Signaling in Markets for Technology: Are licensing agreements reliable immediate and ex-post signals of innovativeness?

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Abstract

This paper examines whether licensing agreements function as signals of innovativeness that influence investors' evaluation of public companies and if they are consistent ex-post the announcement. Joining the literatures on markets for technology and signaling theory, it extends the investigation of the sources of value capture in licensing strategies. It specifically distinguishes the outcomes related to the expectation of the signal (immediate stock market reactions to the licensing agreement) and the confirmation of the signal (ex-post assessment reflecting market follow-up tests that calibrate expectations regarding company's future value). This distinction is addressed based on an empirical strategy that relates the reaction of the investing community to both abnormal stock market returns in the day of the announcement and to Tobin's q one year after the license agreement is made public. Drawing on a sample of 94 companies selected from the Standard & Poors 500 index, the period of analysis comprises seven years (from 2006 to 2012, both included). Results show an immediate positive effect for outward agreements and no significant effect for inward agreements. Regarding the ex-post evaluation of licenses, inward agreements hamper the growth of a company's market value one year after announcement, while outward agreements present no significant impact. Our results have important theoretical and practical implications. They help us understand the complexities involved in signaling effective innovative behavior for shareholders via licensing agreements. Our theory development suggests that licensing agreements are relevant signals to the investing community that can help reduce adverse selection problems. Another contribution is to show that the value of signals varies across time horizons and are therefore dynamic. Our research also prompts managers to be cautions in announcing their licensing strategies and calls for a careful evaluation of immediate gains in the perspective of long-term value deterioration.

Keywords: *Inward licensing, Outward licensing, Markets for Technology, Signaling Theory, Firm Performance*

JEL Codes: *O320, O310, L1*

Introduction

"In a sign of how much investors believe tech giants will supplant traditional sectors in consumer lives in coming years, the five most valuable Fortune 500 companies have become tech firms" (Fortune, May 2018).

Companies recognized as innovative typically enjoy positive reputation and the benefit of high market evaluation, which in turn translates into higher stream of financial resources. A recent and remarkable example is Tesla, whose market capitalization has mounted beyond those of major manufacturers like Ford, GM, BMW, Honda and Nissan, despite bottlenecks in production and poor quarterly results (*The Economist*, April 2018). Chinese SenseTime became the world's most valuable artificial intelligence startup (at a valuation of more than US$ 3 billion), attesting to the high market expectations of real-time surveillance as one of the most lucrative commercial applications of digital technologies (*Bloomberg*, 2018). Shares in Google's parent Alphabet rose to over US$875 million, as the company reported high earnings in upcoming areas outside its core advertising business, such as cloud computing and the Home speaker (*Fortune*, 2018).

To obtain the benefits that these examples elucidate, firms need to provide information on the quality of their innovative activities and their capability to sustain future growth. Because the financial resources of most firms are limited, they often depend on external contributions from stock markets, banks and investors in general to finance their economic activities (Steigenberger and Wilhelm, 2018). With the view of shaping shareholders' expectations and thereby attract financial capital, public firms use extensive signaling activities in a variety of business contexts. Organizations signal in their advertisements, recruiting and annual reports, just to name a few widely recognized instances (Karasek and Bryant, 2012). One of the main purposes of signals is to create an image of the organization as effective, prosperous and long-lived. It is a means of differentiating a company from others in the stock market (Connelly et al., 2011).

An increasingly popular way to flag innovativeness is to be active in markets for technology, where firms complement technologies developed in-house with those acquired externally and those traded via external channels (Arora, Fosfuri and Gambardella, 2001). Licensing strategies have become more crucial than ever, prompted by the intensification of competition and of knowledge tradability, as knowledge has become increasingly disembodied from individuals, organizations and products (Conti, Gambardella and Novelli, 2013; Natalicchio, Petruzzelli and Garavelli, 2014). According to estimates of the World Intellectual Property Organization (2011), the international royalty and licensing fees rose from US$27 billion in 1990 to US$180 billion in 2009.

This study examines whether licensing agreements function as signals that influence investors' evaluation of public companies and if this signal is consistent ex-post the agreement. We seek to join the literatures on markets for technology and signaling theory as to isolate some of the sources of value capture in licensing strategies. Our specific research questions therefore are: *How does the investing community, or the stock market, collectively evaluate inward and outward licensing agreements? And how is this evaluation maintained over time?*

The concept of signaling has been widely used in management and other fields to study a variety of phenomena (see Connelly et al., 2011 and Bergh et al., 2014 for extensive reviews). While a significant part of this literature has focused on the signals sent by managers in relation to investors (Reuer and Ragozzino, 2012), our work extends this theoretical lens to the study of markets for technology (Kotha et al., 2018). One important issue that has not been fully addressed is that existing literature does not distinguish between the expectation of the signal (immediate stock market reactions to the licensing agreement) and the confirmation of the signal (ex-post assessment of the realization of the agreement reflecting market follow-up tests that calibrate expectations regarding company's future growth potential) (Bergh et al., 2014). We contend that making this distinction is relevant because the performance consequences of licensing strategies may not only differ significantly between time periods but also be conflicting. While short-time considerations resolve typically around current market positions (e.g. reaction to competitors) and efficiency in operations, medium to long-time horizons may be connected to the development of new capabilities and the search for upcoming technological trends that will shape future offerings. As licensing strategies may serve different purposes over time, we contend that a comprehensive view is needed.

We address our research questions based on an empirical strategy that relates the reaction of the investing community to both abnormal stock market returns in the day of the announcement and to Tobin's q one year after. Drawing on a sample of 94 companies selected from the Standard & Poors 500 index, our period of analysis comprises seven years (from 2006 to 2012, both included). The results show positive effects of the signals represented by the announcement of outward licensing agreements, while inward agreements yield no returns with respect to the immediate stock market reactions. Yet the ex-post evaluation of licenses is negative, once inward agreements hamper the growth of a company's market value one year after announcement, while outward ones present no significant impact.

Hence, one of the main contributions of this study is to help us understand the complexities involved in signaling effective innovative behavior for shareholders via licensing agreements. Our theory development suggests that licensing agreements are relevant signals to the investing community that can help reduce adverse selection problems. We also develop arguments that the value of signals will vary across time horizons and will therefore be dynamic. Specifically, we suggest that the impact that signals have on shareholders' evaluation of market value vary between the first day and the first year from the announcement date.

Theoretical Framework

Given our objective of bringing signaling theory into research on markets for technology, it is useful to first highlight major findings in this area of research. Therefore, we also provide a brief introduction to signaling theory before developing research hypotheses in our specific empirical context.

We argue that our setting is relevant for informing the predictions of signaling theory. Markets for technology are subject to fundamental and persistent information asymmetries, given the inherent inefficiencies of trading knowledge as a specific asset (Arora and Gambardella, 2010). Licenses are established on the basis of non-disclosure agreements, which contain an appropriate description but not all information describing the focal technology (Aulakh et al., 2010; Cannady, 2013). There are uncertainties regarding not only the content, but also the validity and applicability, i.e. whether the licensee can effectively exploit the acquired technology as to bring it to the market. Moreover, it is difficult to evaluate the commercial value of innovations (Kotha et al., 2018), making it hard to determine the price of an agreement. Information asymmetries are more pronounced when the licensing agreement includes companies that do not belong to the same sector, when it is more difficult to detect opportunistic behavior, understand the agreement and its potential, as well as establish and communicate a common objective (Koh and Verikatraman, 1991; Cabaleiro, 2018). There are many frictions between licensors and licensees. As the theory suggests, the need of signaling is greater in more uncertain environments (Kotha et al., 2018).

Markets for Technology

Research on markets for technology can mainly be categorized in three streams. The focus of the first stream is to investigate whether companies treat in-house R&D and external sourcing as substitutes or complements, i.e. if an increase in one strategy raises or decreases the marginal payoffs of the other (e.g. Pisano, 1990; Arora and Gambardella, 1990; Cassiman and Veugelers, 2006; Laursen and Salter, 2006). The second research stream analyzes companies' determinants to acquire or sell technologies. While the aspect that has received most consideration in the literature is the supply-side determinants of external knowledge sourcing (Fosfuri et al. 2018; Moreira et al. 2018; Ardito et al. 2017; Khoury et al. 2017; Bianchi and Letarraja, 2016; Bianchi, Chiaroni, Chiesa and Frattini, 2011; Cockburn, MacGarvie and Müller, 2010; Fosfuri, 2006; Gambardella, Giuri and Luzzi, 2007; Kani and Motohashi, 2012; Kim and Vonortas, 2006), the demand-side conditions of licensing behavior have recently received pronounced attention (e.g. Tsai and Wang, 2008; Laursen, Leone and Torrisi, 2010; Ceccagnoli et al., 2010; Wang et al. 2013; Ceccagnoli and Jiang, 2013; Wang and Li-Ying, 2014; Wang and Li-Ying, 2015; Li-Ying et al., 2016).

The third research stream is concerned with investigating the impact of licenses on firm performance. However, analyzing the effect of licensing agreements on economic performance as the outcome variable has been challenging due to two main reasons. First, licensing agreements are established confidentially between the parties and it is not compulsory for companies to report licensing revenues as a differentiated item in income statements. Therefore, it is difficult to access the specific economic conditions of the agreements (such as fixed fee and royalties) and thereby to quantify revenue streams (Cabaleiro, 2018). Second, we have limited ability to measure performance in a consistent and proper way since we are not able to know if the agreement effectively accomplished its purpose.

