The Economics of Patent Licensing: An Empirical Analysis of the Determinants and Consequences of Patent Licensing Transactions

Abstract

In this paper, we investigate the economics of patent licensing using a large and unique sample of patent licensing transactions from the ktMINE Patent License Agreement Database. We address three key research questions for the first time in the literature: the characteristics of licensor and licensee firms driving the former firms to license patents to the latter; the patent characteristics driving a licensor's decision to retain, sell, or license certain patents; and the consequences of patent licensing transactions for licensor and licensee firms. Our findings indicate that licensors prefer licensing to downstream firms and firms with less similar patent portfolios. Licensors retain patents closer in technological distance to their own portfolios and sell those farther away, while licensing out patents that are in-between the two. Licensees, on the other hand, prefer to license in patents closer to their own patent portfolios. Both our baseline analysis and a difference-in-differences analysis around the National Technology Transfer and Advancement Act of 1995 show that patent licensing transactions are efficient: they increase the Tobin's Q of both licensors and licensees. However, the channels of equity market value creation for licensors and licensees are different: while licensors' increases in Tobin's Q are greater for firms that can charge higher licensing fees, exposure to new technologies is a source of value increase for licensees. We further find that licensors increase their R&D expenditures and generate more patents following licensing transactions, suggesting that they use some of their proceeds from licensing transactions to enhance their innovation productivity. Licensees, on the other hand, are more likely to cite licensors' patents, introduce more new products, and increase their innovation efficiency after licensing transactions, suggesting that they are able to learn from using the patents they license.

Keywords: Patent licensing; Selling versus licensing; Licensors; Licensees; Corporate innovation

JEL classification: G32; L24; O32; O34

1 Introduction

The transfer of ideas is an important driver of economic growth. Two important ways in which patented ideas are transferred across firms are the buying and selling of patents between firms and the licensing of patents across firms. While a number of papers have studied the transfer of patents across firms through the buying and selling of patents (e.g., Akcigit et al. (2016), Zhang (2020), Ma et al. (2022)), there have been relatively few large sample analyses of the licensing of patents across firms. The objective of this paper is to fill this gap in the literature and analyze several interesting research questions regarding the economics of patent licensing by making use of a large sample of licensing transactions using the ktMINE Patent License Agreement Database.

We first develop a conceptual framework in order to develop testable hypotheses for our empirical analysis. We consider a setting in which a firm develops patentable innovations, some of which are useful for its main line of business, while others are not. The firm retains and builds products around the patents close to its main line of business, while it attempts to monetize the patents further away from its main line of business by either selling these patents to other firms or licensing them. Selling and licensing a patent may involve different costs and benefits to the firm developing the patent. Selling a patent, while the firm may reap substantial financial rewards from the sale, requires the firm to completely relinquish control of the patent to the buying firm, which may eventually use it for uses that are detrimental to the interests of the firm developing the patent. On the other hand, licensing enables the firm licensing the patent (the licensor) to obtain a periodic (quarterly, semi-annually, or annually) licensing fee from the firm to which the patent is licensed (the licensee). Licensing allows the licensor to maintain more control of the patent than selling the patent outright since it allows the licensor to terminate the licensing contract after the initial licensing period.

In the above framework, we address three important sets of research questions. The first set of research questions relates to the characteristics of licensor and licensee firms that drive the former firms to license patents to the latter. Under this overall research question, we ask and empirically examine the following sub-questions. The first sub-question we ask here is the innovation characteristics of a firm that drive it to be a licensor or a licensee in a patent licensing transaction. A market for licensing patents raises the incentive of firms to do R&D, since patents that are not useful for an innovating firm's own products can be licensed to other firms, thus raising the *ex-ante* return from the licensor's R&D expenditures. We thus expect the R&D expenditures of licensors to be higher than those of control firms in the same industry. On the other hand, from a licensee's point of view, when the firm needs a patent around which it can build products, the firm can choose to develop the patent in-house or to acquire it from other firms (by buying or licensing in the patent). When the firm is less able to efficiently conduct the innovation activity in-house, acquiring the patent from other firms through licensing may be a more cost-effective option. In addition, the fact that a firm can license a patent from another firm reduces the reward for it from developing the innovation internally by spending resources on R&D. Therefore, we expect licensee firms to be less efficient in conducting the innovation activities in-house compared to control firms. On the other hand, we do not expect licensee firms to have high R&D expenditures relative to control firms.

The second sub-question we address here relates to the determinants of the pairing between licensor and licensee firms. In determining which firm to license a patent to, a licensor firm may take into account not only the stream of licensing fees it can generate from the licensing transaction but also the indirect benefits and costs of licensing a patent to a particular firm. One indirect benefit of licensing a patent to a firm arises from the licensee firm buying the products of the licensor: i.e., the licensor and the licensee may have an upstream-downstream relationship. In other words, licensing a patent to a certain firm may not only help the licensee firm, but may also help the licensor by inducing some demand for the licensor's products from the licensee firm. Thus, we expect licensors to license their patents to firms having a downstream relationship with them. On the indirect cost side, if a licensor and licensee operate as competitors in the product market, licensing a patent to such a licensee may hurt the licensor, since the licensee firm may use this patent to improve its own products, thereby obtaining a competitive advantage with respect to the products of the licensor. This means that, if a licensor and a potential licensee are technologically similar (and therefore more likely to be competitors), then the two firms are less likely to form a licensor-licensee relationship.

We now turn to our second set of research questions, namely, the nature of the patents involved in licensing transactions. Under this overall research question, we empirically address the following sub-questions through analyses conducted at the patent level. The first sub-question is regarding the nature of patents that a licensor is likely to retain (and build products around) versus the type of patents it chooses to monetize (by either licensing or selling patents to another firm). Clearly, it is less costly for firms to build products around patents closer to their main lines of business, since firms may already have prior knowledge stocks and complementary technologies in place to commercialize such patents (Teece (1986)). In other words, firms will retain those patents which are closer in technological distance (see Akcigit et al. (2016)) to their current patent portfolios, while monetizing (either by licensing or by selling) patents that are further away from their current patent portfolios.

The second sub-question we examine here is regarding the nature of patents a firm has chosen to monetize. If a firm chooses to monetize a patent, does it do so by licensing the patent to another firm or by selling it outright? On the one hand, licensing the patent to another firm allows the firm to maintain some control of the patent going forward (since it has the ability not to renew the license after the initial licensing period) while receiving a licensing fee. On the other hand, if the firm sells a given patent outright, it has no remaining control of the patent going forward, though the monetary reward from the sale of the patent is likely to be greater than the present value of the licensing fees the firm may receive from licensing that patent to another firm. The above cost-benefit trade-off suggests that, among the patents that they choose to monetize, firms are likely to sell patents that are most far away (in terms of technological distance) from their current patent portfolios (which reflects their main lines of business) while licensing those patents that are closer to their current patent portfolios.

The third sub-question we address here relates to the nature of patents licensed by a licensee firm in a patent licensing transaction. Clearly, licensing transactions will not occur for a patent without a firm demanding to license that patent. A firm will likely choose to license a patent from another firm when it needs that patent to develop a product, but it is more expensive for the licensee firm to develop the innovation internally, compared to licensing it from another firm. Further, the above demand for licensing a patent is likely to be greater for patents that are closer to the licensee firm's current line of activity, since it is cheaper for licensee firms to build new products more closely related to their current lines of business. Thus, we expect licensee firms to license in patents that are closer to their main lines of business (as captured by these patents' technological distance to the licensees' patent portfolios).

Finally, we turn to our third set of research questions, namely, the consequences of licensing transactions and the channels through which they occur. We ask and empirically investigate if the licensing transactions are efficient for both licensors and licensees. In other words, do licensing transactions create value for both the licensor and licensee firms? If they do, what are the channels through which licensing transactions create value? The measure of value we use here is equity market value, as captured by licensor and licensee firms' Tobin's Q. We would expect that licensing transactions are beneficial to both licensors and licensees in the sense that they create value for both parties. However, the channels of value creation may differ for the licensor and licensee firms. On the one hand, we expect licensor firms that can extract higher rents from licensing transactions (i.e., receive higher licensing fees) to have a higher level of Tobin's Q. Licensors will be able to use the proceeds to invest in innovation-oriented activities (such as R&D) to further enhance their comparative advantage in innovation, which will contribute to a higher level of Tobin's Q for these licensor firms. Turning to licensee firms, one potential way they may benefit from the licensing transactions is their exposure to new (or relatively unfamiliar) technologies. By getting exposed to new technologies by licensing patents from licensors, licensees can experience an increase in their Tobin's Q through a "learning by doing" channel and learn from using the patents they license. In other words, we expect to find that licensees who are more exposed to new technologies through licensing transactions are likely to achieve a greater increase in their Tobin's Q. In addition, by using the patents they license and thereby learning by doing, licensee firms may introduce a larger number of new products and increase their innovation efficiency.

We address the above research questions using a large and unique sample of patent licensing transactions from the ktMINE Patent License Agreement Database. ktMINE compiles the data on patent licensing transactions primarily from SEC firm disclosures and various online sources. Our sample includes 7,204 patent licensing transactions between public firms from 1976 to 2022, with 1,935 of them specifically listing the patents being licensed in the transactions. The ktMINE database also provides detailed information on transaction terms, types of intellectual property involved, and associated licensing fees. This comprehensive dataset allows us to analyze the economics of patent licensing at both the firm and patent levels.

Our empirical results can be summarized as follows. Our first set of findings deals with the innovation characteristics of firms that drive them to be licensors and licensees, as well as the determinants of the pairing between these two sets of firms. We find that firms with higher innovation productivity (as proxied by their innovation quantity and innovation quality) and higher R&D expenditures are more likely to become licensors. We do not find any significant changes in these firms' innovation productivity prior to the licensing transactions. In contrast, firms with higher innovation stock but facing a deterioration in their innovation productivity are more likely to be licensees. Different from licensor firms, we do not find R&D expenditures to be an important determinant of firms becoming licensees in patent licensing transactions. Taken together, these results suggest that firms with a comparative advantage in conducting innovation are more likely to become licensors. On the other hand, firms that wish to complement their patent portfolios and build products around them but are not able to conduct innovation efficiently in-house are more likely to be licensees.

Our second set of findings is regarding the determinants of the pairing between licensor and licensee firms. Using a matching model, we document two determinants that facilitate the matching between licensors and licensees. The first determinant is the vertical integration potential, using the measure by Frésard et al. (2020), between firms. Specifically, we find that licensors are more likely to license patents to firms that have downstream potential for (upstream) licensor firms. The second determinant is the technological similarity between firms. Specifically, we find that licensors are less likely to license patents to firms that are technologically similar to them (as measured by the cosine similarity between their patent portfolios as of the licensing transactions). Taken together, these results are consistent with our earlier conjecture that a licensor firm may take into account the indirect benefits and costs of licensing a patent to a particular licensee firm. Licensors tend to license patents to their downstream firms, since this may induce the demand for their products from licensee firms. On the other hand, by licensing patents to firms with less technological similarity, licensors take into account the potential costs arising from future product market competition from licensee firms.

Our third set of findings deals with the nature of the patents involved in licensing transactions. We document three findings here as follows. First, licensors retain patents that are closer in technological distance to their firms' current patent portfolio, while monetizing (either by selling or by licensing them to other firms) the patents that are farther away from their current patent portfolio. Second, among the patents that licensors choose to monetize, we find that licensor firms sell patents that are farthest away (in terms of technological distance) from their current patent portfolio, while licensing those that are closer to their patent portfolio. This is consistent with our hypothesis that licensors license patents over which they would like to maintain some control in the future while selling off those patents over which they have no desire to maintain control. Third, among the patents available for licensing (from licensors), licensee firms choose to license those patents closer in technological distance to their own patent portfolio. This is consistent with our hypothesis that an important reason for licensee firms to license patents is to build products around them. Clearly, it is less costly for them to build products close to their current line of business.

Our fourth set of findings deals with the consequences of licensing transactions for both licensor and licensee firms. We document the following results. First, we document that licensing transactions are efficient for both licensor and licensee firms, in the sense that these transactions create equity market value for both licensors and licensees. We measure value creation using the Tobin's Q of a firm, and document that, following patent licensing transactions, both licensor and licensee firms have significantly higher Tobin's Q than their matched control firms. To address endogeneity concerns and establish causality, we make use of the National Technology Transfer and Advancement Act (NTTAA) of 1995. The Act makes it easier for firms to enter into cooperative research and development agreements with the U.S. federal government and makes available the assistance of federal laboratories to the private sector. As a result, we argue that the Act not only makes licensing transactions more efficient but also spurs the demand for licensing and makes licensing more attractive for both potential licensors and licensees.[1] Therefore, by utilizing this quasi-random experiment as a positive shock to licensing transactions, we show that the baseline value creation effect of licensing transactions is likely causal.

After documenting the positive effect of patent licensing transactions on both licensors' and licensees' valuations, we delve into the channels through which this effect occurs. While such value creation may occur through numerous channels, we explore one channel each for the licensor and licensee firms. For licensor firms, their ability to extract rents from licensing transactions is a plausible mechanism through which these transactions create value for them. Specifically,

[1]For potential licensors, after the passage of the Act, they can enter into cooperative research and development agreements with the federal government more easily and utilize technology from federal laboratories. This enables potential licensors to develop higher-quality technology and license it to others more easily in exchange for financial rewards, compared to the pre-NTTAA era. For potential licensees, the enactment of the NTTAA facilitates access to technology they previously could not obtain. Before the NTTAA, licensees might not have been able to secure exclusive licenses for federally funded technology. With the NTTAA in place, it is now easier for potential licensees to obtain these exclusive licenses.

we find that the increase in Tobin's Q is more pronounced for the sub-sample of licensors who receive higher licensing fees (as measured by the royalty received by licensors) from licensing transactions. Further, consistent with the notion that licensors use the proceeds from licensing fees to invest in innovation-oriented activities to further enhance their comparative advantage in innovation, we find that licensors increase their R&D expenditures significantly and generate more patents following licensing transactions. For licensees, their exposure to new technologies is a channel through which patent licensing transactions create value for them. Specifically, we find that licensee firms' increase in Tobin's Q is stronger for the sub-sample of licensees who are exposed to new technologies from licensors as a result of the licensing transactions. Consistent with licensees getting exposed to new technologies brought by licensors and "learning by doing", licensees are more likely to cite licensors' patents, introduce a larger number of new products, and increase their innovation efficiency, subsequent to patent licensing transactions.

The rest of the paper is organized as follows. Section 2 discusses how our paper is related to the existing literature. Section 3 describes the underlying conceptual framework and develops testable hypotheses. Section 4 describes our data and sample selection procedures and presents the summary statistics of our sample. Section 5 analyzes the innovation characteristics of firms that drive them to be licensors or licensees in licensing transactions and the determinants of the pairing between these two sets of firms. Section 6 characterizes the nature of the patents involved in licensing transactions and how they relate to the patent portfolios of licensor and licensee firms. Section 7 analyzes whether licensing transactions are efficient in the sense that they increase the equity market value of both licensor and licensee firms, as well as the different channels through which this effect occurs for licensors and licensees. Section 8 concludes.

2 Relation to the Existing Literature

Our paper is related to several strands in the literature on innovation and the transfer of technology. The literature closest to this paper is the theoretical and empirical literature on patent licensing and the literature on the transfer of patents across firms through the buying and selling of patents. In an important paper, Akcigit et al. (2016) develop a theoretical model involving the transfer of technology through the buying and selling of patents. In their model, a firm operates in a potential technology class, which is fixed over time. A firm developing an idea may wish to sell the idea (patent) that is not close to its own technology class; similarly, it may buy a patent if it fails to innovate. In this context, they explore how their buying and selling of ideas affect firms' incentive to spend resources on R&D. The fact that a patent not useful for the innovator's own production can be sold raises the return for R&D; on the other hand, the fact that a firm can buy a patent rather than generate the innovation internally reduces the return for R&D. Akcigit et al. (2016) calibrate their model using data from the United States Patent and Trademark Office (USPTO) on the buying and selling of patents. They also develop a measure of technological distance between patents, which they use in their empirical analysis.

Akcigit et al. (2016) do not analyze the role of licensing in the transfer of patents, which is our main focus here. We, however, make use of their measure of technological distance in our empirical analysis of the nature of patents that a licensing firm chooses to retain (and build products around) rather than to monetize through selling or licensing, and in our analysis of licensor's choice of patents to sell versus to license. As we discuss below, we also address several other novel research questions for the first time in the literature.

