reveals that many later courts adopted this precise logic set by *Application v. Hunter* to invalidate noncompete agreements of non-California employers. To illustrate, we summarize five (nonexhaustive) cases in Table A.2. These cases have three key features in common: (1) the key issue of litigation is the enforceability of a noncompete agreement signed between an employer based outside of California and its former employee(s) who sought to move to a new position in California; (2) the noncompete agreements have a choice-of-law provision that a non-California state law shall govern; and (3) the court decided to invalidate the noncompete, despite the choice-of-law provision, citing the logic established by *Application v. Hunter*.

For example, in *Stryker Sales Corp v. Zimmer Biomet, Inc.* (2017), a California court invalidated a noncompete agreement between a Michigan employer (Stryker) and a former employee (Mr. Siroonian) with a choice-of-law provision that Michigan law shall govern. Like Dianne Pike in *Application v. Hunter*, Mr. Siroonian resigned from Stryker and joined a California corporation. Citing *Application v. Hunter*, the court concluded that the Michigan choice-of-law would be ignored because "California's interests are materially greater than those of Michigan and that California would be more seriously impaired if its laws were not applied." Please see Table A.2 for other examples; important quotations are highlighted.

In other cases, courts also cite *Application v. Hunter* in a broader context to support the logic that California courts can apply California law to various agreements (not necessarily

noncompetes), despite choice-of-law provisions that designate a non-California state.

(End of page. Please see next page for Table A.2.)

Title	Summary of Litigation	Court's Decision	How the courts cite Application v. Hunter (direct quotes)
Stryker Sales Corp. v. Zimmer Biomet, Inc. [U.S. District Court for the Eastern District of California (2017)]	Stryker, a Michigan-based medical manufacturer, and Siroonian, a former employee, signed an agreement containing a noncompete clause with a choice-of-law provision that <i>Michigan law</i> shall govern. Siroonian resigned from Stryker to join a competitor in California (Tragus). Stryker filed a complaint against Tragus for unfair competition and interference of contract. Tragus moved to dismiss the complaint.	The court concluded the Michigan choice-of-law provision in Stryker's agreement will be ignored with respect to the non- solicitation and noncompetition provisions of those agreements, to the extent they govern Siroonian's post-employment conduct.	"California would have a materially greater interest in ensuring that nemployees located in California are not restricted from freely pursuing their professions, and that California-based third parties such as Tragus are not deterred from freely competing with companies doing business in the state. See Application Grp., 61 Cal. App. 4th at 900 The court therefore concludes that in this case, California's interests are materially greater than those of Michigan."
Signature MD, Inc. v. MDVIP, Inc. [U.S. District Court for the Central District of California (2015)]	Signature MD is a California corporation that offers concierg medicine services. MDVIP is a competitor headquartered in Florida but national in scope. Signature MD alleges that MDVIP engages in anticompetitive behavior by using noncompete clauses to restrict their physicians from joining competitors. MDVIP asserts that its noncompete clauses contain a <i>Florida choice-of-law</i> provision, and that California law therefore does not apply and moves to dismiss the case.	eThe court found that California law should apply to both the issues of competition and misappropriation. MDVIP's motion to dismiss was denied.	"Signature MD has adequately pleaded a violation of Section 16600. MDVIP asserts that its contracts contain a Florida choice-of-law provision, and that California law therefore does not apply When a covenant not to compete contains a choice-of-law provision, well established California choice-of-law principles apply such that California will likely be found to have a materially greater interest in enforcing its strong public policy, as reflected in Section 16600, of maintaining employment mobility See Application Grp. v. Hunter Grp., 61 Cal. App. 4th 881, 896-97, 899-902, 72 Cal. Rptr. 2d 73 (1998)."
Arkley, et al. v. Aon Risk Services Companies, Inc. [U.S. District Court for the Central District of California (2012)]	Arkley et al. are former employees of Aon, an insurance brokerage headquartered in Illinois. The two parties signed an employment agreement that contains a noncompete clause and a choice-of-law provision that <i>Illinois law</i> shall govern. Arkley et al. left Aon to join a competitor who conducts business primarily in California. Arkley et al. moved for a partial summary judgment, seeking a declaration that California law controls the covenants not to compete and that the noncompetes were void.	The court concluded that the noncompetes were void and unenforceable. Arkley et al.'s, motion was granted.	"Such covenants are specifically unenforceable under California Business and Professions Code § 16600. It is beyond dispute that the policy underlying § 16600 is considered "fundamental." See, e.g., Application Grp., Inc. v. Hunter Grp., Inc., 61 Cal. App. 4th 881, 900 (1998) California's interest in enforcing its own law is 'materially greater' than that of Illinois. Under California law, '[t]he interests of the employee in his own mobility and betterment are deemed paramount to the competitive business interests of the employers.' Application Grp., 61 Cal. App. 4th"
Davis v. Advanced Care Techs., Inc [U.S. District Court for the Eastern District of California (2007)]	Davis was a former employee of Advanced Care Techs., a pharmaceutical company whose principal place of business is in Connecticut. The two parties signed an employment agreement with a choice-of-law provision that <i>Connecticut law shall govern</i> . Davis resigned from Advanced Care Techs and joined a competitor (IsoRay) for a position in California. Davis moved for summary judgment on the grounds that the noncompete was void.	The court concluded that s California law is applicable to this dispute and that the noncompete agreement is invalid and unenforceable as a matter of law. The court granted Davis's motion.	"With respect to whether Connecticut law is contrary to a fundamental public policy of California in the determination of the particular issue (i.e., validity of the Non-Competition Agreement), the court must begin lits analysis by determining whether Connecticut law is in conflict with California law and whether both have a significant interest in having its law applied. See Application Group, 61 Cal. App. 4th at 899-900 [cites Hunter multiple times] For these reasons, the court concludes, on balance, that California has a 'materially greater interest' in the outcome of this case."
Jett v. Eco-Air Prods. [U.S. District Court for the Central District of California (2007)]	Jett et al. are former employees of Eco-Air Products, a corporation in the air filtration industry (subsidiary of Flanders Corp). The two parties signed an agreement containing a noncompete clause with a choice-of-law provision that <i>Florida</i> law shall govern. Jett et al. expressed a desire to resign. In response, Eco-Air threatened to enforce the noncompete provisions that they previously signed. Jett et al. claimed that the noncompetes were void and that California law, not Florida law, should apply.	The court decided that California law applies, and that the covenant was void and unenforceable. The application o Jett et al. was granted.	"Plaintiffs [Jett et al.] are also correct that a federal court in California with diversity jurisdiction over a dispute involving an employment agreement containing a covenant not to compete that violates Section f16600 applies California law to invalidate that provision, even if the agreement also contains, a choice of law clause providing for the application of another state's law under which the covenant would be valid [cites cases including] The Application Group v. The Hunter Group, 61 Cal. App. 4th 881, 72 Cal.Rptr. 2d 73 (Ct. App. 1998)"