Given these limitations, regarding the impact of inward licensing, the majority of empirical exercises has evaluated innovation results such as product innovativeness (Tsai et al., 2011; Wang and Li-Ying, 2014; Wang and Li-Ying, 2015; Cassiman and Valentini, 2015; Li-Ying et al., 2016), subsequent market entry (Mulotte et al., 2013), patenting (Joshi and Nerkar, 2011; Wang et al., 2013) and speed of invention (Leone and Reichstein, 2012). The ones that have measured economic proxies suggest opposing results. While Zahra (1996) found that inward licensing agreements are positively associated with return on assets (ROA), Jones et al. (2001) showed that they are negatively associated with profitability and return on investment (ROI). In contrast, Tsai and Wang (2008) did not gather any evidence of the direct relationship between inward licensing agreements and economic performance (as of value added). Regarding the impact of outward licensing, research in this field has focused on describing the negative long-term effect called the rent dissipation effect (Arora and Fosfuri, 2003; Fosfuri, 2006), the strategies to limit such effect (Arora and Gambardella, 1994; Granstrand, Patel and Pavitt, 1997; Bresnahan and Gambardella, 1998; Arora and Ceccagnoli, 2006; Cohen, Nelson and Walsh, 2000, Arora and Fosfuri, 2003, and Fosfuri, 2006) and the value created for the licensor through CARs – cumulative abnormal returns (Walter, 2012; Cabaleiro, 2018). Walter (2012) found evidence that establishing outward licenses created more value than inward ones (2.00% vs 1.06%), while Cabaleiro (2018) demonstrated that establishing outward licensing agreements generated positive CARs and that the magnitude of this effect varies depending on the specific circumstances of the licensor in terms of cash constrains, information asymmetries and relative position of the company in the industry.

Our study contributes to the third research stream. Even though it has been previously suggested than licensing is an important instrument for value creation (Walter, 2012; Cabaleiro, 2018), we still do not know if the value created is maintained over time. As Kale et al. (2002) indicate for the announcement of alliances, the initial positive impact is correlated at the 40% level with ex-post performance. We therefore contend that it is relevant to address this specific gap.

Signaling Theory

We apply signaling theory to examine the signaling mechanism prevalent in licensing agreements, as to explain a core firm performance outcome, i.e. the possibility of economic value capture.

Signaling theory is an established economic theory that focuses on information asymmetries (Connelly et al., 2011). It describes a core problem facing strategic decisions, namely how signals are used to reduce uncertainty in the context of making a selection given a set of choices, when there is incomplete and asymmetrically distributed information among economic agents (Bergh et al., 2014). In the field of management, this theory has been increasingly applied to help explain the influence of informational gaps in a wide range of research fields, e.g. strategy, entrepreneurship studies, human resource management and organizational behavior (Bergh et al., 2014).

Within strategic management research, signaling theory addresses specifically how firms convey relevant information concerning latent and unobservable quality to potential financial resource contributors (Alsos and Ljunggren, 2017, Steigenberger and Wilhelm, 2018). Often firms' core resources (e.g. technologies) and prospects can be difficult for shareholders to understand and value (Reuer et al., 2012). This information asymmetry leads potential investors do receive less-than-perfect information and therefore to demand reliable signals of company quality as to reduce uncertainty in investment decisions (Alsos and Ljunggren, 2017).

One of the key premises of signaling theory is to explain how to reduce such asymmetries of information (Taj, 2016). This is particularly suitable to the current study that examines signaling between firms and shareholders regarding the value of licenses. As put forward by Kotha et al. (2018), the need to signal is especially relevant when receivers are poorly informed about a technology's true value, such as in markets for technology.

The four key elements of signaling theory encompass the *signaler*, the *signal*, the *receiver* and the *feedback* sent to the signaler (Connelly et al., 2011). *Signalers* are insiders who possess information that outsiders would find useful but cannot obtain. This private information involves the underlying quality of some aspect of the individual, product or organization (Taj, 2016). It may include, for instance, specifics about products and clients, early stage R&D results or the competency of certain employees. In our context, the firms are the better-informed party that act as signalers.

Signals are observable information cues sent by one party to another in other to influence desired outcomes (Taj, 2016). They encompass imperceptible and alterable attributes of the insider, typically positive ones, such as the quality of a firms' innovation outputs. Desirable attributes of signals include honesty, credibility and reliability. Signals are only as good and effective as they are observable and enable signalers to set themselves apart from the rest (Karesek and Bryant, 2012). Therefore, they must be sufficiently costly (Bergh and Gibbons, 2011). While evaluating the inherent costs of signaling, signalers decide whether or not to intentionally communicate their private information to outsiders. However, negative signals may be sent out in the process accidentally (Connelly et al., 2011). While signals can be negative or positive, intentional or unintentional, signaling theory mainly addresses the actions taken by insiders to intentionally communicate positive but undetectable qualities of the focal organization (Alsos and Ljunggren, 2017). This paper focuses on licensing agreements as signals. Licensing agreements may be interpreted as substantive signals that provide information about both the focal economic activity (i.e. innovation activities) and the firm seeking resources (i.e. claims related to its innovative capability), aimed at reducing activity-related and firm-related information asymmetries (Steigenberger and Wilhelm, 2018).

The *receiver* of the signal is the third element and refers to outsiders, who would like to receive information about the firm in question. The effect of the signal depends on the receiver's attention to it, as well as on his interpretation and response (Bergh and Gibbons, 2011). Since it is two-way communication, it is subject to different perceptions that can give rise to different outcomes. Therefore, the factors that impact the interpretation of signals by the receivers are crucial for signalers, as they are looking to achieve the intended interpretation and related outcomes (Taj, 2016). In this study, the *receiver* are the investors.

For signaling to take place, the signaler should benefit from *feedback* from the receiver, such as an action that would not have been done otherwise (e.g. hiring, purchasing, investing). Feedback is the response to the received signal returned by the receiver to the signaler indicating the effectiveness of the signal (Alsos and Ljunggren, 2017). In this study, the feedback is the firm's market value. Following Bergh et al. (2014), we assess market value from a more nuanced perspective – both as an expectation of the signal (stock market immediate reaction) and as confirmation of the signal (firm's market value one year after of the realization of the signal). This leads us to two distinct research hypotheses.

Study Hypotheses

Stock Market Reaction

Stock market reaction is the immediate feedback related to the receiver's expectations of the signal (Bergh et al., 2014). It depicts the first interpretation of the signal and an indication of its swift effectiveness. Members of the stock market specially seek signals that differentiate high from low quality firms and that give insights into their future cash flows. This information assists the investing community in determining whether it should invest or divest shares in the focal firm (Bergh et al., 2011). Put shortly, from the perspective of signaling theory firms that buy or sell technologies via licensing agreements are perceived as more likely to have the internal capabilities to capitalize on and leverage new knowledge acquired from others (Bergh et al., 2011).

External technology sales signal to the stock market that the company is a frontrunner, i.e. it is a pioneer in the industry leading to the creation of technologies that will result in radical product and process innovations and that have been valued in the market (its own or other industries).

Pioneer advantages include high-quality products, broad product lines and lower prices. As the technological frontrunner moves offensively to be ahead of competition, the market likely expects it to outperform rivals in a number of ways. As frontrunners, licensors tend to capture premium market segments, achieve economies of scale, set industry standards, shape consumer preferences, control distribution channels and thereby gain a strong market position. The favorable reputation frontrunners often enjoy supposedly influences their share price in a positive fashion (Ali, 1994; Zahra, 1996). As signaling theory contends, reputation captures other signals of the firm's quality, such as prominent network relations and visionary leaders (Reuer and Ragozzino, 2012).

A company that shows technological prowess via the establishment of outward licenses also signals to the market "good management practices". It demonstrates not only the efficacy of previous technological investments (Zahra, 1996), but also the ability to attract and hire competent R&D professionals and to foster an innovative environment. Outward licensing agreements thus confer legitimacy to a company's past innovation efforts. As licensees are very selective in acquiring technologies and undergo an extensive diligence process, they inevitably and indirectly signal the underlying quality of the licensor (with respect to its innovation efforts and outputs). Because of the strong complexity of this activity that demands highly skilled managers (Bianchi et al., 2011), companies that succeed in closing outward agreements are seen as having "good reputation" or being "well known" in their industries or related ones (Alsos and Ljunggren, 2017).

Besides, companies that sell retain control, autonomy and understanding over proprietary technology. It is able to retain full discretion over strategic decisions that are crucial for its forthcoming technological development and for a sustained competitive advantage (Walter, 2012). An out-licensed technology is expected to be readily deployed and commercialized in-house as well (if wanted), generating revenues in current product markets. In accordance with signaling theory, signaling the possession of strategic resources (a given technology) and capabilities (innovation capabilities) reduces activity-related and firm-related information asymmetries. It thereby engenders positive expectations about the firm's performance not only in generating, but also capturing economic value. Outward licenses may thus be regarded as important signals of imminent technological breakthroughs that reflect platforms upon which future innovations will be based (Ahuja et al., 2005).

While signaling an effort to catch up with industry frontrunners that is bound to be regarded as a positive move, licensees at the same time communicate to investors that they are in a disadvantageous position or, at least, that they are not the leaders. In consequence, they will have a secondary market position and will not enjoy the advantages accrue to frontrunners. Furthermore, inward licensing agreements imply a variety of costs such as transaction costs, agency costs, appropriability and integration costs (Arora, Fosfuri and Roende, 2013; Arora and Gambardella, 2010) that prolong new product development projects (Knudsen and Mortensen, 2011). When working with externally developed technologies, licensees need to adapt and integrate them into their specific product markets (Huston and Sakkab, 2006; Lin, 2003). The use of externally sourced technology is more uncertain than internally developed ones because it is contextualized; it needs to be translated to the company's needs, routines and competences (Kessler and Bierly, 2000). As prior research indicates, knowledge is "situated", in that it is defined in relation to a given social and physical setting (Tyre and Von Hippel, 1997). It is characterized by a certain degree of interdependence in specific contexts that limits its reproducibility and expropriation (Natalicchio et al., 2014). Since licensees gain only limited access to licensor's knowledge (Mulotte et al., 2013), this is a far from a straightforward endeavor, which depends on the licensor's ability to transfer knowledge and the licensee's ability to absorb external knowledge (Ceccagnoli and Jiang, 2013). As this is a time-consuming process, the immediate outcomes of purchasing outside technology are not self-evident. According to signaling theory, this implies that important informational gaps persist. As a result, inward licenses probably foster less optimistic evaluations of investors.