Our paper is also related to the extensive theoretical and empirical literature on the motivations for the licensing of patents set in various contexts (e.g., Arora et al. (2001); Arora and Fosfuri (2003); Arora and Ceccagnoli (2006); Gambardella et al. (2007)). In a theoretical paper, Arora and Fosfuri (2003) show that competition in the market for technology induces licensing of innovations, and incumbent firms may find it privately profitable to license even if their joint profits may be higher in the absence of licensing. Gambardella and Giarratana (2013) find that licensing propensity increases with the degree of fragmentation of product markets. Arora and Ceccagnoli (2006) show empirically that increases in the effectiveness of patent protection enhance licensing propensity, but only when the licensor firm does not have the specialized complementary assets required to commercialize new technologies. A number of papers analyze the relationship between the intellectual property rights (IPR) in an industry and the propensity to license (e.g., Yang and Maskus (2001); Gambardella et al. (2007); Yang and Maskus (2009)). Fosfuri (2006) finds, using data from the chemical industry, a negative association between a licensor's market share and the rate of licensing. Gambardella et al. (2007) use a European dataset to document that firm size is an important factor in licensing: patents from smaller firms have a greater propensity to be licensed. Despite the existence of this large literature, ours is the first large sample and first cross-industry study to analyze the characteristics of licensees and the determinants of the pairing between licensors and licensees.

There is also a small literature on the consequences of patent licensing. Moreira et al. (2020) use a dataset from the biopharmaceutical industry and show that licensing-in positively impacts firm innovation, particularly in areas where competitors exert pressure. Moser and Voena (2012) use a dataset from the chemical industry and show that confiscating and licensing enemy-owned patents to American firms boosted domestic innovation in the licensed subclasses, leading to a significant increase in patenting by U.S. inventors after World War I. We contribute to this literature by conducting the first large sample and cross-industry study of the consequences of licensing transactions for licensors and licensees. In particular, we are the first to show that licensing transactions causally lead to an increase in equity market value for both licensor and licensee firms and explore plausible channels for licensors and licensees through which this effect occurs.

Our paper is also related to the broader literature on patent trading. Serrano (2010) and Figueroa and Serrano (2019) document the details of patent transfer and patent renewal. Ma et al. (2022) empirically analyze the trading of patents during bankruptcy reorganizations. Arora et al. (2022) document that science-based innovations are more likely to be traded, thereby enhancing the markets for technology. Han et al. (2022) make use of data from patent exchanges in China to show that patent trading leads to greater specialization by innovating firms. Zhang (2020) analyzes the effects of the selling of patents from the seller's point of view and shows that sellers benefit greatly from patent trading. In particular, he shows that patent trading leads to an increase in seller firms' innovation focus and an increase in their innovation quality and innovation efficiency.

While, as discussed above, there is a large existing literature on the licensing of patents in various specific contexts, there is a scarcity of large sample cross-industry evidence on the economics of patent licensing. In this paper, we have compiled a large and unique dataset on licensing transactions spanning 1976-2022 across all industries, and address three important research questions: the determinants of the pairing between licensors and licensees; the nature of patents that are retained by the licensor versus those monetized by selling or licensing as well as the patent characteristics that drive the choice between the selling and licensing; and the consequences of licensing transactions.

3 Conceptual Framework and Hypothesis Development

In this section, we develop a conceptual framework underlying patent licensing transactions. We then make use of this framework to develop testable hypotheses for our empirical analysis.

We consider an innovative firm which encourages the scientists and inventors it employs to develop patentable innovations. The firm gives considerable freedom to its employees (inventors and scientists) regarding the types of innovative projects that they can work on. This means that not all of the innovations developed by the scientists and employees of the firm (some of which may be patented) are directly related to the main line of business of the firm: some of these innovations may indeed be closely related to the main line of business of the firm, while others may be distant from the firm's main area of activity. This could arise due to the fact that innovation is ultimately uncertain and in-house R&D is usually conducted in a decentralized fashion. The firms may therefore have to decide which of the patents it has developed to keep within the firm; and which of these patents to monetize by either licensing them to other firms or selling them outright in return for financial rewards.

Each choice the firm makes regarding its patents has different costs and benefits. First, while the firm may benefit from building products around some of its patents, it may be prohibitively costly for it to develop products around patents that are (technologically) far away from its main line of activity. It may therefore choose to monetize these patents by either selling these patents or by licensing them to other firms. However, selling a patent, while the firm may reap substantial financial rewards from the sale, requires the firm to relinquish control of the patent completely to the buying firm, which may eventually use it in ways that are detrimental to the interests of the firm developing the patent. An alternative to selling a patent which allows the firm to maintain some control of the patent while monetizing it to some extent is licensing: licensing enables the licensor to obtain a periodic (quarterly, semi-annually, or annually) licensing fee from the firm licensing it (the licensee). In other words, licensing allows the licensor to maintain more control of the patent compared to selling the patent outright, since it allows the licensor to terminate the licensing contract after the initial licensing period.

Based on the above conceptual framework, we now develop testable hypotheses for our empirical analysis. We first develop testable hypotheses for our first set of research questions: what drives firms to be licensors or licensees, and what determines the pairing between them? A market for licensing patents raises the incentive of firms to do R&D, since patents that are not useful for an innovating firm's own products can be licensed to other firms, thus raising the *ex-ante* return from the licensor's R&D expenditures. In addition, licensor firms are likely to have a comparative advantage in efficiently conducting innovation, given that there is demand for their innovation output. Therefore, we expect that, compared to control firms, licensors will have both higher input into innovation (in the form of R&D expenditures) and higher output from innovation (in the form of patents). On the other hand, from a licensee's point of view, when the firm needs a patent around which it can build products, the firm can choose to develop the patent in-house or acquire it from other firms (by buying or licensing in the patent). When the firm is less able to efficiently conduct the innovation activity in-house, licensing the patent from other firms may be the more cost-effective option.[2] In addition, the fact that a firm can license a patent from another firm reduces the reward for it from developing the innovation internally by spending resources on R&D. Therefore, we expect licensee firms to be less efficient in conducting the innovation activities in-house compared to control firms. The above predictions regarding the innovation characteristics of licensor and licensee firms respectively related to control firms is the first hypothesis that we test here (**H1**).

In determining which firm to licensee a patent to, a licensor firm may take into account not only the stream of licensing fees it can generate from the licensing transaction, but also the non-pecuniary benefits and costs of licensing a patent to a particular firm. One non-pecuniary benefit of licensing a patent to a firm arises from the fact that it induces the licensee firm to buy the products of the licensor: i.e., the licensor and the licensee may have a potential upstream-downstream relationship. In other words, licensing a patent to a certain firm may not only help the licensee firm, but may also help the licensor by increasing the demand for the licensor's products from the licensee firm. This gives rise to the testable hypothesis that licensors are more likely to license their patents to firms having a downstream relationship with them. This is the second hypothesis that we test here (**H2**).

[2] Compared to purchasing of patents from other firms, licensing patents usually requires a smaller upfront payment. The majority of licensing fees paid by licensees is in the form of royalty, which is usually a certain percentage of licensees' sales in the next few years. This fee structure allows licensees to "test the water" with the patents that they choose to license.

We now turn to the potential costs that may arise from a licensor licensing a patent to another firm. If a licensor and licensee operate as competitors in the product market, licensing a patent to such a licensee may hurt the licensor, since the licensee firm may use this patent it has licensed from the licensor to improve its own products, thereby obtaining a competitive advantage with respect to the products of the licensor. This means that, if a licensor and a potential licensee are technologically similar, then the two firms are less likely to form a licensor-licensee relationship. This is the next hypothesis that we test here (**H3**).

We now turn to developing testable hypotheses for the second set of research questions that we analyze in this paper: What is the type of patents that a licensor is likely to retain (and build products around) versus monetize (by licensing or selling to another firm)? What is the type of patents that a licensee wants to license? As discussed earlier in this section, firms may choose to retain some of the patents developed by them and build products around these patents. Clearly, it is less costly for firms to build products around their current line of business. In other words, firms will retain those patents that are closer in technological distance (see Akcigit et al. (2016)) to their current patent portfolio, while monetizing (either by licensing or by selling outright) patents that are further away from their current patent portfolio. This is the next hypothesis that we test here (**H4**).

If a firm chooses to monetize a patent, it has to decide how to monetize it: either by licensing the patent to another firm or by selling it outright. On the one hand, licensing the patent to another firm allows the firm to maintain some control of the patent going forward (since it has the ability not to renew the license after the initial licensing period) while receiving a periodic licensing fee. On the other hand, if the firm sells a given patent outright, it has no remaining control of the patent going forward, though the monetary reward from the sale of the patent is likely to be greater than the present value of the licensing fees the firm may receive from licensing that patent to another firm. The above cost-benefit trade-off suggests that, among the patents that they choose to monetize, firms are likely to sell patents that are most far away from their current patent portfolio (which reflects their main line of business) while licensing out those patents that are closer to their current patent portfolio. This is the next hypothesis that we test here (**H5**).

We now turn to the choice made by the licensee regarding a licensing transaction. Clearly, licensing transactions will not occur for a patent without a firm demanding to license that patent.

A firm will likely choose to license a patent from another firm when it needs that patent to develop a product, but it is more expensive for the firm to develop the innovation internally, compared to licensing it from another firm. Further, the above demand for licensing a patent is likely to be greater for patents that are closer to the firm's current line of activity, since firms are more likely to build new products more closely related to their current patent portfolio. This leads to our next testable hypothesis, namely, that licensee firms are more likely to license in patents that are closer in technological distance to their current patent portfolio (**H6**).

We now turn to our third set of research question, namely, the value created as a result of the licensing transaction for the licensor and the licensee firms and the channel through which this value is created. The first question we ask here is this: are licensing transactions efficient on average? In other words, are they value-creating for the licensor and licensee simultaneously? We hypothesize that licensing transactions are efficient so that the stock market valuation of both the licensor and licensee firms increase subsequent to the licensing transactions (**H7**).

We now turn to developing hypotheses about the specific channels through which licensing transactions create value for licensors and licensees. In terms of licensors, clearly, an important benefit of a licensing transaction to a licensor firm is the stream of licensing fees they will receive over time from licensee firms. The licensor firm may be able to use a part of these fees to create further value (and to enhance its comparative advantage in innovation) by investing some of the licensing fees into innovation-oriented activities. Therefore, we conjecture that the increase in valuation will be more pronounced for the sub-sample of licensors who receive higher licensing fees (**H8**). Further, we conjecture that licensors increase their R&D expenditures (i.e., input of innovation) and produce more patents (i.e., output of innovation) following licensing transactions (**H9**).

In terms of the channel for licenses, as part of the licensing transaction, the licensee firm pays a stream of licensing fees to the licensor and in return, obtains legal access to use a patent that it did not develop by itself. An important implication of this is that the licensee firm is able to obtain exposure to new technology that it would not otherwise have been able to get exposure to. This is then reflected in higher equity market valuation. Therefore, we hypothesize that the increase in valuation will be more pronounced for the sub-sample of licensees who obtain more exposure to new technologies (**H10**). Further, through this "learning-by-doing" channel where a licensee firm learns from using the patents that it licenses, we conjecture that the licensee is more likely to cite the corresponding licensor's patents, develop more new products, and improve its innovation efficiency. This is the last hypothesis that we test here (**H11**).

4 Data, Sample Selection, and Summary Statistics

The data used in our study is collected from several sources. The main source from which we obtain the licensing transaction-related information is the ktMINE Patent License Agreement Database. ktMINE collects the data on patent licensing transactions mainly from SEC firm disclosures, which are then supplemented with other various online data sources. With SEC firm disclosures being the main source from which ktMINE collects licensing transaction information, we are able to have relatively comprehensive coverage of substantial licensing transactions (as public firms are required to disclose such transactions). Since the majority of the database comes from SEC firm disclosures, the filer of every patent licensing transaction has a unique identifier denoted by CIK. This identifier allows us to link this firm to other standard databases (such as Compustat). As a result, our sample contains 7204 patent licensing transactions spanning from 1976 to 2022. Of these, 1935 of them have specifically listed patents being bundled and licensed out in these transactions. This comprehensive dataset thus allows us to conduct our empirical analysis at both the firm and patent levels.

Apart from the firms and patents involved in every patent licensing transaction, the ktMINE Patent License Agreement Database provides us with rich information on different terms of licensing transactions. For example, among many other things, this database provides information about the types of transactions (e.g., licensing, manufacturing, commercialization, and distribution), detailed terms of different transactions, filing and effective dates of transactions, and the types of intellectual property (IP) involved.[3] This comprehensive database also provides information on the licensing fees associated with different transactions (in the forms of upfront fixed payment as well as royalty).[4]

[3]Most of IP involved are patents, but many transactions include other types of IP, such as trademarks, copyrights, and brands, among others.

[4]Generally, licensees pay two types of fees to licensors for the patents they license. The first type is fixed fees, which includes upfront payments or one-time license fees. These require licensees to pay licensors a pre-determined amount of money. The second type is variable fees or royalty. This type of fees is typically charged as a percentage of net sales

We link the ktMINE Patent License Agreement Database to Compustat using CIK as the identifier. However, the CIK provided by ktMINE is only the filer's CIK. There are other parties involved in a patent licensing transaction that could also be public firms. Therefore, to make sure we identify every public firm in every transaction, we isolate all the names from every patent licensing transaction, standardize them, and merge them with Compustat using fuzzy name matching. After the fuzzy name matching is completed, we manually inspect every transaction to ensure the quality of our matching. As a result, our sample contains 1300 (1954) unique Compustat public firms that engage in patent licensing transactions as licensors (licensees) over the sample period.

In addition to the ktMINE Patent License Agreement Database and Compustat, we collect information on patent applications and grants, as well as patent-level statistics, from the USPTO PatentsView Database. We also collect trademark data from the USPTO to proxy for a firm's new product introduction. Further, we collect data on firms' vertical integration from Hoberg-Phillips Data Library.[5] This data is originally developed by Frésard et al. (2020) and captures the degree of vertical integration between a given pair of public firms. We report the firm- and patent-level summary statistics in Table 1. Panel A of Table 1 reports the summary statistics for licensor firms and their industry-size matched control firms. Panel B of Table 1 reports the summary statistics for licensee firms and their industry-size matched control firms. Panel C of Table 1 reports the summary statistics for licensor-licensee firm pairs and pairs formed by their industry-size matched control firms. Panel D of Table 1 summarizes the licensing fees invloved in various licensing transactions. Overall, there are three types of fees paid in licensing transactions in our sample. The first kind of fees is an upfront fixed fee paid for each licensing transaction. The second kind of fees is a variable payment based on the number of unit of products sold by the licensee. The third type of fees is a variable payment specified as a percentage of sales of the licensee over a particular period subsequently.[6] Some licensing transactions involve multiple types of fees among the above three categories. Most of the transactions in our sample report missing (or zero) values for the upfront fixed fees and variable payment based on the number of unit of products sold by the licensee. How-

of licensees over a certain period. It could also be charged as a particular dollar amount per unit of products sold by licensees. Among the transactions in our sample, only three exclusively use the fixed fee model, while the rest involve a combination of both fixed and variable payments (royalties).

[5]The data is downloaded from: https://faculty.marshall.usc.edu/Gerard-Hoberg/FresardHobergPhillipsDataSite/index.html.

[6]Both the second and third types of licensee fees are usually referred to as royalty.

ever, the majority of the transactions in our sample report values on the variable payment specified as a percentage of sales of the licensee over a particular period. Hence, we mainly rely on the latter type of licensing fees when conducting our cross-sectional analysis in Section 7.3.1. Lastly, we trim all the continuous variables at the 1st and 99th percentile levels to minimize the impact of outliers.

5 Licensors' and Licensees' Characteristics, Matching Between Licensors and Licensees, and Licensing Transaction Incidence

In this section, we analyze the determinants of patent licensing transactions from both the licensors' and the licensees' point of view. Specifically, we first explore what innovation characteristics drive a firm to become a licensor or licensee in a patent licensing transaction. We then analyze the determinants driving the matching between potential licensor and licensee firms.

