Intellectual Property as Loan Collateral

Laurie Ciaramella*, David Heller†, and Leo Leitzinger‡

Abstract

This study provides a first comprehensive picture of the use of intellectual property (IP) as loan collateral, its determinants, and its effect on firm trajectories. Using novel administrative data, we exploit the French institutional setting and show that firms from diverse industries use selected trademarks (72%), patents (26%), and designs (2%) to secure loans. We find that IP pledges have large positive effects on debt financing, in particular for small, financially constrained firms. The results are robust to exogenous variation in the pledgeability of alternative collateral. Further, using IP as loan collateral is associated with sizable increases in firm-level growth.

JEL Classification: G32; O34; O32; D23; L14

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*Institut Polytechnique de Paris – Télécom Paris & Max Planck Institute for Innovation and Competition; 19 place Marguerite Perey, 91120 Palaiseau, France. Phone: +33 (0)1 75 31 98 72; E-Mail: laurie.ciaramella@telecom-paris.fr.

†Max Planck Institute for Innovation and Competition; Marstallplatz 1, 80539 Munich, Germany. Phone: +49 (0)89 24246 565; E-Mail: david.heller@ip.mpg.de.

‡Goethe University Frankfurt; Theodor-W.-Adorno-Platz 4, 60323 Frankfurt, Germany. Phone: +49 (0)69 79834 820; E-Mail: leitzinger@econ.uni-frankfurt.de.

1 Introduction

The ability to access external financing affects firms' investment strategies and growth (Hall and Lerner, 2010). Firms can provide assets as loan collateral to enhance access to debt financing, and tangible assets have traditionally been the most common type of collateral (Frank and Goyal, 2003; Benmelech and Bergman, 2009; Rampini and Viswanathan, 2013). Yet, alternative ways to secure debt play an increasingly important role, as intangible assets have started to dominate the composition of firm value (Brynjolfsson *et al.*, 2021; Crouzet *et al.*, 2022; Falato *et al.*, 2022). One way for intangible-rich firms to raise debt financing is to collateralize their intellectual property (IP) (Graham *et al.*, 2018; Hochberg *et al.*, 2018; Mann, 2018). Against this background, gaining a deeper understanding on the patterns and the effects of IP collateralization is crucial.

Most of what is known about IP-backed debt financing so far comes from one type of IP – patents – and from specific segments of the economy. There is limited evidence on the collateralization of other IP types, such as designs and trademarks that are relevant to a broader set of firms.[1] Trademarks are directly linked to revenues and are evaluated by financial markets; hence, they are viable for collateralization (Block *et al.*, 2014; Hsu *et al.*, 2022). Furthermore, there is a lack systematic evidence regarding the effects of IP collateralization on all market participants. The rise in intangible capital is an economy-wide topic, and debt financing is the predominant mode of external financing in the US and Europe (see European Investment Bank, 2022). Hence, IP collateralization is likely to be relevant to firms across all sectors and of various legal types and sizes.

In this paper, we provide a first comprehensive picture on the use of IP as loan collateral, its determinants, and on the effects of IP-backed loans on firms' trajectories. We present insights on hitherto undisclosed dimensions of external debt financing, contributing to the literature in several ways. First, we examine trademarks, patents, and designs in a single empirical setting, covering IP-pledging firms from an entire country, and hence impose no restrictions on any firm type or industry. Second, we carve out the determinants of IP pledgeability – across and within firms – for different IP types. Third, we estimate the

[1] For example, 53% of EU firms with at least 250 employees own trademarks while 18% own patents (EPO-EUIPO, 2021). Figure IA1 (Appendix B) compares the share of trademark-, design-, and patent-intensive industries across several economies worldwide. For IP-intensive industries in Europe during the years 2017-2019, trademark sectors contributed 82% to GDP and 71% to employment, while the contribution of patent sectors is 37% for both GDP and employment (EPO-EUIPO, 2022).

heterogeneous effect of IP collateral on the use of debt and subsequent real activities with respect to several firm characteristics. Furthermore, our analysis explores a quasi-natural experiment to account for the fact that alternative collateral may be used together with IP. Overall, our analyses disclose new insights on IP as loan collateral and thereby add to the understanding of external debt financing secured by intangible assets.

We create a novel dataset, relying on previously unexploited administrative data from France. The French institutional setting is well-suited for our objectives. The country's legal requirements lead to consistent registration of all IP pledges. This setting allows us to generate an exhaustive dataset covering all firms that used trademarks, patents, or designs as loan collateral in France from 1995 to 2018.

First descriptive evidence confirms the importance of non-patent IP collateral. Specifically, we find that 81% of IP pledge events involve trademarks, 11% involve patents, and 8% use a combination of different IP types. Design rights are exclusively pledged in combination with other IP types.[2] These findings advocate for considering not only patents but also other IP types when examining IP collateral.

Descriptive evidence corroborates the relevance of IP collateral for a broad set of firms. To show this, we link collateral information to firm-level financial data. Borrowers are predominantly well-established, private firms, mostly limited liability companies, and are dispersed along a variety of sectors and geographic locations within France. In particular, we find that 79% of firms that use IP as collateral are SMEs. Such firms are known to have a high dependency on bank financing (Berger and Udell, 2006; Carbo-Valverde *et al.*, 2009). Yet, they have received little attention in the literature on the use of IP as loan collateral. We demonstrate that the aforementioned IP- and firm-specific patterns are also likely to hold outside of France.

Next, we find that pledged IP is more valuable and redeployable than the average non-collateralized IP. Further, we highlight that specific assets in the firms' IP portfolios are pledged as collateral. French credit law does not allow borrowers to use a general collection of corporate assets, but each asset used as collateral has to be specified individually – an advantage for our empirical analysis. We construct the full IP portfolio of pledging firms at the time of the pledge and add information on IP quality indicators. IP assets with

[2] At the IP level, 72% of pledged assets are trademarks, 26% are patents, and 2% are design rights.

higher private value to the firms, higher redeployability, and higher valuation capacity (i.e., associated certainty) are more likely to be used as collateral. Our findings provide new perspectives on the determinants of IP pledgeability.

Furthermore, we show that IP-backed loans have meaningful consequences for the debt capacities of firms. We estimate a disproportional increase of 61% in the long-term debt-to-asset ratios of firms in the years after their IP pledges relative to a matched sample. We exploit heterogeneity in firm-level characteristics and find that the aforementioned increase in debt applies across industries and geographical locations. The increase in debt ratios is stronger for small and private but well-established firms, and firms that have a high dependency on external financing. Moreover, we show that the use of IP as collateral is associated with a subsequent increase in asset growth and employment. Our results extend previous findings on patent pledges of specific subsets of firms (Hochberg *et al.*, 2018; Mann, 2018), by showing that similar effects apply for a broad set of firms that use either trademarks or patents as loan collateral.

Finally, we provide a solution for a concern inherent to firm-level analyses on debt financing. Indeed, it is usually not possible to the researcher to observe every collateral item in a loan agreement. The systematic use of other assets together with IP collateral would lead to an omitted variable bias that would most likely generate an upward bias in the results. In such a setting, the positive effect on firms' financing and economic activities would be attributed to IP collateral while it may have been driven by unobserved pledges of other assets. We mitigate this concern with a series of tests. First, we show that our baseline results are stable across different levels of asset tangibility – a standard measure of collateral availability (e.g., Frank and Goyal, 2003). Second, we exploit plausibly exogenous variation in the value of tangible collateral. We use a major legislative change in early 2006, the *Ordonnance 2006-346*, as a shock that raised the availability of alternative collateral for firms with a higher level of tangible assets (see, Aretz *et al.*, 2020). Our analyses show that the positive effect of IP collateral on debt is robust to changes in the availability of alternative collateral.

This study covers three main strands of the literature. First, we relate to those studies on the use and implications of collateral in external financing. Prior research highlights the importance of collateral in reducing financing costs and improving the access to debt (Bester,

1985; Stiglitz and Weiss, 1981; Benmelech and Bergman, 2009; Norden and van Kampen, 2013). Securing debt with collateral has important implications for the investment decisions of financially constrained firms, such as small or innovative ones (Hall and Lerner, 2010; Chaney *et al.*, 2012). Second, this study pertains to the literature on the monetization of IP rights. Literature identifies the different ways in which firms use their IP to satisfy financing needs, such as sales, licensing, and collateralization (Arora *et al.*, 2001, 2004; Serrano, 2010; Mann, 2018). Third, we contribute to the studies that investigate the role of IP in external financing. A large body of research shows that IP supports young firms in attracting external equity, such as venture capital (Hsu and Ziedonis, 2008; Conti *et al.*, 2013; Block *et al.*, 2014; Haeussler *et al.*, 2014). A more nascent stream of the literature provides evidence on the positive relationship between ownership of IP and debt financing (Farre-Mensa *et al.*, 2020; Saidi and Žaldokas, 2021; Horsch *et al.*, 2021).

There is a small number of studies at the intersection of these three streams; this group specifically investigate how IP can be used as collateral to raise debt, such as our study. The majority of existing work focuses on patents and shows that patent pledges help specific firms to raise debt, contributing to future growth.[3] Patent-backed loans have positive effects on savings, R&D investments, and performance, especially for intangible-rich firms (Amable *et al.*, 2010; Mann, 2018; Hochberg *et al.*, 2018; Caviggioli *et al.*, 2020). Evidence on the use of other IP types is scarce. Prior literature shows that brand equity improves debt financing and trademarks are recorded in security agreements in the US (Graham *et al.*, 2018; Mauer *et al.*, 2022). To the best of our knowledge, our study is the first to provide a comprehensive picture on the use of IP as loan collateral and its effect on firms' trajectories.

The remainder of the paper is organized as follows. Section 2 outlines the institutional background on the monetization of IP, in particular its use as loan collateral in the French legal system. Section 3 presents the data and displays detailed descriptive evidence on IP collateral in France. Section 4 identifies the determinants of trademark- and patent-pledgeability. Section 5 provides empirical evidence on the effects of IP collateralization. Section 6 concludes.

[3] In the legal literature, the use of non-patent IP collateral is a commonly discussed topic; see Kieninger (2020) for a detailed overview.

2 Institutional background

2.1 Collateralizing IP in France: legislative features

Key features: We outline the legal environment that governs the use of IP as loan collateral in France. There are three key characteristics that render this institutional setting particularly suitable to study IP collateralization. First, French law has a long-established regime enabling lenders to acquire non-possessory interests in their debtors' property which allows patents, trademarks, and designs to be collateralized (Riffard, 2016). According to legal scholars, this regime provides high legal certainty to users (e.g., Séjean and Binctin, 2020). Second, the French legal regime does not authorize a general collection of corporate assets in security agreements, so-called blanket liens, but requires each collateralized asset to be specified in the corresponding loan agreement (Attal, 2004; Aretz *et al.*, 2020). This specification rules out the possibility that an asset is added to the collateral mass by default. Third, the French regime provides strong incentives for the timely registration of IP pledges in the central register of the French national patent and trademark office – the Institut National de la Propriété Industrielle (INPI).

These institutional features are key to a sound analysis of IP collateral. Although they are not exclusive to France per se, they rarely exist in combination in other jurisdictions. For example, legal regimes in most European countries, such as Belgium, Sweden, or the Netherlands, allow for IP collateralization but do not have centralized registers for different IP types (Heller *et al.*, 2022). Other European countries, such as Germany have no mandatory register at all.[4] In the US, the law on IP collateral governs IP types separately and defines registration requirements according to parallel legal regimes, i.e., federal and state laws (Jacobs, 2011; Graham *et al.*, 2018). Moreover, blanket liens are a rather common practice in the US that can bias analyses of IP-backed loans.

The recording of IP collateralization: Out of the three key features of the French IP legal regime, the consistent recording of IP collateralization is particularly important. This feature significantly reduces concerns that the registration of IP pledges are correlated with firm performance (i.e., financing activities) and thus reduces concerns that our analysis

[4]Incomplete registration requirements of security interests in IP are likely to make lenders reluctant to accept IP as loan collateral, as they have limited information on priority claims. In interviews with IP lawyers practicing in Europe, we confirmed that this is a central issue impeding, for example, the collateralization of IP in Germany.

could suffer from selection issues. France has a long-standing tradition of strict registration requirements for loan collateral.[5] The French legal regime specifies that "*all security rights encumbering intellectual property rights must have been established in writing and made public in a register* [...] *of the intellectual property in question*" (Séjean and Binctin 2020, pp. 382). It further stipulates the publication of registered pledges of IP in the official INPI journal. The opposability to third parties is conditional on this publication, providing strong incentives for registering IP collateralization at the INPI. The registration can be made by any involved parties (i.e. borrowers and lenders) and allows lenders to enforce their priority claims, e.g., in the case of subsequent changes in IP ownership or borrower liquidation.[6]

In addition to incentives for the recording of IP pledges at the INPI, the French setting provides incentives for a timely registration (i.e. close to the date of the actual pledge). Previous studies on patent transfers have shown that the French legal regime provides strong incentives to register ownership changes of IP in a timely manner (Ciaramella *et al.*, 2017; Gaessler and Harhoff, 2018). As per the French legal regime, the effective date of enforceability against third parties is the publication date of the pledge in the official INPI journal. Enforceability is not retroactive and the seniority of the claims is determined by the order of the publication of the pledge.

2.2 Using IP as loan collateral

Our analyses covers trademarks, patents, and designs used as loan collateral.[7] Trademarks protect distinct signs that distinguish companies, products, or services through different brands, words, drawings, or symbols. Patents protect technical inventions and should be novel, encompass an inventive step, and offer an industrial application. In Europe, design rights are not patented but are registered IP that protects aesthetic forms and non-functional product features. All three IP types require formal application. Once approved, they grant their owner a temporary monopoly over the protected subject matter. In addition to offering

[5] Appendix C contains more details on establishing and resolving IP loan contracts in France. According to (Riffard, 2016), the French system is "*extremely rigorous, particularly with regard to the form*", as creditors can only enforce their rights if the collateral transaction is "*duly registered, containing the statement of the amount of the secured claim, as well as the species and nature of the encumbered asset*" (p. 371).

[6] These advantages are likely to exceed the monetary costs of registration. Parties have to pay 7 euros per registered IP. The total fee is capped at 270 Euros per transaction, but may be higher for fast track registrations. Administrative work may pose additional non-monetary costs, but is likely to be reasonable. To illustrate, Figure IA2 (Appendix B) displays the form sheet used by INPI to collect respective information.

[7] Table IA1 (Appendix A) summarizes key features of these IP types, including those relevant in the context of IP collateralization. We do not consider personal rights such as copyrights, which are obtained qua creation and not registration. Firms that pledge these rights typically borrow against future expected sales.

a competitive advantage, all IP types provide their owners with additional options to satisfy financing needs, such as using them as collateral to secure loans, but also selling or licensing them.[8] In principle, any type of IP can be pledged as collateral unless prohibited by law.