Table A.2. Selected court decisions citing Application v. Hunter

We further analyzed 604 citations in other legal documents: 476 court documents, 70 law reviews, 46 treatises, 9 other citations, and 3 statutes. We highlight two findings. First, the importance of *Application v. Hunter* was widely understood not only by judges and courts but also by employers, workers, and law practitioners. Plaintiffs and defendants frequently cite *Application v. Hunter* to bolster their argument that out-of-state noncompetes cannot be enforced in California (despite choice-of-law provisions). To illustrate, we summarize three examples in Table A.3 (important quotations are highlighted).

Document Type	Summary	How employers and employees cite Application v. Hunter (direct quotes)			
Brief by Veeva (2019)	In this brief, Veeva appeals that the trial court—where it sued its competitors for using noncompetes to prevent employee departure to California—was mistaken. Veeva requests the appeal court to reverse the trial court's decision. The appeal court reversed trial court's decision (see <i>Veeva Sys</i> <i>v. Quintiles IMS 2019</i>).	"This Division of this Court has held for more than 20 years that California law gives California-based employers the right to recruit and employ nonresident employees for employment in California, even when those employees have signed a restrictive covenant. Application Group, Inc. v. Hunter Group, Inc. (1998) 61 Cal.App.4th 881 ("Hunter"). The Hunter court also held that nonresidents can be employed "in California" within the meaning of California law even when they do not reside in California."			
Motion by e.Digital (2007)	In this motion, e.Digital, a California"More importantly, there is clear authority stating that corporation, argues that the noncompetes of California's interest in enforcing its policies against its competitor, a Washington corporation, are noncompete agreements is very strong. For example, it invalid in California, despite the choice-of-Application Group, Inc., v. Hunter Group, Inc., a law provision that Washington law willCalifornia Court of Appeal evaluated a non-compete govern. The court concludes that Californiacontract created in Maryland. Despite the law should be applied and that theoverwhelming relationship the agreement had with agreement's noncompete clauses are voidMaryland, including an explicit Maryland choice-of-law provision and the parties' residence in Maryland, the Court determined that California law must apply when the employee left to work for a California company."				
Motion by Arminak (2006)	In this motion, Helga Arminak, a president of a California corporation, argues that her noncompete with Airspray, a Florida corporation, should be void under California law. The court granted Arminak's motion.	"In Application Group, Inc. v. Hunter Group, Inc., 61 Cal. App. 4th 881, 902, 72 Cal. Rptr. 2d 73 (1998), the court applied California law over Maryland law despite a a Maryland choice-of-law provision For these reasons, the Court should apply California law to this case and hold the non-compete to be void. Because the non-compete is void under applicable California law, Airspray cannot establish a likelihood of success on the merits. Accordingly, Airspray's motion for an injunction must be denied."			

Table A.3. Selected motions and briefs by employers and employees

 citing Application v. Hunter

Importantly, the decision has changed the *beliefs* held by employers (and workers) in their ability to prevent worker departure and subsequent knowledge leakage.² *Application v. Hunter* was the first court decision to determine that a California court can apply California law to invalidate noncompete agreements of non-California employers. Prior to this decision, it was generally expected that non-California employers could enforce noncompetes when their workers move to California, especially when a choice-of-law provision was present. With this view in mind, the plaintiff, Hunter Inc., argued that the court should decide "under Maryland law *in accordance with the contractual choice-of-law provision* in the employment agreements" (*Application v. Hunter*, 1998). In contrast to such expectations, the court decided that California law should govern.

Furthermore, our readings reveal that many scholars and practitioners view *Application v. Hunter* as a seminal decision that demonstrates California's strong policy of favoring worker moves. Law scholars cite *Application v. Hunter* as a key decision that exhibits why noncompetes are likely to be void in California despite a choice-of-law provision that a non-California state law shall govern. Similarly, practitioners use *Application v. Hunter* as an important reference point when providing legal advice that out-of-state noncompetes are void in California. Treaties and annotated statutes also cite *Application v. Hunter* in the same manner. We summarize four such cases in Table A.4 (important quotations are highlighted).

Title (Year)	Author	Purpose	How other sources cite Application v. Hunter (direct quotes)
Comment:	Michael R.	A law review	"California courts have concluded that §16600 represents a "strong
Protecting an	Kirschbaum	on California's	public policy" of the state of California. The law of other states is not
employer's	(Attorney;	strong public	allowed to defeat California law on this issue. One of the more recent
human capital:	retired)	policy of	cases dealing with this issue was Application Group, Inc. v. Hunter
Covenants not to)	invalidating	Group, Inc The court concluded that 'California has a materially
compete and the		(out-of-state)	greater interest than does Maryland in the application of its law to
changing		noncompetes	the parties' dispute, and that California's interests would be more
business			seriously impaired if its policy were subordinated to the policy of
environment			Maryland.' The federal courts, when dealing with similar issues,
(2000)			have tended to follow the logic outlined in the decisions of the
			California state courts."

Table A.4. Selected law reviews and periodicals citing Application v. Hunter

² We do not mean that it will always be the case that incoming workers to California will absolutely win the case. Employers and workers may also understand that a future case may overturn *Application v. Hunter* with non-zero possibility.