5.1 Licensors' and Licensees' Characteristics and Licensing Transaction Incidence

To being with, we examine the firm-level innovation characteristics that drive a firm to be a licensor or a licensee firm in a patent licensing transaction. We employ the following specification.

$$\begin{aligned} \textit{Licensor}_{i,k,t}\ (\textit{or Licensee}_{i,k,t}) = \alpha &+ \beta_1 \textit{Firm Innovation Characteristics}_{i,t-1} \\ &+ \beta_2 \textit{Firm Characteristics}_{i,t-1} + \textit{Transaction FE}_k + \epsilon_{i,k,t} \end{aligned} \tag{1}$$

In specification (1), the dependent variable, $\textit{Licensor}_{i,k,t}\ (\textit{or Licensee}_{i,k,t})$, is a dummy variable that equals one if firm i is a licensor (licensee) firm in a patent licensing transaction k in year t. This variable is equal to zero for the licensor's (licensee's) matched control firms. We discuss in detail how we match each licensor or licensee firm with its control firms below.

The main independent variable of interest, $\textit{Firm Innovation Characteristics}_{i,t-1}$, includes a set of different innovation characteristics of firm i measured in year $t-1$ that proxy for the firm's innovation quantity or innovation quality. Specifically, we examine the effect of the following innovation characteristics on the patent licensing transaction incidence: (i) Num_Pat_3, which is the truncation-adjusted number of patents generated by a firm in the last three years up to a given year; (ii) CPP_3, which is the number of truncation-adjusted lifetime citations per patent for patents generated by a firm in the last three years up to a given year; (iii) ΔNum_Pat_3, which is the growth rate of a firm's truncation-adjusted number of patents over the last three years; and (iv) ΔCPP_3 is the growth rate of a firm's truncation-adjusted number of citations per patent over the last three years. We adjust for the truncation bias in the number of patents a firm generates as well as the number of citations received by patents following the methodology in Hall et al. (2001) and Seru (2014). Together, these variables capture a firm's innovation productivity (as measured by its quantity and quality of innovation) and the firm's innovation dynamics (as measured by the growth rate of its innovation activity).

In specification (1), we also include several firm-level fundamentals that may be important for a firm to engage in a licensing transaction as a licensor or licensee. These firm-level controls, *Firm Characteristics*$_{i,t-1}$, are measured for firms in year $t-1$ and include *Size*, *R&D*, *ROA*, *Leverage*, *Cash*, *CAPEX*, and *B/M*. The definitions of these variables are illustrated in Table 1. Further, we include licensing transaction fixed effects, so that we are comparing an actual licensor (licensee) firm with its matched non-licensor (non-licensee) firms within the same licensing transaction.

For every patent licensing transaction, we match the actual licensor (licensee) firms with non-licensor (non-licensee) firms based on the industry and firm size measured as of the year prior to the patent licensing transaction. Specifically, for each licensor (licensee) of a licensing transaction in year t, we identify up to five non-licensors (non-licensees) in the same industry with the closest firm size measured in year $t-1$. For industry classification, we start selecting matched non-licensor or non-licensee firms using the most stringent industry classification (i.e., four-digit SIC). In our final sample, 94.79% of licensors and 93.61% of licensees are matched with five control firms from the same four-digit SIC industry. When there are not enough control firms in the same four-digit SIC industry, we then gradually relax our industry classification to three-digit and finally two-digit SIC industry levels. We also require that these matched control firms not be licensors or licensees in the last three years prior to year t. Finally, we run a conditional logit regression of specification (1), since the conditional logit model allows us to account for matching (e.g., Bena and Li (2014); Cunningham et al. (2021)).

We first examine which firms are more likely to become licensors in patent licensing transactions. Table 2 presents the results on the effect of a firm's innovation characteristics on the probability of the firm becoming a licensor in a patent licensing transaction. On average, a firm's innovation quantity and innovation quality have a positive and significant effect on the probability of the firm licensing out some of its patents, as indicated by the positive and statistically significant coefficients of Num_Pat_3 and CPP_3. However, the growth rate of a firm's innovation quantity or quality over the last three years does not significantly predict the likelihood of the firm becoming a licensor in a licensing transaction. Notably, across different columns of Table 2, the coefficients of a firm's R&D expenditures in the year prior to a licensing transaction are positive and statistically significant.

In terms of economic significance, since we obtain coefficient estimates by running a conditional logit regression of specification (1), the coefficient estimates should be interpreted in a relative odds fashion. Specifically, one standard deviation increase in Num_Pat_3 is associated with an approximately 35% increase in the propensity of a firm to become a licensor in a patent licensing transaction. This is almost twice as much as the unconditional probability. On the other hand, a standard deviation increase in CPP_3 is associated with an approximately 8% increase in the propensity of the firm to become a licensor, or 43% of the unconditional sample mean. The coefficients of $R\&D$ is also of great economic significance. Take the coefficient of $R\&D$ in Column (1) of Table 2 as an example: one standard deviation increase in $R\&D$ translates to a 18% increase in the propensity of the firm to become a licensor. This is economically very significant, since this is close in magnitude to the unconditional mean. Overall, the results in Table 2 suggest that firms characterized with higher innovation quantity, higher innovation quality, and higher R&D expenditures are more likely to become licensors in patent licensing transactions.

Next, we turn to the other side of patent licensing transactions, namely, the licensees, and examine which innovation characteristics drive a firm to become a licensee firm in a patent licensing transaction. Table 3 presents the results. Columns (1) and (2) of Table 3 suggest that firms with higher innovation quantity or quality are more likely to become licensees in patent licensing transactions, as indicated by the positive and statistically significant coefficients of Num_Pat_3 and CPP_3. However, when we examine firms' innovation dynamics (as captured by the growth rate in their innovation quantity or quality) and their effects on firms' propensity to become licensees, we document a pattern in sharp contrast to that of licensors (Table 2). Specifically, we find that firms that experience a decline in their growth of innovation quantity or quality are more likely to become licensees. These effects are economically meaningful. For instance, a standard deviation decrease in ΔNum_Pat_3 is associated with a 14% increase in the probability of a firm becoming a licensee, compared to its matched control firms. This is about 82% of the unconditional mean. On the other hand, one standard deviation decrease in ΔCPP_3 is associated with a 17% increase in the probability of a firm becoming a licensee. This is economically very meaningful, since it is slightly greater in magnitude than the unconditional mean. Further, it should be noted that we also document an opposing pattern when it comes to the effect of R&D expenditures: compared to what we find for licensor firms, a firm's R&D expenditures in the previous year has insignificant effect on the probability of the firm becoming a licensee.

Taken together, the results presented in Tables 2 and 3 suggest that while firms with higher innovation productivity (as captured by their innovation quantity or quality) and higher expenditures are more likely to be licensors, firms that face a deterioration in their internal innovation (as captured by the growth rate of their innovation quantity or quality) are more likely to be licensees. These results together support the conjectures of our first hypothesis (**H1**).

5.2 The Matching Between Licensors and Licensees and Licensing Transaction Incidence

In this section, we examine the determinants of the matching between potential licensor and licensee firms. We using the following regression specification.

$$\begin{aligned} \textit{Actual\_Pair}_{i,j,k,t} = \alpha &+ \beta_1 \textit{Pairing Characteristics}_{i,j,k,t-1} \\ &+ \beta_2 \textit{Licensor Innovation Characteristics}_{i,k,t-1} \\ &+ \beta_3 \textit{Licensee Innovation Characteristics}_{j,k,t-1} \\ &+ \beta_4 \textit{Licensor Characteristics}_{i,k,t-1} + \beta_5 \textit{Licensee Characteristics}_{j,k,t-1} \\ &+ \textit{Transaction FE}_k + \epsilon_{i,j,k,t} \end{aligned} \quad (2)$$

In specification (2), the dependent variable, $\textit{Actual\_Pair}_{i,j,k,t}$, is equal to one if a firm pair *i-j* is the actual licensor-licensee pair in licensing transaction k. This dummy variable is equal to zero otherwise. The main independent variable of interest here is $\textit{Pairing Characteristics}_{i,j,k,t-1}$. This variable measures the characteristics between a firm pair *i-j*. In this paper, we focus on two particular characteristics for a given pair of firms: $\textit{Vertical\_Integrate}_{i,j,k,t-1}$ and $\textit{Tech\_Similarity}_{i,j,k,t-1}$. These two variables capture the product market as well as technological relationship between a pair of firms. Specifically, $\textit{Vertical\_Integrate}_{i,j,k,t-1}$ captures the vertical integration potential for a given pair of firms. It is a dummy variable equal to one if firm i and j are vertically integrated in year $t-1$ (i.e., the year prior to licensing transaction k). It is equal to zero otherwise. We obtain the data on the vertical integration relationship between a given pair of firms from Frésard et al. (2020), where we use the 10% granularity version of the VTNIC (Vertical TNIC) database provided by the authors.[7] This version of the VTNIC database contains the firm pairs that have vertical relatedness scores in the top 10% of all pairwise scores in the given year. If a given firm pair in our sample appears in this database (with the order of firm i being the upstream firm and firm j being the downstream firm), the $\textit{Vertical\_Integrate}_{i,j,k,t-1}$ for this pair of firms will take the value of one. Otherwise, it is equal to zero. On the other hand, $\textit{Tech\_Similarity}_{i,j,k,t-1}$ captures the technological similarity between a given pair of firms. This variable is constructed as the cosine similarity between firm *i*'s and firm *j*'s patent portfolios by counting the number of patents in different technology classes of these firms' portfolio up to the year $t-1$ (i.e., the year prior to licensing transaction k). This variable takes values that range from zero to one. If this variable takes a value that is closer to one (zero) for a given firm pair *i-j*, this indicates that firm *i* and *j* are more (less) similar to each other in their technology expertise. All other variables included in specification (2) are constructed in the same way as those in specification (1).

To be able to run regressions of specification (2), we need both actual licensor-licensee pairs and pseudo pairs formed by matched non-licensor and non-licensee firms. We employ an identical matching procedure to that in specification (1) and choose size-matched control firms that are in the same industry as licensors and licensees. Specifically, for a given licensor-licensee firm pair in our sample, we first select up to five industry- and size-matched control firms for this licensor and licensee. Then, we form pairwise combinations between each of these matched non-licensor firms and each of these matched non-licensee firms. As a result, for every actual licensor-licensee firm pair, we generate up to 25 (i.e., 5×5) pairwise combinations of matched non-licensor and

[7] We use the data from "Pairwise Vertical Related Network: Basic 10% Granularity Version" on the website: https://faculty.marshall.usc.edu/Gerard-Hoberg/FresardHobergPhillipsDataSite/index.html.

non-licensee control firms.

Table 4 reports the results on different pairing characteristics that drive a given pair of firms to form a licensor-licensee relationship in a patent licensing transaction. Panel A of Table 4 reports the regression results on the effect of the vertical integration between two firms on the likelihood of these two firms forming a licensor-licensee relationship in a licensing transaction. Column (1) of Panel A presents the results in a univariate setting. The positive and statistically significant coefficient of $Vertical\_Integrate$ indicates that, if firms i and j are vertically integrated in the product market where firm i (j) is the upstream (downstream) firm, it is more likely for firm i to license out some of its patents to firm j (i.e., firm i being the licensor and firm j being the licensee in a licensing transaction). In Column (2) of Panel A, we include controls (such as firms' innovation characteristics and firms' fundamentals) for both licensors and licensees and their matched firms. Further, we include transaction fixed effects in the regression. The coefficient of $Vertical\_Integrate$ becomes larger in magnitude while remains statistically significant. Overall, the results in Panel A of Table 4 suggest that when deciding which firm to license patents to, licensor firms prefer to license patents to firms that are more likely to be their downstream partners. These findings confirm the prediction in Hypothesis **H2**.

Panel B of Table 4 reports the regression results on the effect of the technological similarity between two firms on the likelihood of these two firms forming a licensor-licensee relationship in a licensing transaction. Column (1) of Panel B presents the regression results in a univariate setting. The negative and statistically coefficient on $Tech\_Similarity$ suggest that if firms i and j are similar to each other in terms of their technological expertise (indicated by a greater value of $Tech\_Similarity$), then it is less likely for firm i (i.e., licensor) to license out some of its patents to firm j (i.e., licensee). In Column (2) of Panel B, apart from controlling for transaction fixed effects, we also control for innovation characteristics and firms' fundamentals for licensors and licensees and their matched firms. The coefficient of $Tech\_Similarity$ remains negative and statistically significant. Overall, the results in Panel B suggest that licensors are less likely to license their patents to firms that are technologically more similar to themselves (and thus less likely to be their competitors). These findings confirm the prediction in our Hypothesis **H3**.

6 The Nature of Patents Involved in Licensing Transactions

In this section, we delve into patent-level analysis and characterize the patents that are licensed in patent licensing transactions. We use the following patent-level regression specification to address our second set of research questions: What is the type of patents that a firm is likely to retain (and build products around) versus monetize (by licensing or selling it to another firm)? In addition, conditional on a firm choosing to monetize some of its patents, what is the type of patents that are more likely to be licensed versus sold?

$$Licensed\_Patent_{i,j,t} = \alpha + \beta Tech\_Dist_{i,j,t} + \boldsymbol{X_{i,\tau}}\gamma + \epsilon_{i,j,t} \tag{3}$$

The dependent variable in specification (3), $Licensed\_Patent_{i,j,t}$, is a dummy variable. It equals one if patent i is licensed out by licensor j or licensed in by licensee j at year t, and it equals zero otherwise. $\boldsymbol{X_{i,\tau}}$ is a vector of patent-level control variables for patent i filed in year τ. These patent-level controls include the number of backward citations, number of forward citations, number of claims, and a patent litigation dummy. The main independent variable of interest is $Tech\_Dist_{i,j,t}$, representing the technological distance of patent i from firm j's patent portfolio in the licensing transaction year t.

We follow Akcigit et al. (2016) to construct the measure of technological distance between a patent and the owning firm's existing patent portfolio.[8] This measure is constructed in two steps. In the first step, we calculate the technological distance between technology classes X and Y as follows based on the citation pattern of patents:

$$d(X, Y) = 1 - \frac{\#(X \cap Y)}{\#(X \cup Y)} \tag{4}$$

In equation (4), $d(X, Y)$ denotes the technological distance between technology classes X and Y. The numerator, $\#(X \cap Y)$, denotes the number of patents that cite patents from both technology classes X and Y simultaneously. The denominator, $\#(X \cup Y)$, denotes to the number of patents that cite patents in either technology class X or Y. This symmetric measure suggests that, among all the patents that cite patents in either technology class X or Y, if the number of patents that

[8] This measure is widely used in other papers (e.g., Zhang (2020), Ma et al. (2022), and Han et al. (2022)).

simultaneously cite patents in technology classes X and Y is larger, then it indicates that the technology class X and Y is more proximate to each other in the knowledge space. This will lead to $d(X,Y)$ taking a value closer to zero. In sum, a higher value of $d(X,Y)$ indicates that X and Y are technologically more distant from each other.

After constructing the technological distance between every pair of technology classes X and Y in the first step, we calculate the technological distance between a patent p and the owning firm f's patent portfolio as follows in the second step:

$$d_\iota(p,f) = \left(\frac{1}{\parallel P_f \parallel} \sum_{p' \in P_f} d(X_p, Y_{p'})^\iota \right)^{\frac{1}{\iota}} \tag{5}$$

In equation (5), $d_\iota(p,f)$ denotes the technological distance of patent p from the owning firm f's patent portfolio. P_f denotes the set (i.e., portfolio) of patents of firm f filed prior to patent p. Thus, $\parallel P_f \parallel$ denotes the number of patents in the firm f's patent portfolio before patent p. $d(X_p, Y_{p'})$ denotes the technological distance between technology class of patent p and that of every other patent p' in the owning firm's patent portfolio. In addition, ι is a weighting parameter, where $0 < \iota \leq 1$. In this paper, we follow the existing literature and set ι equal to 2/3.[9] In sum, a higher value of $d_\iota(p,f)$ indicates that the focal patent p is technologically more distant to the patent portfolio of the owning firm f.

We first start with the monetization decision faced by firms in general. Firms may choose to retain some of the patents developed by them and build products around these patents. Clearly, it is less costly for firms to retain patents that are more relevant to their main line of business and thus build products around such patents. In other words, firms will retain those patents that are closer (in technological distance) to their current patent portfolio, while monetizing (either by licensing or by selling outright) patents that are further away from their current patent portfolio.