Trademarks, patents, and designs differ along several dimensions that may play a crucial role in financing activities. Trademarks may be more easily related to actual revenues compared to patents, as products are typically branded (Hsu *et al.*, 2022).[9] In contrast, single products may often comprise a large number of patents, and a large share of patents may not be associated with product innovation (Argente *et al.*, 2020). These characteristics may suggest that trademarks are better suited for collateralization as compared to patents. Yet, the rigorous and lengthy examination process of patents and the high costs associated with obtaining and maintaining them may act as a positive signal about the associated revenues. Patents can signal a firm's ability and future growth potential, in particular if the firm does not yet generate revenues.

In addition to features inherent to the type of IP, there are characteristics at the IP-level that are likely to affect its probability to be used as collateral in a loan agreement. The redeployability of the asset, and thus its liquidation value on the market, determines the extent to which the lender can compensate the loss given default of a loan (Benmelech and Bergman, 2009; Gavazza, 2011). In fact, lenders sell seized IP in case of default to offset losses (Ma *et al.*, 2022). Hence, we expect the redeployability to be positively associated with collateralization. We also expect the ability to measure the actual collateral value to play a positive role, as it reduces the risk associated with collateralization for the lender. This aspect is crucial in the context of IP which typically encompasses a high degree of asymmetric information and uncertainty of returns (Harhoff *et al.*, 1999; Arora and Gambardella, 2010). Finally, the private value of the asset to the borrower may be particularly important as well. Indeed, defaulting on a loan may mean losing an exclusive right over a strategic asset, such as the company name or a key technology. This potentially induces two opposite effects on the likelihood of IP collateralization: borrowers may be more reluctant to collateralize valuable assets, while for the lender, value to the borrower reduces the risk associated with the loan (e.g., Stulz and Johnson, 1985).

[8] Appendix D summarizes the key characteristics of these three monetization strategies.

[9] Mathias Schumacher, an expert in business valuation at corporate advisers Duff & Phelps states that trademarks may be accepted as collateral more quickly than patents, since revenue generation "can be proven easily" (Financial Times, 2020).

3 Data and descriptive insights

3.1 Construction of the data set

We create a novel dataset by combining information on IP collateral, detailed IP characteristics, and firm-level financial data. As a key component, we exploit data from the INPI registers on the use of trademarks, patents, and designs as loan collateral, and retrieve the exact dates of the pledge event. We then use the unique IP number to extract information on the initial owner and subsequent transfers of ownership from the official INPI website. Accounting for changes in IP ownership allows us to ensure that we allocate the true owner (i.e., pledging firm) and actual bundle of IP to respective loan events. We add information about third parties such as law firms and banks when available. We collect bibliographic information (on IP applications, registrations, grants, and renewals) and detailed trademark- and patent-level characteristics from INPI's FTP server and the worldwide patent statistical database, Patstat Spring 2021 edition.

We take advantage of the Siren number that is a unique national identifier of French businesses provided by public authorities and is part of the INPI data. The Siren number allows us to systematically identify and distinguish among the French firms in our dataset. Moreover, it provides a 1:1 link with the firm identifier in the Orbis database provided by Bureau Van Dijk, which we use as a source of firm-level annual financial data.

Our data contain information both at the IP- and firm-levels for the years from 1995 to 2018. We divide these data into two separate parts: one IP-level dataset and one firm-level dataset. Table 1 presents both datasets.

The initial IP-level dataset contains 29,193 IP-event combinations. Removing foreign firms, individual entrepreneurs, and observations with no Siren identifier results in 24,216 IP-(loan) event combinations.[10] In total, these observations comprise 18,058 trademarks, 5,709 patents, and 449 designs. IP can be used more than once as collateral (i.e. appear in more than one event). In total, 16,354 distinct IP rights are pledged at least once in 2,876 distinct events; they comprise 11,838 trademarks (72%), 4,186 patents (26%), and 330 design rights (2%).

[10] In addition, we winsorize all continuous variables at the one-percent level, to avoid confounding effects from outliers. We also exclude information on one specific IP loan event enacted by Alcatel Lucent in 2013. This exceptional case included several thousand patents and hundreds of trademarks and was well-documented in the public press (e.g. Reuters, 2012). Excluding these observations ensures that our results are not driven by this singular event.

Table 1: Sample composition: IP collateral, events, and firms by types of IP

	IP-level sample			
	Total	Trademarks	Patents	Designs
All IP-events	29,193	20,169	8,055	592
- Foreign firms	4,240	1,614	2,404	143
- Individuals/entrepreneurs	331	125	199	0
- Missing SIREN	406	372	33	0
= IP collateral-event combinations	24,216	18,058	5,419	449
Corresponding IP rights	16,354	11,838	4,186	330
Corresponding collateral events	2,876	2,558	520	38
	Firm-level sample			
	Total	Trademarks	Patents	Designs
Collateral events	2,876	2,558	520	38
Corresponding firms	1,816	1,593	382	25
(with Orbis data)	(1,122)	(1,004)	(249)	(22)
Corresponding firm-year obs.	17,269	15,637	3,950	357

Notes: This table provides an overview on the sample composition and provides counts on the different number of IP rights and events by legal entities that use IP collateral in France between 1995 and 2018. The full sample covers foreign firms, French individuals/entrepreneurs, and French firms (with or without an unambiguous Siren identifier). The table lists the corresponding numbers of IP rights and loan events, distinguishing among trademarks, patents, and designs. The bottom displays the observations of the IP- and firm-level samples used in our analyses. Note that the corresponding firms (and observations) do not add up to the total, since firms may pledge any combination of trademarks, patents, or designs.

For the firm-level data, we aggregate the IP-level data and collapse it in an unbalanced firm-year panel. The original dataset contains 1,816 unique French firms with Siren numbers. We retrieve annual balance sheet and profit and loss data from the Orbis database. Any observations with zero, negative, or missing total assets are removed. The final firm-level sample comprises 1,122 firms, corresponding to 17,269 firm-year observations.

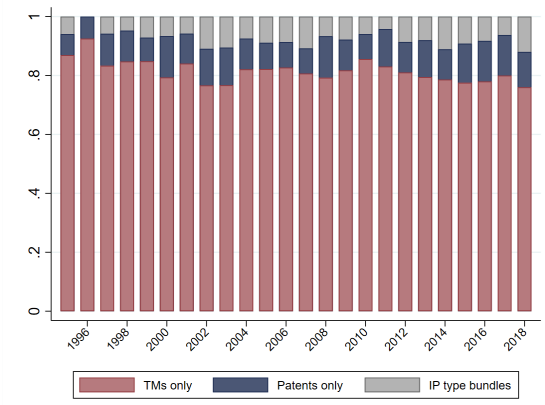
3.2 Descriptive evidence

Collateral statistics: This subsection provides a broad set of descriptive insights into the use of IP as loan collateral on different levels of aggregation. We first consider the characteristics on the (loan) event-level. Panel A of Figure 1 displays the composition of IP-backed loans with respect to the types of IP deployed. The vast majority (81%) of IP-backed loans in France exclusively use trademarks as collateral. About 11% exclusively rely on patents, while designs are only pledged in bundles with other IP types. Combined pledges

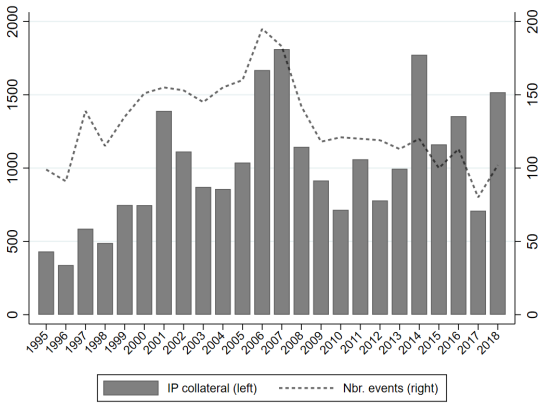
that use at least two out of the three types of IP represent on average 8% of the loans with IP collateral. These patterns are mostly stable over time, although the share of patents slightly increases. Panel B of Figure 1 shows the annual number of pledged IP (left-axis) and the number of corresponding events (right-axis). The yearly number of collateralized assets oscillates between 800 and 1,800 since the early 2000s.

Figure 1: IP collateral: composition and frequency of events, by year

Panel A: Share of IP types in events



Panel B: IP collateral and event counts

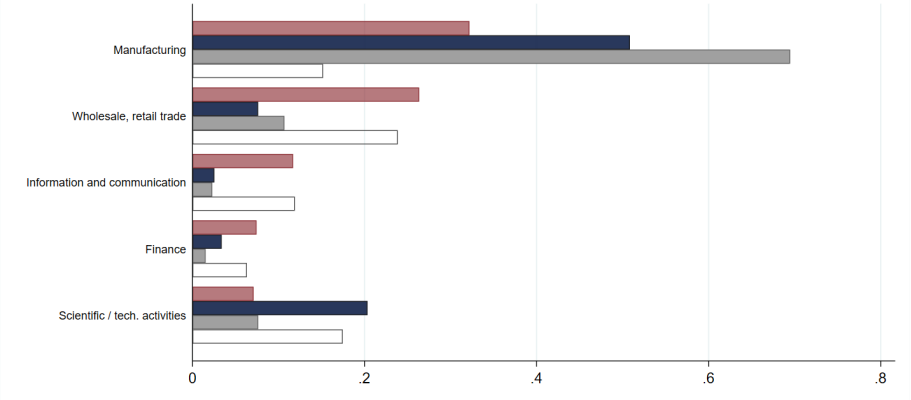


Industry statistics: Next, we provide descriptive evidence on the sectoral affiliations of the firms that pledge IP. To do so, we assess the NACE industry codes of firms. Panel A of Figure 2 displays the five largest sectors in which these firms operate and which comprise about 86% of the sample. Manufacturing constitutes the sector covering the largest share of IP-pledging firms, including 32%, 51%, and 69% of firms that pledge respectively trademarks, patents or any combination thereof. Further, firms using trademarks as loan collateral operate in the sectors of wholesale and retail trade (26%), information and communications (12%), and finance (7%), while firms that use patents as loan collateral operate in scientific and other technical services (20%). Panel A further shows that manufacturing firms are over-represented among pledging firms, compared to the NACE distribution of non-pledging French firms owning at least one trademark or patent as identified in Orbis.

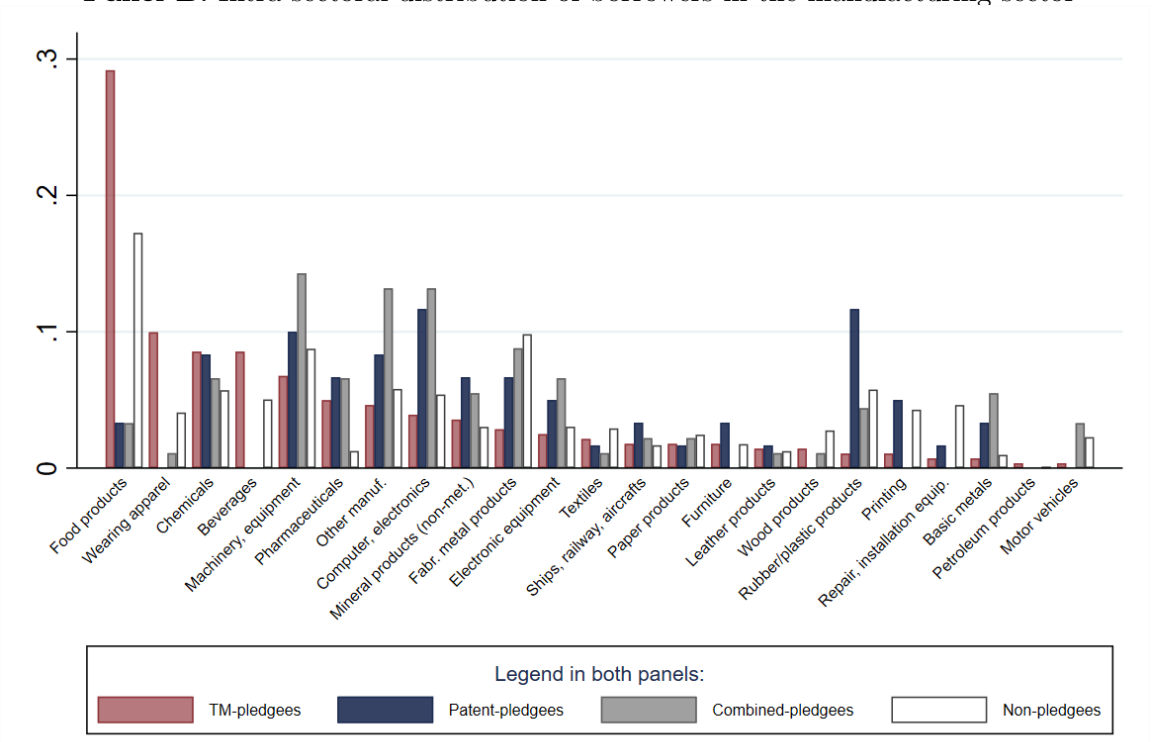
Panel B of Figure 2 provides a closer look at the distributions in the manufacturing sub-sector categories. The manufacturers that pledge trademarks operate predominantly in food, wearing apparel, and beverages (48%), while this is the case for only 3% of manufacturers that pledge patents. Instead, these manufacturers operate in the production of machinery, equipment (10%) or computer electronics (12%). Manufacturing of chemical and of phar-

Figure 2: Sectoral affiliations across firm types

Panel A: Five sectors with the highest share of IP-pledging firms, by main NACE class



Panel B: Intra-sectoral distribution of borrowers in the manufacturing sector



maceutical products constitute the greatest intra-sectoral overlap between firms that pledge patents or trademarks. Taken together, the statistics at the sectoral and sub-sectoral levels show that firms pledging trademarks tend to operate in different business fields than firms pledging patents. This difference indicate that firms pledge IP that are at the center of their business activities.

Firm statistics: Panel A of Table 2 displays the firm-level characteristics. The majority of pledging entities are SMEs (79%), privately-owned limited liability firms (58%), and not listed (95%). These features generally hold for all firms regardless of the type of pledged

IP, although firms that pledge patents are more frequently listed on the stock market (10%) compared to those that pledge trademarks (4%). The median firm that uses IP as loan collateral has about 68 employees and is 15 years old. Firms pledging combinations of IP types are the oldest and largest among pledging firms. In general, firms that pledge IP are larger and older than the average firm that owns IP but does not pledge it.