Taken altogether, our arguments developed in accordance with signaling theory suggest that the investing community rewards firms more for announcing outward licensing agreements than the inward ones. Thus, we propose:

Hypothesis 1: Companies that announce outward technological transfer (outward licensing agreements) will capture greater cumulative abnormal returns than companies that announce external technology acquisition (inward licensing agreements), all else being equal.

Future Market Value

Future market value relates to the confirmation of the signal. It represents an ex-post feedback, based on an assessment after the realization of the licensing agreement. It reflects investors' "follow-up tests to the stock market valuation of the signal" (Bergh et al., 2014: 1357), used to calibrate expectations regarding the company's future growth potential.

Once a licensing agreement is announced, investors may not know its full economic potential straightaway (Ahuja et al., 2005). One year later, investors are in a better position to appraise competitors' moves regarding the focal company. They are therefore more informed about the unobservable ability of the organization to sustain cash flows. As Park and Mezias (2005) contend, future growth is a critical factor determining firm value.

The rents attainable through innovative activities are often termed Schumpeterian or entrepreneurial rents because they are the rewards to firms who are prepared to act in the face of ex-ante uncertainty (Gunther McGrath and Nerkar 2004). While technological licenses signal intentions to pursue efficiently or longer-term risk sharing for R&D activities (Park and Mezias, 2005), it is in time that their extra surplus value become clearer, since it depends on market acceptance, property rights protection, competition and so forth. They thus represent the possibility of a firm to capture Schumpeterian rents, which is likely to be interpreted by shareholders as a positive indication of future value.

After closing an inward licensing agreement, it may take time before a technology actually appears in the firm's products or processes (Wang and Li-Ying, 2014). A later assessment of the applicability of the focal technology tends to be more accurate than an immediate one. Announced inward licensing agreements represent a serious commitment made by the focal firm, which helps establish credibility. They also signal intentions to investors, that is, the fields and knowledge domains the firm is focusing resources in the future. However, in uncertain and dynamic environments, high-performing firms bet on many different projects under the assumption that some will ultimately lack promise and will not be brought to the market (Ahuja et al., 2005). Some technologies are naturally opted out in the process of the establishment of dominant designs. Even if it is unclear which ones will prevail, having access to a large number of technologies via inward licensing agreements increases the likelihood of a firm to adapt to future transformation. The evolution of technological trajectories become more and more clear as time goes by. Additionally, given the incomplete nature of licensing agreements, licensees might realize afterwards that the technology is not suitable for their projects as expected, that the companies involved do not have the required capabilities to collaborate or that they themselves lack the capabilities to capture, internalize and integrate new knowledge in an efficient way (Wang and Li-Ying, 2014). Therefore, sometime after a firm bought a license, shareholders can place a value on the nature and quality of the agreement and make an informed (and more accurate) assessment about whether it is prepared to handle the inherent technological and market uncertainties.

An outward licensing agreement represents in principle a secure source of revenue and consequently a greater likelihood that firms will more easily survive and achieve strategic goals.

However, an ex-post assessment after the first year serves as a safer signal of the commercial opportunities the agreement realistically entails. In this sense, it is important to point out that establishing a licensing agreement most of the times implies a trade-off (Arora and Fosfuri, 2003; Fosfuri, 2006). On one hand, companies will receive a stream of income flows in the form of fixed fee or royalties, called revenue effect – the expectation of this effect is the one that generates a positive reaction to the licensing signal. On the other hand, through licensing companies allow others to use and know in depth their technologies. Licensees could invent around them and this could generate new competitors, reducing the price-cost margin or the market share of the company. This latter effect is called rent dissipation effect (Arora and Fosfuri, 2003; Fosfuri, 2006). Often the revenue effect is more immediate, while the rent dissipation is a medium to long-term effect. Given this trade-off, companies need to carefully balance the revenue effect against the rent dissipation effect, and take the decision to out-license only if the former overcomes the latter. However, not all licensors consider the importance of the risks involved in the rent dissipation effect (Cabaleiro et al. 2018). This could cause licensors to regret the agreement after a while. To limit the extent of the latter effect, previous research has suggested several strategies: choose technologies based on scientific knowledge (Arora and Gambardella, 1994), related to non-core technologies, targeted toward geographically separated markets (Granstrand, Patel and Pavitt, 1997), confined to general technologies (Bresnahan and Gambardella, 1998), when patent protections are strong (Arora and Ceccagnoli, 2006; Cohen, Nelson, and Walsh, 2000), when competition in the product market is high (Arora and Fosfuri, 2003) and when the firm's market share is small (Fosfuri, 2006). However, out-licensing always entails a risk (Fosfuri, 2006). After one year, investors are in a better position to account if the specific outward agreement was taken under the careful consideration of the trade-off and if the firm possesses a strategy to limit the rent dissipation effect.

All in all, when the stock market participants actually realize what happened after the signal, they look back to make an assessment of how licensing truthfully represents an improvement in the financial performance of the firm. This likely means that the focal firm's market value will increase one year after the announcement of the licensing agreement. Thus, we propose:

Hypothesis 2: Companies that announce external technological acquisition (inward licensing agreements) and outward technological transfer (outward licensing agreements) will experience a higher market value in the following year.

Methodology

Sample

Our empirical analysis began with a dataset of 104 companies selected from the Standard & Poors 500 index (as of 31 December 2006). Widely regarded as the best single instrument of the U.S. equities market, this index includes 500 leading companies listed on the NYSE or the NASDAQ stock market. It selects constituent companies based on their asset and revenue location (U.S. company), level of market capitalization (minimum US$ 4 billion), public float (at least 50%), financial viability (four quarters of positive reported earnings) and sector representation. The companies were selected according to their sector classification, i.e. if they belonged to the energy, materials or consumer staples sectors in the terminology of the Global Industry Classification Index. These sectors were chosen because they encompass only manufacturing firms and are characterized by medium-levels of technology intensity, thereby being highly comparable. Previous studies have shown that the development of markets for technology are unequally distributed across sectors, being the chemical and pharmaceutical the ones where licensing practices are most common (NISTEP, 1997; Cohen et al., 2002) and the ones that have deserved the interest of most scholars (Arora and Fosfuri, 2003; Fosfuri, 2006; Laursen, Leone and Torrisi, 2010; Leone, Moreira and Oriani, 2015). Given that markets for technology have not yet achieved the development that academics and professionals expected two decades ago, we intend to analyze the impact of licensing agreements in other sectors and to advance the understanding of why they are not so common. This selection implies nevertheless a trade-off: on one hand, it can provide insights or explanations that help us understand why licensing is not such a common practice but, on the other hand, it cannot be generalized to the whole population, given the specific characteristics of our sample. We consider that extending the analysis of licensing to other sectors is beneficial to the literature on markets for technology.

The period chosen for analysis is 2006-2012. During these years, the economic crisis has influenced people economically as well psychologically (Ang et al. 2000). In this context, the behavior of economic actors changed to become more money-minded (Ferrel and Hartline, 2002). The increasing control and evaluation by investors put more pressure on managers to deliver short-term targets. Hence, understanding the value created by licensing strategies during this time period is particularly relevant.

The dataset extracted from Standard & Poors 500 index was integrated with information gathered from multiple additional sources, including Compustat (financial information), Center for Research in Security Prices – CRSP (stock market information), Factiva (licensing agreements information) and United States Patent and Trademark Office – USPTO (patenting information), using firm level identifiers (gvkey) and manual matching, as explained below. After the matching, our final sample comprises 94 companies of which 52 established 92 licensing agreements (53 inward and 39 outward agreements). During the matching, we lost information of 10 companies because they did not present the data needed in Compustat to compute our key variables. A further description regarding this point is presented below.

Measures

Dependent variables. The two dependent variables of interest are *Cumulative Abnormal Returns* (first hypothesis) and *Tobin's q* (second hypothesis).

Several studies have taken *Cumulative Abnormal Returns* (CARs) as a measure of economic performance (Fosfuri and Giarratana, 2009; Walter, 2012; Flammer, 2013; Cabaleiro, 2018). CARs measure how much a stock price deviates from its expected value during an event window (Gulati et al., 2009; Kale, Dyer and Singh, 2003). CARs were calculated in the following way: First, for each firm *i,* we computed the abnormal returns using the market model (Fama et al., 1969), which assumes a stable linear relationship between market returns and returns on the financial instrument, as well as accounts for market trends and firm risk. In this way, the market model improves the chances of isolating the effect of specific events (Campbell et al., 1997). To estimate the coefficients α_i (average return of the firm compared with the market average) and β_i (sensitivity of its return to the market return or risk of the stock), we used ordinary least squares (OLS) with the 200 trading days in the estimation, which correspond to the interval (-240, -41) according to daily return data from the CRSP database. Formally:

$$R_{it} = \alpha_i + \beta_i \times R_{mt} + e_{it},$$

where R_{it} is the return on the stock of company *i* on day *t,* α_i is the intercept, β_i is the systematic risk of stock *i,* R_{mt} is the daily return of the equally weighted CRSP market portfolio, and e_{it} is the daily risk-adjusted residual for firm i. The corresponding estimated return on the stock for firm i on day t is given by:

$$\hat{R}_{it} = \alpha_i + \beta_i \times R_{mt}.$$

Next, we calculated the abnormal daily return (AR) of company *i* on day *t* as follows:

$$AR_{it} = R_{it} - \hat{R}_{it}.$$

Finally, we computed the cumulative abnormal returns (CARs) for each time interval by summing up the abnormal returns within the specific time window (-1,0).