We empirically examine this conjecture and report the patent-level results in Table 5. Here, the dependent variable is a dummy that is equal to one if a patent is monetized by a firm. Here, we define a patent as monetized if the firm chooses to license it or sell it to another firm. This dummy variable is equal to zero otherwise. The main independent variable of interest here is *Dist_to_Owner*, which captures a focal patent's technological distance to the owning firm's patent

[9] See Akcigit et al. (2016), Brav et al. (2018), Zhang (2020), Han et al. (2022), and Ma et al. (2022).

portfolio. We include firm fixed effects in Columns (1) and (2) of Table 5 in order to absorb any firm-specific factors that affect a firm's propensity to monetize a focal patent. The coefficients of *Dist_to_Owner* in Columns (1) and (2) are positive and statistically significant. This suggests that, within the same firm, patents that are technologically further away from the owning firm's main knowledge space (as captured by its patent portfolio) are more likely to be monetized (i.e., either sold or licensed out) by the owning firm. In Columns (3) and (4) we include tech class-by-filing year fixed effects to absorb the varying technological trend over time, and the main empirical pattern remains consistent. Overall, the results in Tables 5 suggest that firms are more likely to monetize patents that are technologically further away from their main operations while retaining patents that are technologically closer to their main operations. Overall, the results in Table 5 are consistent with the prediction of our Hypothesis **H4**.

Next, we examine, conditional on a firm monetizing some of its patents, how the firm will monetize these patents. If a firm chooses to monetize some of its patents, it can do that either by licensing these patents to another firm or by selling them outright. On the one hand, licensing a patent to another firm allows the firm to maintain some control of the patent going forward (since it has the ability not to renew the license after the initial licensing period) while receiving a periodic licensing fee. On the other hand, if the firm sells that patent, the firm will have no remaining control of the patent going forward. However, the monetary reward from the sale of the patent is likely to be greater than the present value of the licensing fees the firm may receive from licensing that patent to another firm. The above cost-benefit trade-off suggests that, among the patents that they choose to monetize, firms are likely to sell patents that are farther away (in technological distance) from their current patent portfolio since these patents are less relevant to their main operations, while licensing out those patents that are closer to their current patent portfolio.

We empirically examine this conjecture and report the results in Table 6. Here, the dependent variable is a dummy variable that equals one if a focal patent is licensed out by the owning firm. It is equal to zero if this patent is sold by the firm. The main independent variable of interest here is *Dist_to_Licensor*, which captures a focal patent's technological distance to the licensor firm's patent portfolio. Column (1) of Table 6 includes firm and year fixed effects to account for any firm-specific and time-varying factors that may potentially affect the choices made by licensors regarding different ways to monetize a patent. The negative and statistically significant coefficient of *Dist_to_Licensor* suggests that a patent with a greater technological distance from the licensor's patent portfolio is less likely to be licensed out relative to being sold in a patent transaction. In other words, conditional on a firm choosing to monetize a patent, the firm is more likely to sell patents that are technologically further away from its main operation. On the contrary, a firm is more likely to license out patents that are technologically closer to its main operation. When we control for a set of patent-level variables in Column (2) or technology class by filing year fixed effects in Columns (3) and (4), the overall empirical pattern remains consistent. Put together, the results in Table 6 support the prediction of Hypothesis **H5**.

We now turn to the licensee's point of view. Clearly, licensing transactions will not occur for a patent without a firm demanding to license that patent. A firm will likely choose to license a patent from another firm when it needs that patent to develop a product, but it is more expensive for the licensee firm to develop the innovation internally, compared to licensing it from another firm. Further, the above demand for licensing a patent is likely to be greater for patents that are closer to the licensee firm's current line of activity, since it is cheaper for licensee firms to build new products more closely related to their current lines of business. Thus, licensee firms are likely to license in patents that are technologically closer to their main lines of business.

To empirically examine the above conjecture, we run specification (3) with $\textit{Licensed\_Patent}_{i,j,t}$ being equal to one for the licensed patent i and zero for other patents in the corresponding licensor's patent portfolio as of the transaction year t.[10] The independent variable $\textit{Tech\_Dist}_{i,j,t}$ in the specification (3) is now *Dist_to_Licensee*, which denotes the technological distance of every patent in the corresponding licensor's patent portfolio to the licensee's patent portfolio as of the transaction year t.

Table 7 reports the results on the relationship between a patent's distance from the patent portfolio of a licensee firm and the probability of the patent being licensed in by the licensee. Column (1) of Table 7 reports the results in a univariate regression. The coefficient of *Dist_to_Licensee* is negative and statistically significant. This indicates that the shorter the technological distance

[10]Here we assume that conditional on a licensee firm licensing from the corresponding licensor, which patents in the licensor's patent portfolio will the licensee choose to license. Of course, it could be the case that licensee firms first consider which technology class they need to license a patent from and then choose a specific patent from this technology class to license in. Thus, we also use a different control group, where $\textit{Licensed\_Patent}_{i,j,t}$ dummy equals one for the actual licensed patents and zero for all the other patents in the same technology class as of the transaction year. The results continue to hold.

between a patent and a licensee firm's patent portfolio, the more likely the licensee will choose to license in that patent. The implications remain consistent when we add patent-level control variables (Columns (2) and (4)) and control for technology-specific time-varying factors that may potentially affect the licensee's decision to license a patent (Columns (3) and (4)). Overall, the results in Table 7 are consistent with the prediction in Hypothesis **H6**, which suggests that licensee firms are more likely to license patents that are closer to their current patent portfolio.[11]

In summary, our patent-level analysis finds that, for licensors, when choosing to monetize a patent (by either licensing it to another firm or by selling it outright), firms tend to sell patents that are most distant from their current patent portfolio and license those that are closer to it. By engaging in patent licensing transactions, licensor firms are able to monetize those patents that they do not wish to build products around while maintaining some control over those patents. Similarly, licensee firms are more likely to license patents that are closer to their current line of business, since it would be more cost-effective for them to build products around such patents.

7 Are Patent Licensing Transactions Efficient?

In this section, we empirically test whether patent licensing transactions are efficient in the sense that they increase the equity market value of both licensor and licensee firms.

7.1 Baseline Analysis

We first construct a control group for each licensor and licensee firm. We use a propensity score matching method to construct the control group. To some extent, This allows us to attribute the differences in outcomes between licensor/licensee firms and control firms to the patent licensing transaction. To form the control group, we require that the control firms be in the same industry as the licensor/licensee firms. For each firm that becomes a licensor/licensee in year t, we match up to five control firms that, in year $t-1$, have similar size, R&D expenditure, ROA, leverage, cash, capital expenditure, total number of patents in the previous three years, and total number of citations per patent in the last three years as the actual licensor/licensee firms.

[11]It is interesting to note that the coefficients on the litigation dummy are positive and significant in Tables 6 and 7. This suggests that when a patent has been subject to litigation (perhaps indicating greater demand for using that patent), it is more likely to be licensed.

We examine whether patent licensing transactions are efficient for both licensor and licensee firms using the following specification:

$$TobinQ\_1\_3_{i,t} = \alpha_j \times \alpha_t + \beta \textit{Licensor/Licensee}_{i,t} + \boldsymbol{X_{i,t}}\gamma + \epsilon_{i,t} \quad (6)$$

we use Tobin's Q to measure a firm's equity market valuation. Specifically, the dependent variable in specification (6) is firm i's average Tobin's Q in the three years following year t. The independent variable of interest is *Licensor/Licensee*$_{i,t}$, which equals one if the firm is a licensor/licensee, and zero for the matched control firms. We control for a vector of firm-level variables, $\boldsymbol{X_{i,t}}$, including firm's number of patents, size, R&D expenditure, ROA, leverage, cash, and capital expenditure at year t, all of which may potentially affect a firm's Tobin's Q. We also include industry-by-year fixed effects to account for any industry-specific unobservables that may vary over time. Robust standard errors are clustered at the industry level.

Table 8, Panel A, reports the regression results for licensors associated with specification (6). Column (1) shows the univariate regression results, where the coefficient for *Licensor* is positive and statistically significant. Column (2) includes industry-by-year fixed effects, and column (3) controls for a set of firm-specific characteristics. To further test whether patent licensing transactions indeed increase the subsequent Tobin's Q for licensor firms, column (4) controls for the Tobin's Q at the year of the patent licensing transactions. The estimated coefficients for the *Licensor* dummy remain positive and statistically significant. This suggests that, on average, three years after engaging in patent licensing transactions, licensor firms tend to have higher Tobin's Q than matched non-licensor firms. Panel B reports the regression results for licensee firms. The estimated coefficients in columns (1)–(4) are positive and significant, indicating that, compared to the matched non-licensee firms, licensee firms tend to have a higher Tobin's Q after patent licensing transactions.

Overall, our baseline results show that, after patent licensing transactions, both licensor and licensee firms have higher Tobin's Q relative to matched control firms. Through licensing transactions, licensors are able to monetize patents which they do not wish to build products around while receiving periodic licensing fees. These financial rewards can subsequently be utilized to create firm value. On the other hand, by accessing new technology more quickly, licensee firms also benefit from the licensed patents. Therefore, patent licensing transactions facilitate both licensor and licensee firms in utilizing assets more efficiently to create market value. The baseline results lend support to the prediction in our testable hypothesis **H7**.

7.2 Identification

Our above baseline regressions can potentially address the concern that firms with higher Tobin's Q, usually associated with higher growth potential, are more likely to engage in patent licensing transactions. However, there may still be omitted variables that correlate with the main independent variable *Licensor/Licensee* and affect a firm's Tobin's Q. To address this concern and establish the causality between patent licensing transactions and equity market value, we utilize a Difference-in-Differences (DiD) framework. This approach is based on the National Technology Transfer and Advancement Act (NTTAA) of 1995, which serves as a positive exogenous shock to firms' patent licensing transaction decisions.

The National Technology Transfer and Advancement Act of 1995 was signed into law on March 7, 1996. The NTTAA amended several existing laws and mandated new directions for federal agencies with the purpose of accelerating the commercialization of technology and industrial innovation. It aimed to encourage cooperative research and development between businesses and the federal government by providing access to federal laboratories and making it easier for businesses to obtain exclusive licenses to technology and inventions resulting from such cooperative research.

Given this background, we argue that the NTTAA is an appropriate positive shock to licensing transaction incidence, since it spurs the demand for licensing and makes licensing more attractive for both future potential licensors and licensees. For potential licensors, the Act allows them to enter into cooperative research and development agreements with the federal government and utilize technology from federal laboratories. This enables potential licensors to develop higher-quality technology and more easily license it to others in exchange for financial rewards, compared to the pre-NTTAA era. For potential licensees, the enactment of the NTTAA facilitates access to technology they previously could not obtain. Before the NTTAA, licensees might not have been able to secure exclusive licenses for federally funded technology. With the NTTAA in place, it is now easier for potential licensees to obtain these exclusive licenses.

Based on the above arguments, we utilize the passage of the NTTAA as a positive exogenous shock to the licensing transaction for both licensor and licensee firms. We estimate the following DiD framework using panel data of a five-year window around the year 1996:

$$TobinQ_{i,t} = \alpha_i + \alpha_t + \beta Licensor/Licensee_i \times Post_t + \boldsymbol{X_{i,t}}\gamma + \epsilon_{i,t} \tag{7}$$

where the dependent variable is firm i's Tobin's Q in year t. The independent variable of interest is the interaction term $Licensor/Licensee_i \times Post_t$, where $Licensor/Licensee_i$ equals one if firm i engages in patent licensing transactions during the ten-year window, and zero for the matched control firms. Here, we use the same matched control firms as in specification (6). $Post_t$ is a dummy variable that equals one if the observation is in the year 1996 and within five years after 1996, and zero if it is within five years before 1996. We control for the same firm-level characteristics as our earlier specifications and include both firm and year fixed effects.

Table 9 reports our regression results using specification (7). Column (1) shows the regression results for $Licensor_i \times Post_t$. The estimated coefficient is positive and significant, indicating that in the five years following the enactment of the NTTAA, licensor firms, on average, experience an increase in their Tobin's Q compared to matched non-licensor firms. Column (2) shows the regression results for $Licensee_i \times Post_t$. The estimated coefficient is also positive and statistically significant, suggesting that licensee firms similarly show an increase in their Tobin's Q five years following the NTTAA compared to matched non-licensee firms. Overall, Table 9 suggests that patent licensing transactions causally create equity market value for both licensor and licensee firms and supports the prediction of our Hypothesis **H6**.

The causal interpretation of the above results relies on the parallel trend assumption required by the DiD approach being satisfied. To empirically test this assumption, we estimate the following regression:

$$TobinQ_{i,t} = \alpha_i + \alpha_t + \sum_{t=-5,t\neq-1}^{5} \beta_t Licensor_i(or Licensee_i) \times Period_t + \boldsymbol{X_{i,t}}\gamma + \epsilon_{i,t} \tag{8}$$

Here, we examine the dynamics of the impact of NTTAA by replacing the time dummy ($Post_t$) in equation (7) with a set of dummies representing each annual period ($Period_t$). The dummy for the year when the NTTAA was signed into law (year 1996) is dropped to avoid multicollinearity and served as the baseline group for comparison. Other variables are the same as those in specification (7). We plot the coefficients of β_t for the regression specification (8) in Figure 1. The upper panel shows the estimated coefficients for licensor firms, and the lower panel shows the coefficients for licensee firms.

Neither panels in Figure 1 demonstrate any significant trend prior to the NTTAA enactment: none of the coefficient estimates on $Licensor/Licensee_i \times Period_t$ are statistically different from zero at the 10% significance level. After the enactment, both licensor and licensee firms exhibit an increasing trend, indicating that the passage of the NTTAA indeed had a positive effect on both licensor and licensee firms' equity market valuation (as measured by their Tobin's Q). Thus, Figure 1 provides supporting evidence that the parallel trend assumption is satisfied. Therefore, we argue that patent licensing transactions are efficient for both licensor and licensee firms and create value for these firms involved in licensing transactions.

7.3 Channels of Value Creation

7.3.1 Channels of Value Creation for Licensors

We next examine the channels through which patent licensing transactions create value for both licensor and licensee firms. We first examine the channel of value creation through the lens of licensor firms. For licensor firms, licensing out some of their patents results in financial rewards through periodic licensing fees. This financial inflow is expected to positively impact their equity market value. Therefore, we hypothesize that, for licensor firms, the higher the licensing fees they receive, the higher their Tobin's Q following the patent licensing transactions.

We begin by testing whether receiving licensing fees is an important channel for licensor firms to achieve subsequent higher equity market valuation. We utilize the licensing fee data from kt-MINE. While, as discussed in Section 4, licensing transactions involve three types of licensing fees, the predominant type of licensing fees in our sample involves variable payment specified as a percentage of the sales of the licensee (royalty payments), we therefore divide the licensors into two groups based on the median value of the variable payment related to sales (7.5%): one group with above-median royalty payments, labeled "High Royalty," and another group with below-median royalty payments, labeled "Low Royalty."[12]

We split licensor firms into two sub-samples based on the royalty as discussed above and combine the corresponding propensity score-matched non-licensor firms to run separate regressions based on specification (6). Table 10 shows the regression results. Columns (1) and (4) indicate that firms receiving higher royalties (higher variable payments related to sales) exhibit higher subsequent Tobin's Q following the patent licensing transactions compared to non-licensor firms, even after controlling for licensor firms' Tobin's Q at the year of patent licensing transactions. Column (2) and (5) show that licensor firms receiving relatively lower royalty payments based on licensee firms' future sales do not have a higher equity market value following the patent licensing transactions compared to non-licensor firms. Column (3) and (6) present the difference between the estimated coefficients for licensor firms in the two regressions, with the positive and significant difference indicating that the distinction between the two groups is indeed significant. Thus, Table 10 supports our prediction that licensing fees are indeed one of the channels leading to higher equity market valuation, making patent licensing transactions value enhancing for licensor firms. This is consistent with the prediction of our hypothesis **H8**.

If the ability to extract rents (i.e., obtain licensing fees) from licensing transactions is one potential mechanism of the value creation for licensors, we would expect to find that licensors reinvest some of the proceeds in innovation-oriented activities (such as R&D) to further enhance their comparative advantage in developing innovation. If this is the case and licensors increase their input into innovation (in the form of R&D expenditures) subsequent to licensing transactions, we would also expect an increase in their innovation output (in the form of new patents).