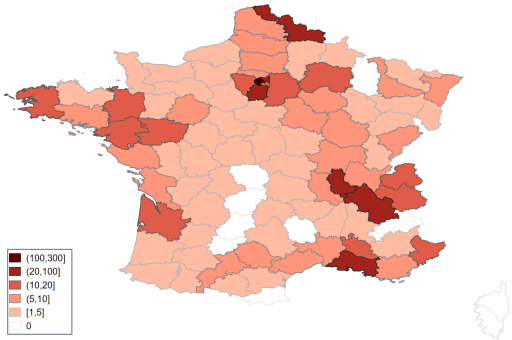
Table 2: Descriptive statistics on the firms that use IP as collateral

Panel A: Firm types by IP collateral types

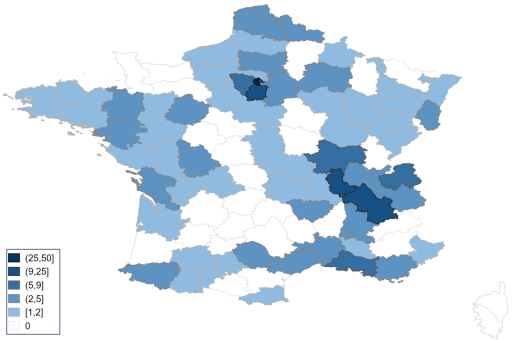
	IP-pledging firms by type				
	All	Trademarks	Patents	Combined	Non-pledgees
SMEs	78.5%	80.2%	85%	61.6%	96.5%
Private limited liability (LLC)	57.8%	58.9%	53.4%	55.0%	79.2%
Listed firms	4.8%	3.8%	10.2%	6.1%	0.5%
Median age	15	15	11	18	12
Median size (nbr. employees)	68	58	45	170	8

Panel B: Locations of trademark- and patent-pledging firms

Trademarks:



Patents:



Panel C: Most frequently involved credit institutions

Credit institutions	Share	Cumulative
Crédit Agricole	16.7%	16.7%
Groupe BPCE	14.9%	31.6%
Crédit Mutuel	8.5%	40.1%
BNP Paribas	6.7%	46.8%
Société Générale	4.7%	51.5%

Panel B of Table 2 2 shows the geographical distribution of firms that pledge trademarks or patents. The French economy is heavily centralized around Paris; and consistently, 44%

of IP-pledging firms in our sample are located in the Île-de-France region.[11] Apart from the concentration in the Paris region, IP pledging firms are dispersed across France. Only 29% of the firms are headquartered in the departments that comprise the three largest French cities of Paris, Marseille, and Lyon.

Panel C of Table 2 presents the credit institutions most frequently involved in IP-backed loans from 2015 to 2018.[12] French savings banks represent the majority of lenders in this sample. Specifically, Crédit Agricole, Banque Populaire (BPCE), and Crédit Mutuel - Banque CIC are the top three providers from 2015 to 2018, accounting for more than 40% of IP-backed loans.

To summarize, the descriptive findings show that small and private firms from the entire country use trademarks, patents, and designs to back loans provided by ordinary French banks. These findings underline the broad applicability – and potential – of IP-backed loans. They shed new light on the findings of previous literature which has focused on specific subsets of firms or sectors (e.g., Mann, 2018; Hochberg *et al.*, 2018).

3.3 External validity

The statistics from Section 3.2 show that trademarks are the most common type of IP collateral in France, and that the majority of firms that pledge IP are relatively small, private but well-established. Since these findings are based on one specific institutional setting, it is important to discuss whether the observed patterns are specific to the setup. In the following, we show that our previous results are likely to apply outside of France.

First, we assess the prevalence of trademarks among IP collateral types in the US by using both the Trademark and Patent Assignment Datasets from the USPTO. We select changes in the legal status of trademarks and patents that likely correspond to IP collateralization. Figure IA3 (Appendix B) plots the number of respective events per year between 2000 and 2020. Even though US data on IP pledges has reporting biases (Jacobs, 2011; Graham *et al.*, 2018), the dominance of trademark-backed loans is similar to the one observed for France.[13]

Second, it is likely that SMEs are also the most common type of firm that uses IP as

[11] Indeed, 31% of total GDP and 40% of R&D expenditures accrued in the eight departments of the Île-de-France region in 2019 (L'Institute Paris Region, 2022).

[12] For several pledges occurring from 2015 onwards, we observe the lending institution. Unfortunately, this information is not consistently documented such that we chose not to analyze it in more depth.

[13] For example, the share of trademark events represents 67% in the US, and 76% in France. This difference may reflect the fact that the share of patenting-intensive sectors to GDP is significantly higher in the US (22%) as compared to France (13%), as illustrated in Figure IA1 (Appendix B).

loan collateral outside of France. Bracht and Czarnitzki (2022) find that SMEs are the main users of patents as loan collateral in Sweden and the Netherlands. Mann (2018) provides cross-sectional evidence that US public corporations have a significantly lower probability of using patents as loan collateral compared to private firms. These statistics are likely to be downward biased, due to the different registration requirements in the US. As such, underreporting is likely to be stronger for SMEs that are also more bank-dependent and subject to high informational opacity (Berger and Udell, 2006; Carbo-Valverde *et al.*, 2009) than for large firms. In sum, the aforementioned aspects are consistent with our descriptive evidence presented in Section 3.2.

4 IP characteristics as determinants of collateralization

4.1 Defining the relevant dimensions of value in IP collateral

In Section 2, we posited that the collateral value of IP is related to market value, measurement capabilities, and private value to the borrower. In this section, we test these relations, extending prior work on the determinants IP characteristics for financing purposes in two distinct ways. First, there is limited evidence on the determinants of patent collateralization *within* firms, i.e., controlling for unobservables at the firm and loan levels.[14] Second, there is no evidence on the determinants of trademark collateralization, for either across or within firms. Since financial markets observe and evaluate trademark characteristics, the value and quality of trademarks is likely to affect their pledgeability (Block *et al.*, 2014).

We develop and estimate the following equation using (conditional) logistic regressions:

$$I(Collateral)_{xl} = \alpha_l + \delta Asset_x + u_{xl} \quad , \tag{1}$$

where $I(Collateral)_{xl}$ is a dummy equal to one if the IP asset x is collateralized to secure loan l and zero otherwise. α_l is a complete vector of firm-event (i.e. loan) fixed effects. It controls for unobserved factors at the firm-year level, such as a tendency to own more qualitative patents. It also controls for unobservables at the loan level, such as a lender's

[14] Caviggioli *et al.* (2020) study the relationship between various characteristics of pledged patents and the timing of collateralization and find that patent quality affects the hazard rates of pledges. Similarly, Mann (2018) shows that the number of forward patent citations is correlated with pledgeability. He does not distinguish patents owned by pledging and non-pledging entities, nor does he include loan or firm fixed effects. Zhang *et al.* (2021) use firm fixed effects in a robustness test but do not provide any details on it in their main analysis.

propensity to accept a certain type of collateral from the focal firm in a given year. $Asset_x$ is a vector of quality and value indicators at the IP level. In addition to filing year and technological sector fixed effects, the vector contains several indicators that are different for trademarks and for patents. These indicators are summarized in Table IA2 (Appendix A) and detailed below. Robust standard errors are clustered at the firm level.

Patent quality and value measures: In France, patents have to be renewed every year up to a maximum of 20 years in order to maintain legal protection. Renewal fees increase with patent age, such that patents of higher commercial or strategic relevance are maintained over longer periods (Trajtenberg, 1990; Hall *et al.*, 2005). Further, uncertainty about the associated revenues decreases with patent age. Hence, we expect that $PatentAge$ is positively correlated with the likelihood of collateralization.

Patent protection is a jurisdiction-based right. Patents seeking protection in several legal jurisdictions have higher associated costs and are likely to be of higher value (Harhoff *et al.*, 2003; Gill and Heller, 2022). We expect higher $FamilySize$ values to indicate relevance of the underlying technology for many markets and larger associated revenues, and hence to reflect a higher likelihood of collateralization.

IP offices examine patent applications, usually for several years, before deciding whether to grant the rights. This pendency period is associated with high uncertainty regarding the scope and validity of the associated rights (Lemley and Shapiro, 2005; Hegde and Luo, 2018). We posit that pre-grant uncertainty harms the abilities to redeploy and to valuate patents and that granted patents ($Granted$) are more likely to be used as collateral.

To avoid spurious correlation between the aforementioned observables and the likelihood of collateralization, we control for additional quality indicators at the patent level. We add the number of technology classes ($\#IPC4Classes$) as a proxy for the technological breadth of the patent. We account for the reliance on previous patents and to scientific literature as measured by the number of backward citations of a patent to patent and non-patent literature ($\#BwdCits\_pat$ and $\#BwdCits\_nopat$). We control for the number of patent co-inventors ($\#Inventors$) as a proxy for technological complexity and hence with its market value, and for the number of co-applicants ($\#Applicants$) as a proxy for the complexity of legal ownership (Roach and Cohen, 2013; Kuhn *et al.*, 2020).

Trademark quality and value measures: There are several analogies but also differences when determining the collateral values of trademarks and patents. Trademarks have to be renewed every 10 years to maintain protection. While proving their use in commerce is not mandatory to renew a trademark in France, the process is costly; so renewals indicate that the trademark has some value to its owner. Moreover, trademark renewals relate to valuation capacity, as a longer track record facilitates the evaluation of revenue streams arising from specific a IP (Krasnikov *et al.*, 2009; Nasirov, 2020). Hence, we expect *Renewal* to be positively associated with trademark collateralization. To measure the use of a trademark in commerce, we collect information on the adjustments in its legal status ($IndicationUse$) and previous transfers ($Transferred$).[15] We expect these variables to be positively associated with trademark collateralization.

Furthermore, we explore information about the NICE classes of trademarks, i.e., the number of categories in which it is protected (e.g., Sandner and Block, 2011). Trademark breadth refers to the number of different NICE classes ($\#NiceClasses$). It defines the legal boundaries of a trademark and reflects the limits of exploitation of the exclusive right (Cabral, 2000; Graham *et al.*, 2018). Trademark breadth is thus a value measure, and we expect it to be positively correlated with the likelihood of collateralization. Moreover, NICE classes can be grouped in product- or service-related classes. As service trademarks ($ServiceMark$) may be harder to link to revenues, we expect such trademarks to be less collateralized compared to product trademarks (Block *et al.*, 2015).

Finally, we exploit the fact that the underlying trademark value varies across different trademark types. First, we posit that corporate trademarks ($CorporateMark$), which represent the firms that stand behind the products or services provided to consumers and are usually valuable, are more likely to be collateralized than other types of trademarks (Sandner and Block, 2011; Agostini *et al.*, 2015). Second, we expect figurative trademarks ($FigurativeMark$), which informally convey the meaning of brands to the customers and have a rather supportive character, to be less likely to be used as loan collateral (Krasnikov *et al.*, 2009).[16]

[15] We collect information on adjustments to trademarks' legal status, such as change in address of the owner, legal oppositions, licensing agreements, and transfers from the INPI registers. These entries provide a good indication on whether the trademark is being used (Sandner and Block, 2011). Yet, we acknowledge that some of this information is not subject to mandatory registration in France.

[16] To illustrate, "NIKE" is a corporate trademark of the American sportswear designer and retailer Nike Inc., while the company's logo (the Swoosh) is a figurative trademark and subject to modifications over time.

4.2 Descriptives

Descriptive statistics support the proposed relationships between IP characteristics and their use as loan collateral as outlined above. To show this, we compute the IP portfolio of firms at the time of collateralization. We rely on data on patent and trademark application from INPI that we complement with information on ownership changes, renewals, and lapses. We find that firms pledge specific rights rather using their full IP portfolio as collateral. Only 36% of the firms that pledge patents and 24% of those that pledge trademarks collateralize their entire portfolio; these numbers being pulled up by firms owning a single asset.

Table IA3 (Appendix A) displays statistics on all characteristics introduced in this section, distinguishing among pledged and non-pledged IP owned by firms that pledge IP at the time of the event.[17] We find that relative to all other trademarks, those used as collateral are renewed more often, are more likely to be used in commerce, have a greater breadth, and are more frequently corporate trademarks but less likely to be service or figurative trademarks. Furthermore, pledged patents are on average older, are more likely to be granted, and belong to larger patent families compared to non-pledged ones. As for technological features, they receive less forward citations, are issued from smaller teams of inventors, belong to fewer technology classes, and rely more on previous patents and less on science compared to non-pledged assets.

Next, Table IA3 (Appendix A) shows that the average portfolio of firms that pledge trademarks contains 37 trademarks, of which 47% are used as collateral. Patent-pledging firms own on average 25 patents, and use 64% of their portfolio as loan collateral. These insights show that firms provide specific valuable assets as collateral, suggesting that these items are central to the loan agreement they secure.

4.3 Characteristics of collateralized trademarks

We analyze IP characteristics as collateral determinants in a multivariate setting as presented in Equation 1. Table 3 presents the results of logistic regressions at the trademark level. All regressions contain registration-year fixed effects to account for general time trends. Column I presents the results for the full sample of trademarks that were valid in France at any point

We follow previous studies and flag i) corporate trademarks by string matching the legal name of a firm with the trademark text and ii) figurative trademarks if it only consists of figurative elements (e.g., Agostini *et al.*, 2015; Nasirov, 2020).

[17] To mitigate selection concerns, we focus on patents filed via the national route and applied for by French firms. We are grateful to Carole Pesenti and Franck Dazin for kindly providing us with patent data.

from 1995 to 2018. The estimates show that pledged trademarks are more often renewed, are more likely to be used in commerce, are more often transferred, have a greater breadth, and are less likely to be a service trademark. In Column II, we account for the highly skewed value distributions typically observed for IP and screen out low quality trademarks by excluding those that were never renewed (e.g., Harhoff *et al.*, 1999; Arora and Gambardella, 2010). In Column III we add industry fixed effects to account for heterogeneous patterns across sectors. In both cases, the previous results hold.

Table 3: Logit estimations on the determinants of TM collateral

Dep. variable	I(Collateral)				
	I	II	III	IV	V
Renewal	0.824***	0.500***	0.507***	0.952***	0.949***
	(0.013)	(0.019)	(0.019)	(0.104)	(0.103)
log_NiceClasses	0.116***	0.204***	0.128**	0.381***	0.236
	(0.019)	(0.021)	(0.056)	(0.075)	(0.151)
IndicationUse	0.457***	0.367***	0.332***	-0.133	-0.153
	(0.034)	(0.036)	(0.036)	(0.195)	(0.195)
Transferred	0.809***	0.516***	0.502***	-0.087	-0.089
	(0.022)	(0.023)	(0.023)	(0.157)	(0.154)
ServiceMark	-0.988***	-0.882***	-0.575***	-0.056	-0.155
	(0.037)	(0.052)	(0.061)	(0.140)	(0.153)
CorporateMark				1.458***	1.457***
				(0.238)	(0.243)
FigurativeMark				-0.334**	-0.339**
				(0.147)	(0.150)
Sample TMs:	All	Renewed		Pledgee-owned	
Fixed effects:					
Registration-year	yes	yes	yes	yes	yes
Industry class (NICE)	no	no	yes	no	yes
Firm-event	no	no	no	yes	yes
N	2,307,035	473,065	473,065	69,236	69,236

Notes: The table displays the estimates of a logit regression explaining whether a trademark is pledged in a loan agreement. The dependent variable is an indicator equal to one if a trademark is used as loan collateral. The regressions contain different trademark-level characteristics as outlined in Section 4.3. Column I uses the sample of all trademarks that are active in France between 1995-2018. Columns II and III use a similar sample but exclude trademarks that were never renewed. That sample includes trademarks registered after 2010. Conditional logistic regressions in Columns IV and V contain only those trademarks that are owned by a trademark-pledging firm at the time of the initial collateralization. Within samples, the specifications use different sets of fixed effects as indicated in the bottom of the table. The constant is included but not reported. Robust standard errors are clustered at the firm-level and displayed in parentheses below coefficients. $^{*}(p < 0.10)$, $^{**}(p < 0.05)$, $^{***}(p < 0.01)$.