$$CAR(-1,0) = \sum_{t=-1}^{0} A\overline{R}_t$$

To test the second hypothesis, we use *Tobin's q* in the year after the announcement of licensing agreement as the dependent variable. Tobin's q (Tobin, 1969; Tobin,1978) has been widely applied as a proxy for future investment opportunities, not only in the finance literature (Berger and Ofek, 1995; Cho, 1998), but also in the literature that relates a firm's innovative capacity to its financial performance (Simon and Sullivan, 1993; Bhardwaj et al. 1999; Fosfuri and Giarratana, 2009; Aksoy, 2015). Tobin's q reflects investors' expectations of the firm future performance upon evidence of firms' strategic decisions. For instance, it has been used to measure the impact of strategies such as diversification (Montgomery, 1982; Montgomery and Wernerfeldt, 1988), acquisitions (Anand and Singh, 1997; Lang and Stulz, 1994), branding (Simon and Sullivan, 1993; Rao et al., 2004) and patenting (Chen and Shih, 2011). Following previous studies (McGahan and Silverman, 2006), the variable is computed as the ratio between the market value of each firm and their book value one year after the licensing agreement, where firm market value is the number of shares outstanding times the firm's fiscal year-end price stock price and the book value of the firm's assets. All the variables were collected from Compustat. Daines (2001) states that even if more complex estimates of Tobin's q can be computed (Lindenberg and Ross, 1981; Lewellen and Badrinath, 1997), this specific ratio is expected to produce unbiased and conservative estimates (Perfect and Wiles, 1994). This ratio is interpreted in the following way: when the value of Tobin's q is greater than one, a firm's growth opportunities are positive, when it is lower than one, they are negative. Furthermore, as Fu et al. (2016) found that firms with higher Tobin's q ratios experience superior operating performance (measured as EIBTDA/SALES) in the following five years, we consider that it is an appropriate measure to capture the ex-post assessment of the licensing agreement signal.

Independent variables. Our independent variables are *inward* and *outward licensing agreements.* They are measured by the number of licensing agreements available in the press. The data originates from the Factiva database, a comprehensive database of global news and business information that includes local newspapers, same-day newswires, company reports and media programs. Factiva contains business news from more than 14,000 news sources, 12,000 websites and 4,000 blogs, covering sources from more than 159 countries in 22 languages. In a recent study, Flammer (2013) attained the high accuracy and reliability of the data contained in this database.

Using the Factiva database, we extracted related news articles in the period of interest (2006–2012) using the following search term: "company name" near30 "licensing agreement". The resulting hits were all individually examined by a specially trained graduate research assistant and scrutinized for information regarding licensing agreements. The codification captured the names of the licensor and licensee and the date of announcement. Further, two dummy variables captured whether the license is a cross-licensing agreement and whether it is an amendment. For the purpose of this study, we eliminated the latter cases. To the degree possible, the economic conditions and the content of the licensing agreements were obtained (this information is not always disclosed). From our searchers, we identified 96 licensing agreements established by 57 companies (from 104 in the original sample), where 57 covered inward agreements and 39 covered outward ones. After matching our database with the one of CRSP, we lost 3 inward agreements (reducing also the number of companies involved in licensing agreements) because they were announced during weekends. As the stock market is closed during weekends, we decided not to use the next labor day to avoid capturing unrelated events. After matching this database with the financial information from Compustat, we lost information related to companies whose important variables were not available. All in all, we have 52 companies that established 92 licensing agreements (out of 94 companies in the final sample), where 53 covered inward agreements and 39 outward ones.

One concern is that we only capture a small part of the total population of licensing agreements. We may suspect that not all are reported in the media and therefore not included in our dataset (it is not compulsory for companies to report licensing revenues as a separate item in the income statement). Since we are investigating the impact of signals, we are only interested in the agreements disclosed to the general public. Besides, as Schilling (2009: 258) claimed, *"even though each database only captures a sample of alliance activity, it may yield reliable results for many – if not all – purposes*". Moreover, the fact that we could not measure all licensing agreements goes against our research. If we are not identifying all the licensing agreements made public, we are not considering all "increases" in the stock market. In consequence, the "normal" returns used to make the prediction are greater than in the case of identifying the whole population. Therefore, obtaining significant "abnormal returns" should be more difficult.

Control variables. Data on control variables was gathered primarily from the Compustat database and complemented by USPTO and internet searches. We included control variables related to internal technology development, firm characteristics (size and age) and investments, alongside year.

Internal technology development is proxied by patents granted by the USPTO in the period of interest (2006-2012), since they are seen as complementary to external technological transactions. Patents are preferred over R&D investments because they constitute an output measure related to a firm's innovation efforts (and not an input measure). Even if a limited amount of a firm's internally developed technologies is granted exclusive property rights, patents provide a suitable approximation for in-house inventive activity. As our dataset contains exclusively U.S. companies, we deemed appropriate to only include patents granted by the American patent office (in line with previous studies such as Fosfuri and Giarratana (2009)). In the electronic USPTO patent database (http://patft.uspto.gov/netahtml/PTO/search-bool.html), we used two terms in our query, accordingly: 1) "company name" in "assignee name" and 2) "1/1/2006->12/31/2012" in "issue date". Using a web crawler, we searched the USPTO database using the terms described above for each of our sampled companies. These searches resulted in more than 24,000 patents, from which we extracted relevant information, e.g. date granted, number, class, assignee name. Due to the nature of the search term, a number of patents from companies with names similar to those of our sampled companies were collected, as were patents registered to subsidiaries and joint ventures. To clean our sample, we manually examined the extracted data. Patents registered to subsidiaries or companies with similar names were removed. We considered that 'name of the company'='name of the company+ co'='name of the company+ company'. After cleaning the data, we had 13.398 patents. After the matching with CRSP, our final sample comprises 12,270 patents.

We controlled for *firm size* by using the natural logarithm of number of employees available in Compustat, as larger firms are expected to deter a higher market capitalization. *Firm age* was defined as the natural logarithm of years since its foundation, calculated as: 2006 (first year of analysis) minus the foundation year. Data on the foundation year was gathered via Internet searches in the companies' websites and Wikipedia. Older companies who have operated for longer time are likely to possess larger market value (e.g. acquired via brand differentiation). In order to capture possible non-linear effects, we also control for the square term of this variable. Investments were measured as *capital expenditures, acquisitions, short-term investments and total assets*, as provided by Compustat. As they refer to the present situation of the company and to the purchase of assets other than technology to provide future income, they represent other growth strategies that may signal a firm's market value. Specifically, capital expenditures represent the funds used for additions to property, plant, and equipment. Acquisitions, in turn, refer to the fixed assets of purchased companies. Short-term investments reflect currently marketable investments and total assets represent current assets plus net property, plant and equipment plus other noncurrent assets. Finally, *year* dummies were included to account for our longitudinal approach.

Methods

Regarding the first hypothesis, whose objective is to capture the stock market reactions to licensing announcements, we ran an event study using the Eventus Software. This package performs event studies using data read directly from the CRSP databases. In order to run the event study, we examined the stock price variation by analyzing the average CARs during the event window. These CARs captured how much the stock price deviated from its expected value on the day of the licensing announcement. This methodology relies on the assumption that stock markets are efficient and that prices perfectly reflect all public information related to the prospects of the company. Thus, the effect of a specific event should be reflected immediately in the stock market. When an event occurs, the market updates its forecast, causing a shift in market value.

To avoid including unrelated events that might influence stock returns, the event window needs to be sufficiently narrow (Gulati et al., 2009). A common approach is to set the event day (day 0) as the day of the announcement and to consider the possibility that the event might have happened on the previous day, before the stock market closed (day -1) (MacKinlay, 1997). Previous research has indicated that a two-day window is more effective for capturing stock market reactions than longer windows, since longer windows are likely to include confounding effects that make difficult to obtain reliable statistical inference (Crutchley et al., 1991). We therefore use the two-day event window (-1,0) as our main specification. Since licensing strategies may be influenced by fixed factors (i.e. the operating sector, location and the organizational culture), we used a fixed effects model as a way to account for the substantial unobserved firm heterogeneity and to reduce the chances of omitted variables bias from stable firm characteristics. Year dummies were used to rule out any specific time shock during our period of analysis and, finally, robust standard errors were used to acknowledge potential heteroscedasticity (Wooldridge, 2002).

Results

Table 1 shows our sampled companies organized by sector: 37 companies belong to consumer staples, 29 to materials and 28 to energy. Companies involved in licensing agreements along our period of study are denoted by an asterisk. We notice that 26 out of 37 companies from the consumer staples sector were involved in licensing (70% of the companies), 15 out of 29 companies from the materials sector (52%) and 12 out of 28 companies from the energy sector (43%).

Table 2 displays the descriptive statistics of the main variables. The maximum number of outward agreements per year per company is equal to 3, while this number is 4 for inward agreements. The figures are much higher for patents (internal technological development): the maximum number per year per company is 597. The large difference between the propensity to patent and to license is not surprising, since the establishment of licensing agreements is unequally distributed across sectors. Even in sectors where licensing practices are common, companies just license between the 6.6 to 6.8 % of their patent portfolio (Radauer and Dudenbostel, 2013).

Table 3 provides a more thorough explanation regarding our data on licensing agreements. The variation in the number of licensing agreements is very low. In particular, only 6.20% of the sample have established one inward agreement per year, while just 0.65% have 2 per year. Similarly, 4.97% of the sampled companies have established an outward licensing agreement per year, while just 0.5% of the sample present two.