To empirically examine these conjectures that licensor firms increase their R&D expenditures and produce more new patents following licensing transactions, we run a regression based on specification (6). The independent variable is $Licensor$ which equals one for licensor firms and zero for the propensity score-matched non-licensor firms. The dependent variables are $R\&D\_1\_3_{i,t}$ and $Num\_Pat\_1\_3_{i,t}$. $R\&D\_1\_3_{i,t}$ represents the average R&D expenditure for firm i over the three years following the patent licensing transaction year t, while $Num\_Pat\_1\_3_{i,t}$ represents the average total number of truncated patents for firm i over the three years following the patent licensing transaction year t.

[12] Detailed summary statistics are reported in Table 1.

Table 11 shows the results of our analysis for the dependent variable $R\&D\_1\_3_{i,t}$. Column (1) reports the univariate regression results of the relationship between being a licensor and the subsequent R&D expenditure three years following the patent transaction, where we find a positive and significant coefficient. Column (2) includes industry-year fixed effects to account for time-varying industry-specific characteristics that may affect a firm's R&D expenditure. In addition to the industry-year fixed effect, column (3) controls for a set of firm characteristics that may influence a firm's decision on R&D expenditure over time. Across all the specifications, the estimated coefficients remain positive and statistically significant. Therefore, the results in Table 11 indicate that licensor firms have higher R&D expenditures compared to matched non-licensor firms in the three years following the patent licensing transactions.

Table 12 reports the regression results of our analysis for the dependent variable $Num\_Pat\_1\_3$. Across the three specifications, the estimated coefficients are positive and statistically significant, even after controlling for firm-specific characteristics and accounting for industry-year fixed effects. The results in Table 12 indicate that, compared to matched non-licensor firms, licensor firms tend to generate a greater number of patents in the three years following patent licensing transactions. The findings in Tables 11 and 12 suggest that the financial inflows from licensing fees are effectively utilized by licensor firms to invest in additional R&D activities, fostering the development of new technologies. Consequently, licensor firms exhibit higher innovation productivity relative to their counterparts who do not engage in patent licensing transactions.

Overall, for licensor firms, patent licensing transactions enhance their equity market valuation by enabling them to utilize licensing fees effectively for further investment in R&D activities and to pursue additional innovations. The ability to convert licensing revenues into increased R&D and innovation productivity demonstrates a significant value-creating mechanism for licensor firms. The results underscore the strategic importance of patent licensing as a means to not only monetize existing technology but also to reinvest in the firm's innovative capabilities. These results are consistent with the prediction of our Hypothesis **H9**.

7.3.2 Channels of Value Creation for Licensees

We now examine the channel of value creation of licensing transactions for licensee firms. Licensee firms gain access to new technologies by engaging in patent licensing transactions. This access allows them to leverage these technologies for subsequent innovation and to gain a competitive advantage, potentially enhancing their equity market value. Consequently, we hypothesize that for licensee firms, greater exposure to new technologies will correlate with a higher Tobin's Q following the patent licensing transactions.

To test whether exposure to new technology is a possible channel for licensee firms to gain higher equity market value, we split licensee firms based on their degree of exposure to new technologies. Specifically, we utilize the cosine similarity between the licensee firm and the corresponding licensor firm's patent portfolio. We then divide licensee firms into two groups based on their technology similarity scores. The group with above-median technology similarity scores, indicating less exposure to new technology (since the licensees' patent portfolio is more similar to that of the licensors in this case), is assigned to the "Less Exposure" group. The group with below-median technology similarity scores, indicating greater exposure to new technology, is assigned to the "More Exposure" group. For each group of licensee firms, we combine the corresponding propensity-score matched non-licensee control firms and run regressions for each group based on specification (6).

Table 13 shows the results of the above two regressions. Columns (1) and (4) report the results for the licensee group with more exposure to new technology, with column (4) including the licensee firms' Tobin's Q at the year of patent licensing transaction as a control variable. The positive and statistically significant coefficient suggests that the greater the exposure of licensee firms to new technology, the higher their subsequent Tobin's Q following the patent licensing transactions compared to their matched control firms. In contrast, the coefficients in Columns (2) and (5) suggest that for licensee firms with less exposure to new technology, there is no significant difference in future equity market value between the licensee firms and the non-licensee firms. Columns (3) and (6) present the difference between the estimated coefficients in "More Exposure" and "Less Exposure" groups, which are positive and significant. This indicates that the distinction between the two groups is meaningful, with licensee firms that have greater exposure to new technology experiencing a higher Tobin's Q following the patent licensing transactions compared to their counterparts with less exposure. Overall, Table 13 suggests that exposure to new technology through licensing transactions enables licensee firms to engage in "learning by doing", which may help them to learn new technologies, develop new products in the future, and increase their innovation efficiency, thereby enhancing their equity market value. This is consistent with the prediction in our Hypothesis **H10**.

If the exposure to new technologies is one plausible mechanism of value creation for licensees, by making use of the licensed patents, we would expect to find a "learning by doing" effect for licensee firms. Specifically, we would expect to find that licensees learn from licensors' technologies, introduce more new products following licensing transactions, and utilize their innovation resources more efficiently. We test the above chain of value creation for licensees in the following analysis.

We first analyze whether licensees learn from licensors by studying the citation of licensors' patents by licensees subsequent to patent licensing transactions. Table 14 reports the results associated with this conjecture. Here, the dependent variable is a dummy that equals one if an actual (matched) licensee (non-licensee) cites the patents of the corresponding (matched) licensor (non-licensor) over the three years following a licensing transaction. This dummy variable is equal to zero otherwise. The main independent variable of interest is *Actual_Pair*, which is an indicator equal to one if a licensor-licensee pair is an actual transaction pair. It is equal to zero if a firm pair is a pseudo/matched pair. Columns (1) and (2) of Table 14 test the above relationship in a univariate regression framework, where the only difference between these two columns is the inclusion of transaction fixed effects in Column (2). In Columns (3) to (5) we include the full set of firm-level controls (i.e., the same as in Tables 4) for both licensors and licensees. We also include some important innovation characteristics of licensors and licensees. The positive and statistically significant coefficients of *Actual_Pair* across all columns suggest that licensees are more likely to cite licensors' patents over the three years following patent licensing transactions, compared to their matched counterparts.

We have established that, through licensing transactions, licensees gain exposure to new technologies and also learn from licensors through licensing transactions. One consequence of this is that licensees develop additional new products subsequent to the licensing transactions. Another consequence is that licensees may become more efficient in conducting subsequent innovation. We empirically test each of these consequences in turn in the following analysis. Table 15 shows the results associated with new products introduced by licensees after patent licensing transactions. In this table, the dependent variable $Num\_Trademark\_1\_3$, which is the number of trademarks filed by firm i over the three years following year t. We use the number of trademarks filed by a firm to proxy for the number of new products introduced by the firm. Column (1) reports the univariate regression results, Column (2) controls for the time-varying industry-specific characteristics, and Column (3) also controls for a set of firm characteristics that may affect a licensee firm's capability of introducing new products (as proxied by the number of new trademarks filed). Across all the specifications, we find a positive and statistically significant relationship between being a licensee firm and the subsequent number of new trademarks. This finding suggests that, compared to matched non-licensee firms, licensee firms experience an increase in the number of new trademarks on average three years following the patent licensing transactions. Therefore, the results in Table 15 suggest that patent licensing transactions facilitate the expansion of trademark portfolios for licensee firms. This highlights the strategic value of patent licensing as a mechanism for accessing new technologies and fostering product commercialization for licensee firms.

We now turn to analyzing whether the innovation efficiency of licensee firms increases following licensing transactions. We follow Hirshleifer et al. (2013) to construct the proxy for innovation efficiency.[13] Table 16 presents the results regarding the effect of licensing transactions on licensee firms' subsequent innovation efficiency. Utilizing similar specifications as before, we find that licensee firms tend to increase their innovation efficiency on average three years after licensing in patents compared to the matched non-licensee firms. Therefore, the results in Table 16 indicate that licensing in patents enables licensee firms to effectively leverage external innovations, which leads to an increase in overall innovation efficiency within these firms. By accessing new technologies through licensing agreements, licensee firms are able to enhance their innovation processes, resulting in a higher ratio of patents granted relative to their R&D expenditures.

[13]Specifically, innovation efficiency of firm i in year t is calculated as the ratio of the number of patents of the firm that are granted in year t ($Patents_{i,t}$) scaled by the firm's R&D capital. Firm i's R&D capital is calculated as the five-year cumulative R&D expenses, assuming an annual depreciation rate of 20%, in the fiscal year ending in year $t-2$:

$$Innovation\_Efficiency_{i,t} = \frac{Patents_{i,t}}{(R\&D_{i,t-2} + 0.8 \times R\&D_{i,t-3} + 0.6 \times R\&D_{i,t-4} + 0.4 \times R\&D_{i,t-5} + 0.2 \times R\&D_{i,t-6})}$$

where $R\&D_{i,t-2}$ denotes firm i's R&D expenses in the fiscal year ending in year t–2, and so on. We set missing R&D to zero when computing the denominator.

Overall, the results in Tables 14, 15, and 16 provide support for the prediction of our hypothesis **H11**. These results provide further evidence that licensee firms benefit from licensing transactions through their exposure to new technologies brought by licensor firms. By gaining access to new technologies and consistent with the "learning by doing" channel, licensees are more likely to learn from licensors' technologies (in the form of citing their patent portfolios) subsequent to licensing transactions. In addition, by incorporating new technologies in their operations, licensees manage to introduce a larger number of new products and improve their innovation efficiency significantly over the three years following licensing transactions. The increase in the equity market value of licensee firms following licensing transactions that we documented earlier (as measured by Tobin's Q) may be potentially attributable to the channels we have documented in this section.

8 Conclusion

In this paper, we make use of a large sample of patent licensing transactions from the ktMINE Patent License Agreement database to conduct a large sample, cross-industry study to analyze the economics of patent licensing. We study three important research questions for the first time in the literature. First, what are the characteristics of licensors and licensees that drive the former set of firms to license out their patents to the latter set of firms? Second, what is the nature of the patents that the licensor firms choose to retain and build products around versus that of patents that it choose to monetize by selling or licensing to other firms? Further, given that it has chosen to monetize a patent, what patent characteristics drive the choice of a licensor firm between selling a patent versus licensing it to another firm? Third, what are the consequences of patent licensing for licensor and licensee firms? In particular, are patent licensing transactions efficient in the sense that the equity market perceives such transactions as creating value for licensor and licensee firms? We also investigate the channels that lead to value creation for licensor and licensee firms in the equity market.

Our empirical analysis allows us to develop a number of novel findings, which can be summarized as follows. First, we find that firms with higher innovation productivity and R&D expenditures are more likely to be licensors, while firms facing a decline in their innovation productivity are more likely to be licensees. In terms of the determinants of the pairing between licensors and licensees, we find that licensors are more likely to license patents to firms with whom they have a downstream relationship, suggesting that licensor firms take into account the indirect benefits from licensing patents (in addition to direct monetary benefits from licensing fees) when choosing firms to license their patents to. On the other hand, licensor firms are less likely to license patents to firms with technologically similar patent portfolios, suggesting that licensors may take into account the potential for future product market competition from licensee firms.

Second, our patent level analysis results suggest that licensors are likely to retain patents closer in technological distance to their current patent portfolio for their own use, while monetizing (either by selling or licensing) patents that are farther away. Further, among patents that licensor firms choose to monetize, licensors choose to license patents that are closer to their patent portfolio while selling those farther away. This is consistent with the notion that licensing allows the licensor firm to maintain some future control of the patents licensed, whereas selling a patent involves completely relinquishing control of the patent. Conversely, when choosing which patents to license, licensee firms choose patents closer in technological distance to their own patent portfolio, suggesting that they license those patents that are cheaper for them to build products around.

Third, our analysis of the consequences of patent licensing transactions for licensor and licensee firms provides us with the following findings. First, licensing transactions are efficient in the sense that these transactions increase the equity market value of both licensor and licensee firms (as measured by their Tobin's Q). We establish the causality of these baseline findings using a DiD analysis around the National Technology Transfer and Advancement Act of 1995. The results of our DiD analysis suggest that licensing transactions casually and significantly increase the Tobin's Q of both licensor and licensee firms.

In terms of the channels through which licensing transactions create value for licensors and licensees, we document one plausible mechanism each for licensor and licensee firms. For licensor firms, we find that their ability to extract rents (i.e., charge licensing fees) is one potential mechanism. Specifically, we find that the increase in Tobin's Q is greater for the sub-sample of licensors which receive higher licensing fees from the licensing transactions. Consistent with the notion that licensors reinvest some of the proceeds from licensing transactions in innovation-oriented activities to further enhance their comparative advantage in innovation, we document that, compared to similar non-licensors, licensor firms increase their R&D expenditures significantly and generate a larger number of new patents over the three years following licensing transactions.

For licensee firms, we find that their exposure to new technologies is one potential channel through which licensing transactions create value for them. Specifically, we show that the increase in Tobin's Q is more pronounced for the sub-sample of licensees whose patent portfolios are less similar to the corresponding licensors' patent portfolios (thus gaining greater exposure to new technologies). Consistent with the "learning by doing" notion that licensees learn from their newly licensed patents, we show that, compared to similar non-licensees, licensee firms are learning from corresponding licensors' technologies (as shown by licensees' greater propensity to cite licensors' patents), introduce a larger number of new products (as proxied by their new trademarks registered), and increase their innovation efficiency over the three years following patent licensing transactions.

References

Aghion, P., N. Bloom, R. Blundell, R. Griffith, and P. Howitt (2005). Competition and innovation: An inverted-u relationship. *The Quarterly Journal of Economics 120*(2), 701–728.

Akcigit, U., M. A. Celik, and J. Greenwood (2016). Buy, keep, or sell: Economic growth and the market for ideas. *Econometrica 84*(3), 943–984.

Arora, A., S. Belenzon, and J. Suh (2022). Science and the market for technology. *Management Science 68*(10), 7176–7201.

Arora, A. and M. Ceccagnoli (2006). Patent protection, complementary assets, and firms' incentives for technology licensing. *Management Science 52*(2), 293–308.

Arora, A. and A. Fosfuri (2003). Licensing the market for technology. *Journal of Economic Behavior & Organization 52*(2), 277–295.

Arora, A., A. Fosfuri, and A. Gambardella (2001). Markets for technology and their implications for corporate strategy. *Industrial and corporate change 10*(2), 419–451.

Bena, J. and K. Li (2014). Corporate innovations and mergers and acquisitions. *The Journal of Finance 69*(5), 1923–1960.

Brav, A., W. Jiang, S. Ma, and X. Tian (2018). How does hedge fund activism reshape corporate innovation? *Journal of Financial Economics 130*(2), 237–264.

Cunningham, C., F. Ederer, and S. Ma (2021). Killer acquisitions. *Journal of Political Economy 129*(3), 649–702.

Elzinga, K. G. and D. E. Mills (2011). The lerner index of monopoly power: origins and uses. *American Economic Review 101*(3), 558–564.

Figueroa, N. and C. J. Serrano (2019). Patent trading flows of small and large firms. *Research Policy 48*(7), 1601–1616.

Fosfuri, A. (2006). The licensing dilemma: understanding the determinants of the rate of technology licensing. *Strategic Management Journal 27*(12), 1141–1158.

Frésard, L., G. Hoberg, and G. M. Phillips (2020). Innovation activities and integration through vertical acquisitions. *The Review of Financial Studies 33*(7), 2937–2976.

Gambardella, A. and M. S. Giarratana (2013). General technological capabilities, product market fragmentation, and markets for technology. *Research Policy 42*(2), 315–325.

Gambardella, A., P. Giuri, and A. Luzzi (2007). The market for patents in europe. *Research Policy 36*(8), 1163–1183.

Hall, B. H., A. B. Jaffe, and M. Trajtenberg (2001). The nber patent citation data file: Lessons, insights and methodological tools.

Han, P., C. Liu, and X. Tian (2022). Does trading spur specialization? evidence from patenting. *Available at SSRN 3681360*.

Hirshleifer, D., P.-H. Hsu, and D. Li (2013). Innovative efficiency and stock returns. *Journal of Financial Economics 107*(3), 632–654.