Feature: Have	Chiara F.	A law review	"For years people have presented contracts with noncompete clauses
noncompete	Orsini	on why	to me and have asked if the company can really stop them from
clauses become	(Attorney	noncompetes	getting a job in California with a competing company, even if they
enforceable in	specializing in	are void in	were involuntarily separated My advice to employees not to worry
California?	intellectual	California.	received additional support when a state court decided that the public
(2000)	property)		policy against covenants not to compete was so strong that it
			outweighed the choice of law provision of an out-of-state company's
			contract, even as it applied to employees outside California who
			chose to come to work in California (Application Group, Inc. v.
			Hunter Group, Inc., 61 Cal.App.4th 881, 902 (1998))."
New light on	Geoffrey	Research	"California is substantially less permissive towards choice-of-law
contract	Parsons Miller	rarticle that	clauses Application Group, Inc. v. Hunter Group, Inc., 284 a 1998
theory. Cardozo	(Professor o	fcompares New	case from the First District Court of Appeal, illustrates California's
L. Rev. 31 (2009)	: Law; NYU)	York and	approach to choice-of-law clauses. A California corporation
1475.		California	recruited and hired an employee of a Maryland competitor in clear
		choice-of-law	violation of a covenant not to compete But citing to the
		provisions	importance of California's policy favoring free competition in
			employment relationships, the court held that California had a
			materially greater interest in applying its law to the dispute; it
			further held that California's interests would be the more seriously
			impaired if its policy were subordinated to the policy of Maryland.
			Hence the court rejected the choice-of-law clause, applied California
			law, and invalidated the noncompete clause."
Choice of Law	Gillian Lester	Article on	"If the court concludes that a state other than the chosen state has a
and Covenants	(Professor of	choice-of-law	materially greater interest, then it must determine whether
Not To Compete	:Law, Berkeley	provisions and	application of the chosen law would offend the public policy of that
United States:	Law School)	non-competes	other stateCourts in California, another state with a strong public
Choice of Law	and Elizabeth		policy against non-compete agreements, have taken a similar
And Employee	Ryan (Harvard		position. The seminal case is Application Group v. Hunter, in
Restrictive	Law School,		which a Maryland employer sought to enforce a restrictive covenant
Covenants: An	J.D.)		containing a Maryland choice of law clause against a former
American			employee who had departed to work for a California employer and
Perspective			yet was not, and had never been, a resident of California."
(2010)			

Our interviews with legal experts and practitioners also demonstrate that *Application v*. *Hunter* was a radical decision that unexpectedly and significantly increased the threat of worker departure faced by non-California employers.

Overall, our quantitative and qualitative analyses demonstrate that *Application v*. *Hunter* set a milestone precedent for future cases and substantially increased the threat of worker departure and knowledge leakage faced by employers that use noncompetes.

A.3 Comparison with other important cases

The 2002 decision in the case of *Advanced Bionics Corp. v. Medtronic, Inc.*, 29 Cal. 4th 697 (henceforth, *Advanced Bionics v. Medtronic*) and the passage of Section 925 of the California Labor Code in 2017 (henceforth, Section 925) also dealt with interstate noncompete issues.

Based on our careful examination of these two events, we are confident that (1) *Application v. Hunter* was a decision that set a strong precedent for future courts regarding the enforceability of *out-of-state* noncompetes in California; (2) *Advanced Bionics v. Medtronic* likely reversed, to some extent, the impact of *Application v. Hunter* on cross-border mobility of workers but did so only after 2002; and (3) Section 925 does not undermine the validity of our research design. Here, we elaborate on our argument by briefly explaining the two events and comparing them with *Application v. Hunter*.

Advanced Bionics v. Medtronic (2002)

Briefly summarized, in *Advanced Bionics v. Medtronic*, a former employee of a Minnesota corporation sought to move to a California competitor. A unique aspect of this case is that there were parallel litigations in two different courts on the same claim as new and previous employers filed actions in California and Minnesota courts, respectively. The key issue arose when the California employer asked the California court to grant a temporary restraining order to prohibit the Minnesota employer from taking any further steps in the Minnesota courts. The California Supreme Court decided (2002) that "while California did have a strong public policy against enforcing noncompetition agreements, it was not so strong as to warrant enjoining an employer from seeking relief in another forum."

Although *Advanced Bionics v. Medtronic* is a noncompete case that also involves two states, it does not rebuff our argument or the validity of our research design. Most importantly, the foci of the two cases are different. *Application v. Hunter* is about whether California courts can nullify noncompetes signed in other states, despite a choice-of-law provision specifying a state other than California. *Advanced Bionics v. Medtronic*, on the other hand, is concerned with whether California courts can prohibit non-California employers from proceeding with litigations *outside California*. Thus *Advanced Bionics v. Medtronic* concerns whether California courts have even stronger authority—preventing litigation in other states—than merely nullifying out-of-state noncompetes in California.

In *Advanced Bionics v. Medtronic*, it was not contested whether California courts could nullify out-of-state noncompetes in California (a point which was already made clear in *Application v. Hunter*). The issue was whether California courts could prohibit Minnesota employers from taking any further steps in the Minnesota courts. Legal scholars and experts make it clear that *Advanced Bionics v. Medtronic* did not overrule *Application v. Hunter*:

The decision of the California Supreme court in Advanced Bionics did not overrule the Application Group case and similar cases. Thus, Application Group remains a good example of how California courts would resolve a conflict between California's policy against non-compete covenants and the countervailing policy of the first employment state, when there is no pending litigation in the other state. (Symeonides, 2003; p. 59)

Our legal analyses also confirm that courts and other legal documents continue to cite *Application v. Hunter* to nullify out-of-state noncompetes, even after *Advanced Bionics v. Medtronic* in 2002. Further, *Application v. Hunter* is a much more impactful case (cited 168 times by later court decisions, 773 total times as of March 17, 2021) than is *Advanced Bionics v. Medtronic* (cited 54 times by later court decisions; 347 times total).

However, it is important to note that the impact of *Application v. Hunter* was *de facto* mooted by *Advanced Bionics v. Medtronic*, which set a precedent that California courts will not interfere when there is pending litigation in another state (Symeonides, 2003). Our interviews with the legal experts in this area also confirmed that the effect of *Application v. Hunter* was weakened by *Advanced Bionics v. Medtronic*. After *Advanced Bionics v. Medtronic*, non-California firms may seek to enforce non-competes involving California-bound workers by including a choice-of-venue provision and rushing first to a non-California court. A California attorney who has been practicing since 1998 noted in an interview that: "in the wake of *Advanced Bionics*, companies outside of California tightened up their venue clauses."

This limits our ability to estimate the long-term effects of *Application v. Hunter* but, at the same time, provides us with another experimental opportunity. In 1998 *Application v. Hunter* significantly *increased* the threat of worker departure from the treated states to go to California. In contrast, in 2002 *Advanced Bionics v. Medtronic* then *decreased* such a threat by allowing an option for non-California employers to rush to a non-California court to enforce

non-competes because the California court would not enjoin the case in another forum. Therefore, if the threat of worker departure is the key mechanism in play, we should observe the opposite effect on patent filings around 1998 and 2002. Figure A.1 shows the longer-term effects on patent filings. The increased patent filings gradually revert to the pre-1998 level during 2003–2006, bolstering our argument that firms changed their patent filings in response to the threat of worker departure.