Table 4 portrays the Pearson correlation coefficients of the variables. It reveals two striking results. Firstly, the correlation between the patents and inward licensing agreements is higher (0.30) than the correlation between patents and outward licensing agreements (0.09), suggesting that companies with more patents are not the ones that establish more outward agreements. This result is in line with previous studies that show that small firms out-license a higher share of their patents than large firms, which usually own a more extensive patent portfolio (Radauer and Dudenbostel, 2013). Secondly, the correlation between the number of inward and outward agreements is low (0.04), indicating that companies that establish inward licenses not necessarily establish more outward licenses and vice-versa. Since we are considering the effects of two endogenous and interrelated choices, we analyzed in greater depth the correlation between the two main independent variables, as to account for potential endogeneity issues. As Brynjolfsson and Milgrom (2012, pp. 32) state: "*The assumption that the adoption decisions are exogenous and uncorrelated is a strong one. [...]. If the managers have perfect foresight and full control over both choice variables, then in the absence of other exogenous forces, the complementarity variables will always be adopted together*". In order to explore complementarity, we followed the same approach as Arora and Gambardella (1990). In particular, we regressed two separate equations with inward licenses and outward licenses as dependent variables and our control variables as regressors, using OLS. After, we computed the correlation between the residuals. The resulting correlation was equal to 0.16, what confirms that complementarity between the variables is not a problem for our study.

First Hypothesis

Our analysis starts with the test of Hypothesis 1, concerning whether companies capture higher cumulative abnormal returns with the announcement of outward licensing agreements than with the announcement of inward licensing agreements.

The results are presented in Table 5. Whereas model 1 displays only the control variables, model 2 incorporates the number of inward agreements, model 3 includes the number of outward agreements and model 4 includes both variables simultaneously. Our results indicate that companies capitalize on announcing outward licensing agreements, but not on inward ones. In particular, the coefficient of outward licensing agreements is positive (0.199 under model 3 and 0.196 under model 4) and significant at the 5% level in both models. Even though the coefficient for inward licensing is positive too, it is not significant. With respect to controls, only firm size is positive and significant at the 10% level, indicating that larger firms tend to experience higher fluctuations in the stock market.

Hence, the findings of our event study support the acceptance of *Hypothesis 1*. In line with our expectations, shareholders react more positively to the announcement of outward licensing agreements than to the announcement of inward ones. This may be interpreted as a signal of technological proactivity and market leadership, resulting in immediate increase in revenue streams and optimistic expectations of future returns. In this way, our study corroborates Walter (2012), who found that licensors capture more value from the announcement of agreements than licensees (2.00% vs. 1.06%), in examining the U.S. computer and pharmaceutical sectors.

Second Hypothesis

Hypothesis 2 tests if companies that announced inward and outward licensing agreements experience a higher market value in the following year. The panel data analysis based on the fixed effects model is presented in Table 6, where model 1 presents solely the control variables, model 2 incorporates the inward licensing variable, model 3 adds the outward licensing variable and model 4 includes both variables. Table 6 reveals that the coefficient of outward licensing is negative (-0.0957 under model 3 and –0.0871 under model 4) and not significant, whereas the coefficient of inward licensing is also negative (-0.0831 under model 2 and -0.0753 under model 4) and significant at the 5% level. These results suggest that establishing outward agreement has not a significant effect in a company's market value after one year, while establishing inward agreement is detrimental for a company's market value a year after.

Hence, our results do not support *Hypothesis 2*. Companies that have announced either an inward or an outward licensing agreement do not show positive growth in market value after one year. Contrariwise, the fact that Tobin's q coefficient is negative and lower than one implies that a year after the announcement, inward licenses have influenced negatively a firm's market value.

Overall, our results show two striking outcomes: First, the announcement of outward licensing agreements generates a positive immediate reaction in the stock market, yet this increase in market value is not maintained a year after. Second, the announcement of inward licensing agreements does not have an immediate effect in the stock market, but is negatively related to the firm's market value after one year. Our study thus suggests that the stock market feedback to the public announcements of licensing agreements varies significantly in different periods of time.

Discussion and Conclusions

A lively scholarly debate exists around the role played by technological licensing for innovation, where external acquisition and external sales of technology assets are seen as important strategies for increasing market value. The objective of this paper is to empirically evaluate if the investing community perceives a firm's inward and outward licensing agreements as signals of innovativeness. An additional objective is to distinguish the outcomes related to the expectation of the signal (immediate reaction) and the confirmation of the signal (ex-post realization).

The event study analysis shows that outward licensing agreements positively and significantly influence cumulative abnormal returns (CARs), while the impact is absent for inward licensing. In most cases, the stock market community bids up the market value of the firm when it publicly discloses external technology sales. Companies thus capture higher stock market returns when selling intellectual property than when purchasing it. These findings are consistent with signaling theory arguments which suggest that when evaluating a situation where there is information asymmetry and risk, then the parties will consider signals or attributes of the partners before deciding how to respond. As the stock market participants cannot directly observe the company's technological base and innovative capability (a subjective quality), they become vulnerable to adverse selection and moral hazard risks, making it difficult for them to assess performance outcomes. To help mitigate these potential problems, investors appear to view outward licensing agreements as a signal to differentiate firms, informing about serious actions involving commitments. Outward licenses seem to serve as the basis for making conclusions about the firm's reputation as an industry frontrunner and the underlying quality of its past innovation efforts and future outputs.

However, one year after the announcement date, outward licensing agreements show no effect with respect to the company's market value (as measured by Tobin's q). From a signaling perspective, this finding may be interpreted as outward licenses constitute non-relevant signals in this time period. Previous research shows that investors tend to look for a specific set of criteria and signals not conforming to these criteria may not be received or perceived as important (Alsos and Ljunggren, 2016).

Besides, inward licensing agreements lead to a relative decrease in the companies' market value in the year following announcement. The results are negative because shareholders expect that, if companies establish inward licenses, they will not have any differentials in the market. Countering the optimism portrayed in hypothesis 2, these firms may be revealing that they have weaker capabilities. The investing community possibly values them as having both lower quality and higher risk (Bergh et al., 2011), given the challenges and difficulties of attaining successful integration of externally developed technologies and of keeping up with intensified competition (Kessler and Bierly, 2000). After obtaining resources from potential competitors that are likely to be further diffused and imitated, the investing community might question where the source of the firm's competitive advantage is. This seems to increase the risk perceived by investors, generating the skepticism captured in our analysis. Besides, firms that publicly announce inward licensing agreements might appear to be taking steps to improve, but their situations could imply that they have problems benefitting from the technologies they possess. To the investing community, the inward agreements seem to convey trouble: firms that do not have a robust innovation strategy, non-scarce resources, weaker innovative capabilities, restricted or eroding competitive advantages. Buying outside technology may also indicate the need for the absorption of external knowledge and integration with internal knowledge base, all of which is an expensive, difficult and uncertain endeavor (Kesseler and Bierly, 2000; Wang and Li-Ying, 2014; Li-Ying et al. 2016).

One visible example is Nokia. On February 11, 2011, it announced a plan to develop a new global mobile ecosystem switching from proprietary software Symbian to Windows Phone platform. The licensing agreement was expected to catapult Microsoft, whose Windows Phone operating system lagged behind Apple and Google Android into second place worldwide. Nokia planned to augment the Windows Phone Operating system with proprietary software, enabling brand differentiation. Sometime after the announcement, shares in Nokia fell 14% (Alcacer, Khanna and Furey, 2011), indicating that shareholders reacted negatively to the announcement of an inward licensing agreement.

These findings have implications for academic research and managerial practice. From a theoretical perspective, our study contributes to establishing links between the literature on markets for technology and signaling theory. Our paper expands the analysis of outcomes of technology markets by relating theoretical arguments explaining the value of signals embedded in licensing agreements to abnormal stock market returns and changes in market value. In this way, it provides a comparative analysis of the disparate performance outcomes in different time horizons. As a result, the paper also links to a research tradition that focuses on analyzing the relationship between external knowledge and performance consequences by providing a contribution in terms of measurement that is worth mentioning. Compared to prior investigations on outcomes of licensing (Cabaleiro, 2018; Walter, 2012; Anand and Khanna, 2000), this study adds a dynamic financial and market perspective to the study of the value captured by the parties. Besides, except for Walter (2012), existing empirical exercises investigated inward and outward licensing separately, which limits the comparability of the findings. As we apply different performance measures, we are able to provide a more comprehensive and nuanced view of the financial outcomes of licensing strategies.

Our study also offers two theoretical advancements for the signaling literature. First, we show how firms can use licensing agreements to signal value to the investing community. Second, we inform signaling theory by showing how companies' signals and receiver's interpretation vary over time. Even though the signals are the same, they are evaluated differently in terms of time horizons – the feedback of the investing community (receiver) is not the same with respect to the market value of companies immediately after and one year after the licensing agreement is announced. The findings thus imply that signals have differentiated meanings and may be sensitive to the time horizon of the receiver. Examining different time horizons allowed us to show why predictions of signals may be difficult to confirm, as their outcomes either change, are strengthened or weakened as time goes by. Signaling theory has not previously consider the role of this dynamics, i.e. how the interpretation of the signal (feedback) changes over time, while holding constant the signaler, the signal and the receiver. The results of this study suggest that a dynamic perspective can improve our understanding, not only in the firm-investor relationship, but also in other types of signaling processes. This stands in contrast to the static environment typically assumed in this literature, as Kotha et al. (2018) underline. More generally, our findings serve as a stimulant for further research into identifying additional factors that influence the market value of firms active in markets for technology, and whether other signals beyond licensing agreements play a role.

From a practical perspective, our study helps innovation managers responsible for licensing decisions to assess how they can best capture value. In addition to maintaining their jobs, earning higher salaries, and enhancing their reputations, managers also want to make decisions that improve stock market measures. Our analysis of the situations that generate stronger/weaker impacts in the market value offers managers some guidance in making strategic decisions. Our research prompts managers to be cautions in publicly announcing their licensing strategies and calls for a careful evaluation of short-term gains in the perspective of long-term value creation/deterioration. Since the investing community uses licensing agreements as relevant signals of firms' performance, managers need to make informed decisions in signaling innovativeness. Our work suggests that they may choose to make or not public announcements as to more proficiently profit from licensing. Even if announcing external technology sales (outward licensing agreements) may generate immediate positive returns in the stock market prompted by optimistic evaluations from shareholders, it may not compensate in the sense of limiting the potential for future market value. Likewise, announcing the acquisition of external technology (inward licensing agreements) does not seem to pay off, as it decreases market value in the following year, while not creating any immediate impact in the stock price.