The regressions in Columns IV and V focus on the trademarks owned by pledging firms at the time of the collateral event. These regressions include firm-event fixed effects that control

for the unobserved characteristics of the pledging firm, the bank, and the loan transaction. These fixed effects absorb a large share of spurious correlations. The previous results on renewals and breadth hold and show that even within pledging firms, these value indicators are significant determinants of pledgeability. The coefficients associated with the indication of use, transfers and service trademarks turn insignificant, suggesting that the effect was firm-year driven. Hence, it indicates that firms that actively use their trademark or own product trademarks are generally more likely to use (any of their) trademarks as loan collateral. Furthermore, we confirm our hypothesis that specific trademark types are more likely to be pledged than others: corporate (figurative) trademarks have a higher (lower) probability of being used as collateral. Taken together, higher private value and higher valuation capabilities raise the likelihood of a trademark being pledged and thus appear to determine their collateralization, even within firms.

4.4 Characteristics of collateralized patents

Next, we examine the different patent characteristics as determinants for their use as loan collateral. In particular, we assess a broad set of patent features and put an emphasis on the portfolios of pledging firms, hence adding to the contribution of previous studies (Mann, 2018; Caviggioli *et al.*, 2020). Table 4 presents the results of estimating Equation 1 at the patent-level. Regressions presented in Columns 1 and 2 consider the full universe of French patents regardless of their owner. To compare with previous literature, the regression reported in Column I only comprises the number of forward citations together with the filing-year and technology sector fixed effects. Our results for French patents are similar to the ones found for US patents (e.g., Mann, 2018; Farre-Mensa *et al.*, 2020). They confirm that patents receiving more citations are more likely to be used in financial transactions. Column II comprises the full set of quality indicators as explanatory variables. Patents with more citations are still significantly more likely to be pledged but the coefficient is more than halved compared to Column I. Patents with a larger family size, with more inventors, and more patent references are more likely to be pledged; while patents with more non-patent references, IPC classes, and co-inventors are less likely to be collateralized.

Columns III to VI present the results of conditional logistic regressions that focus on the subsample of patents owned by pledging firms at the time of the loan event. The regressions

Table 4: Conditional logit estimations on the determinants of patent collateral

Dependent variable	I(Collateral)					
	I	II	III	IV	V	VI
#FwdCits, log	0.382***	0.182***	0.188***	0.071		0.047
	(0.018)	(0.024)	(0.051)	(0.054)		(0.051)
FamilySize, log		0.397***		0.302***		0.304***
		(0.024)		(0.089)		(0.091)
#Applicants, log		-1.608***		-2.367***		-2.362**
		(0.227)		(0.693)		(0.768)
#Inventors, log		0.185***		-0.012		0.012
		(0.054)		(0.164)		(0.169)
#BwdCits_pat, log		0.310***		-0.042		-0.035
		(0.040)		(0.131)		(0.121)
#BwdCits_nopat , log		-0.240***		-0.142		-0.088
		(0.054)		(0.139)		(0.157)
#IPC4Classes, log		-0.282***		-0.066		-0.068
		(0.048)		(0.095)		(0.104)
PatentAge					0.287*	0.258*
					(0.114)	(0.125)
Granted					1.586***	1.570***
					(0.253)	(0.269)
Sample patents:	All		Pledgee-owned			
Fixed effects:						
Filing-year	yes	yes	yes	yes	yes	yes
Technology sector	yes	yes	yes	yes	yes	yes
Firm-event	no	no	yes	yes	yes	yes
N	316,442	316,442	8,082	8,082	8,082	8,082

Notes: The estimation method is a conditional logistic regression. The dependent variable is *I(Collateral)*, a dummy variable indicating whether the corresponding patent is used as loan collateral in the focal event. All variables are specified in Table IA2 (Appendix A). Robust standard errors are clustered at the firm level. If not indicated otherwise, all regressions contain firm-event and filing-year fixed effects. The constant is included but not reported. $^{*}(p < 0.10)$, $^{**}(p < 0.05)$, $^{***}(p < 0.01)$.

reported in Columns III and IV mimic the ones in Columns I and II and add firm-event fixed effects. Including the patent family size as a regressor causes the coefficient that is associated with forward citations to turn insignificant. This insignificance may be due to the fact that patent family proxies for the economic value of a patent, while forward citations measure its technological value (see Hall *et al.*, 2005). Hence, the results indicate that, rather than its technological value, the economic value of a patent determines its pledgeability. Patents with several applicants, a situation that adds administrative complexity to the transfer of the associated rights, are less likely to be pledged.

Column V shows the relationship between age, grant, and the likelihood of being pledged. We find that granted patents are more likely to be collateralized. This result is in line with the idea that the legal certainty conferred by granted IP rights is positively associated with collateralization. Holding the grant information constant, older patents are more likely to be pledged than younger ones. These findings remain unchanged when adding all the quality indicators as regressors (Column VI). Overall, the results from this subsection show that, similar to trademarks, the patents that are used as loan collateral are more valuable and more likely to be redeployable than the average patent.

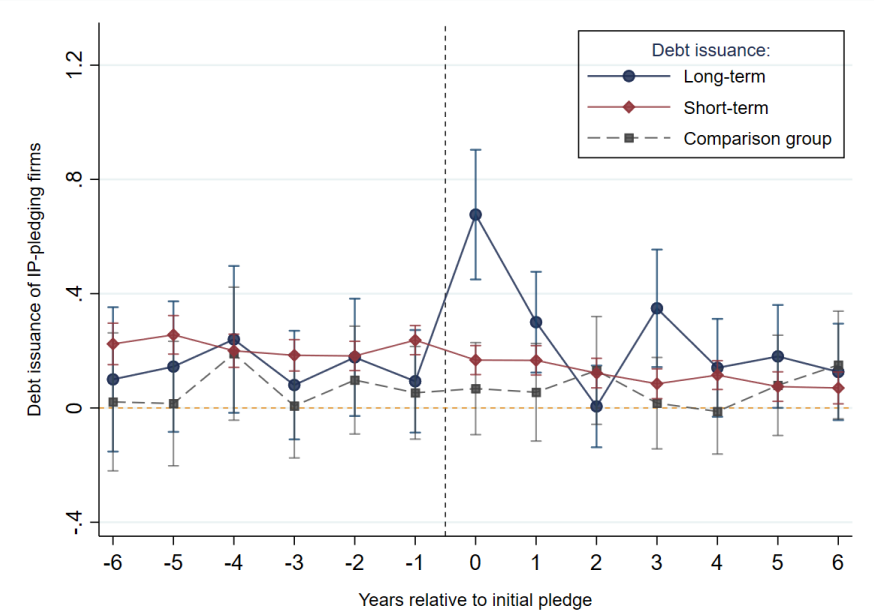
5 Empirical evidence on pledging firms

In this section, we study the firm-level implications of the use of IP as collateral. To this end, we identify the effect of the collateralization of IP on firms' debt financing and on other subsequent economic activities. These analyses compare firms that pledge IP over time to those that do not pledge IP but have similar time-variant and time-invariant characteristics prior to the first pledge.

5.1 Methodology: Matching approach and model specifications

Generating a control group: We use a combination of exact matching and Coarsened Exact Matching (CEM) to flag suitable firms for the comparison group. First, we require that firms share the same industry affiliation, legal type (private versus public corporation), age, IP ownership (trademarks, patents, or both), and loan demand (zero loans or non-zero loans). Second, we match firms using CEM based on their size, capital structure, and asset tangibility; all of which are determinants of firms financing behavior (see Frank and Goyal, 2003). These firm characteristics are measured prior to the first IP collateralization to avoid reverse-causality issues. CEM then assigns firms into stratas with similar characteristics. Third, we keep the closest matching partner in each strata to avoid a large imbalance in the number of firms that pledge IP and those that do not. The matching procedure yields a sample containing 1,028 firms that results in 19,971 firm-year observations from 1995 to 2018. Table IA4 (Appendix A) shows that there are no statistically significant differences in the means for several observable firm characteristics when comparing the two groups.

Figure 3: Debt financing activities around the IP loan event year



Notes: The figure plots mean values of the annual year-to-year growth rate, or debt issuance, in a symmetrical time window around the initial use of IP as collateral (t=0). Long-term and short-term refer to the year-to-year growth rate in long-term debt ($DebtIssuance$) and in short-term debt ($ShortDebtIssuance$) of firms that pledge IP. *Comparison group* refers to the year-to-year growth rate in long-term debt of matched firms that do not pledge IP. All variables are defined in Table IA2 (Appendix A). The whiskers span the 95 percent confidence intervals.

Descriptives: Figure 3 illustrates debt financing dynamics in the six-year time window around the firms' initial use of IP as collateral and those for the matched group. The year-to-year long-term debt growth rate for pledging firms ($DebtIssuance$) jumps in the year of the pledge and is significantly higher than in any other year of the observed time frame. Further, the level of short-term debt of these firms remains constant around the pledge. This is in line with previous studies that have shown that IP-backed lending is associated with increases in long-term debt ratios (e.g., Mann, 2018; Gill and Heller, 2022).

Confirming our matching approach, the debt issuance of the matched group remains constant. For robustness, we also analyze the evolution of the long-term debt-to-asset ratios of firms that pledge IP over time. As illustrated in Figure IA4 (Appendix B), the respective debt ratios increase, on average, by 2.15 percentage points (40%) from 5.41 to 7.56% (t-value: 2.94) in the year of the collateral event relative to the year before. Again, there is no statistically significant change in debt ratios for non-pledging firms.

Econometric specification: The matching approach provides us with a well-suited setting to conduct a difference-in-difference (DID) analysis with two-way fixed effects. For each

matched pair, the year prior to the initial IP collateralization is our reference point to split time between a pre- and a post-pledge period. We use a symmetrical time window of six years around the IP pledge without binning observations at the borders of the sample; we cluster the standard errors at the firm level. Because our matching approach yields equally sized groups of firms that do or do not pledge IP, our estimation approach is unlikely to be prone to issues arising from two-way fixed effect DID estimations with staggered treatments (see Baker *et al.*, 2022). The baseline specification thus reads as:

$$Y_{ijst} = \phi X_{it} + \beta(IP_i \times Post_{it}) + \alpha_{js} + \alpha_i + \alpha_t + u_{ijst} \quad , \tag{2}$$

where Y_{ijst} is the value of the outcome variable for firm i operating in industry j in calendar year s, relative to the initial IP collateralization (in $t = 0$). In the main specifications, Y_{ijst} equals the long-term debt-to-asset ratio ($LongTermDebt$). X_{it} is a vector of firm-level control variables containing size, profitability, tangibility, liquidity, and cash flow. IP_i is a dummy variable that is equal to one for firms that use their IP as loan collateral and zero otherwise. $Post_{it}$ is a dummy variable equal to one for pairs in all years after the first use of IP collateral, both for pledging firms and the matched comparison group. α_{js} denotes the industry-calendar year fixed effects that account for aggregate economic fluctuations at the industry level, α_i are firm fixed effects that control for time-invariant firm-specific features, and α_t are (stacked) panel-year fixed effects that capture the unobserved factors associated with the relative timing to the initial loan event.[18] Combined with the matched sample, these multi-level fixed effects control for loan demand (see Degryse *et al.*, 2019). u_{ijst} is the idiosyncratic error term. Table IA2 (Appendix) contains detailed variable descriptions.

The parameter of interest in Equation 2 is β that captures the change in $LongTermDebt$ after the first use of IP as collateral relative to firms in the matched group. A priori, it is not clear whether $\beta > 0$ or not. As such, in the case that firms roll over existing credit lines and add IP as collateral, the coefficient would be zero. If the use of collateral were to occur in the context of reorganization or liquidation processes (i.e., to serve as measure of last resort), the effect might be negative. Furthermore, our specification also allows us to assess heterogeneity in the effects across the firms that pledge IP.

[18] In the baseline specification, the components of the interaction term drop due to perfect multicollinearity arising from the addition of the fixed effects.

5.2 IP collateralization and firms' use of debt

Table 5 presents the estimates of different variants of Equation 2. In Column I, we estimate a DID regression without fixed effects. The coefficient associated with IP is statistically not significant, suggesting that there is no differences in debt ratios prior to the IP pledge between firms that pledge IP and those that do not. The insignificant coefficient associated with $Post$ indicates that the debt ratios of the matched firms do not change after the loan event of the IP-pledging firm. The coefficient for $Post \times IP$ is positive and statistically significant at the one-percent level, indicating that the long-term debt ratios of pledging firms increase after the initial IP pledge compared to non-pledging firms. In line with this finding, estimates on the baseline specification in Column II show an economically significant increase in the debt ratios for the average pledging firm relative to the matched group after the first use of IP collateral. The point estimate of 0.033 is significant at the one-percent level, suggesting a rise in debt ratios of about 61%.[19]

We repeat the baseline regression on different subsamples. In Column III, the subsample is all firms without any long-term debt outstanding at the end of the year prior to an IP pledge. The coefficient of interest remains highly significant, suggesting that IP pledges help firms to raise new debt financing. In Column IV, we exclude years during which France faced economic recessions, i.e., 2003, 2008 and 2009. The coefficient of interest is similar to the main specification, supporting the idea that IP loans do not only provide benefits under certain economic (and thus lending) conditions. Furthermore, we distinguish between trademark pledges (Column V) and patent pledges (Column VI). Both coefficients are large, positive, and highly significant. The coefficient for the group that pledge patents is larger (0.044) than that of the group that pledges trademarks (0.030). In Column VII, we test the significance of this difference and repeat the baseline estimation (Column II) by adding an interaction term to capture the additional effect of patent pledges (relative to trademark pledges), $IP^{\text{pat.}} \times Post$. The associated coefficient is positive but insignificant, illustrating that the effects of IP pledges are similar across IP types.

Next, we disentangle the timing of the baseline effect by using an event-study design. We decompose the pledge-indicator $Post_{it}$ into $Post^S_{it}$ and Pre^S_{it}, respectively, that is equal

[19] The magnitude of the effects is calculated dividing the β-coefficient (0.033) by the average pre-pledge debt ratio of firms that pledge IP (0.054). The effect is comparable to previous studies on patenting and debt financing (e.g., Gill and Heller, 2022).