Notes. The blue dots represent estimates in the flexible difference-in-differences model interacted with year indicators (event-study approach) as in Equation (2), for 1993–2007. The blue vertical lines represent the 95% confidence interval. The red-shaded area shows the years between *Application v. Hunter* (1998) and *Advanced Bionics v. Medtronic* (2002). The year of the earlier court decision, 1998, is used as a baseline (an omitted category). Standard errors are clustered at the state level.

California Labor Code Section 925 (2017)

In January 2017, California added a new statute, Section 925, to the California Labor Code. The key objective of this amendment was to establish a statute that restricts the use of choiceof-law and forum selection clauses by California firms with workers who primarily reside and work in California; this restriction is in addition to previously existing restrictions on in-state noncompetes (California Business and Professions Code Section 16600: "Code 16600").

The target population and objective of Section 925 are different from those of *Application v. Hunter*. The enactment of Section 925 was an attempt to prevent an employer from requiring "an employee who primarily resides and works in California ... to adjudicate outside of California a claim arising in California" (Cal. Lab. Code §925.a.1) and "to deprive the employee of the substantive protection of California law with respect to a controversy arising in California" (Cal. Lab. Code §925.a.2).

Section 925 pertains to *California residents* (and not to non-California residents) who are at risk of being judged by courts outside California. *Application v. Hunter*, in contrast, affects *non-California residents* who seek to move to California and to be judged by California courts. Our empirical strategy precisely exploits the fact that *Application v. Hunter* affected *non-California residents* (like Dianne Pike) by setting a precedent that they could join California employers without being restricted by their noncompetes with their prior employers.

Based on our reading of legal documents, we are also convinced that the motivation behind Section 925 was not to clear up any ambiguity surrounding *Application v. Hunter*. Rather, Section 925 was enacted to prevent employers from signing noncompete agreements with *California residents* by using a loophole in the law.³ For example, before Section 925, some non-California employers sought to enforce noncompetes with their employees who resided in California (e.g., their salespeople in California) by including a forum-selection clause so that the enforceability of their noncompete agreements would be determined by a court *outside* California. Section 925 seeks to protect California residents by preventing such practices.

More practically, Section 925 went into effect on January 1, 2017. Thus, it should not affect our estimations using 1993–2003 data.

³ California's new Labor Code Section 925: What happens in California stays in California (by Mark A. Konkel, Esq., Kelley Drye & Warren). https://www.kelleydrye.com/KelleyDrye/media/News-Pubs-and-Events-Images/Mark-Konkel-Westlaw-California-Code.pdf.

A.4 The uniqueness of Application v. Hunter compared to existing studies

Studies have examined different changes in law and policy that are appropriate for their research questions and contexts. While our study builds upon their insights, findings, and contributions, we believe that *Application vs. Hunter* is the best research setting to answer our research question, for several reasons.

First, the variation in *Application v. Hunter* is via a court decision rather than via a legislative change. Court decisions are more attractive than legislative changes in our setting because they are generally unpredictable and firms or individuals (other than the plaintiffs and defendants in the case) can exert little influence on the decisions (Ewens & Marx, 2018). More importantly, this court decision applies both retrospectively and prospectively. That is, *Application v. Hunter* immediately affects all workers with noncompete agreements in their contracts, including those who signed contracts before the court decision in 1998. Because of its retrospective application, our research setting can study an immediate and significant threat of worker departure faced by employers.

This feature differs from the Michigan Antitrust Reform Act (MARA), which affects contracts written after the effective date specified in the legislation—i.e., applies prospectively but not retrospectively. MARA is well-suited for studying the post-amendment mobility patterns of new or potential workers. To answer our research question on the threat of knowledge leakage, however, we need a shock that *immediately* changes the risk of departure of existing workers and thereby increasing the possibility of leakage of existing knowledge that was previously kept secret (embodied in workers). *Application v. Hunter* provides us with this exact opportunity: employers immediately faced a risk of worker departure and knowledge leakage after the decision, thanks to its retrospective application.

Second, *Application v. Hunter* allows us to examine how a court decision in California affects the behaviors of firms *outside* California. This is a unique feature of our setting that further increases the validity of our analysis. That is, even if the California court decision is correlated with legal and business environments within California (such as lobbying), we can circumvent these potentially unknown endogeneity issues by examining firms that are located

outside California.

Third, a unique feature of *Application v. Hunter* is that it only affects firms' ability to retain workers (outbound mobility) and not their ability to hire workers (inbound mobility). As changes in firms' hiring abilities can affect their patenting behavior through inbound mobility, this feature is important to ensure the validity of our findings.

Finally, our analyses of legal documents indicate that *Application v. Hunter* is a seminal decision regarding how California courts interpret choice-of-law provisions. Many future courts and legal scholars have discussed the importance and representativeness of this case. Given the importance of *Application v. Hunter*, we believe we can contribute to the strategy literature by studying how this seminal court decision affected firms' knowledge protection strategies.

B Non-compete enforceability indices: Garmaise (2011) and Starr (2018)

Garmaise (2011) developed an index that quantifies the state-level enforceability of noncompetes. Across twelve dimensions of enforceability, Garmaise assigns 1 point for each dimension if the state's enforcement of non-competes in that dimension exceeds a given threshold. A possible value for the index ranges from 0 to 12 with a higher point indicating stronger enforceability. Building on the work of Bishara (2010), Starr (2019) also developed a state-level non-compete enforceability index. Expanding on Bishara's state-level ranking of seven dimensions of enforceability, Starr further implemented confirmatory factor analysis to reweight different factors and normalized the score to take the standard normal distribution.

Each index has its advantages and disadvantages. To determine the enforceability of state-level non-competes, we use both the Garmaise (2011) and Starr (2019) indices. We create a state-level indicator, $Enforce_s$, that equals one if a state's enforceability is above the mean score in both indices ("strong enforcement") and zero if it is below the mean score in both indices ("weak enforcement"). This approach is doubly robust, because the two independent indices consistently assigned a high (higher than or equal to 5 for Garmaise *and* higher than or equal to 0 for Starr) or low score for a state. We exclude states where Garmaise and Starr indices are conflicting ("unclear"). Table B.1 compares the three—Garmaise, Starr, and ours—indexes.