Our study has nevertheless a number of noteworthy limitations. First, our sample is restricted to large American firms that belong to three specific sectors characterized by medium-levels of technology intensity. Even though focusing on this sample helped us to provide further evidence regarding licensing in other sectors not so explored until the moment, their specific characteristics make our findings not generalizable to the whole population and should be replicated in other contexts in order to be validated. Besides, financial performance may be assessed in a number of ways. While we consider cumulative abnormal returns (CARs) and Tobin's q as valid and comparable measures to assess the feedback of the investing community, we strongly encourage the use of additional performance variables to confirm our findings. Besides, our measure of independent variables unlikely captures all inward and outward licensing agreements of the sampled companies. We are conscious that it is likely that not all announced licensing agreements are published in press and therefore, we did not capture them in our sample, producing biased results. However, the fact that we did not capture all the licensing agreements made public should go against our results. That is, if we do not have all the licensing agreements we are not analyzing all these "increases" in the stock market. Hence, the "normal" returns used to compute the prediction are greater than in the case of having the whole population of licensing agreements. Despite this last comment, the lack of more complete license databases in these sectors is a limitation and constitute a noteworthy effort for future scholarly work.

References

Ahuja, G., R.W. Coff, and P.M. Lee. 2005. Managerial foresight and attempted rent appropriation: Insider trading on knowledge of imminent breakthroughs. *Strategic Management Journal* 26(9): 791-808.

Aksoy-Yurdagul, D., 2015. The Impact of Open Source Software Commercialization on Firm Value, *Industry and Innovation* 22 (1): 1-17.

Alcacer, J., T.Khanna, M. Furey and R.Mabud. 2011. Emerging Nokia? *Harvard Business School Case* 710-429.

Ali, A. 1994. Pioneering versus incremental innovation: Review and research propositions. *Journal of Product Innovation Management,* 11(1) 46-61.

Alsos, G. A., and E. Ljunggren. 2017. The role of gender in entrepreneur–investor relationships: A signaling theory approach. *Entrepreneurship Theory and Practice* 41(4): 567-590.

Anand, J., and H. Singh. 1997. Asset redeployment, acquisitions and corporate strategy in declining industries. *Strategic Management Journal* 18, 99-118.

Anand, B. and T. Khanna. 2000a. Do firms learn to create value? The Case of Alliances. *Strategic Management Journal* 21(3): 295-315.

Ang, J.S., R.A. Cole and J. Wuh-Lin. 2000. Agency Costs and Ownership Structure. *The Journal of Finance* 55 (1): 81-106.

Ardito, L., A. Natalicchio, A. Messeni and C.Garavelli. 2017. Organizing for Continuous Technology Acquisition: The Role of R&D Geographic Dispersion. *R&D Management* 48 (2): 165-176.

Arora, A., A. Fosfuri and A. Gambardella. 2001. Markets for Technology: The Economics of *Innovation and Corporate Strategy: MIT Press*.

Arora, A., A. Fosfuri, and T.Roende. 2013. Managing Licensing in a Market for Technology. *Management Science* 59(5): 1092-1106.

Arora, A., and A. Gambardella. 2010. Ideas for rent: an overview of markets for technology. *Industrial & Corporate Change* 19(3): 775-803.

Arora, A., and A.Gambardella. 1990. Complementarity and External Linkages: The Strategic of the Large Firms in Biotechnology. *Journal of Industrial Economics* 38 (4): 361-79.

Arora, A., and A. Gambardella. 1994. The Changing Technology of Technological Change: General and Abstract Knowledge and the Division of Innovation Labour. *Research Policy* 23 (5):523-532.

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.

Aulakh, P. S., M.S. Jiang and Y.Pan. 2010. International Technology Licensing: Monopoly Rents, Transaction Costs and Exclusive Rights. *Journal of International Business Studies* 41(4): 587-605.

Balakrishnan, S., and M.P. Koza. 1993. Information Asymmetry, Adverse Selection and Joint Ventures. *Journal of Economic Behavior and Organization* 20: 99-117.

Berger, P., E. Ofek. 1995. Diversification's effect on firm value. *Journal of Financial Economics* 37: 39–66.

Bergh, D. D., and P. Gibbons. 2011. The stock market reaction to the hiring of management consultants: A signalling theory approach. *Journal of Management Studies* 48(3): 544-567.

Bergh, D. D., B.L., Connelly, Jr, D. J. Ketchen, and L.M. Shannon, 2014. Signalling theory and equilibrium in strategic management research: An assessment and a research agenda. *Journal of Management Studies* 51(8): 1334-1360.

Bianchi, M., D. Chiaroni, V.Chiesa, and F. Frattini. 2011. Exploring the role of human resources in technology out-licensing: an empirical analysis of biotech new technology-based firms. *Technology Analysis & Strategic Management* 23(8): 825-849.
Bianchi, M. and J. Lejarraga, 2016. Learning to License Technology: The Role of Experience and Workforce's Skills in Spanish Manufacturing Firms. *R&D Management* 46 (S2): 691-705.
Bloomberg (2018, April 8). China now has the most valuable AI startup in the world. Bloomberg. Retrieved from www.bloomberg.com/news on August 19, 2018.
Bresnahan, T. and A. Gambardella, 1998. The division of inventive labor and the extent of the market. In General Purpose Technologies and Economic Growth, ed. Elhanan Helpman, 245267. Cambridge, MA: MIT Press.
Brynjolfsson, E. and P.Milgrom, 2012.Complementarity in Organizations. Princeton University Press, December, 2012. https://www.jstor.org/stable/j.ctt1r2ggg.5
Cabaleiro, G., 2018. Sources of Appropriation Capacity in Licensing Agreements. *Technovation*. Forthcoming.
Campbell, J. Y., A.W.Lo, and A.C. MacKindley, 1997. The Econometrics of Financial Markets: *Princeton University Press.*
Cannady, C., 2013. Technology Licensing and Development Agreements. *New York: Oxford University Press*
Cassiman, B., and R. Veugelers. 2006. In Search of Complementarity in Innovation Strategy: Internal R&D and External Knowledge Acquisition. *Management Science* 52: 68-82.
Cassiman, B. and G.Valentini, 2015. Open Innovation: Are inbound and outbound knowledge flows really complementary? *Strategic Management Journa*l 37(6):1034-1046.
Ceccagnoli, M., S.J.H.Graham, M.J.,Higgins and J.Lee. 2010. Productivity and the role of complementary assets in firms' demand for technology innovations. *Industrial & Corporate Change* 19(3): 839-869.
Ceccagnoli, M., and L. Jiang, 2013. The cost of integrating external technologies: supply and demand drivers of value creation in the markets for technology. *Strategic Management Journal* 34: 404-425.
Chen, Y.S., and C.Y. Shih, 2011. Re-examine the relationship between patents and Tobin's q. *Scientometric* 89: 781-789.
Cho, M. 1998. Ownership structure, investment, and the corporate value: An empirical analysis.*Journal of Financial Economics* 47 (1): 103-121.
Cockburn, I., M.J.MacGarvie and E. Müller. 2010. Patent thickets, licensing and innovative performance. *Industrial & Corporate Change* 19(3): 899-925.
Cohen, W.M., R.R.Nelson and J.P.Walsh. 2000. Protecting their Intellectual Assets: Appropriability Conditions and why U.S. Manufacturing Firms Patent (or not). *NBER Working Paper* No.7552.
Cohen, W.M., A.Goto, A.Nagata, R.R.Nelson and J.P.Walsh. 2002. R&D Spillovers, patents and the incentives to innovate in Japan and the United States. *Research Policy* 31:1349-1367.
Connelly, B. L., S.T. Certo, R.D. Ireland and C.R. Reutzel, 2011. Signaling theory: A review and assessment. *Journal of management* 37(1): 39-67.
Conti, R., A.Gambardella and E. Novelli. 2013. Research on Markets for Inventions and Implications for R&D Allocation Strategies. *Academy of Management Annals* 7(1): 717-774.
Crutchley, C. E., E. Guo and R.S. Hansen, 1991. Stockholder Benefits from Japanese-U.S. Joint Ventures. *Financial Management* 20(4): 22-30.
Daines, R., 2001a. Does Delaware law improve firm value? *Journal of Financial Economics* (62): 525–558.