Table 5: High dimensional fixed effect regressions explaining firms' debt ratios

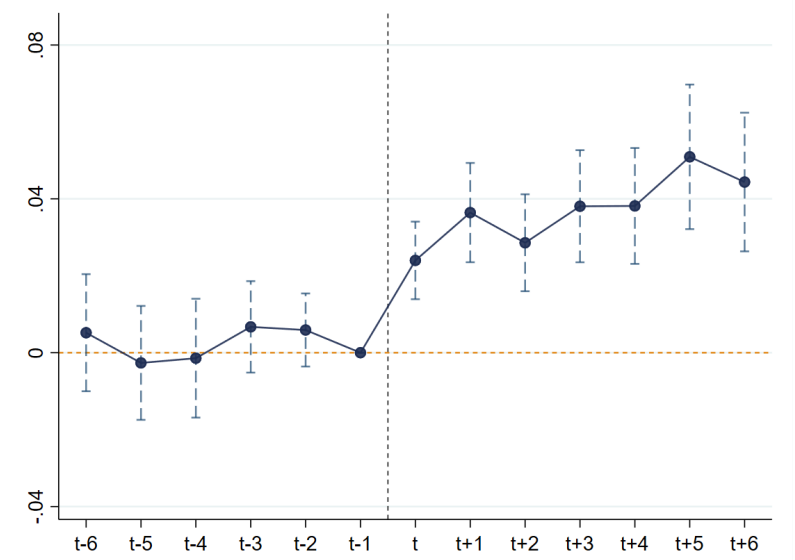
Dep. variable	*LongTermDebt*						
	I	II	III	IV	V	VI	VII
IP × Post	0.027*** (0.006)	0.033*** (0.006)	0.023*** (0.006)	0.034*** (0.006)	0.030*** (0.006)	0.044*** (0.013)	0.029*** (0.006)
Post	-0.001 (0.004)						
IP	0.006 (0.005)						
$IP^{pat.}$ × Post							0.018 (0.015)
Constant	-0.008 (0.023)	-0.048 (0.057)	0.025 (0.056)	-0.050 (0.058)	-0.072 (0.056)	0.156 (0.140)	-0.047 (0.057)
Sample:	Full	Full	Zero loans pre-pledge	Excl. crises years	Trademark pledgee	Patent pledgee	Full
Additional controls:							
Firm-level	yes	yes	yes	yes	yes	yes	yes
Industry FE	yes	no	no	no	no	no	no
Industry-Year FE	no	yes	yes	yes	yes	yes	yes
Timing FE	no	yes	yes	yes	yes	yes	yes
Firm FE	no	yes	yes	yes	yes	yes	yes
R^2	0.064	0.479	0.351	0.492	0.485	0.511	0.480
N	10,856	10,856	6,317	9,077	9,947	2,187	10,856

Notes: The table displays the estimates from fixed effect regressions that are similar to those in Equation 2; all variables are specified accordingly. The dependent variable is firms' long-term debt-to-asset ratio ($LongTermDebt$). The sample is truncated to a symmetric time window of six years around the initial pledge of IP-pledging firms and the corresponding years for the comparison group. Column I shows the estimates of Equation 2 but omits any fixed effects. Hence, the base variables of the interaction term ($Post \times IP$) are not omitted in this specification. Columns II-VI comprise multi-leveled fixed effects in accordance with Equation 2. Column II uses the full matched sample; Column III uses only those firms which had zero loans outstanding in the year prior to the initial collateralization; Column IV excludes the years of recession, i.e., those with declining GDP growth and a growth rate of less than 1% (2003, 2008, 2009). The next two columns distinguish between the collateralization of trademarks (Column V) or patents (Column VI), respectively. Note that these two categories are not mutually exclusive. Column VII is similar to Column II but adds an interaction term $IP^{pat.} \times Post$ that captures any additional effects of patent pledge ($IP^{pat.}$) on $LongTermDebt$. Standard errors (in parentheses below coefficients) are clustered at the firm level. $^{*}(p < 0.10)$, $^{**}(p < 0.05)$, $^{***}(p < 0.01)$.

to one for all observations in S years after ($Post$, $S \in [0, 6]$) and before (Pre, $S \in [-6, -2]$) the initial use of IP collateral, such that $t = -1$ is the reference year. We interact these dummy variables with the indicator IP_i. Figure 4 displays the regression specification (in the notes) and plots the associated coefficients. It confirms the positive shift in the use of long-term debt by firms in the year of the pledge that persists over time. The insignificant small coefficients for the pre-pledge period suggest that pledging and matched non-pledging firms move in parallel trends prior to the initial use of IP collateral.

Multiple tests confirm the robustness of our previous results to different model specifications. In Table IA5 (Appendix A), we omit the last step of the matching procedure (in which

Figure 4: Event-study regression: baseline effect of IP pledges on debt ratios



Notes: The graph plots the dynamic treatment effects using event-study regressions that explain the effect of the use of IP collateral on debt financing by firms relative to a matched group that does not pledge IP and over time. The graph shows β-coefficients from the following estimation equation: $LongTermDebt_{ijst} = \varphi X_{it} + \sum_{S=-6}^{-2} \beta_1^S (IP_i \times Pre_{it}^S) + \sum_{S=0}^{6} \beta_2^S (IP_i \times Post_{it}^S) + \gamma_{js} + \gamma_i + \gamma_t + \varepsilon_{ijst}$, where all variables are defined as in the baseline regression from Equation 2. The year before the initial pledge ($t = -1$) serves as the reference year. Standard errors are clustered at the firm level. $^{*}(p < 0.10)$, $^{**}(p < 0.05)$, $^{***}(p < 0.01)$.

we condition the matched group to only consist of the closest neighbor of the pledging firm). The results are not sensitive to the exact specification of the matching approach. Panel A of Figure IA5 (Appendix B) shows that using the alternative matching criteria also does not affect the results from the event-study regression. Further, Panel B illustrates that separating patent and trademark pledges yields comparable effects for the two IP types. Overall, our analyses show the positive effect of IP pledges on firms' use of debt. To the best of our knowledge, this finding provides the first evidence of such effects using different IP types as loan collateral.

5.3 The role of alternative collateral in IP loan contracts

The data on IP collateral data do not allow us to disentangle whether the firms that pledge IP use other assets as collateral at the same time. This is a common feature in studies on IP-backed loans (see Hochberg *et al.*, 2018; Mann, 2018; Caviggioli *et al.*, 2020). In this subsection, we conduct a series of tests to investigate the role of alternative collateral.[20] This

[20]Several factors already mitigate concerns that other collateral confounds the main results. First, the baseline estimations control for asset tangibility, i.e., the availability of more conventional collateral (see Frank and Goyal, 2003; Benmelech and Bergman, 2009). Second, the firms that pledge IP in our sample are unlikely to own large amounts of alternative collateral – as illustrated by a mean tangibility ratio of 10.3% (see Table IA4, Appendix A). Third, our previous results show that the majority of those firms pledge distinct parts of their IP portfolio, suggesting that IP is a key part of the collateral mass.

is important because unobserved systematic use of other assets as collateral could potentially affect our main findings. If the use of alternative collateral correlates with IP pledges, we could attribute the full effect on firms' use of debt to IP collateral, when it may actually come from the use of other unobserved collateral. Such an omitted variable issue, if it exists, would generate an upward bias in our estimated coefficients.

High and low tangibility: Table 6 presents the effect of alternative collateral by comparing firms with high and low tangibility. The rationale is that the opportunity for alternative collateral is higher when a firm has more tangible assets. In Columns I to IV, we estimate Equation 2 for different subsamples of firms depending on their level of tangible assets ($Tangibility$) in the year prior to the initial use of IP as collateral; we select firms in the bottom half, bottom tercile, bottom decile, and top half of the tangibility distribution, respectively. The coefficient associated with the effect of IP pledges on debt is similar both in magnitude and significance across specifications, indicating that the level of tangible assets does not influence the effect associated with the use of IP collateral. This suggests that unobserved use of alternative collateral does not drive our previous results.

For robustness, we repeat the baseline specification for the full sample but add a triple interaction term $IP \times Post \times Tan^{\text{high}}$. In Column V, Tan^{high} is equal to one if the firm has above median levels of tangible assets, while in Column VI it is a continuous variable of asset tangibility. In both regressions, the coefficient associated with the triple interaction term is small and insignificant. It indicates that there is no additional effect of IP pledges on the debt ratios of firms that own many tangible assets, and confirms that the level of alternative collateral is unlikely to drive our previous findings.

Quasi-natural experiment – Legal change in the pledgeability of tangible assets: Next, we exploit the exogenous variation in the collateral value of tangible assets that arose from the implementation of the *Ordonnance 2006-346* (hereafter the Ordonnance) in France in 2006. This major legislative change significantly enlarged the number assets that firms could pledge in loan agreements; in particular, it enabled the use of hard movable assets such as machinery and equipment. Aretz *et al.* (2020) show that this amendment provided firms with new opportunities to pledge tangible fixed assets as collateral in loan agreements.

The Ordonnance provides an ideal testing ground, as it allows to causally disentangle the importance of alternative forms of collateral in IP-backed loans. In fact, any unobservable use

Table 6: The role of alternative collateral available at the time of IP collateralization

Dep. variable	$LongTermDebt$					
	I	II	III	IV	V	VI
IP × Post	0.033***	0.024**	0.036*	0.031***	0.034***	0.030***
	(0.008)	(0.010)	(0.020)	(0.008)	(0.008)	(0.008)
Post × Tan^{high}					0.003	0.029
					(0.007)	(0.029)
IP × Post × Tan^{high}					-0.002	0.021
					(0.011)	(0.047)
Constant	-0.077	-0.093	-0.095	-0.001	-0.049	-0.051
	(0.063	(0.085)	(0.098)	(0.106)	(0.057)	(0.057)
Sample: Tangibility	$< P50$	$< P33$	$< P10$	$> P50$	all	all
Tan^{high} definition:	-	-	-	-	binary	continuous
Additional controls:						
Firm-level	yes	yes	yes	yes	yes	yes
Industry-Year FE	yes	yes	yes	yes	yes	yes
Timing FE	yes	yes	yes	yes	yes	yes
Firm FE	yes	yes	yes	yes	yes	yes
R^2	0.491	0.520	0.534	0.491	0.480	0.480
N	5,294	3,377	893	5,551	10,856	10,856

Notes: The table displays estimates from fixed effect-regressions explaining firms' use of debt. The specifications estimate Equation 2. Columns I-IV use the subsample of firms with a tangible fixed-assets-to-total asset ratio in the bottom half, bottom tercile, bottom decile, and top half respectively. Column V is run on the full sample but adds two variables: i) a triple interaction term $IP \times Post \times Tan^{\text{high}}$ in which Tan^{high} is equal to one if a firm has above median levels of i assets and zero otherwise and ii) the base value of $Post \times Tan^{\text{high}}$. The level variables are dropped because of perfect multicollinearity due to the inclusion of the fixed effects. Column VI repeats Column V but here Tan^{high} is a time-invariant, continuous measure, of firms' fixed asset ratio. In all specifications, asset ratios are measured in the year prior to the use of collateral. All regressions include controls equivalent to those specified before; for consistency, only the first four columns do not additionally control for asset tangibility. Standard errors (in parentheses below coefficients) are clustered at the firm level. $^{*}(p < 0.10)$, $^{**}(p < 0.05)$, $^{***}(p < 0.01)$.

of tangible assets as alternative collateral would become more salient after the adoption of the Ordonnance, i.e., an omitted variable bias would be stronger from 2006 onward. Moreover, the bias would be higher for firms with more opportunities to pledge tangible assets, i.e. firms rich in tangible assets.

We explore the sensitivity of our baseline specification with respect to the Ordonnance. Our analysis is based on the same data source for firm-level financials (Orbis) as Aretz *et al.* (2020). We therefore follow their approach and use the time frame from 2001 to 2009. Further, we adopt their classification procedure and distinguish among firms with a tangible fixed assets-to-total assets ratio in the top quartile of the pre-pledge distribution and those below ("treated" high-tangible versus "control" low-tangible firms). We estimate variants of

the following fixed effect regression specification:

$$\begin{aligned} LongTermDebt_{ijst} &= \alpha_{js} + \alpha_i + \alpha_t + \phi X_{it} + \gamma(Post_{it} \times Ordonnance_i^{Post}) \\ &+ \delta(IP_i \times Post_{it}) \\ &+ \delta'(IP_i \times Post_{it} \times Ordonnance_i^{Post}) + \varepsilon_{ijst} \quad , \end{aligned} \tag{3}$$

which is a variation of Equation 2 but adds the interaction of the DID-estimator with a post-Ordonnance indicator ($IP_i \times Post_{it} \times Ordonnance_i^{Post}$) and the interaction term of the base variables ($Post_{it} \times Ordonnance_i^{Post}$). $Ordonnance_i^{Post}$ is a dummy equal to one for firms (and their matched partner) whose first use of IP collateral was after the adoption of the Ordonnance (i.e. from 2006 onward) and zero otherwise. γ captures the general effect of the Ordonnance on firms' long-term debt ratios in the post-pledge period. The remaining base variables are captured by the addition of fixed effects.

The two coefficients of interest are δ and δ'. They capture the baseline effect of the use IP collateral on the long-term debt ratio of IP-pledging firms (δ) and the additional effect of these IP pledges after the adoption of the Ordonnance in 2006 (δ'). We estimate this specification for the full sample and separately for firms with high and low shares of tangible assets, i.e., the treated and control group firms as defined in Aretz *et al.* (2020).

Table 7 presents the main results. In Column I, we reestimate the baseline regression from Equation 2 on the 2001-2009 subsample. The DID estimator (0.038) is significant, positive, and comparable in magnitude to our baseline estimation (0.033, see Column II in Table 5). Column II presents the results of estimating Equation 3. The coefficient associated with the triple interaction, δ', is not statistically significant. This lack of significance indicates that the effect of IP pledges on debt ratios is not different before and after the Ordonnance and therefore mitigates the concern that unobserved use of tangible assets as collateral might bias our results.