State	Garmaise	Starr	Combined indicator
	(score as of 1997)	(score as of 1991)	$(Enforce_s)$
Alabama	5	0.36	Strong enforcement
Alaska	3	-0.98	Weak enforcement ^a
Arizona	3	0.15	Unclear
Arkansas	5	-0.58	Unclear
California	0	-3.79	Weak enforcement ^a
Colorado	2	0.38	Unclear
Connecticut	3	1.26	Unclear
Delaware	6	0.52	Strong enforcement
District of Columbia	7	0.12	Strong enforcement

Table B.1. Three indices of non-compete enforceability

Florida	9	1.60	Strong enforcement ^a
Georgia	5	0.02	Strong enforcement
Hawaii	3	-0.17	Weak enforcement ^a
Iowa	6	1.01	Strong enforcement
Idaho	6	0.77	Strong enforcement
Illinois	5	0.95	Strong enforcement
Indiana	5	0.70	Strong enforcement
Kansas	6	1.21	Strong enforcement
Kentucky	6	0.85	Strong enforcement
Louisiana	4	0.50	Unclear ^a
Massachusetts	6	0.48	Strong enforcement
Maryland	5	0.60	Strong enforcement
Maine	4	0.41	Unclear
Michigan	5	0.46	Strong enforcement
Minnesota	5	-0.07	Unclear
Missouri	7	1.08	Strong enforcement
Mississippi	4	0.04	Unclear
Montana	2	-0.65	Weak enforcement
North Carolina	4	0.18	Unclear
North Dakota	0	-4.23	Weak enforcement
Nebraska	4	-0.13	Weak enforcement
New Hampshire	2	0.26	Unclear
New Jersey	4	0.90	Unclear
New Mexico	2	0.74	Unclear
Nevada	5	0.03	Strong enforcement
New York	3	-1.15	Weak enforcement
Ohio	5	0.08	Strong enforcement
Oklahoma	1	-0.94	Weak enforcement
Oregon	6	0.14	Strong enforcement
Pennsylvania	6	0.14	Strong enforcement
Rhode Island	3	-0.33	Weak enforcement
South Carolina	5	-0.27	Unclear
South Dakota	5	1.02	Strong enforcement
Tennessee	7	0.45	Strong enforcement
Texas	3	-0.28	Weak enforcement ^a
Utah	6	1.00	Strong enforcement
Virginia	3	-0.29	Weak enforcement
Vermont	5	0.60	Strong enforcement
Washington	5	0.34	Strong enforcement
Wisconsin	3	-0.09	Weak enforcement
West Virginia	2	-0.80	Weak enforcement
Wyoming	4	0.23	Unclear

^a We exclude assignee firms in three states that underwent significant changes in the enforceability of noncompetes during our sample period: Florida (1996), Louisiana (2001, 2003), and Texas (1994) (Garmaise, 2011; Kang & Fleming, 2020). Assignee firms in Alaska and Hawaii also have been omitted to account for geographic barriers that restrict interstate mobility. The results are robust to the inclusion of firms in these states.

C Analysis of realized worker moves

C.1 Realized worker moves

We analyze the realized moves of inventors using patent data. We identified inventor moves by finding inventors who filed a patent with a new employer in a new state and marked the year the patent was filed as the year of movement.

First, we graphically represent the realized moves by comparing two different groups: (a) moves from treated states to California; (b) moves from comparison states to California. To guide our comparisons, we also provide a linear fitted line derived from pretreatment (1991–1997) data in the figures.

Figure C.1 shows that moves from treated states to California increased significantly after 1998, whereas moves from comparison states did not increase compared as shown by the fitted line derived from pre-1998 trends. Further, we observe that the increase in moves from treated states to California persists for a long time after *Application v. Hunter*.



Figure C.1. Moves of patent inventors to California, 1991–2005

Notes. Blue/red lines: count of inventor relocations. Solid gray line: fitted line with data from 1991–1997. Dashed gray line: predicted line with data from 1991–1997.

We also examine moves to California from *Maryland*, where Hunter Group Inc. is headquartered. In Figure C.2a, we find that moves from Maryland to California increased after 1998, compared to the fitted line derived from pre-1998 trends.

This result is striking when compared to realized moves to *other states* from Maryland (Figure C.2b). The moves to other states do not increase, and even decrease, after 1998 compared to the fitted line based on pre-1998 trends. This provides further evidence that increased moves to California from Maryland are not driven by confounders (e.g., changes in macroeconomic conditions in Maryland) but by the *Application v. Hunter* decision.



Figure C.2. Moves of patent inventors from Maryland, 1991–2005

We provide more formal comparisons in Table C.1. We run difference-in-differences estimation using moves to California as a dependent variable. We create a balanced panel from 1991–2005 at the state-pre/post level (by averaging the number of moves over years; column 1) and state-year level (column 2). Columns (3) and (4) show the results from the same exercise but focus only on Maryland as the treated state.

We find that the inventor moves from treated states to California are on average 39.5% to 46.2% higher than those from comparison states to California, after the 1998 decision (Table

C.1, columns 1 and 2). The estimates are larger when we focus on the moves from Maryland, where Hunter Group, Inc. and Dianne Pike were located (columns 3 and 4).

	Dependent variable (log): Inventor-moves to California						
	From All	States	From Ma	aryland			
	(1)	(2)	(3)	(3)			
	State-pre/post level	State-year level	State-pre/post level	State-year level			
Enforce×Pos	0.395	0.462	0.619	0.677			
t	(0.123)	(0.087)	(0.095)	(0.216)			
	[<i>p</i> =0.003]	[p=0.001]	[p=0.001]	[<i>p</i> =0.002]			
State FE	Y	Y	Y	Y			
Year FE	_	Y	_	Y			
R^2	0.979	0.905	0.989	0.913			
Adjusted R^2	0.956	0.895	0.975	0.898			
Observations	70	490	24	168			

Table C.1. Effects of the threat of worker departure on realized moves to California

Notes. Robust standard errors are provided in parentheses. p-values are provided in brackets.

We want to note that our (natural) experiment does not require workers to actually move to California. Workers may or may not move to California, depending on their (re)negotiations with the current employer. We argue that *Application v. Hunter* increases the *threat* of worker departure faced by employers and, consequently, their incentives to file a patent for their existing (and future) inventions that have been kept as a secret. Nonetheless, we believe that the interstate migration patterns that we find are consistent with our argument that *Application v. Hunter* was an important shock that affected many employers.