Fama, E. F., L. Fisher, M.C. Jensen and R. Roll. 1969. The Adjustment of Stock Prices to New Information. *International Economic Review* 10(1): 1-21.
Flammer, C., 2013. Corporate Social Responsibility and Shareholder Reaction: The Environmental Awarennes of Investors. *Academy of Management Journal* 56(3): 758-781.
Ferrel, O. and M.Hartline. 2002. Estratégia de marketing. *Cengage Learning Editores.*
Fortune (2018, July 23) Alphabet inches closer to $1Trillion market cap after strong earnings at Google. Fortune. Retrieved from www.fortune.com on August 19, 2018.
Fosfuri, A., 2006. The Licensing Dilemma: Understanding the Determinants of the Rate of Technology Licensing. *Strategic Management Journal* 27(12): 1141-1158.
Fosfuri, A., and M.S.Giarratana, 2009. Master of War: Rival's Product Innovation and new Advertising in Mature Product Markets. *Management Science* 55(2): 181-191.
Fosfuri, A., M. Giarratana and S.S.Sebrek, 2018. Resource Partitioning and Strategies in Markes for Technology. *Strategic Organization* 1-24.
Fu, L.; Singhal, R.and Parkash, M., 2016. Tobin's q Ratio and Firm Performance. *International Research Journal of Applied Finance* Vol. VII (4)
Gambardella, A., Giuri, P. and Luzzi, A., 2007. The market for patents in Europe. *Research Policy* 36: 1163-1183.
Grimpe, C. and Sofka, W., 2016. Complementarities in the search for innovation. Managing markets and relationships. *Research Policy* 45 (10): 2036-2053.
Granstrand, O., Bohlin, E., Oskarsson, C., and Sjöberg, N., 1992. External technology acquisition in large multi-technology corporations. *R&D Management* 22: 111–134.
Granstrand, O., Patel, P. and Pavitt, K., 1997. Multi-technology Corporations: Why They Have "Distributed" rather than "distinctive core" compentencies. *California Management Review* 39 (4).
Gulati, R., D. Lavie and H.Singh. 2009. The Nature of Partnering Experience and the Gains from Alliances. *Strategic Management Journa*l 30:1213-1233.
Gunther McGrath, R., and A.Nerkar. 2004. Real options reasoning and a new look at the R&D investment strategies of pharmaceutical firms. *Strategic Management Journal* 25(1): 1-21.
Huston, L., and N.Sakkab. 2006. Connect and Develop: Inside Procter & Gamble's New Model for Innovation. *Harvard Business Review* 84 (3): 58-66.
Jones, G. K., JR.A.Lanctot and H.J. Teegen. 2001. Determinants and performance impacts of external technology acquisition. *Journal of Business Venturing* 16(3): 255 - 283.
Joshi, A. M., and A.Nerkar. 2011. When do strategic alliances inhibit innovation by firms? Evidence from patent pools in the global optical disc industry. *Strategic Management Journal* 32: 1139-1160.
Kale, P., Dyer, J., and H.Singh. 2002. Alliance capability, stock market response and long-term alliance success: The role of the alliance function. *Strategic Management Journal* 23(8): 747–767.
Kale, P., J.Dyer and H.Singh. 2003. Value Creation and Success in Strategic Alliances. *European Management Journal* 19(5): 463-471.
Kani, M., and K.Motohashi. 2012. Understanding the technology market for patents: New insights from a licensing survey of Japanese firms. *Research Policy* 41: 226-235.
Karasek III, R., and P. Bryant. 2012. Signaling theory: Past, present, and future. *Academy of Strategic Management Journal* 11(1): 91-99.
Kessler, E.H. and P.E.Bierly, 2000. Internal vs extenal learning in new product development: effects on speed, costs and competitive advantage. *R&D Management* 30(3):213-224.
Khoury, T.A., E.G. Pleggenkuhle-Miles and J. Walter. 2017. Experiential Learning, Bargaining Power, and Exclusivity in Technology Licensing. Journal of Management.
Kim, Y., and N.S.Vonortas. 2006. Technology licensing partners. *Journal of Economics and Business* 58, 273-289.

Knudsen, M. P., and T.B. Mortensen. 2011. Some Immediate - but Negative - Effects of Openness on Product Development Performance. *Technovation* 31: 54-64.

Koh, J. and N.Venkatraman. 1991. Joint Venture Formations and Stock Market Reactions: An Assessment in the Information Technology Sector. *Academy of Management* 34 (4): 869- 892.

Kotha, R., P. Crama and P.H.Kim. 2018. Experience and Signaling Value in Technology Licensing Contract Payment Structures. *Academy of Management Journal* 61(4): 1307-1342.

Lang, L.H.P., and R.M. Stulz, 1994, Tobin's q, corporate diversification, and firm performance, *Journal of Political Economy* 102: 1248-1280.

Laursen, K., M.Leone and S.Torrisi. 2010. Technological exploration through licensing: new insights from the licensee's point of view. *Industrial & Corporate Change* 19(3): 871-897.

Laursen, K., and A.Salter. 2006. Open for Innovation: The Role of Openness in Explaining Innovation Performance Among U.K. Manufacturing Firms. *Strategic Management Journal* 27(2): 131-150.

Leone, M. I., and T.Reichstein. 2012. Licensing-in fosters rapid invention! the effect of the grant-back clause and technological unfamiliarity. *Strategic Management Journal* 33(8): 965-985.

Lewellen, W.G. and S.G.Badrinath. 1997. On the measurement of Tobin's q. *Journal of Financial Economics* 44: 77-122.

Li-Ying, J., Y.Wang and L.Ning. 2016. How do dynamic capabilities transform external technologies into firms' renewed technological resources? A mediation model. *Asia Pacific Journal Management* 33: 1009-1036.

Lin, B.-W. 2003. Technology transfer as technological learning: a source of competitive advantage for firms with limited R&D resources. *R & D Management* 33(3): 327-341.

Lindenberg, E.B. and S.A. Ross. 1981. Tobin's q Ratio and Industrial Organization. *The Journal of Business* 54 (1): 1-32.

MacKinlay, A. C. 1997. Event Studies in Economics and Finance. *Journal of Economics Literature* 35(1): 13-39.

McGahan, A.M. and B.S. Silverman, 2006. Profiting from technological innovation: The effect of competitor patenting on firm value. *Research Policy* 35(8):1222-1242.

Merchant, H. and D.Schendel. 2000. How do international joint ventures create shareholder value? *Strategic Management Journal*, 21(7): 723-737.

Montgomery, C.A., 1982. The measurement of firm diversification: some new empirical evidence, *Academy of Management Journal* 25: 299-307.

Montgomery, C.A., and B. Wernerfeldt, 1988. Diversification, Ricardian rents and Tobin's q. *The RAND Journal of Economics* 19: 623-632.

Moreira, S., G.Cabaleiro and T. Reichtein. 2018.. Understanding Licensing Behaviour: A Rent Dissipation Lens Applied to Product Market Competition, Openness to External Knowledge and Exogenous Sunk Costs. *Industrial and Corporate Change*, forthcoming.

Mulotte, L., P.Dussauge and W.Mitchell. 2013. Does Pre-entry Licensing Undermine the Performance of Subsequent Independent Activities? Evidence from the global aerospace industry, 1944-2000. *Strategic Management Journal* 34: 358-372.

Natalicchio, A., A.M.Petruzzelli and A.C. Garavelli. 2014. A literature review on markets for ideas: Emerging chracteristics and unasnwered questions. *Technovation* 34: 65-76.

NISTEP, 1997. Appropriability and technological opportunity in innovation: A Japan-U.S. comparative study using survey data, in Japanese. *National Institute of Science and Technology Policy Report* No. 48.

Park, S.H. and D. Kim. 1997. Market valuation of joint ventures: joint venture characteristics and wealth gains. *Journal of Business Venturing* 12 (2):83-108.

Park, N. K., and J.M. Mezias. 2005. Before and after the technology sector crash: The effect of environmental munificence on stock market response to alliances of e-commerce firms. *Strategic Management Journal* 26(11): 987-1007.
Perfect, S.B. and K.W. Wiles. 1994. Alternative constructions of Tobin's q: an empirical comparison. *Journal of Empirical Finance* 1: 313–341.
Pisano, G. P., and R. Verganti. 2008. What Kind of Collaboration Is Right for You? *Harvard Business Review* 86(12): 78-87.
Radauer, A. and T.Dudenbostel. 2013. A Survey on Patent Licensing Activities by Patenting Firms. *European Commission*.
Rao, V. R., M. K. Agarwal, D. Dahloff . 2004. How is manifest brand- ing strategy related to the intangible value of a corporation? *Marketing* 68: 126-141.
Reuer, J.J. and M.P.Koza, 2000. Asymmetric information and joint venture performance: theory and evidence for domestic and international joint venture. *Strategic Management Journal* 21 (1):81-88.
Reuer, J. J., and R. Ragozzino. 2012. The choice between joint ventures and acquisitions: Insights from signaling theory. *Organization Science* 23(4): 1175-1190.
Reuer, J. J., T.W.Tong, and C.W.Wu. 2012. A signaling theory of acquisition premiums: Evidence from IPO targets. *Academy of Management Journal* 55(3): 667-683.
Schilling, M. A. 2009. Understanding the Alliance Data. *Strategic Management Journal* 30(3): 233-260.
Simon, C. J.and M. W. Sullivan. 1993. The measurement and deter- minants of brand equity: A financial approach. *Marketing Sei* 12(1) 28-52.
Steigenberger, N., and H.Wilhelm. 2018. Extending Signaling Theory to Rhetorical Signals: Evidence from Crowdfunding. *Organization Science* 29(3): 529-546.
Taj, S. A. 2016. Application of signaling theory in management research: Addressing major gaps in theory. *European Management Journal* 34(4): 338-348.
The Economist (2018, April 5). Tesla is heading for a cash crunch. The Economist. Retrived from: www.economist.com on August 19, 2018.
Tobin, J. 1969. A general equilibrium approach to monetary theory. *Journal of Money Credit and Banking* 1 (1): 15–29.
Tobin, J. 1978. Monetary policies and the economy: the transmission mechanism. *Southern Economic Journal* 37 (April): 421-31.
Tsai, K.-H., M.H. Hsieh and E.J. Hultink. 2011. External technology acquisition and product innovativeness: The moderating roles of R&D investment and configurational context. *Journal of Engineering and Technology Management* 28(3): 184-200.
Tsai, K.-H., and J.C.Wang. 2008. External technology acquisition and firm performance: A longitudinal study. *Journal of Business Venturing* 23: 91-112.
Tyre, M. J., and E.Von Hippel. 1997. The Situated Nature of Adaptive Learning in Organizations. *Organization Science* 8(1): 71-83.
Walter, J. 2012. The influence of firm and industry characteristics on returns from technology licensing deals: Evidence from the US computer and pharmaceutical sectors. *R & D Management* 42(5): 435-454.
Wang, Y. and J.Li-Ying. 2014. When does inward technology licensing facilitate firms' NPD performance? A contingency perspective. *Technovation* 34: 44-53.
Wang, Y., N. Roijakkers and W.Vanhavrbeke. 2013. Learning-by-Licensing: How Chinese Firms Benefit from Licensing-In Technologies. *IEEE Transactions on Engineering Management,* 60(1): 46-58.