Lerner, A. P. (1934). The concept of monopoly and the measurement of monopoly power. *The Review of Economic Studies 1*(3), 157–175.

Ma, S., J. T. Tong, and W. Wang (2022). Bankrupt innovative firms. *Management Science 68*(9), 6971–6992.

Moreira, S., T. M. Klueter, and S. Tasselli (2020). Competition, technology licensing-in, and innovation. *Organization Science 31*(4), 1012–1036.

Moser, P. and A. Voena (2012). Compulsory licensing: Evidence from the trading with the enemy act. *American Economic Review 102*(1), 396–427.

Nickell, S. J. (1996). Competition and corporate performance. *Journal of Political Economy 104*(4), 724–746.

Serrano, C. J. (2010). The dynamics of the transfer and renewal of patents. *The RAND Journal of Economics 41*(4), 686–708.

Seru, A. (2014). Firm boundaries matter: Evidence from conglomerates and r&d activity. *Journal of Financial Economics 111*(2), 381–405.

Teece, D. J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy 15*(6), 285–305.

Yang, G. and K. E. Maskus (2001). Intellectual property rights, licensing, and innovation in an endogenous product-cycle model. *Journal of International Economics 53*(1), 169–187.

Yang, L. and K. E. Maskus (2009). Intellectual property rights, technology transfer and exports in developing countries. *Journal of Development Economics 90*(2), 231–236.

Zhang, J. (2020). Selling patents: An empirical analysis of the determinants and consequences of secondary market patent transactions. *Available at SSRN*.

Table 1: Summary Statistics

This table reports the summary statistics of variables used in this paper. Panel A (Panel B) reports the summary statistics for the sample of licensors (licensees) and their corresponding industry-size matched firms. $Licensor$ is a dummy variable equal to one if a firm is a licensor in a patent licensing transaction, and it is equal to zero for the industry-size matched non-licensor firms. $Licensee$ is a dummy variable equal to one if a firm is a licensee in a patent licensing transaction, and it is equal to zero for the industry-size matched non-licensee firms. Num_Pat_3 is the truncation-adjusted number of patents generated by a firm in the last three years up to a given year. CPP_3 is the number of truncation-adjusted lifetime citations per patent for patents generated by a firm in the last three years up to a given year. ΔNum_Pat_3 is the growth rate of a firm's truncation-adjusted number of patents over the last three years. ΔCPP_3 is the growth rate of a firm's truncation-adjusted number of citations per patent over the last three years. Panel C reports the summary statistics for the sample of licensor-licensee pairs and their corresponding industry-size matched pairs. $Actual\_Pair$ is a dummy variable equal to one if a firm pair is the actual licensor-licensee pair in a patent licensing transaction. It is equal to zero if a firm pair is a pseudo licensor-licensee pair formed by the industry-size matched firms of licensors and licensees. $Vertical\_Integrate$ is a dummy equal to one if a firm pair is vertically integrated and equal to zero otherwise. The data on firm pairs' vertical integration relationship is obtained from Frésard, Hoberg, and Phillips (2020). $Tech\_Similarity$ is the cosine similarity between the patent portfolios (as of a licensing transaction year) of two firms forming a pair. Panel D reports the summary statistics of licensing fees at the licensor firm-level and transaction level. Firm-level control variables include $Size$, $R\&D$, ROA, $Leverage$, $Cash$, B/M, and $CAPEX$, all of which are defined the same as in Appendix A. All continuous variables are trimmed at 1% and 99% percentile to minimize the impact of outliers.

Variables	Mean	Median	Std. Dev.	Num. of Obs.
	(1)	(2)	(3)	(4)
Panel A: Licensors and Industry-Size Matched Firms				
Licensor	0.184	0	0.387	8,872
Num_Pat_3	0.087	0.003	0.305	8,784
CPP_3	0.665	0.465	0.681	7,023
ΔNum_Pat_3	0.720	-0.133	3.270	5,534
ΔCPP_3	0.735	-0.075	2.995	4,753
Size	5.338	4.900	2.948	8,583
R&D	0.220	0.115	0.298	8,533
ROA	-0.244	0.011	0.647	8,574
Leverage	0.220	0.124	0.334	8,647
Cash	0.222	0.132	0.230	8,501
B/M	0.315	0.245	0.375	7,495
CAPEX	0.045	0.033	0.044	8,543
Panel B: Licensees and Industry-Size Matched Firms				
Licensee	0.170	0	0.376	10,088
Num_Pat_3	0.050	0.001	0.171	9,988
CPP_3	0.694	0.455	0.772	7,660
ΔNum_Pat_3	0.704	-0.170	3.033	5,779

ΔCPP_3	0.900	-0.065	3.647	4,836
Size	4.917	4.454	2.817	9,713
R&D	0.233	0.116	0.317	9,660
ROA	-0.286	-0.032	0.728	9,684
Leverage	0.234	0.111	0.456	9,772
Cash	0.236	0.143	0.242	9,670
B/M	0.312	0.253	0.451	8,445
CAPEX	0.043	0.031	0.044	9,661
Panel C: Licensor-Licensee Pairs and Industry-Size Matched Pairs				
Actual_Pair	0.023	0	0.148	28,374
Vertical_Integrate	0.044	0	0.206	28,294
Tech_Similarity	0.443	0.084	0.474	28,374
Panel D: Licensing Fees				
Transaction Level:				
Fixed Payment (million $)	0.723	0	16.275	7,124
Variable Payment Based on Unit (million $)	0.025	0	1.027	7,124
Variable Payment Based on Sales (%)	14.548	6.667	30.421	7,124
Licensor Firm Level:				
Fixed Payment (million $)	1.787	0	27.286	1,328
Variable Payment Based on Unit (million $)	0.100	0	2.448	1,328
Variable Payment Based on Sales (%)	15.324	7.500	21.564	1,328

Table 2: Which Firms Are More Likely to Be Licensors?

This table reports the results on the relationship between a firm's innovation characteristics and the probability of the firm being a licensor in a patent licensing transaction. $Licensor$ is a dummy variable equal to one if firm i is an actual licensor firm who licenses out some of its patents in year t. This variable is equal to zero for the corresponding industry-size matched non-licensor firms. Num_Pat_3 is the truncation-adjusted number of patents generated by firm i in the last three years prior to the transaction year t. CPP_3 is the number of truncation-adjusted lifetime citations per patent for patents generated by firm i in the last three years prior to the transaction year t. ΔNum_Pat_3 is the growth rate of firm i's truncation-adjusted number of patents over the last three years prior to the transaction year t. ΔCPP_3 is the growth rate of firm i's truncation-adjusted number of citations per patent over the last three years prior to the transaction year t. Firm-level control variables include $Size$, $R\&D$, ROA, $Leverage$, $Cash$, B/M, and $CAPEX$, all of which are defined the same as in Appendix A and are measured in the year prior to a licensing transaction. Transaction fixed effects are included. Robust standard errors are clustered at the transaction level and are reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

	Licensor			
	(1)	(2)	(3)	(4)
Num_Pat_3	0.975***			
	(0.175)			
CPP_3		0.117*		
		(0.062)		
ΔNum_Pat_3			-0.011	
			(0.015)	
ΔCPP_3				0.013
				(0.017)
R&D	0.556**	0.772**	0.907**	1.326**
	(0.220)	(0.318)	(0.447)	(0.565)
Size	0.351***	0.501***	0.701***	0.856***
	(0.070)	(0.077)	(0.099)	(0.128)
ROA	-0.389***	0.130	-0.626**	0.061
	(0.138)	(0.179)	(0.258)	(0.347)
Leverage	-0.398***	0.034	0.472*	0.585**
	(0.147)	(0.202)	(0.242)	(0.290)
Cash	0.309	0.551**	0.467	0.618
	(0.197)	(0.226)	(0.312)	(0.385)
B/M	-0.502***	-0.578***	-0.667***	-0.722***
	(0.139)	(0.152)	(0.191)	(0.212)
CAPEX	-4.451***	-3.127***	-2.110**	-1.533
	(1.161)	(1.215)	(1.404)	(1.449)
Transaction FE	Yes	Yes	Yes	Yes
Number of Obs.	4,727	3,759	2,858	2,341
Pseudo R^2	0.0718	0.0624	0.0955	0.1126

Table 3: Which Firms Are More Likely to Be Licensees?

This table reports the results on the relationship between a firm's innovation characteristics and the probability of the firm being a licensee in a patent licensing transaction. $Licensee$ is a dummy variable equal to one if firm i is an actual licensee firm who licenses in some patents in year t. This variable is equal to zero for the corresponding industry-size matched non-licensee firms. Num_Pat_3 is the truncation-adjusted number of patents generated by firm i in the last three years prior to the transaction year t. CPP_3 is the number of truncation-adjusted lifetime citations per patent for patents generated by firm i in the last three years prior to the transaction year t. ΔNum_Pat_3 is the growth rate of firm i's truncation-adjusted number of patents over the last three years prior to the transaction year t. ΔCPP_3 is the growth rate of firm i's truncation-adjusted number of citations per patent over the last three years prior to the transaction year t. Firm-level control variables include $Size$, $R\&D$, ROA, $Leverage$, $Cash$, B/M, and $CAPEX$, all of which are defined the same as in Appendix A and are measured in the year prior to a licensing transaction. Transaction fixed effects are included. Robust standard errors are clustered at the transaction level and are reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

	Licensee			
	(1)	(2)	(3)	(4)
Num_Pat_3	1.786***			
	(0.297)			
CPP_3		0.132**		
		(0.054)		
ΔNum_Pat_3			-0.042*	
			(0.024)	
ΔCPP_3				-0.044**
				(0.021)
R&D	-0.133	-0.133	0.049	0.274
	(0.188)	(0.335)	(0.493)	(0.545)
Size	0.297***	0.620***	0.989***	1.230***
	(0.061)	(0.090)	(0.104)	(0.125)
ROA	-0.860***	-1.020***	-1.367***	-1.330***
	(0.145)	(0.276)	(0.387)	(0.502)
Leverage	-0.122	-0.268	0.514*	0.927***
	(0.134)	(0.196)	(0.277)	(0.320)
Cash	0.532***	0.289	0.048	0.521
	(0.180)	(0.220)	(0.301)	(0.376)
B/M	-0.585***	-0.541***	-0.369***	-0.478***
	(0.106)	(0.126)	(0.142)	(0.152)
CAPEX	0.907	0.686	2.915**	3.050**
	(1.070)	(1.156)	(1.363)	(1.527)
Transaction FE	Yes	Yes	Yes	Yes
Number of Obs.	4,828	3,526	2,424	2,022
Pseudo R^2	0.0709	0.0669	0.1105	0.1434

Table 4: Matching Between Potential Licensors and Licensees and the Likelihood of Licensing Transactions

This table reports the results on the determinants of the pairing between licensor and licensee firms. Panel A reports the results on the relationship between the product market relation between two firms and the probability of them having an actual patent licensing transaction. Panel B reports the results on the relationship on the technology relation between two firms and the probability of them having an actual patent licensing transaction. $Actual\_Pair$ a dummy variable equal to one if a firm pair is an actual licensor-licensee pair in a patent licensing transaction, and it is equal to zero if the firm pair is a pseudo licensor-licensee pair formed by the corresponding industry-size matched firms of licensors and licensees. $Vertical\_Integrate$ is a dummy variable equal to one if a firm pair is vertically integrated: this variable is equal to one if licensees (matched pseudo licensees) have downstream relationship with licensors (matched pseudo licensors). It is equal to zero otherwise. The data on firm pairs' vertical integration relationship is obtained from Frésard, Hoberg, and Phillips (2020). $Tech\_Similarity$ is the cosine similarity between the patent portfolios (as of the licensing transaction year) of the two firms forming a pair. $Licensor\_Num\_Pat\_3$ ($Licensee\_Num\_Pat\_3$) is the truncation-adjusted number of patents generated by a licensor (licensee) firm or its corresponding industry-size matched non-licensor (non-licensee) firms in the last three years up to a transaction year. $Licensor\_CPP\_3$ ($Licensee\_CPP\_3$) is the number of truncation-adjusted lifetime citations per patent for patents generated by a licensor (licensee) firm or its corresponding industry-size matched non-licensor (non-licensee) firms in the last three years up to a transaction year. Firm-level control variables include $Size$, $R\&D$, ROA, $Leverage$, $Cash$, B/M, and $CAPEX$, all of which are defined the same as in Appendix A and are measured in the year prior to a licensing transaction. Transaction fixed effects are included. Robust standard errors are clustered at the transaction level and are reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

Panel A: Product Market Relation		
	Actual_Pair	
	(1)	(2)
Vertical_Integrate	0.328*	0.686*
	(0.168)	(0.392)
Licensor_Num_Pat_3		2.339***
		(0.455)
Licensee_Num_Pat_3		2.448***
		(0.482)
Licensor_CPP_3		0.409***
		(0.111)
Licensee_CPP_3		0.220*
		(0.116)
Licensor Firm Controls	No	Yes
Licensee Firm Controls	No	Yes
Transaction FE	No	Yes
Number of Obs.	28,294	5,427
Pseudo R^2	0.0006	0.0817

Panel B: Technology Relation		
	Actual_Pair	
	(1)	(2)
Tech_Similarity	-0.354***	-0.491**
	(0.100)	(0.219)
Licensor_Num_Pat_3		2.076***
		(0.499)
Licensee_Num_Pat_3		2.064***
		(0.488)
Licensor_CPP_3		0.488***
		(0.113)
Licensee_CPP_3		0.257**
		(0.126)
Licensor Firm Controls	No	Yes
Licensee Firm Controls	No	Yes
Transaction FE	No	Yes
Number of Obs.	28,374	5,229
Pseudo R^2	0.0028	0.0951

Table 5: Retaining versus Monetizing Patents by Firms

This table reports the results on the relationship between a patent's technological distance from a firm's patent portfolio and the probability of the patent being retained versus monetized (either by licensing or by selling) by the firm. The dependent variable, $Monetized\_Pat$, is an indicator variable equal to one if patent i filed in the year t is monetized by owning firm j and equal to zero otherwise. We define the monetization of a patent as the focal patent being licensed out or sold by owning firm j. $Dist\_to\_Owner$ is the technological distance of patent i filed in year t to the patent portfolio of owning firm j. This variable is constructed based on the methodology in Akcigit et al. (2016) and is detailed in Section 6. Patent-level control variables include $Backward\_Cite$, $Forward\_Cite$, Num_Claim, and $Litigate$, all of which are defined the same as in Appendix A. Owning firm and filing year (or tech class-by-filing year) fixed effects are included. Robust standard errors are clustered at the firm level and are reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

	Monetized_Pat			
	(1)	(2)	(3)	(4)
Dist_to_Owner	0.189*	0.197**	0.167*	0.184*
	(0.098)	(0.100)	(0.099)	(0.101)
Backward_Cite		-0.015		0.002
		(0.019)		(0.015)
Forward_Cite		0.118***		0.124***
		(0.017)		(0.013)
Num_Claim		-0.005		0.014
		(0.044)		(0.026)
Litigate		0.948**		0.988***
		(0.092)		(0.092)
Firm FE	Yes	Yes	Yes	Yes
Filing Year FE	Yes	Yes	No	No
Tech Class × Filing Year FE	No	No	Yes	Yes
Number of Obs.	2,307,100	2,138,703	2,276,373	2,109,463
Pseudo R^2	0.3524	0.3591	0.3688	0.3749

Table 6: Licensing versus Selling Patents by Licensors

This table reports the results on the relationship between a patent's technological distance from a licensor firm's patent portfolio and the probability of the patent being licensed out versus sold by the licensor firm. The dependent variable, $Licensed\_Pat$, is an indicator variable equal to one if patent i filed in the year t is licensed out by firm j, and zero if patent i filed in year t is sold by firm j. $Dist\_to\_Licensor$ is the technological distance of patent i filed in year t to the patent portfolio of licensor firm j. This variable is constructed based on the methodology in Akcigit et al. (2016) and is detailed in Section 6. Patent-level control variables include $Backward\_Cite$, $Forward\_Cite$, Num_Claim, and $Litigate$, all of which are defined the same as in Appendix A. Licensor firm and filing year (or tech class-by-filing year) fixed effects are included. Robust standard errors are clustered at the firm level and are reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

	Licensed_Pat (Licensed Patent = 1, Sold Patent = 0)			
	(1)	(2)	(3)	(4)
Dist_to_Licensor	-1.050*	-1.313**	-1.311**	-1.413**
	(0.605)	(0.627)	(0.670)	(0.689)
Backward_Cite		0.364***		0.372***
		(0.126)		(0.125)
Forward_Cite		0.135		0.163**
		(0.089)		(0.075)
Num_Claim		0.082		0.053
		(0.126)		(0.138)
Litigate		0.956**		0.838**
		(0.442)		(0.421)
Firm FE	Yes	Yes	Yes	Yes
Filing Year FE	Yes	Yes	No	No
Tech Class × Filing Year FE	No	No	Yes	Yes
Number of Obs.	72,046	71,031	33,025	32,400
Pseudo R^2	0.5629	0.6384	0.6714	0.6897

Table 7: Which Patents Are More Likely to be Licensed in by Licensees?