There are other sources of migration data. The Current Population Survey (CPS) March Supplement is available for our sample period. However, the CPS data is not ideal for tracking the relocation of workers in our study. First, the CPS covers only 60,000 or 0.059% of a probability-selected sample of households in the United States (as of December 31, 1998, there were 102.53 million households in the United States). Second, we can only track the movement of households for two consecutive years because the surveyed sample keeps changing over time (a repeated cross-sectional data). Third, as Saks and Wozniak (2011) note, there are several critical issues with the CPS, which affect our analyses. The years 1990 and 1995 are missing because the CPS did not ask respondents where they were living in the previous year. The Census Bureau's methodology for imputing migration is also said to artificially boost migration rates in certain years, but the imputation flag is only available from 1996. Last, the CPS survey is conducted at the household level, which may fail to accurately capture individual-level moves. Overall, our analysis of CPS data shows that the number of relocations is small and highly variable across years, which is consistent with Saks & Wozniak's (2011) findings. Other data, including the American Community Survey (ACS), Job-to-Job Flows (J2J), and LEHD Origin-Destination Employment Statistics (LODES), are not available for our sample period.

C.2 A case example of worker departure and patent filings by the outbound firm

In this section, we provide a case example of *Agere Systems Guardian Corp*. ("Agere") in Florida (the state that most strongly enforces noncompetes), as evidence that links departing inventors to the patent filings of the outbound firm.

1. Agere includes noncompetes in their employment contracts and enforces them. We

confirmed from Agere's 10-K annual report filings to the US Securities and Exchange Commission that the firm actively used noncompete agreements in their employment contracts. For example, in their employment contracts with Mark T. Greenquist (dated December 15, 2000) and Ronald B. Black (dated February 28, 2001), the company specified⁴:

NON-COMPETITION: The Supplemental Pension Plan, the Deferred Compensation Plan and the Executive Life Insurance Plan are subject to non-competition constraints.

Agere also enforced noncompetes by taking legal action in the courts. For example, in 2000, its parent company (Lucent Technologies, Inc.) sought a preliminary injunction in an attempt

⁴ Greenquist's contact is available at

https://www.sec.gov/Archives/edgar/data/0001129446/000095012301509126/y55437ex10-23.txt. Black's contract is available at

https://www.sec.gov/Archives/edgar/data/0001129446/000095012301509126/y55437ex10-24.txt

to enforce its noncompetition and nondisclosure agreements with ten former employee defendants. (Lucent Techs., Inc. v. Tymann, 106 F. Supp. 2d 189)

2. Agere's inventors moved to competitors in California, after Application v. Hunter.⁵ We

identified inventor move dates based on the inventors' first patent filing with their new employer.

- 1990–1998: No moves of inventors to California.
- 1999: One inventor moved to *Intel Corporation* (Santa Clara, CA).
- 2000: Two inventors moved, one to *Mobilink Telecom Co., Ltd* (Santa Clara, CA) and one to *TMC Enterprises*, a division of *Tasco Industries, Inc.* (Diamond Bar, CA).
- 2002: One inventor moved to *Aeluros, Inc.* (Mountain View, CA).
- 2003: Two inventors moved, one to *Broadcom Corp*. (Irvine, CA) and one to *Intel Corporation* (Santa Clara, CA).

3. Agere increased its patent filings significantly on and after 1998 as shown in Figure

C.3(a). Importantly, most of the increased patenting was in the departed inventors' areas of expertise. Figure C.3(b) shows the patent filings from 1998–2003 by technology class (four-digit CPC). Red bars represent the technology fields that the departed inventors patented in while they were at Agere. We find that Agere filed significantly more patents in the exact areas of the expertise of the departed workers, even when using granular 4-digit patent classes.

⁵ This analysis is based on the patents filed by Agere Systems Guardian Corp., Agere Systems Guardian Corporation, Agere Systems Guardian Corp, Agere System Guardian Corp., Agere Systems Guardian, and Agere Systems Guardin Corp.



Figure C.3. The threat of worker departure and Agere's patent filings

The Agere case illustrates how a firm that enforces noncompetes against its workers disproportionately increased its patent filings when its high-skilled inventors moved to its competitors in California, after *Application v. Hunter*. However, we want to note that our interests are not confined to these types of firms that experienced realized moves of high-skilled workers. Our research question and research setting more broadly focus on how an increased threat of worker departure affects firms' knowledge-protection strategies.

D Dealing with preexisting trends

In the main analyses reported in the paper, we find a parallel trend in patent filings before the year of decision, 1998. In this section, we additionally conduct an analysis that allows the pre-1998 outcome variable to affect the post-1998 outcome variable. That is, we include interaction terms between each firm's outcome variable (in logs) in each pre-1998 year and a full set of year dummies. By absorbing all the pre-1998 differences in patent filings and some of the post-1998 differences, this analysis makes the post-1998 comparisons close to ceteris paribus (for more details on this analysis, see Cantoni, Dittmar, & Yuchtman, 2018).

Figure D.1 illustrates the results for patent filings and R&D expenditures. By design, there are no pre-1998 differences in trends between the treatment and comparison groups in this specification. We again confirm from this strict specification that the firms in the treatment group increased their patent filing by about 7.9 percent (*p*-value = 0.010) after the 1998 decision.



Figure D.1. Effects of worker mobility on patent filings: Absorbing pre-trends in an event study approach

E Poisson Quasi-Maximum Likelihood Estimation

We check whether our results are robust to alternative model choices. The Poisson regression model effectively deals with count data that have an excess number of zero counts. Compared to alternative count models, such as the negative binomial, the Poisson model is more robust to distributional misspecification, even if the data-generating process is misspecified, as long as the conditional mean is correctly specified (Cameron & Trivedi, 2013). The Poisson regression model, however, relies on the assumption that the conditional mean and variance are the same, although in many cases, including our data, the variance is larger than the mean. The Poisson quasi-maximum likelihood estimator (QMLE) relaxes this assumption and estimates the overdispersion parameter (ϕ) from the data.

The Poisson QMLE estimates coefficients that are identical to those obtained via the Poisson model, but the former model leads to *larger* standard errors, because it accounts for the overdispersion parameter when estimating standard errors (i.e., the standard Poisson model underestimates standard errors in the presence of overdispersion). In addition, in the Poisson QMLE model, standard errors need to be adjusted for the clusters in which errors are correlated; otherwise, standard errors tend to overstate estimator precision, leading to absurdly small standard errors (Cameron & Miller, 2015). We ran our main analysis using the Poisson QMLE model, instead of an ordinary least squares (OLS) model, to compare different types of standard errors.

Figure E.1 shows the results. We present different standard errors for comparison, including nonparametric clustered bootstrap standard errors based on 10,000 repetitions. We find a statistically significant increase in patenting intensity for the years after *Application v*. *Hunter* across all types of standard errors. However, standard errors based on Poisson and quasi-Poisson are clearly underestimated (these do not account for correlation within clusters), whereas bootstrapping provides more conservative standard errors. In sum, that loglinear OLS estimation and the Poisson QMLE produce similar results, which assure us that our findings are not sensitive to our model choices.