Columns III to V present the results on the differential effects of the Ordonnance in more detail. The regression presented in Column III uses the subsample of firms outside the top quartile of the tangible asset distribution, i.e. low-tangible firms, and corroborates our earlier results. The regression displayed in Column IV focuses on high-tangible firms (i.e. firms "treated" by the Ordonnance as defined by Aretz *et al.*, 2020). The coefficient for the interaction term $Post_{it} \times Ordonnance_i^{post}$ is positive and significant at the 10 percent

Table 7: IP collateralization with increased alternative collateral available

Dep. variable	*LongTermDebt*				
	I	II	III	IV	V
IP × Post	0.038***	0.030***	0.035***	0.029*	0.031***
	(0.008)	(0.010)	(0.011)	(0.016)	(0.012)
IP × Post × Ordonnance$^{\text{Post}}$		0.023	0.026	-0.003	0.029
		(0.018)	(0.021)	(0.032)	(0.021)
Post × Ordonnance$^{\text{Post}}$		0.012	0.010	0.040*	0.002
		(0.015)	(0.018)	(0.023)	(0.018)
Post × Tan$^{\text{high}}$					-0.008
					(0.012)
IP × Post × Tan$^{\text{high}}$					-0.003
					(0.021)
Post × Ordonnance$^{\text{Post}}$ × Tan$^{\text{high}}$					0.045**
					(0.020)
IP × Post × Ordonnance$^{\text{Post}}$ × Tan$^{\text{high}}$					-0.039
					(0.039)
Constant	-0.093	-0.093	-0.098	-0.043	-0.093
	(0.081)	(0.081)	(0.085)	(0.179)	(0.081)
Sample: Tangibility	Full	Full	<P75	>P75	Full
Additional controls:					
Firm-level	yes	yes	yes	yes	yes
Industry-Year FE	yes	yes	yes	yes	yes
Timing FE	yes	yes	yes	yes	yes
Firm FE	yes	yes	yes	yes	yes
R^2	0.431	0.432	0.444	0.483	0.433
N	5,288	5,288	3,766	1,512	5,288

Notes: The table displays estimates from fixed effect-regressions explaining firms' use of debt. The sample is all matched firms from the main part during the years from 2001 to 2009. Column I repeats the baseline specification (Equation 2 and Column II in Table 5) for this sample. Columns II-IV estimate Equation 3 for different subsamples. Column II uses the full sample; Column III uses firms with a fixed assets-to-total assets ratio in the bottom three quartiles in the year prior to the IP pledge. Column IV uses firms that with a fixed assets-to-total assets ratio in the top quartile in respective years. Column V repeats Column II but adds interactions with Tan$^{\text{high}}$ that is an indicator as defined in Aretz *et al.* (2020) and equal to one for all firms with a fixed assets-to-total assets ratio in the top quartile and zero otherwise. All regressions include controls equivalent to those specified before. Standard errors (in parentheses below coefficients) are clustered at the firm level. $^{*}(p < 0.10)$, $^{**}(p < 0.05)$, $^{***}(p < 0.01)$.

level. This result shows that the Ordonnance is associated with an increase in post-pledge, long-term debt ratios both for tangible-rich IP-pledging and non-pledging firms. This is consistent with Aretz *et al.* (2020) who show that the Ordonnance affected firms with a large stock of fixed assets. The insignificant coefficient of the triple interaction term indicates that there is no differential effect of IP-pledges after the Ordonnance for high-tangible firms, which further undermines potential concerns of alternative unobserved collateral.

For robustness, the regression presented in Column V follows the same approach as the

ones presented in Columns III and IV. It uses the full sample and interacts all terms with an indicator ($> P75$), equal to one for high-tangible firms. The results support the ones presented in Columns III and IV, and emphasize that alternative collateral is unlikely to drive our main results.

5.4 Treatment heterogeneity and real effects of IP-backed loans

Next, we explore the heterogeneous effect of IP pledges with respect to firm characteristics. Our objective is to investigate whether some types of firms in particular benefit from IP-backed loans and what are the implications thereof.

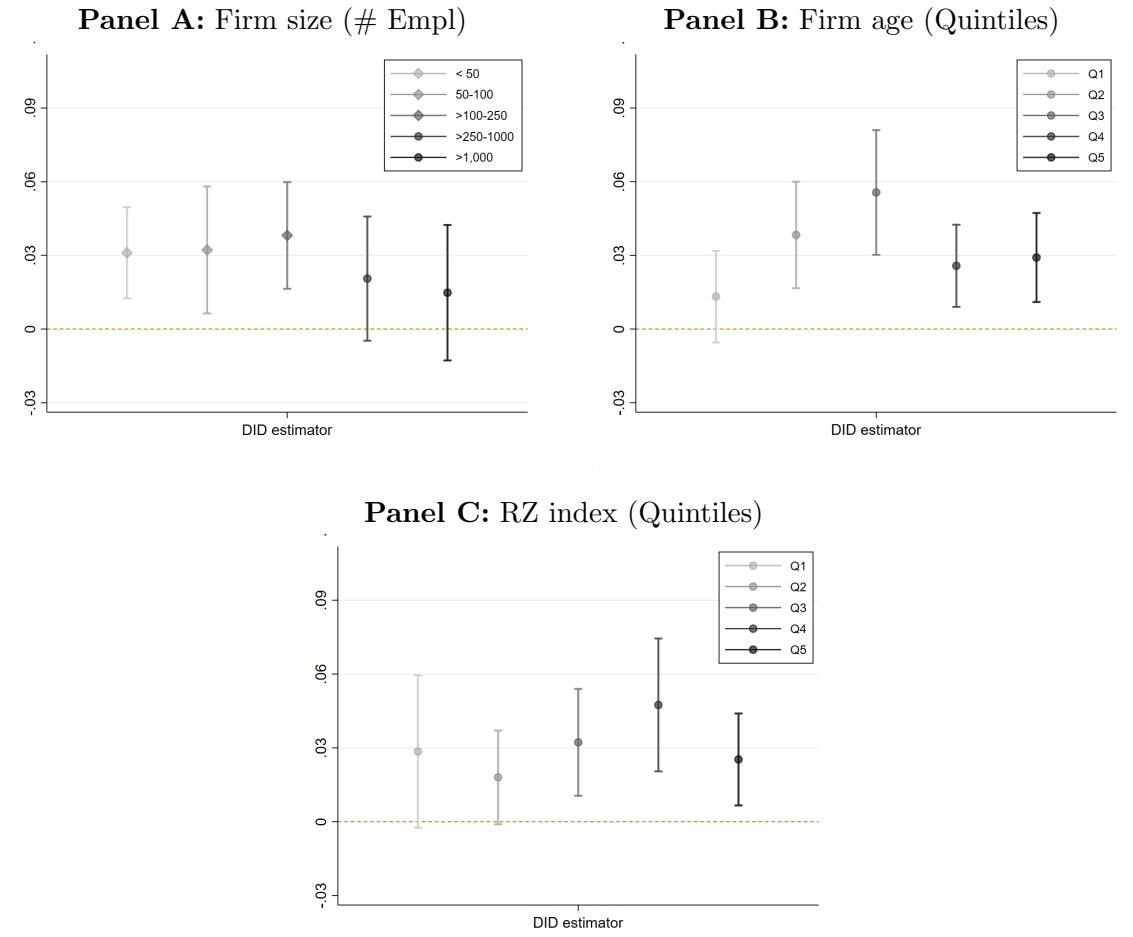
5.4.1 Heterogeneous effect of IP collateralization

Panel A of Figure 5 plots the coefficients of the DID estimator obtained from splitting the sample regressions into five different firm size categories. Specifically, we delineate groups in terms of the number of employees at the end of the year prior to the initial IP pledge. The five bins are <50, 50-100, 101-250, 251-1,000, and >1000 employees. All DID coefficients are positive for the respective subgroups. However, in terms of size and significance, only the coefficients for SMEs (firms with less than 250 employees) are similar to the baseline estimate. For larger firms, the DID estimators are smaller and insignificant. These findings are consistent with the idea that debt financing is most relevant for SMEs, which are also more dependent on monetizing their IP rights as compared to larger firms (Freixas and Rochet, 2008; De Rassenfosse, 2012).[21] Furthermore, the results highlight the potential of IP to help SMEs raise debt.

Panel B of Figure 5 illustrates the differential effects along the firm age distribution after splitting it into quintiles. The estimates display an inverted U-shape: The effects are largest for firms in the second and third quintile, that correspond to ages from 12 to 28 years. By contrast, for firms in both the bottom quintile and the top two quintiles of the age distribution, the DID estimators are positive but insignificant – or small and only weakly significant. These findings may indicate that firms might need an already established track-record that helps approximate the returns associated with IP to effectively use them as collateral. They also suggest that older firms may already have access to other non-bank

[21] Moreover, the results are in line with the previously discussed anecdotal evidence which showed that large corporates typically have other ways to obtained external financing and instead pledge IP when facing economic hardship, as illustrated by the case of Alcatel-Lucent (see, e.g., Reuters, 2012).

Figure 5: Differential effects of IP pledges across firm-types



Notes: The figures plot the DID estimators of the baseline regressions estimated for different subsamples. Subsamples are created based on three firm-level categories: size (measured as the number of employees), age (splitting the age distribution into quintiles), and dependence on external financing (splitting the RZ index distribution into quintiles); all of which are measured in the year prior to the initial IP collateralization. The RZ index is defined in Rajan and Zingales (1998) and measures the wedge between total capital expenditures and total net cash flow in the year before its first use of IP collateral (or of its matched firm). All variables are defined in Table IA2. In all panels, the whiskers span the 90 percent confidence intervals.

sources of financing and hence rely less on IP to raise debt.

The results from Panels A and B of Figure 5 imply that more financially constrained firms benefit disproportionally from IP-backed loans, since the size and age of firms are important determinants of financing constraints (e.g. Hadlock and Pierce, 2010). In Panel C, we explore a related characteristic, that is the heterogeneity in the firms' ex-ante dependence on external financing. To do so, we use the RZ index that reflects the capital expenses to the cash flows within a year, as proposed by Rajan and Zingales (1998). Higher values indicate that capital expenses exceed generated cash flows, i.e., a higher dependence on external financing. We split the sample into quintiles along the RZ index distribution of firms measured in the year prior to the initial IP pledge. While all coefficients for the DID estimators are positive, they

are only statistically significant (at the one-percent level) for samples with high ex-ante RZ index values, i.e., the top three quintiles. It suggests that IP collateralization particularly raises debt ratios of firms most dependent on external financing.

Moreover, our main results depend on firm-specific characteristics but do not vary across industries of geographically regions. To show this, we distinguish between firms active in different high-tech and knowledge-intensive industries as well as firms located in different urban or rural areas across France. The results are displayed in Panels A and B of Figure IA6 (Appendix B). The fairly homogeneous results along these dimensions support the notion of the broad applicability of using IP as loan collateral.

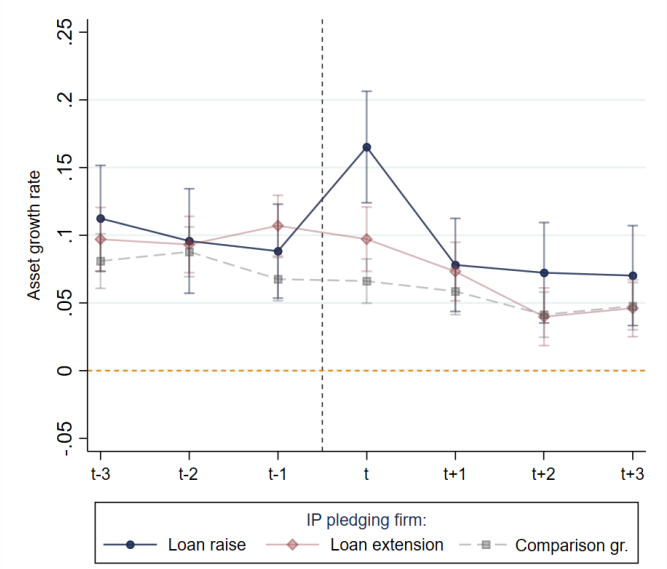
5.4.2 Real economic implications for firms that pledge IP

We show that the increased use of debt associated with the use of IP collateral has real economic implications. To this end, we first assess firms' year-to-year asset growth rates and distinguish between IP-pledging firms that raise their debt ratios after the pledge or do not.[22] Figure 6 plots the average values of asset growth rates for these two categories of firms and for the matched group of firms that do not pledge IP, in a symmetrical time window around the initial IP pledge. It shows that the subgroup of those firms which pledge IP and raise their debt financing have significantly higher growth rates in the year of their use of IP collateral. This pattern is not observable for both the subgroup of firms that pledge IP and renew loans, and for non-pledging firms. This result provides suggestive evidence that IP collateral used for raising new loans supports firm-level growth.

To assess this relationship in more detail, we reestimate regression similar to the baseline specification but that use different firm-level growth measures as alternative dependent variables. As in Figure 6, we divide firms that pledge IP into those raising additional debt and those renewing loans. Table 8 displays the DID estimators for the respective subsamples where the dependent variable is either the log of total assets (Columns I and II), of total sales (Columns III and IV), or of the number of employees (Columns V and VI). The results show large positive and statistically significant growth effects from the use of IP collateral

[22] Specifically, we flag firms that fulfill one of the two criteria: 1) they increase long-term debt holdings from zero to a positive number of debt exceeding 2% of assets that corresponds to the mean increase in debt (see Section 5.1), or 2) they hold long-term debt prior to the IP collateralization and increase their debt holdings by at least a factor of 0.2 or more. For robustness we check several combinations of these thresholds, which does not significantly affect the main conclusions in this section. Firms that pledge IP but do not increase their debt ratios are considered to roll over or renew existing loans.

Figure 6: Asset growth rates relative to the pledge



Notes: This figure plots average values of firm-level year-to-year asset growth rates, *AssetGrowth* as defined in Table IA2 (Appendix A). It distinguishes firms that pledged IP collateral and increased their debt ratios ("loan raise") as well as those that did not increase their debt ratios ("loan renewal") and the matched control group of non-IP pledging firms ("comparison group"). Whiskers span the 95 percent confidence intervals.

Table 8: DID estimates relating IP pledges to firms' trajectories

Dep. variable	Log (assets)		Log (sales)		Log (employees)	
	I	II	III	IV	V	VI
IP × Post	0.231**	0.085*	0.435**	0.136	0.231**	0.019
	(0.084)	(0.051)	(0.204)	(0.145)	(0.110)	(0.145)
IP collateral raising/renewing debt:	Raising	Renewing	Raising	Renewing	Raising	Renewing
Additional controls:						
Firm-level	yes	yes	yes	yes	yes	yes
Industry-Year FE	yes	no	yes	no	yes	no
Timing FE	yes	yes	yes	yes	yes	yes
Firm FE	yes	yes	yes	yes	yes	yes
R^2	0.941	0.947	0.752	0.751	0.890	0.922
N	3,096	7,728	3,096	7,728	2,120	5,661

Notes: The table displays the estimates of Equation 2 using a set of dependent variables related to firm-level growth, namely total assets (Columns I and II), total sales (Columns III-IV), and the number of employees (Columns V-VI) measured using the natural logarithm. Further regressions are estimated for firms that pledge IP and significantly raise their debt financing after the initial use of IP collateral (Columns I, III, and V) and those that do not extend their debt financing (Columns II, IV, and VI). Standard errors (in parentheses below coefficients) are clustered at the firm level. $^{*}(p < 0.10)$, $^{**}(p < 0.05)$, $^{***}(p < 0.01)$.

on all growth indicators for the firms that pledge IP. The effects are particularly strong and significant for firms raising debt and smaller for firms renewing loans. The effects are also economically meaningful; the growth rate of firms that pledge IP and raise new loans ranges between 23 and 44% higher relative to the matched group that do not pledge IP. These

findings show that firms enhancing debt financing via IP-backed loans are associated with a significantly high asset-growth rate in the year of the pledge that then translates into larger growth in terms of assets, size, and employment.