This table reports the results on the relationship between a patent's technological distance from a licensee firm's patent portfolio and the probability of the patent being licensed in by the licensee firm in a patent transaction. The dependent variable, $Licensed\_Pat$, is an indicator variable equal to one if patent i filed in the year t is licensed in by firm j and equal to zero otherwise. $Dist\_to\_Licensee$ is the technological distance of patent i filed in year t to the patent portfolio of licensee firm j. This variable is constructed based on the methodology in Akcigit et al. (2016) and is detailed in section 6. Patent-level control variables include $Backward\_Cite$, $Forward\_Cite$, Num_Claim, and $Litigate$, all of which are defined the same as in Appendix A. Licensee firm and tech class-by-filing year fixed effects are included. Robust standard errors are clustered at the firm level and are reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

	Licensed_Pat			
	(1)	(2)	(3)	(4)
Dist_to_Licensee	-1.381***	-1.385***	-2.255***	-1.980***
	(0.378)	(0.410)	(0.345)	(0.347)
Backward_Cite		0.217**		0.291***
		(0.087)		(0.090)
Forward_Cite		0.414***		0.449***
		(0.069)		(0.075)
Num_Claim		-0.182*		-0.156
		(0.105)		(0.114)
Litigate		1.728***		1.648***
		(0.273)		(0.320)
Firm FE	Yes	Yes	Yes	Yes
Filing Year FE	Yes	Yes	No	No
Tech Class × Filing Year FE	No	No	Yes	Yes
Number of Obs.	159,166	144,553	106,085	93,303
Pseudo R^2	0.4728	0.5185	0.5363	0.5504

Table 8: The Effect of Patent Licensing Transactions on Firm Valuation: Baseline Analysis

This table reports the results on the baseline effect of patent licensing transactions on the subsequent performance of both licensor and licensee firms, where we measure firms' performance using their Tobin's Q. Panel A reports the results on the effect of licensing transactions on licensors' Tobin's Q, and Panel B reports the results on the effect of licensing transactions on licensees' Tobin's Q. The dependent variable in both panels, $TobinQ\_1\_3$, is firm i's average Tobin's Q over the three years following the transaction year t. Firm i's Tobin's Q in an individual year is calculated as the sum of its book value of debt and market value of equity and then divided by the sum of its book value of debt and book value of equity (Compustat item: (dlc+dltt+csho$\times$prcc_f)/(dlc+dltt+ceq)). The independent variable of interest, $Licensor$ ($Licensee$), is an indicator variable equal to one if the firm i is an actual licensor (licensee). It is equal to zero for firm i's corresponding control firms in the same industry and year. We select the control firms using a propensity-score matching procedure based on $Size$, $R\&D$, ROA, $Leverage$, $Cash$, $CAPEX$, Num_Pat_3, and CPP_3, all of which are measured in the year prior to a licensing transaction. Num_Pat is the number of patents generated by firm i in the transaction year t. Firm-level control variables include $Size$, $R\&D$, ROA, $Leverage$, $Cash$, and $CAPEX$, all of which are defined the same as in Appendix A and are measured in the year of a licensing transaction. Industry-by-year fixed effects are excluded in the specification (1) for both panels and included in other specifications. Robust standard errors are clustered at the industry level and are reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

Panel A: Licensors				
	TobinQ_1_3			
	(1)	(2)	(3)	(4)
Licensor	1.231***	1.093***	0.993***	0.865***
	(0.225)	(0.253)	(0.235)	(0.217)
Num_Pat			1.855	0.463
			(4.210)	(4.229)
Size			-0.110	-0.079
			(0.083)	(0.085)
R&D			0.869	0.007
			(0.608)	(0.656)
ROA			0.387	-0.020
			(0.377)	(0.427)
Leverage			0.186	0.272
			(0.883)	(0.853)
Cash			2.987***	2.018***
			(0.294)	(0.316)
CAPEX			5.414**	5.682***
			(1.604)	(1.396)
TobinQ				0.185***
				(0.033)
Industry × Year FE	No	Yes	Yes	Yes
Number of Obs.	2,329	2,329	2,184	2,071

Adj. R^2	0.0066	0.0233	0.0258	0.0827

Panel B: Licensees

	TobinQ_1_3			
	(1)	(2)	(3)	(4)
Licensee	0.654***	0.598***	0.801***	0.655***
	(0.106)	(0.092)	(0.123)	(0.119)
Num_Pat			4.477	3.631
			(3.462)	(2.488)
Size			-0.066	-0.052
			(0.045)	(0.031)
R&D			1.623***	-0.106
			(0.304)	(0.403)
ROA			0.852***	0.156
			(0.187)	(0.276)
Leverage			-0.363*	0.411
			(0.176)	(0.270)
Cash			2.695***	1.922***
			(0.356)	(0.208)
CAPEX			-4.523***	-2.105*
			(0.924)	(1.069)
TobinQ				0.233***
				(0.029)
Industry × Year FE	No	Yes	Yes	Yes
Number of Obs.	2,741	2,740	2,576	2,403
Adj. R^2	0.0019	0.0127	0.0408	0.1046

Table 9: The Effect of Patent Licensing Transactions on Firm Valuation: Difference-in-Differences (DiD) Analysis

This table reports the difference-in-differences (DiD) results on the effect of a positive shock to patent licensing transaction incidence, based on the National Technology Transfer and Advancement Act of 1995, on firms' performance. The dependent variable, $TobinQ$, is firm i's Tobin's Q in year t. It is calculated as the sum of its book value of debt and market value of equity and then divided by the sum of its book value of debt and book value of equity (Compustat item: (dlc+dltt+csho×prcc_f)/(dlc+dltt+ceq)). $Licensor$ and $Licensee$ are dummy variables equal to one if firm i is an actual licensor firm or licensee firm in a patent transaction, respectively. They are equal to zero for firm i's corresponding control firms in the same industry and year. We select the control firms using a propensity-score matching procedure based on $Size$, $R\&D$, ROA, $Leverage$, $Cash$, $CAPEX$, Num_Pat_3, and CPP_3, all of which are measured in the year prior to a licensing transaction. $Post$ is a dummy variable equal to one if the observation is within a five-year period after the year 1996 (when the Act was enacted). It is equal to zero if the observation is within a five-year period before 1996. Num_Pat is the number of patents generated by firm i in year t. Firm-level control variables include $Size$, $R\&D$, ROA, $Leverage$, $Cash$, and $CAPEX$, all of which are defined the same as in Appendix A and are measured in year t. Firm and year fixed effects are included. Robust standard errors are clustered at the firm level and are reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

	TobinQ	
	(1) Licensor	(2) Licensee
Licensor × Post	1.123**	
	(0.478)	
Licensee × Post		0.943**
		(0.392)
Num_Pat	2.237	2.513
	(2.283)	(2.889)
Size	-0.843***	-0.628***
	(0.212)	(0.170)
R&D	3.183***	3.146***
	(1.217)	(0.967)
ROA	-0.343	-0.438
	(0.769)	(0.628)
Leverage	0.198	-0.670
	(0.782)	(0.737)
Cash	3.906***	2.876***
	(0.747)	(0.618)
CAPEX	5.229**	3.979*
	(2.290)	(2.090)
Firm FE	Yes	Yes
Year FE	Yes	Yes
Number of Obs.	5,268	6,188
Adj. R^2	0.3418	0.3613

Table 10: Channel of Licensors' Valuation Improvement: Licensing Fees

This table reports the results on the heterogeneous effects of licensing transactions on licensors' subsequent performance based on their ability to extract rents from patent licensing transactions. The "High Royalty" denotes the sub-sample of licensor firms which charge above-median royalties for the patents they license out, while the "Low Royalty" denotes the sub-sample of licensor firms which charge below-median royalties. The dependent variable, $TobinQ\_1\_3$, is firm i's average Tobin's Q over the three years following the licensing transaction year t. Firm i's Tobin's Q in an individual year is calculated as the sum of its book value of debt and market value of equity and then divided by the sum of its book value of debt and book value of equity (Compustat item: (dlc+dltt+csho$\times$prcc_f)/(dlc+dltt+ceq)). $Licensor$ is an indicator variable equal to one if firm i is an actual licensor in a licensing transaction in year t. It is equal to zero for firm i's corresponding control firms in the same industry and year. We select the control firms using a propensity-score matching procedure based on $Size$, $R\&D$, ROA, $Leverage$, $Cash$, $CAPEX$, Num_Pat_3, and CPP_3, all of which are measured in the year prior to a licensing transaction. Num_Pat is the number of patents generated by firm i in the transaction year t. Firm-level control variables include $Size$, $R\&D$, ROA, $Leverage$, $Cash$, and $CAPEX$, all of which are defined the same as in Appendix A and are measured in the year of licensing transaction. Industry-by-year fixed effects are included. Robust standard errors are clustered at the industry level and are reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

	TobinQ_1_3			TobinQ_1_3		
	(1)	(2)	(3)	(4)	(5)	(6)
	High Royalty	Low Royalty	Difference	High Royalty	Low Royalty	Difference
Licensor	1.503***	0.635	0.868***	1.136***	0.614	0.522**
	(0.236)	(0.352)	(0.229)	(0.241)	(0.400)	(0.227)
Num_Pat	6.731	1.464		5.964	-0.519	
	(3.784)	(3.039)		(4.145)	(2.710)	
Size	-0.083***	-0.064		-0.059**	-0.038	
	(0.024)	(0.036)		(0.023)	(0.029)	
R&D	0.136	-0.130		-0.967	-0.768	
	(0.701)	(0.796)		(0.751)	(0.801)	
ROA	-0.206	-0.151		-0.651*	-0.376	
	(0.284)	(0.306)		(0.340)	(0.366)	
Leverage	-0.529*	-0.884***		-0.745**	-1.101***	
	(0.258)	(0.250)		(0.230)	(0.140)	
Cash	2.698***	2.274***		1.463***	1.433***	
	(0.720)	(0.552)		(0.420)	(0.317)	
CAPEX	7.254***	2.306**		7.529***	2.661*	
	(1.003)	(0.693)		(1.709)	(1.193)	
TobinQ				0.186***	0.164*	
				(0.051)	(0.076)	
Industry $\times$ Year FE	Yes	Yes		Yes	Yes	
Number of Obs.	1,879	1,848		1,780	1,751	
Adj. R^2	0.0430	0.0340		0.0833	0.0689	

Table 11: Licensors' R&D Expenditures Following Patent Licensing Transactions

This table reports the results on the effect of patent licensing transactions on licensor firms' subsequent R&D expenditures. The dependent variable, $R\&D\_1\_3$, is firm i's average R&D ratio over the three years following the licensing transaction year t. Firm i's R&D ratio in an individual year is constructed as its R&D expense in that year scaled by its total assets (i.e., the same as the construction in Appendix A). $Licensor$ is an indicator variable equal to one if firm i is an actual licensor in a licensing transaction in year t. It is equal to zero for firm i's corresponding control firms in the same industry and year. We select the control firms using a propensity-score matching procedure based on $Size$, $R\&D$, ROA, $Leverage$, $Cash$, $CAPEX$, Num_Pat_3, and CPP_3, all of which are measured in the year prior to a licensing transaction. Num_Pat is the number of patents generated by firm i in the transaction year t. Firm-level control variables include $Size$, $R\&D$, ROA, $Leverage$, $Cash$, and $CAPEX$, all of which are defined the same as in Appendix A and are measured in the year of a licensing transaction. Industry-by-year fixed effects are excluded in the specification (1) and included in other specifications. Robust standard errors are clustered at the industry level and are reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

	R&D_1_3		
	(1)	(2)	(3)
Licensor	0.047***	0.040***	0.033**
	(0.011)	(0.011)	(0.010)
Num_Pat			0.306**
			(0.126)
Size			-0.021***
			(0.004)
R&D			0.468***
			(0.031)
ROA			-0.030**
			(0.011)
Leverage			-0.012
			(0.007)
Cash			0.160***
			(0.002)
CAPEX			-0.313***
			(0.075)
Industry × Year FE	No	Yes	Yes
Number of Obs.	2,324	2,324	2,203
Adj. R^2	0.0032	0.0511	0.4475

Table 12: Licensors' Innovation Output Following Patent Licensing Transactions

This table reports the results on the effect of patent licensing transactions on licensor firms' subsequent innovation output. The dependent variable, $Num\_Pat\_1\_3$, is the average (truncation-adjusted) number of patents generated by firm i over the three years subsequent to the licensing transaction in year t. $Licensor$ is an indicator variable equal to one if firm i is an actual licensor in a licensing transaction in year t. It is equal to zero for firm i's corresponding control firms in the same industry and year. We select the control firms using a propensity-score matching procedure based on $Size$, $R\&D$, ROA, $Leverage$, $Cash$, $CAPEX$, Num_Pat_3, and CPP_3, all of which are measured in the year prior to a licensing transaction. Num_Pat is the number of patents generated by firm i in the transaction year t. Firm-level control variables include $Size$, $R\&D$, ROA, $Leverage$, $Cash$, and $CAPEX$, all of which are defined the same as in Appendix A and are measured in the year of a licensing transaction. Industry-by-year fixed effects are excluded in the specification (1) and included in other specifications. Robust standard errors are clustered at the industry level and are reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

	Num_Pat_1_3		
	(1)	(2)	(3)
Licensor	0.019***	0.019***	0.004***
	(0.005)	(0.005)	(0.001)
Num_Pat			2.123***
			(0.258)
Size			0.002***
			(0.001)
R&D			0.002***
			(0.000)
ROA			-0.001
			(0.001)
Leverage			0.001**
			(0.000)
Cash			0.000
			(0.001)
CAPEX			0.013
			(0.021)
Industry $\times$ Year FE	No	Yes	Yes
Number of Obs.	2,920	2,920	2,751
Adj. R^2	0.0206	0.1360	0.6808

Table 13: Channel of Licensees' Valuation Improvement: Exposure to New Technologies

This table reports the results on the heterogeneous effects of licensing transactions on licensees' subsequent performance based on their exposure to licensors' new technologies. The "More Exposure" denotes the sub-sample of licensee firms which have below-median cosine similarity scores between their patent portfolio and the corresponding licensor firms' patent portfolios (i.e., thus greater exposure to new technologies). The "Less Exposure" denotes the sub-sample of licensee firms which have above-median cosine similarity scores discussed above (i.e., thus less exposure to new technologies). The dependent variable, $TobinQ\_1\_3$, is firm i's average Tobin's Q over the three years following the transaction year t. Firm i's Tobin's Q in an individual year is calculated as the sum of its book value of debt and market value of equity and then divided by the sum of its book value of debt and book value of equity (Compustat item: (dlc+dltt+csho×prcc_f)/(dlc+dltt+ceq)). $Licensee$ is an indicator variable equal to one if firm i is an actual licensee in a licensing transaction in year t. It is equal to zero for firm i's corresponding control firms in the same industry and year. We select the control firms using a propensity-score matching procedure based on $Size$, $R\&D$, ROA, $Leverage$, $Cash$, $CAPEX$, Num_Pat_3, and CPP_3, all of which are measured in the year prior to a licensing transaction. Num_Pat is the number of patents generated by firm i's in the transaction year t. Firm-level control variables include $Size$, $R\&D$, ROA, $Leverage$, $Cash$, and $CAPEX$, all of which are defined the same as in Appendix A and are measured in the year of a licensing transaction. Industry-by-year fixed effects are included. Robust standard errors are clustered at the industry level and are reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