Figure E.1. Effects of worker mobility on patent filings: Poisson quasi-Maximum likelihood estimation

Notes. This figure shows difference-in-differences estimates from the Poisson quasi-maximum likelihood estimation. The dispersion parameter for the quasi-Poisson family is 1.7, suggesting the presence of overdispersion in our sample. We provide four different standard errors for comparison. Excluded are the Top 1% outlier firms in terms of their size.

F The qualitative characteristics of patents

We test the qualitative characteristics of patents to see whether firms begin to patent a different set of inventions in response to the threat of worker departure. In Table F.1, columns 1 through 3, we do not find a meaningful change in the number of backward citations, in-text citations (which are quite different from "front page" backward citations and better capture knowledge flow; Bryan, Ozcan, and Sampat, 2020), and forward citations (which are said to be highly correlated with patent quality or the market value of an innovation; Hall, Jaffe, & Trajtenberg, 2005; Lampe & Moser, 2016; Trajtenberg, 1990; Kuhn and Thompson, 2019). In addition, we analyzed the ratio of *triadic* patents. Triadic patents belong to patent families in which their members have filed for patent protection in all three major patent offices: US (USPTO), Europe (EPO), and Japan (JPO). Triadic patents are often used as an indicator for more important patents (Nagaoka and Walsh, 2009; Bryan, Ozcan, and Sampat, 2020). In column 4, we do not find evidence that the ratio of triadic patents had been changed around 1998. Further, the number of patent claims, the number of inventors per patent, and the length of patent examination did not change around the 1998 decision, as shown in Table F.1, columns 5, 7, and 8.

The number of words used in the first claim decreased by 3.4 percent, or 4.7 words, in Table F.1, column 6 (*p*-value = 0.074). This measure effectively captures the breadth of patent scope (Kuhn and Thompson, 2019) because fewer words mean fewer restrictions and a broader scope. That is, firms pursued a broader range of protection for a given patent after *Application v. Hunter*. This result is consistent with our theoretical account that firms increased their patent filings to protect their knowledge against the heightened risk of worker departure. Other than the scope of patents, we do not find evidence that firms changed the qualitative characteristics of the patents they filed.

	Dependent variables (log):								
	Backward	In-text	Forward	Triadic	Number	Number of	Number	Examination	
	citations	citations	citations	patents	of claims	words in	of	length	
						the first	inventors	(days)	
						claim			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
Enforce×Post	0.010	-0.001	-0.015	0.015	0.005	-0.033	0.010	0.022	
	(0.034)	(0.009)	(0.051)	(0.009)	(0.034)	(0.018)	(0.011)	(0.016)	
	[<i>p</i> =0.764]	[<i>p</i> =0.956]	[<i>p</i> =0.774]	[<i>p</i> =0.127]	[<i>p</i> =0.894]	[<i>p</i> =0.074]	[p=0.373]	[<i>p</i> =0.183]	
Unit FE	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	
Time FE	Year	Year	Year	Year	Year	Year	Year	Year	
R^2	0.695	0.845	0.746	0.837	0.694	0.720	0.709	0.627	
Adjusted R^2	0.454	0.722	0.545	0.708	0.450	0.497	0.478	0.332	
Observations	53,483	53,483	53,483	53,483	53,481	53,481	53,483	53,479	

Notes. This table reports regression coefficients from seven regressions based on Equation (1). The sample includes all patent assignees that had at least one inventor from 1993 to 1997. The dependent variable consists of the average number of backward citations made (column 1), the average number of in-text citations made (column 2), the average number of forward citations received (column 3), the number of triadic patents (column 4), the average number of claims per patent (column 5), the average number of words used in the first claim (column 6), the average number of inventors per patent (column 7), and the average length of patent examination (i.e., the days between patent filing and registration; column 8). Standard errors, clustered at the state level, are provided in parentheses. *p*-values are provided in brackets.

G Analysis of public firms

G.1 Sample comparison: PatentsView versus CRSP/Compustat-Merged data

In this section, we empirically examine how firms changed their innovation input—namely, R&D investments—around *Application vs. Hunter*. Ideally, we would want to examine the R&D investments of all firms in our sample used for our main analysis. However, because information on R&D investments is often considered confidential information that has important strategic value, it is difficult to obtain such data for all patenting firms, especially for private companies. Using the CRSP/Compustat-Merged Data, we focus on all *publicly traded firms* in the United States that are required to disclose such information. Kogan, Papanikolaou, Seru, and Stoffman (2017) provide the *bridge* between Compustat firms (GVKEY) and their patents (patent ID).

The CRSP/Compustat-Merged data cover a much smaller number of larger firms. The Compustat data cover only 1.65 percent of the firms covered by PatentsView. Because there is a significant discrepancy about which firms are covered in each data, we compare the size of firms in 1998, measured by the number of inventor stocks from 1993 to 1997. There clearly exists a huge difference in firm sizes between the two data, as shown in Table G.1.

Furthermore, the meaning of a "firm" differs between the two data sets. The assignee firm in the patent data refers to the smallest business unit that files patents under its name, whereas a firm in the CRSP/Compustat-Merged data refers to a company (issue, currency, index) in the CRSP/Compustat file (GVKEY or PERMNO). The latter is generally broader than the former, and a company in the CRSP/Compustat file often holds multiple patent assignee firms. This further complicates the issue because one company could hold patenting assignee firms in different states. Therefore, the high level of aggregation in the CRSP/Compustat data makes these data less desirable for studying state-level outcomes. At a minimum, we note that the results from these two different data sets cannot be compared at the same level, and one should be very careful if linking and interpreting the results.

	Number	Firm size in 1998				
	of firms	Mean	SD	First	Second	Third
				quantile	quantile	quantile
PatentsView	51,462	8.2	91.0	1.0	2.0	4.0
(All patenting firms)						
CRSP/Compustat-Merged	848	95.5	442.2	6.0	14.0	42.3
(All patenting <i>public</i> firms)						

Table G.1. Comparison of firm sizes in PatentsView and Comput	stat
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Note. Firm size is measured by the number of (unique) inventor stock from 1993 to 1997. Sample consists of firms that had at least one inventor in 1993-1997.