6 Conclusion

Firm value has been shifting towards intangible capital, making the financing of intangible-rich firms increasingly crucial. The surge in intangible capital that unfolded in the second half of the 20^{th} century has caused a secular decline in commercial bank lending and pushes bank dependent borrowers, such as SMEs, to build up cash buffers (Dell'Ariccia *et al.*, 2021; Falato *et al.*, 2022). This study demonstrates the significant economic value of intangible collateral to its owners. As such, using IP to secure debt financing widens the available menu of financing opportunities for intangible-rich firms. Our study extends prior knowledge about the most fundamental aspects for participants in this market and has implications for academics and policy makers alike. Specifically, we disclose several novel facts about IP collateralization, its determinants, and its effect on firms' trajectories.

We show that the vast majority of IP-backed loans in France from 1995 to 2018 exclusively used trademarks; an asset that has been mostly overlooked by previous work on IP collateral. Well-established SMEs, also understudied by previous literature, are the most common type of firm using IP as collateral. Moreover, we find that rather than using their full IP portfolio as collateral, firms pledge specific assets with high value and characteristics that facilitate valuation, both of which enhance asset redeployability and liquidation value.

At the firm-level, we show that IP pledges significantly increase firms' debt ratios. This result holds for firms across all sectors and geographical regions in France. It is driven by small, middle-aged firms, with a high dependence on external financing. We provide robust evidence that the positive effects of pledging IP on firms' debt capacity is unlikely to be attributable to alternative collateral. Finally, we find that using IP as loan collateral translates into economically meaningful increases in growth rates for firms that use IP loans to enhance their use of debt. Taken together, our results shed light on previously undisclosed dimensions of debt financing. They emphasize the large economic potential of IP pledges, especially for small, financially constrained, intangible-rich firms.

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Internet Appendix A : Tables

Table IA1 : Definition of IP rights: Trademarks, patents, and designs

IP right	**Trademark**	**Patent**	**Design**
Subject matter	Disinct signs that distinguish firms (i.e., brands, words, drawings, and/or symbols)	Technical invention	Aesthetic creative forms and non-functional product features
Conferred rights	Exclusive right to use the trademark and prevent use for similar goods/services	Exclusive right to make, use, and sell the patented invention	Exclusive right to use the design
Requirement	Distinctiveness, use in commerce	Novelty, material, non-obviousness, industrial application	Similar to patents (lower threshold)
Protection length	10 years	1 year	1 year
Max. protection	indefinite	20 years	25 years
Maintenance/ activation costs	low	high	high
Benefits	Promotes quality and competition; information provider	Incentive to innovate; Knowledge protection and diffusion	Provides means for product differentiation

Notes: The table defines the three most common IP right types: trademarks, patents, and designs. For comparison, uniformly applicable definition criteria are displayed, such as the object which is subject to protection, the basic requirements that need to be fulfilled to obtain the right, the actual procedural steps needed for activation, the protection length without renewals after grant, the maximum protection length, and a qualitative assessment of the average costs to activate and maintain the IP right. These definitions comprise IP rights filed and registered in Europe, i.e., at the EPO, EUIPO, or national IP offices. Most features also apply in other main IP jurisdictions, such as the US, Japan, or Korea.

Table IA2: List of variables

IP-level variables:	
I(Collateral)	Dummy = 1, if IP is pledged as loan collateral
Patent-specific variables:	
#FwdCits	Number of forward citations received by a patent
FamilySize	Number of jurisdictions a patent is active in
#Applicants	Number of applicants in the patent filing (i.e., patent owners)
#Inventors	Number of different inventors in the patent application
#BwdCits_pat	Number of backward citations made to patent literature
#BwdCits_nopat	Number of backward citations made to non-patent literature
#IPC4Classes	Count of different main patent IPC technology classes (4-digit level)
PatentAge	Count of patent renewals (due every year); years the patent has been active
Granted	Dummy = 1, if patent is (already) granted
Trademark-specific variables:	
Renewal	Count of trademark renewals (due every 10 years)
# NiceClasses	Trademark-breadth; Count of different registered trademark classes
Transferred	Dummy = 1, if trademark is transferred prior to its first use as collateral
IndicationUse	Dummy = 1, if there are any notes in the trademark file listed as legal change prior to its first use as collateral
ServiceMark	Dummy = 1, if mark is registered in any of the services classes (NICE 35-45)
FigurativeMark	Dummy = 1, if trademark includes a figurative element
CorporateMark	Dummy = 1, if trademark represents the company name
Firm-level variables:	
Main regressors:	
IP	Dummy = 1 if firm pledges an IP right at any point in time and zero for matched comparison group firms
Post	Dummy = 1 for any firm-specific year t after the first use of IP collateral (within matched strata) and zero otherwise
$Post^S$	Dummy = 1 for any firm-specific year S ($\in$ [1,6]) after the first use of IP collateral (within matched strata) and zero otherwise
Pre^S	Dummy = 1 for any firm-specific year S ($\in$ [-6,-1]) before the first use of IP collateral (within matched strata) and zero otherwise
$IP^{pat.}$	Dummy = 1 if firm pledges a patent at any point in time and zero for matched comparison group firms
$Ordonnance^{Post}$	Dummy = 1 for firms (and their matched partner) whose first IP pledge is in 2006 or later and zero otherwise

(*Continued on next page*)

Table IA2: List of variables (*continued*)

Other firm-level variables (Orbis `code`):	
SME	Dummy = 1 for firms with less than 250 employees (`empl`), and a maximum turnover (`turn`) of 50 million Euro or a maxiumum balance sheet total (`toas`) of 43 million Euro.
Private LLC	Dummy = 1 for with `Standardised_legal_form` equal to "Private limited companies" and zero otherwise.
Listed firm	Dummy = 1 for firms listed on the stock market (`Listed`="Listed") and zero otherwise.
FirmAge	Time (full years) since incorporation date (`Date_of_incorporation`) and the balance sheet reporting date (`Closing_date`)
TotalDebt	Total liabilities (`culi`+`ncli`) divided by total assets (`toas`)
LongTermDebt	Long-term debt (`ltdb`) divided by total assets (`toas`)
DebtIssuance	Year-to-year growth in long-term debt (`D.ltdb`/`L.ltdb`)
ShortTermDebt	Total short-term debt (`loan`+`cred`) divided by total assets (`toas`)
ShortDebtIssuance	Year-to-year short-term debt growth (*D.ShortTermDebt*/*L.ShortTermDebt*)
*FirmSize**	Logarithm of total assets (`toas`)
*Profitability**	Return on assets: earnings before interest and taxes (`ebit`) divided by total assets (`toas`)
*Tangibility**	Share of fixed tangible assets (`tfas`) over total assets (`toas`)
*CashFlow**	Total cash flow (`cf`) scaled by total assets (`toas`)
*CurrentRatio**	Liquidity risk: total current assets (`cuas`) over current liabilities (`culi`)
RZindex	The wedge between capital expenditures (`exp_mat`) and firms' cash flows (`cf`) measured as `exp_mat-cf`)/`cf`.
# Empl	Number of employees at end of period (`empl`)
AssetGrowth	Year-to-year growth in total assets (`D.toas`/`L.toas`)
Tan^{high}	Dummy = 1 for firms with high levels of *Tangibility*; with varying thresholds as defined in the text and indicated with P*threshold*.
Log (sales)	Logarithm of total sales (`sale`)
Log (employees)	Logarithm of the number of employees at end of period (`empl`)

Notes: The table lists and defines all variables used in this paper. * indicate firm-level controls that are included in all regressions (unless explicitly stated otherwise). Firm-level variables are obtained from ORBIS; IP-level data is obtained from INPI and PATSTAT. For firm-level variables, corresponding Orbis codes are stated in parentheses.

Table IA3: Descriptive statistics on the characteristics of IP rights

Panel A: Trademark characteristics

Variable	min.	max.	Mean		Difference
			Pledged	Not-pledged	
Renewal	0	3	1.268	0.802	0.466***
#NiceClasses	1	45	3.022	2.866	0.156***
Transferred	0	1	0.111	0.062	0.068***
IndicationUse	0	1	0.413	0.257	0.156***
ServiceMark	0	1	0.066	0.081	-0.015***
FigurativeMark	0	1	0.032	0.042	-0.010***
CorporateMark	0	1	0.013	0.003	0.010***

*$(p < 0.10)$, **$(p < 0.05)$, ***$(p < 0.01)$

	P5	P25	P50	P75	P95	Mean
Size of the TM portfolio	1	3	8	25	140	36.733
Share of pledged TMs	0.0189	0.1111	.3868	0.9211	1	0.4696

Panel B: Patent characteristics

Variable	min.	max.	Mean		Difference
			Pledged	Not-pledged	
PatentAge	0	20	6.491	5.168	1.323***
Granted	0	1	0.792	0.645	0.147***
FamilySize	1	59	5.687	5.004	0.683***
#FwdCits	0	237	8.809	9.938	-1.129***
#Inventors	0	10	1.999	2.535	-0.536***
#Applicants	1	5	1.021	1.067	-0.046***
#BwdCits_pat	0	18	4.217	3.852	0.365***
#BwdCits_nopat	0	30	0.375	0.808	-0.433***
#IPC4Classes	1	11	1.646	1.861	-0.215***

*$(p < 0.10)$, **$(p < 0.05)$, ***$(p < 0.01)$

	P5	P25	P50	P75	P95	Mean
Size of the patent portfolio	1	3	7	15	79	24.526
Share of pledged patents	0.0667	0.3334	0.6940	1	1	0.6350

Table IA4: Comparison of sample means for pleading and comparison group firms

	Mean			
	IP pledging firm	Matched counterparty	Differences in means	*t-values*
Firm size (log. assets)	16.476	16.359	0.118	(0.816)
Age	20.913	21.800	-0.887	(-0.784)
Debt-ratio	0.656	0.645	0.011	(0.449)
Tangibility	0.103	0.117	-0.014	(-1.386)
Profitability (RoA)	0.031	0.029	0.002	(0.151)
Current-ratio	1.938	2.061	-0.201	(-0.667)
Cash flow-ratio	0.050	0.057	-0.007	(-0.606)

Notes: This table displays statistics on observable key financial variables using the matched sample described in Section 5.1. It compares mean values, distinguishing IP-pledging firms with the firms from the matched group, and differences in means. The corresponding t-values are displayed in parentheses in the last column. $^{*}(p < 0.10)$, $^{**}(p < 0.05)$, $^{***}(p < 0.01)$.

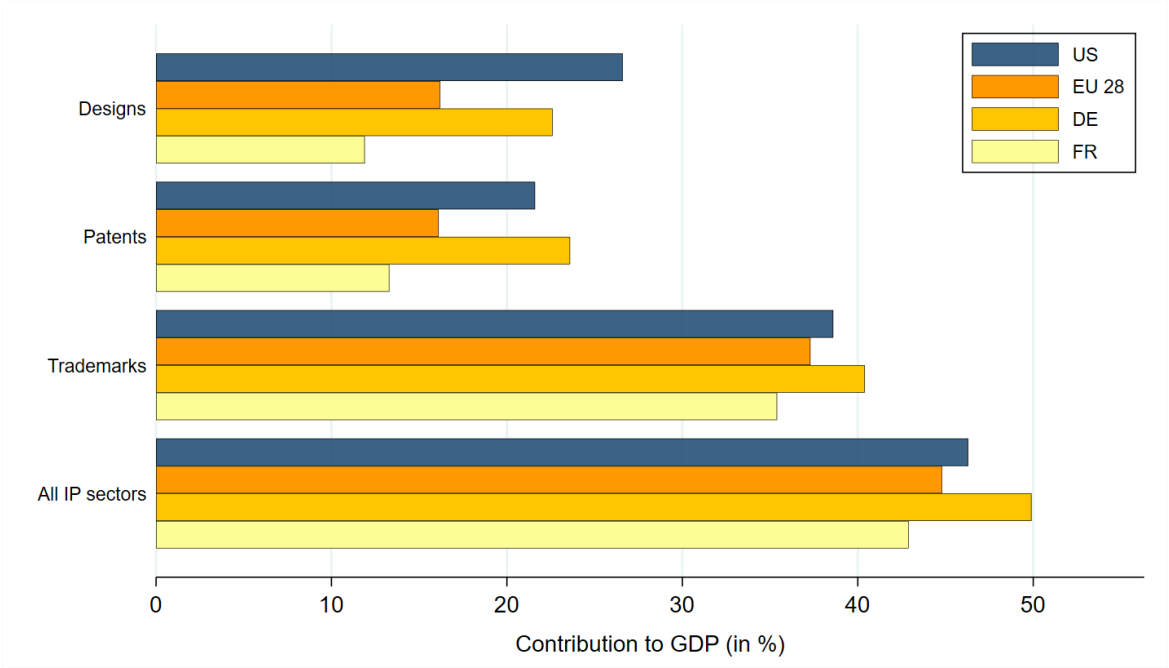
Table IA5: Baseline regression using alternative specification of the comparison group

Dep. variable	Long-term debt-ratio					
	I	II	III	IV	V	VI
IP × Post	0.029***	0.027***	0.017**	0.028***	0.027***	0.038***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.011)
Post	-0.002***					
	(0.001)					
IP	0.007*					
	(0.004)					
Constant	0.032***	-0.083***	-0.055***	-0.071***	-0.086***	0.055
	(0.004)	(0.014)	(0.015)	(0.015)	(0.014)	(0.050)
Sample:	Full	Full	Zero loans pre-pledge	Excl. crises years	Trademark pledgee	Patent pledgee
Additional controls:						
Firm-level	yes	yes	yes	yes	yes	yes
Industry FE	yes	no	no	no	no	no
Industry-Year FE	no	yes	yes	yes	yes	yes
Timing FE	no	yes	yes	yes	yes	yes
Firm FE	no	yes	yes	yes	yes	yes
R^2	0.048	0.486	0.283	0.505	0.489	0.427
N	277,933	277,933	166,004	236,128	266,793	21,065

Notes: The table displays high dimensional fixed effect regressions equivalent to Table 5, only here the matched group of non-pledging firms is specified differently. In the matching procedure, we omit the selection on the closest neighbors of the IP-pledging firms but instead keep all firms that satisfy the matching criteria defined in Section 5.1. Standard errors (in parentheses below coefficients) are clustered at the firm level. $^{*}(p < 0.10)$, $^{**}(p < 0.05)$, $^{***}(p < 0.01)$.