	TobinQ_1_3			TobinQ_1_3		
	(1)	(2)	(3)	(4)	(5)	(6)
	More Exposure	Less Exposure	Difference	More Exposure	Less Exposure	Difference
Licensee	1.403***	0.197	1.206***	1.139***	0.072	1.067***
	(0.230)	(0.213)	(0.348)	(0.270)	(0.190)	(0.316)
Num_Pat	4.120	5.642		2.856	4.541*	
	(5.145)	(3.593)		(4.141)	(2.443)	
Size	-0.154**	-0.063		-0.105**	-0.052	
	(0.056)	(0.052)		(0.039)	(0.036)	
R&D	1.489***	2.154***		0.016	0.373	
	(0.282)	(0.428)		(0.636)	(0.416)	
ROA	0.882***	1.273***		0.297	0.599*	
	(0.183)	(0.246)		(0.397)	(0.295)	
Leverage	-0.468**	-0.647**		0.534	0.256	
	(0.205)	(0.242)		(0.470)	(0.363)	
Cash	2.712***	2.996***		2.121***	2.262***	
	(0.422)	(0.368)		(0.219)	(0.184)	
CAPEX	-5.424***	-6.403***		-2.961***	-3.441*	
	(1.558)	(1.167)		(0.802)	(1.650)	
TobinQ				0.260***	0.248***	
				(0.023)	(0.033)	
Industry × Year FE	Yes	Yes		Yes	Yes	
Number of Obs.	2,170	2,146		2,035	2,009	
Adj. R^2	0.0363	0.0414		0.1129	0.1128	

Table 14: Licensing Transaction and Subsequent Citing of Licensors' Patents by Licensees

This table reports the results on the effect of patent licensing transactions on the subsequent citing of licensors' patents by licensees. $Cite$ is a dummy variable equal to one if the licensee firm i (its corresponding matched non-licensee firms) in a patent licensing transaction cites the patents of the licensor firm j (its corresponding matched non-licensor firms) over the three years following the licensing transaction in year t. This dummy variable is equal to zero otherwise. $Actual\_Pair$ is a dummy variable equal to one if a firm pair is an actual licensor-licensee pair in a patent licensing transaction, and it is equal to zero if the firm pair is a pseudo licensor-licensee pair formed by the corresponding industry-size matched firms of licensors and licensees. $Licensor\_Num\_Pat\_3$ ($Licensee\_Num\_Pat\_3$) is the truncation-adjusted number of patents generated by a licensor (licensee) firm or its corresponding industry-size matched non-licensor (non-licensee) firms in the last three years up to the transaction year t. $Licensor\_CPP\_3$ ($Licensee\_CPP\_3$) is the number of truncation-adjusted lifetime citations per patent for patents generated by a licensor (licensee) firm or its corresponding industry-size matched non-licensor (non-licensee) firms in the last three years up to the transaction year t. Firm-level control variables include $Size$, $R\&D$, ROA, $Leverage$, $Cash$, B/M, and $CAPEX$, all of which are defined the same as in Appendix A and are measured in the year prior to a licensing transaction. Transaction fixed effects are included. Robust standard errors are clustered at the transaction level and are reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

	Cite				
	(1)	(2)	(3)	(4)	(5)
Actual_Pair	1.213***	1.762***	1.676***	1.614***	1.351***
	(0.094)	(0.125)	(0.192)	(0.223)	(0.230)
Licensor_Num_Pat_3			2.376***		2.504***
			(0.429)		(0.396)
Licensee_Num_Pat_3			2.125***		2.142***
			(0.285)		(0.277)
Licensor_CPP_3				0.360***	0.357***
				(0.076)	(0.074)
Licensee_CPP_3				0.355***	0.365***
				(0.057)	(0.057)
Licensor Firm Controls	No	No	Yes	Yes	Yes
Licensee Firm Controls	No	No	Yes	Yes	Yes
Transaction FE	No	Yes	Yes	Yes	Yes
Number of Obs.	28,374	22,543	12,442	10,146	9,825
Pseudo R^2	0.0077	0.0170	0.1736	0.1197	0.1796

Table 15: Licensees' Trademark Activity Following Licensing Transactions

This table reports the results on the effect of patent licensing transactions on licensee firms' introduction of new products after licensing transactions. The dependent variable, $Num\_Trademark\_1\_3$, is the average number of new trademarks filed by firm i over the three years following the licensing transaction in year t. $Licensee$ is an indicator variable equal to one if firm i is an actual licensee in a patent licensing transaction in year t. It is equal to zero for firm i's corresponding control firms in the same industry and year. We select the control firms using a propensity-score matching procedure based on $Size$, $R\&D$, ROA, $Leverage$, $Cash$, $CAPEX$, Num_Pat_3, and CPP_3, all of which are measured in the year prior to a licensing transaction. Num_Pat is the number of patents generated by firm i in the transaction year t. Firm-level control variables include $Size$, $R\&D$, ROA, $Leverage$, $Cash$, and $CAPEX$, all of which are defined the same as in Appendix A and are measured in the year of a licensing transaction. Industry-by-year fixed effects are excluded in the specification (1) and included in other specifications. Robust standard errors are clustered at the industry level and are reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

	Num_Trademark_1_3		
	(1)	(2)	(3)
Licensee	0.600***	0.616***	0.431**
	(0.176)	(0.154)	(0.154)
Num_Pat			11.762***
			(2.100)
Size			0.575***
			(0.056)
R&D			-0.099
			(0.240)
ROA			-0.268*
			(0.130)
Leverage			0.078**
			(0.034)
Cash			-0.228**
			(0.998)
CAPEX			2.464**
			(1.086)
Industry × Year FE	No	Yes	Yes
Number of Obs.	2,776	2,774	2,621
Adj. R^2	0.0084	0.0473	0.2165

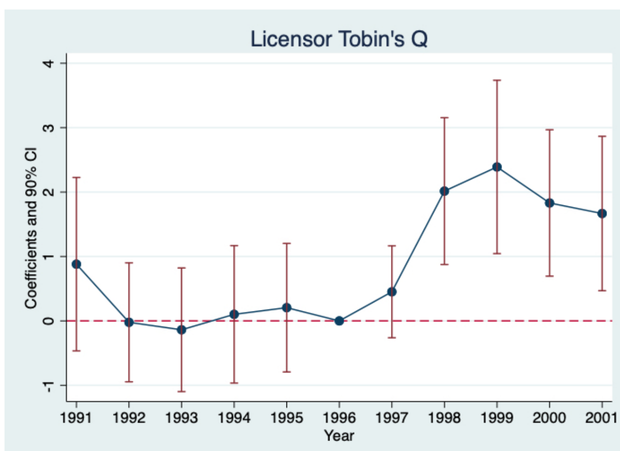
Table 16: Licensees' Innovation Efficiency Following Licensing Transactions

This table reports the results on the effect of patent licensing transactions on licensee firms' subsequent innovation efficiency. The dependent variable, $Innovation\_Efficiency\_1\_3$, is the average innovation efficiency of firm i over the three years following a patent transaction in year t. A firm's innovation efficiency in an individual year is constructed following the methodology in Hirshleifer et al. (2013). $Licensee$ is an indicator variable equal to one if firm i is an actual licensee in a patent licensing transaction in year t. It is equal to zero for firm i's corresponding control firms in the same industry and year. We select the control firms using a propensity-score matching procedure based on $Size$, $R\&D$, ROA, $Leverage$, $Cash$, $CAPEX$, Num_Pat_3, and CPP_3, all of which are measured in the year prior to a licensing transaction. Num_Pat is the number of patents generated by firm i in the transaction year t. Firm-level control variables include $Size$, $R\&D$, ROA, $Leverage$, $Cash$, and $CAPEX$, all of which are defined the same as in Appendix A and are measured in the year of a licensing transaction. Industry-by-year fixed effects are excluded in the specification (1) and included in other specifications. Robust standard errors are clustered at the industry level and are reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

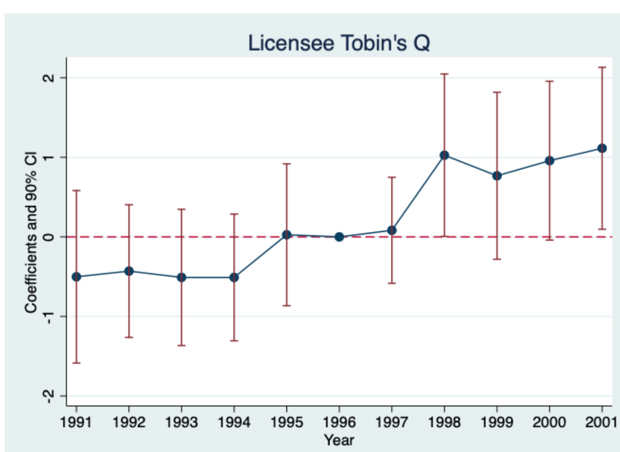
	Innovation_Efficiency_1_3		
	(1)	(2)	(3)
Licensee	0.036**	0.037**	0.036**
	(0.013)	(0.015)	(0.015)
Num_Pat			0.826***
			(0.091)
Size			-0.015***
			(0.003)
R&D			-0.037**
			(0.017)
ROA			0.007
			(0.006)
Leverage			-0.005
			(0.006)
Cash			0.049
			(0.030)
CAPEX			0.377
			(0.246)
Industry × Year FE	No	Yes	Yes
Number of Obs.	2,811	2,810	2,630
Adj. R^2	0.0038	0.1105	0.1380

Figure 1: Dynamic Effects of the National Technology Transfer and Advancement Act of 1995 on Firms' Valuation

This figure shows the dynamics of licensors' and licensees' Tobin's Q around the enactment of the National Technology Transfer and Advancement Act of 1995. The center points represent the point estimates of β_t and the vertical lines denote the 90% confidence intervals of β_t estimates in the regression specification (8). Panel A plots the coefficient dynamics for licensor firms, while Panel B plots such dynamics for licensee firms. The dependent variable here is firm i's Tobin's Q in year t (Compustat item: (dlc+dltt+csho$\times$prcc_f)/(dlc+dltt+ceq)). $Licensor_i$ ($Licensee_i$) is a dummy variable equal to one if firm i is an actual licensor (licensee) firm. It is equal to zero for firm i's corresponding control firms in the same industry and year. We select the control firms using a propensity-score matching procedure based on $Size$, $R\&D$, ROA, $Leverage$, $Cash$, $CAPEX$, Num_Pat_3, and CPP_3, all of which are measured in the year prior to a licensing transaction. $Period_t$ is a set of dummies denoting every year within a five-year period around the year 1996 (when the Act was enacted). The year dummy denoting the year 1996 is dropped to avoid collinearity. Firm-level control variables include $Size$, $R\&D$, ROA, $Leverage$, $Cash$, and $CAPEX$, all of which are defined the same as in Appendix A and are measured in year t. Firm and year fixed effects are included. Robust standard errors are clustered at the firm level and are reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.



(a) Licensor Tobin's Q



(b) Licensee Tobin's Q

Appendix to

The Economics of Patent Licensing: An Empirical Analysis of the Determinants and Consequences of Patent Licensing Transactions

A Variable Definition

This table displays the detailed constructions of all firm-level and patent-level control variables used across different specifications.

Panel A: Firm-level Control Variables	
Size	Natural logarithm of a firm's book assets (Compustat item: at) in a given year
R&D	The ratio of a firm's R&D expense (Compustat item: xrd) to its book assets (Compustat item: at) in a given year
ROA	The ratio of a firm's EBIT (Earnings Before Interest) (Compustat item: ebit) to its book assets (Compustat item: at) in a given year
Leverage	The ratio of a firm's total debt (Compustat item: dlc+dltt) to its book assets (Compustat item: at) in a given year
Cash	The ratio of a firm's cash (Compustat item: ch) to its book assets (Compustat item: at) in a given year
B/M	The ratio of a firm's book value of common equity (Compustat item: ceq+txdb) to its market value of common equity (Compustat item: prcc_f × csho) in a given year
CAPEX	The ratio of a firm's capital expenditure (Compustat item: capx) to its book assets (Compustat item: at) in a given year
Panel B: Patent-level Control Variables	
Backward_Cite	The number of backward citations of a patent
Forward_Cite	The number of truncation-adjusted lifetime forward citation received by a patent
Num_Claim	The number of claims in a patent's application
Litigate	A dummy variable equal to one if a patent is ever litigated and equal to zero otherwise

B Additional Results

In addition to a firm's innovation characteristics, the product market environment where a firm operates may also influence its decision to become a licensor or licensee in a patent licensing transaction. Table B.1 explores such a possibility. Table B.1 reports the coefficient estimates from the conditional logit regression predicting the relationship between product market competition or firm market power and the likelihood of becoming a licensor or licensee. We use the Herfindahl-Hirschman Index (HHI) for every three-digit SIC-year combination as a proxy for product market competition and the Lerner Index as a proxy for firms' market power (Lerner (1934); Nickell (1996); Aghion et al. (2005); Elzinga and Mills (2011)). Following Aghion et al. (2005), we construct the Lerner Index for each firm-year as the firm's operating income net of depreciation scaled by the firm's total sales in a given year.

Columns (1) and (3) in Table B.1 report the relationship between product market competition in an industry and the likelihood of a firm becoming a licensor or a licensee, respectively. The estimated coefficients on the HHI are both positive and statistically significant, indicating that higher market concentration increases the likelihood of firms being involved in patent licensing transactions. In other words, if the market is highly competitive, licensors are less willing to license out their patents to protect their own technology and maintain a competitive advantage. From the licensees' perspective, when the market is more concentrated, licensing technology becomes a strategic move to quickly access new innovations without incurring the full costs and time associated with internal development, thereby gaining a competitive edge over existing firms.

Columns (2) and (4) show the relationship between firms' market power and the likelihood of being involved in patent licensing transactions. For licensors, market power does not significantly impact their decision to license out their patents. However, for licensees, having less market power increases the likelihood of licensing new technology. This approach provides a faster route to market for new products and helps them gain market power in the future.

Table B.1: Product Market Characteristics and Licensing Propensity

This table reports the results on the relationship between a firm's product market characteristics and the probability of the firm being a licensor or licensee firm in a patent licensing transaction. $Licensor$ ($Licensee$) is a dummy variable equal to one if firm i is an actual licensor (licensee) firm who licenses out (in) some patents in year t. It is equal to zero for the corresponding industry-size matched non-licensor (non-licensee) firms. HHI is the sales-based Herfindahl-Hirschman Index constructed at the 3-digit SIC industry level of a firm. It is calculated by dividing the sales of each firm in the same industry by the total sales of that industry in a particular year, squaring the result, and summing the squared fraction across all the firms in the same industry. $Lerner\_Index$, constructed following Aghion et al. (2005), is defined as the firm i's operating income net of depreciation (Compustat item: oibdp - dp) scaled by the firm's total sales, both of which are measured in the year prior to a licensing transaction. Firm-level control variables include $Size$, $R\&D$, ROA, $Leverage$, $Cash$, B/M, and $CAPEX$, all of which are defined the same as in Appendix A and are measured in the year prior to a licensing transaction. Transaction fixed effects are included. Robust standard errors are clustered at the transaction level and are reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

	Licensor		Licensee	
	(1)	(2)	(3)	(4)
HHI	7.282**		10.661***	
	(3.059)		(2.729)	
Lerner_Index		0.000		-0.003*
		(0.003)		(0.002)
Size	0.518***	0.550***	0.419***	0.430***
	(0.065)	(0.070)	(0.059)	(0.062)
R&D	0.560**	0.755***	-0.118	-0.408*
	(0.220)	(0.282)	(0.191)	(0.242)
ROA	-0.480***	-0.675***	-0.916***	-0.958***
	(0.138)	(0.170)	(0.150)	(0.186)
Leverage	-0.426***	-0.044	-0.127	0.067
	(0.148)	(0.172)	(0.135)	(0.145)
Cash	0.295	0.559**	0.525***	0.524**
	(0.200)	(0.230)	(0.180)	(0.210)
B/M	-0.548***	-0.495***	-0.633***	-0.570***
	(0.139)	(0.136)	(0.104)	(0.108)
CAPEX	-3.700***	-2.135*	1.267	1.636
	(1.120)	(1.139)	(1.040)	(1.036)
Transaction FE	Yes	Yes	Yes	Yes
Number of Obs.	4,795	4,427	4,865	4,380
Pseudo R^2	0.0654	0.0788	0.0656	0.0558