Wang, Y. and J.Li-Ying. 2015. Licensing Foreign Technovation and the Moderating Role of Local R&D Collaboration: Extending the Relational View. *Journal of Product Innovation Management* 32 (6): 997-1013.

WIPO, 2011. World Intellectual Property Report: The Changing Face of Innovation. http://www.wipo.int/edocs/pubdocs/en/intproperty/944/wipo_pub_944_2011.pdf

Wooldridge, J. M. 2002. Econometric analysis of cross section and panel data. Cambridge, Mass.: MIT Press.

Zahra, S. A. 1996. Technology strategy and financial performance: Examining the moderating role of the firm's competitive environment. *Journal of Business Venturing, 11*(3): 189-219.

Table 1. Companies by sector in the sample

Consumer Staples	Materials	Energy
Alberto-Culver Co *	Air Products & Chemicals Inc *	Anadarko Petroleum Corp
Altria Group Inc	Alcoa Inc *	Apache Corp
Anheuser-Busch Cos Inc *	Allegheny Technologies Inc	Baker Hughes Inc *
Archer-Daniels-Midland Co *	Ashland Inc *	Bj Services Co
Avon Products *	Ball Corp *	Chesapeake Energy Corp
Brown-Forman -Cl B *	Bemis Co Inc	Consol Energy Inc
Campbell Soup Co *	Dow Chemical *	Devon Energy Corp
Clorox Co/De *	Du Pont (E I) De Nemours *	El Paso Corp *
Coca-Cola Co *	Eastman Chemical Co *	Eog Resources Inc
Colgate-Palmolive Co *	Ecolab Inc *	Exxon Mobil Corp *
Conagra Foods Inc *	Freeport-Mcmoran Cop&Gold	Halliburton Co *
Constellation Brands	Intl Flavors & Fragrances	Hess Corp *
Costco Wholesale Corp *	Intl Paper Co *	Kinder Morgan Inc
Cvs Caremark Corp	Louisiana-Pacific Corp	Marathon Oil Corp*
Dean Foods Co	Meadwestvaco Corp *	Murphy Oil Corp*
General Mills Inc *	Monsanto Co *	Nabors Industries Ltd
Heinz (H J) Co *	Newmont Mining Corp	National Oilwell Varco Inc
Hershey Co *	Nucor Corp	Noble Corp *
Hillshire Brands Co	Pactiv Corp	Occidental Petroleum Corp *
Kellogg Co *	Ppg Industries Inc *	Peabody Energy Corp
Kimberly-Clark Corp *	Praxair Inc *	Rowan Companies Plc
Kroger Co *	Rohm And Haas Co *	Schlumberger Ltd *
Lauder (Estee) Cos Inc -Cl A *	Sealed Air Corp	Smith International Inc
Mccormick & Co Inc *	Sigma-Aldrich Corp *	Sunoco Inc *
Molson Coors Brewing Co	Temple-Inland Inc	Transocean Ltd *
Pepsico Inc *	United States Steel Corp	Valero Energy Corp
Procter & Gamble Co *	Vulcan Materials Co	Weatherford International
Reynolds American Inc	Weyerhaeuser Co	Williams Cos Inc
Safeway Inc *		Xto Energy Inc
Supervalu Inc		
Sysco Corp		
Tyson Foods Inc -Cl A *		
Ust Inc		
Wal-Mart Stores Inc *		
Walgreen Co *		
Whole Foods Market Inc		
Wrigley (Wm) Jr Co *		

Note: * denotes companies in the sample involved in licensing agreements (as licensors or licensee).
Source: Authors' elaboration

Table 2. Descriptive Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
Internal technological development	2668	141,4	180,8	0	597
Inward licensing	2668	0,262	0,699	0	4
Outward licensing	2668	0,103	0,389	0	3
Firm size	2668	2,919	1,038	0,223	7,650
Firm age	2661	3,922	1,099	0	5,394
Firm age^2	2661	16,59	7,120	0	29,09
Capital expenditures	2668	1315	2133	9,600	26871
Acquisitions	2540	777,4	3099	-204	21087
Total assets	2668	19014	24148	1367	302510
Short-term investments	2661	142,4	602,2	0	4604
CARs (-1,0)	2332	0,123	2,157	-20,84	23,02
Tobin's q (t+1)	2254	1,896	0,844	0,525	6,759

Source: Authors' elaboration

Table 3: Description of Licensing Agreements

Number of Agreements	Inward Licensing Agreements		Outward Licensing Agreements	
	Number	Percent	Number	Percent
0	569	92.82%	570	94.37%
1	38	6.20%	30	4.97%
2	4	0.65%	3	0.50%
3	1	0.16%	1	0.17%
4	1	0.16%	0	0%
Total	613	100%	613	100%

Source: Authors' elaboration

Table 4. Pairwise Correlations

Variable	**Int. tech. develop.**	**Inward licensing**	**Outward licensing**	**Firm size**	**Firm age**	**Firm age^2**	**Capital expend.**	**Acquisitions**	**Total assets**	**Short-term invest.**	**CAR (-1,0)**	**Tobin's q (t+1)**
Int. tech. develop.	1,0000											
Inward licensing	0,3058	1,0000										
Outward licensing	0,0994	0,0446	1,0000									
Firm size	-0,4890	-0,1632	-0,0685	1,0000								
Firm age	-0,3483	-0,0043	-0,2512	0,2513	1,0000							
Firm age^2	-0,3401	-0,0305	0,2221	0,2818	0,9829	1,0000						
Capital expend.	-0,0095	-0,0060	0,0229	0,1112	0,0550	0,0241	1,0000					
Acquisitions	0,2477	-0,0172	-0,0501	-0,0724	0,0073	-0,0175	0,2314	1,0000				
Total assets	-0,0933	-0,1041	-0,0660	0,3649	0,1391	0,1215	0,8200	0,3144	1,0000			
Short-term invest.	-0,1609	-0,0447	0,0391	0,2877	0,0757	0,0804	0,2603	0,0010	0,2674	1,0000		
CAR (-1,0)	-0,0135	0,0057	0,0051	0,0179	-0,0251	-0,0245	-0,0176	0,0010	-0,0190	-0,0037	1,0000	
Tobin's q (t+1)	-0,1297	0,0427	-0,0244	0,1723	0,1089	0,1090	0,0505	0,0868	0,2404	-0,1190	-0,0229	1,0000

Source: Authors' elaboration

Table 5. Cumulative Abnormal Returns (-1, 0). Fixed Effects Model. Count variables

Variable	**(1)** **CAR(-1,0)**	**(2)** **CAR(-1,0)**	**(3)** **CAR(-1,0)**	**(4)** **CAR(-1,0)**
Outward licensing			0.199**	0.196**
			(0.0778)	(0.0800)
Inward licensing		0.0293		0.0165
		(0.0830)		(0.0816)
Internal technological development	0.000246	0.000225	6.23e-05	5.27e-05
	(0.000604)	(0.000599)	(0.000620)	(0.000611)
Firm age	0.113	0.126	0.194	0.200
	(0.618)	(0.618)	(0.603)	(0.603)
Firm age^2	-0.0371	-0.0393	-0.0471	-0.0482
	(0.100)	(0.100)	(0.0980)	(0.0979)
Firm size	0.156*	0.149*	0.154*	0.150*
	(0.0813)	(0.0882)	(0.0792)	(0.0862)
Total assets	-1.35e-05	-1.26e-05	-1.51e-05	-1.46e-05
	(1.18e-05)	(1.27e-05)	(1.15e-05)	(1.25e-05)
Acquisitions	2.31e-05	2.33e-05	2.36e-05	2.37e-05
	(1.62e-05)	(1.58e-05)	(1.55e-05)	(1.53e-05)
Capital expenditures	9.12e-05	8.87e-05	0.000109	0.000108
	(9.71e-05)	(9.92e-05)	(9.51e-05)	(9.81e-05)
Short-term investments	-0.000187	-0.000184	-0.000179	-0.000177
	(0.000199)	(0.000198)	(0.000196)	(0.000195)
Constant	-0.0349	-0.0536	-0.163	-0.172
	(0.898)	(0.904)	(0.883)	(0.887)
Observations	2,193	2,193	2,193	2,193
R-squared	0.008	0.008	0.009	0.009
Number of gvkey	52	52	52	52
Year Dummies	YES	YES	YES	YES

Source: Authors' elaboration
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6. Tobin's q (t+1). Fixed Effects Model, Robust Standard Errors. Count variables.

Variable	(1) **Tobin's q (t+1)**	(2) **Tobin's q (t+1)**	(3) **Tobin's q (t+1)**	(4) **Tobin's q (t+1)**
Outward licensing			-0.0957	-0.0871
			(0.0679)	(0.0652)
Inward licensing		-0.0831**		-0.0753**
		(0.0387)		(0.0359)
Internal technological development	-0.0014	-0.0013	-0.0013	-0.0013
	(0.0014)	(0.0015)	(0.0014)	(0.0015)
Total assets	-0.0000	-0.0000*	-0.0000	-0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Acquisitions	0.0000**	0.0000**	0.0000**	0.0000*
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Firm size	0.0743**	0.0773**	0.0751**	0.0777**
	(0.0337)	(0.0338)	(0.0336)	(0.0336)
Firm age	0.1962	0.1927	0.2012	0.1976
	(0.1255)	(0.1258)	(0.1283)	(0.1284)
Firm age^2	-0.0335*	-0.0327	-0.0340*	-0.0333
	(0.0200)	(0.0201)	(0.0204)	(0.0204)
Capital expenditures	0.0000*	0.0000**	0.0000*	0.0000**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Short-term investments	0.0000	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Constant	1.7012***	1.7054***	1.6907***	1.6954***
	(0.2189)	(0.2205)	(0.2233)	(0.2244)
Observations	460	460	460	460
R-squared	0.3068	0.3117	0.3118	0.3157
Number of gvkey	94	94	94	94
Year Dummies	YES	YES	YES	YES

Source: Authors' elaboration
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0