G.2 Patent value and R&D expenditures of public firms

We first examine the commercial value of patents by public firms in the Compustat sample. The average commercial value of patents did not meaningfully change after *Application v*. *Hunter*, as shown in Table G.2, column 1 (2.2 percent, p=0.692). With regard to R&D expenditure, in column 2, the point estimate is 7 percent with *p*-value 0.168. We cannot reject the null hypothesis at a significance level of 0.10 that the estimated coefficient is equal to zero. Yet, we want to note that there are several difficulties in estimating firms' response in R&D expenditure. First, the information on R&D expenditures is not available for every firm; only 50.3% of observations have valid information on R&D expenditures. Some firms do not invest in R&D projects and therefore have no information on R&D expenditures. Some firms have missing information for random years.

More importantly, R&D investment (xrd in Compustat) includes expenditures on patent filings. Thus, it is possible that firms are reducing real investments in R&D projects but, simultaneously, spending a significant budget to file and maintain additional patents. Our conversation with patent attorneys in one of the largest multinational companies in Europe (the name of which we cannot disclose due to nondisclosure agreements) suggests that filing a single patent costs from \$5,000 to \$25,000, not including the maintenance fees and enforcement costs.

Furthermore, Hall and Lerner (2010) note that more than 50% of R&D expenditure is wages paid to research activities. Having more outside options provides workers with more bargaining power. If workers leverage *Application v. Hunter* to demand higher wages and

other forms of considerations (Starr, 2019), this may be reflected in a firm's R&D expenditure. Thus, it is possible that firms are reducing investment in R&D projects but, simultaneously, increasing wages and considerations paid to knowledge workers to prevent them from departing.

In sum, we do not find evidence that firms meaningfully increased R&D investment following *Application v. Hunter* and conclude that the increased patent filings indeed come from changes in knowledge protection strategies, not from fundamental R&D activities (Png, 2017a; Png, 2017b).

	Dependent variables (log):			
-	Patent commercial value	R&D expenditure		
	(1)	(2)		
Enforce×Post	0.022	0.068		
	(0.056)	(0.049)		
	[<i>p</i> =0.692]	[p=0.168]		
Firm FE	Yes	Yes		
Year FE	Yes	Yes		
R^2	0.800	0.963		
Adjusted R ²	0.764	0.957		
Observations	12,779	12,881		

Table G.2. Additional analyses of the knowledge protection mechanisms

Notes. This table reports regression coefficients from the sample of publicly traded firms. *Data.* CRSP/Compustat-Merged data.

H Additional Analyses

Section 5 of the main paper examines the migration rate of high-skilled workers to California and the moderation effect of this rate by measuring mobility through the use of patent inventor data. In this section, we further examine the *population* migration rate to California from 1985 through 1990 using the 1990 Decennial US Census. Table H.1., column 3, shows the results with population migration rate as a moderation term. The interaction model with full sample shows that the main effect is larger for firms in states that show a higher population migration rate to California, but the difference is economically small and statistically not distinguishable from zero (-0.0 percent; *p*-value: 0.984). Overall, our analyses on two different migration rates suggest that firms responded differentially based on the migration rate of *high-skilled* workers but not much based on that of all population. This finding is consistent with our theoretical argument that firms increase patent filings in the fear of knowledge leakage via the departure of scientists and inventors.

One might expect that the threat of worker departure is greater for states that are physically close to California because workers in those states have shorter moving distances and lower moving costs. The testable implication of this argument is that the effects are greater for firms in physically proximate states. We use data on state centroids from the United States Geological Survey (USGS) and calculate the distances between each state's centroid and that of California. We divide the treated group with the threshold of 1,311 (half the maximum distance). The results are report in Table H.1., columns 4 through 6. We find that the effect is larger for firms in treated states that are physically closer to California (5.4 percent, p=0.016; column 4), while the effect is still strong for firms in distant states (4.9 percent, p=0.008; column 5). In column 6, the difference between the two is estimated as 0.4 percent but is not statistically different from zero (p=0.796). Our interpretation is that physical proximity to California is not a primary factor that affects the threat of mobility faced by firms. When workers make decisions on job moves, other factors such as the number of job opportunities, quality of jobs available, salary level, amenities, and living conditions may be more important than the one-time fixed cost of physical relocation. For example, in *Application v. Hunter*, Dianne Pike moved from Maryland to California, although Maryland and California are relatively distant states.

	Dependent variable: patent fillings (log)						
_	Migration	rate to CA: All	population	Proximity to California (statute miles)			
	Split-s	sample	Interaction	Split-s	Interaction		
	Yes	No	Interaction	High	Low	Interaction	
	(1)	(2)	(3)	(4)	(5)	(6)	
Enforce×Post	0.044	0.053	0.049	0.053	0.048	0.048	
	(0.015)	(0.020)	(0.018)	(0.020)	(0.017)	(0.017)	
	[p=0.008]	[<i>p</i> =0.018]	[p=0.011]	[p=0.016]	[<i>p</i> =0.008]	[p=0.007]	
Enforce×Post	-	_	-0.000	_	_	0.004	
×Indicator			(0.015)			(0.017)	
			[<i>p</i> =0.984]			[<i>p</i> =0.796]	
Sample	Patent	Patent	Patent	Patent	Patent	Patent	
Unit FE	Firm	Firm	Firm	Firm	Firm	Firm	
Time FE	Year	Year	Year	Year	Year	Year	
R^2	0.815	0.807	0.811	0.809	0.811	0.811	
Adjusted R ²	0.663	0.649	0.660	0.637	0.662	0.660	
Observations	31,442	35,941	53,483	19,711	47,672	53,483	

Table H.1. Additional tests of the threat of worker departure as a key mechanism:Population migration rate and physical proximity to California

Notes. This table reports regression coefficients from six regressions based on Equation (1) in the paper. The sample includes all patent assignees that had at least one inventor from 1993 to 1997. The dependent variable consists of the number of patent filings: by firms in states that exhibit high and low migration rates to California for all population (columns 1 and 2); by all firms with an indicator for firms in states that exhibit a high migration rate to California for all population (column 3); by firms in states that are physically close or distant to California in statute miles (columns 4 and 5); and by all firms with an indicator for firms in states that are close to California in statute miles. For columns 1 through 3, we constructed the migration rate to California variable as the ratio of each state's outflow moves to California between 1985 and 1990 to the state's population in 1990, using the 1990 Decennial US Census. Alternatively, we also use the Job-to-Job Flows (J2J) Data for 2000 (the earliest year available) from the Census Longitudinal Employer-Household Dynamics (LEHD). The findings are robust to this alternative measure of interstate job moves.

Appendix references

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