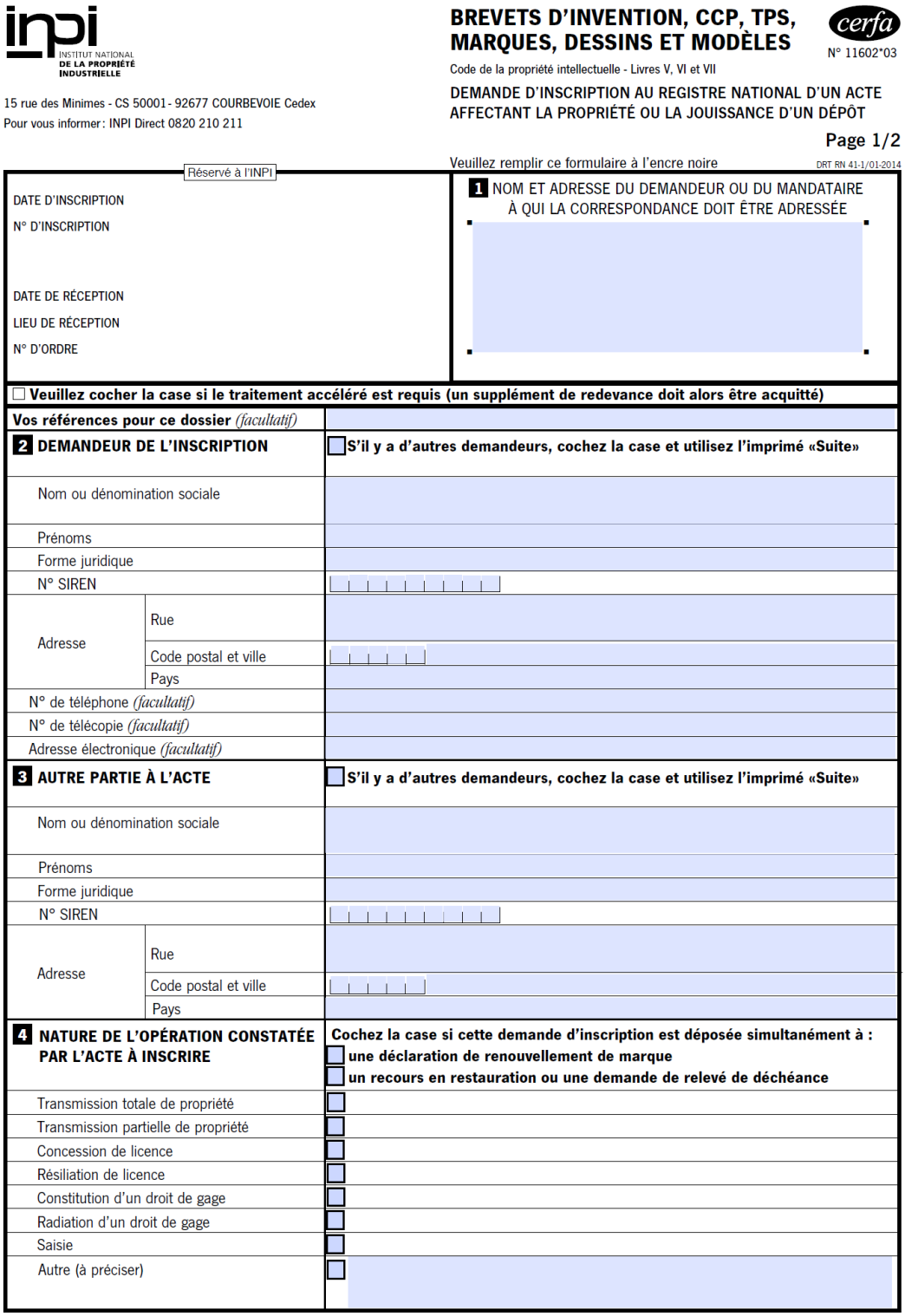
Internet Appendix B: Figures

Figure IA1: Contribution of IP-intensive sectors to GDP in selected economies



Notes: The graph shows the contribution of IP-intensive sectors (designs, patents, trademarks and overall) to the overall GDP in the US, the EU, Germany, and France in 2016. Industries are classified as IP-intensive, if the industry average of IP types per employee exceeds the overall average. We obtain information on the industry-classifications from USPTO (2016) and EPO-EUIPO (2022) for the US and European countries, respectively.

Figure IA2: Form sheet of IP-related legal changes at INPI



INPI
INSTITUT NATIONAL DE LA PROPRIÉTÉ INDUSTRIELLE

15 rue des Minimes - CS 50001 - 92677 COURBEVOIE Cedex
Pour vous informer : INPI Direct 0820 210 211

BREVETS D'INVENTION, CCP, TPS, MARQUES, DESSINS ET MODÈLES

cerfa N° 11602*03

Code de la propriété intellectuelle - Livres V, VI et VII

DEMANDE D'INSCRIPTION AU REGISTRE NATIONAL D'UN ACTE AFFECTANT LA PROPRIÉTÉ OU LA JOUISSANCE D'UN DÉPÔT

Page 1/2

Veuillez remplir ce formulaire à l'encre noire

DRT RN 41-1/01-2014

Réservé à l'INPI

DATE D'INSCRIPTION
N° D'INSCRIPTION

DATE DE RÉCEPTION
LIEU DE RÉCEPTION
N° D'ORDRE

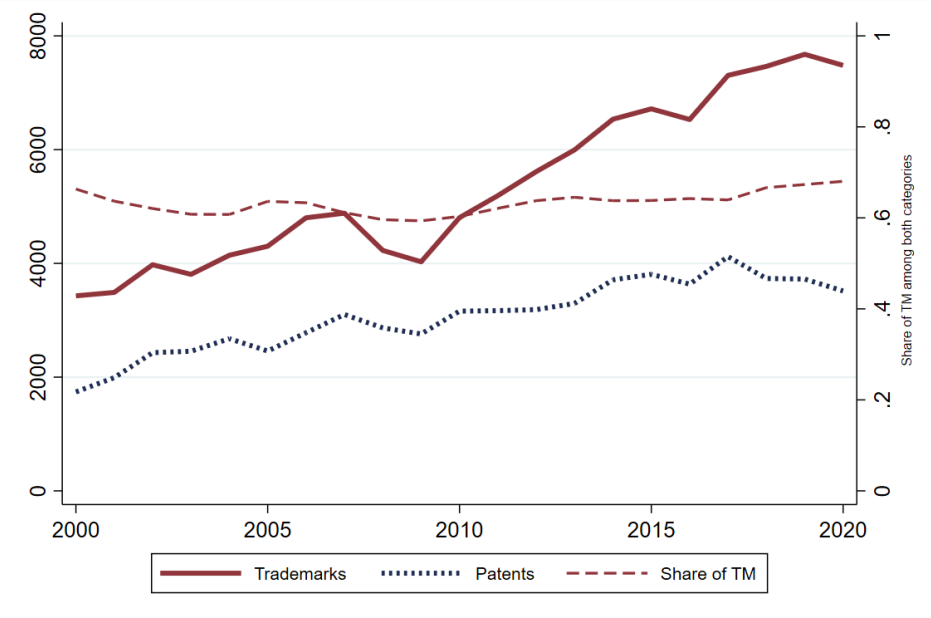
1 NOM ET ADRESSE DU DEMANDEUR OU DU MANDATAIRE À QUI LA CORRESPONDANCE DOIT ÊTRE ADRESSÉE

☐ Veuillez cocher la case si le traitement accéléré est requis (un supplément de redevance doit alors être acquitté)

Vos références pour ce dossier *(facultatif)*		
2 DEMANDEUR DE L'INSCRIPTION		☐ **S'il y a d'autres demandeurs, cochez la case et utilisez l'imprimé «Suite»**
Nom ou dénomination sociale		
Prénoms		
Forme juridique		
N° SIREN		
Adresse	Rue	
	Code postal et ville	
	Pays	
N° de téléphone *(facultatif)*		
N° de télécopie *(facultatif)*		
Adresse électronique *(facultatif)*		
3 AUTRE PARTIE À L'ACTE		☐ **S'il y a d'autres demandeurs, cochez la case et utilisez l'imprimé «Suite»**
Nom ou dénomination sociale		
Prénoms		
Forme juridique		
N° SIREN		
Adresse	Rue	
	Code postal et ville	
	Pays	
4 NATURE DE L'OPÉRATION CONSTATÉE PAR L'ACTE À INSCRIRE		**Cochez la case si cette demande d'inscription est déposée simultanément à :** ☐ **une déclaration de renouvellement de marque** ☐ **un recours en restauration ou une demande de relevé de déchéance**
Transmission totale de propriété		☐
Transmission partielle de propriété		☐
Concession de licence		☐
Résiliation de licence		☐
Constitution d'un droit de gage		☐
Radiation d'un droit de gage		☐
Saisie		☐
Autre (à préciser)		☐

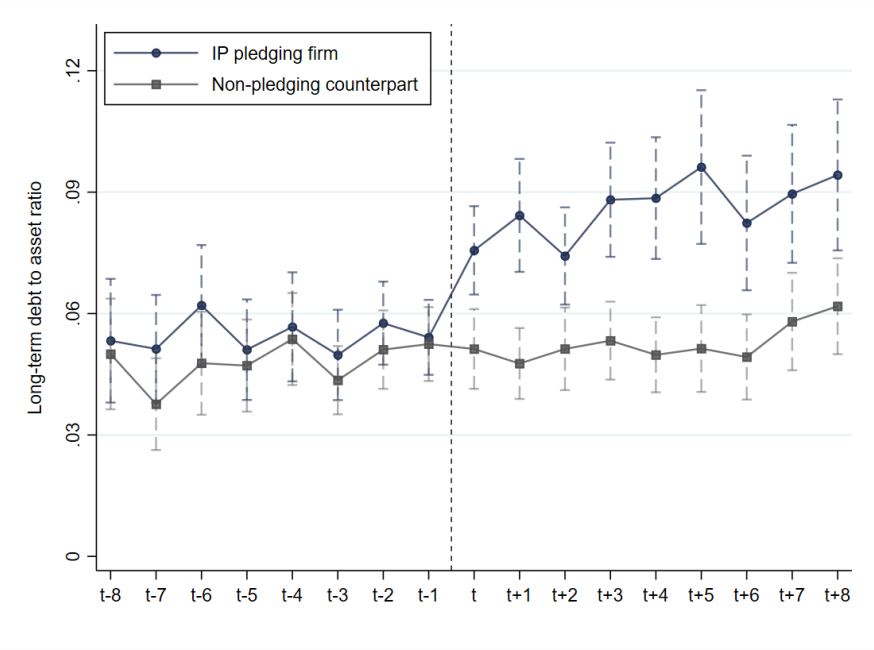
Notes: The figure displays the first page of the form sheet for IP-related legal changes at the French IP office (INPI). IP owners are asked to indicate any changes in ownership, which are specified under point 4. Specifically, pledges of trademarks, patents, and designs are indicated by *Constitution d'un droit de gage*.

Figure IA3: External validity: Trademark and patent as collateral in the US



Notes: The graph displays the use of IP rights as loan collateral in the US for the years from 2000 to 2020, distinguishing between trademarks and patents. Data are obtained from the USPTO trademark and patent assignment datasets. Observations are marked as IP pledges whenever the convey text indicates the establishment of either a "security agreement" or a "security interest". The numbers of patent and trademark loan events are represented on the left-axis. The share of TM indicates the share of trademarks among all IP collateral events, i.e., the sum of patent and trademark events, and is indexed on the right y-axis.

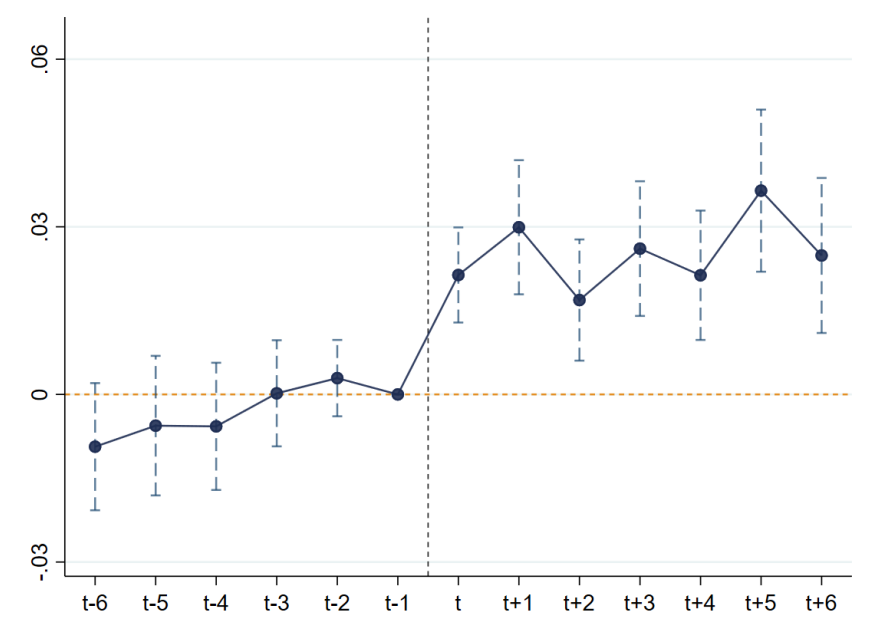
Figure IA4: Mean plots of long-term debt-to-asset ratios relative to pledge year



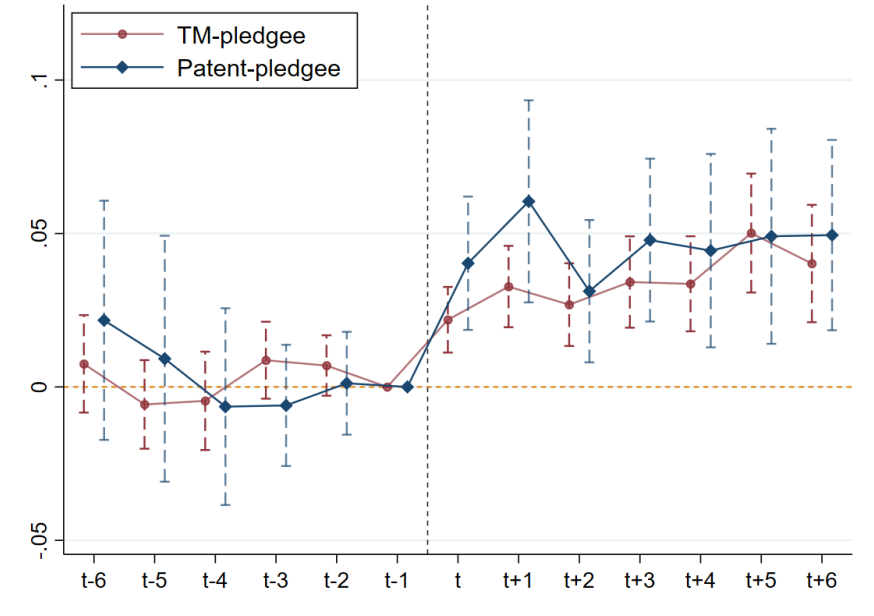
Notes: The figure plots mean values of firms' total debt-to-asset ratios in a symmetric time window of eight years around the initial pledge. The graphs differentiate between IP-pledging firms and matched non-pledging firms from the comparison group. The whiskers span the 95 percent confidence intervals.

Figure IA5: Robustness test on the baseline specifications - coefficient plots

Panel A: Event-study regression design: alternative specification of the matched group

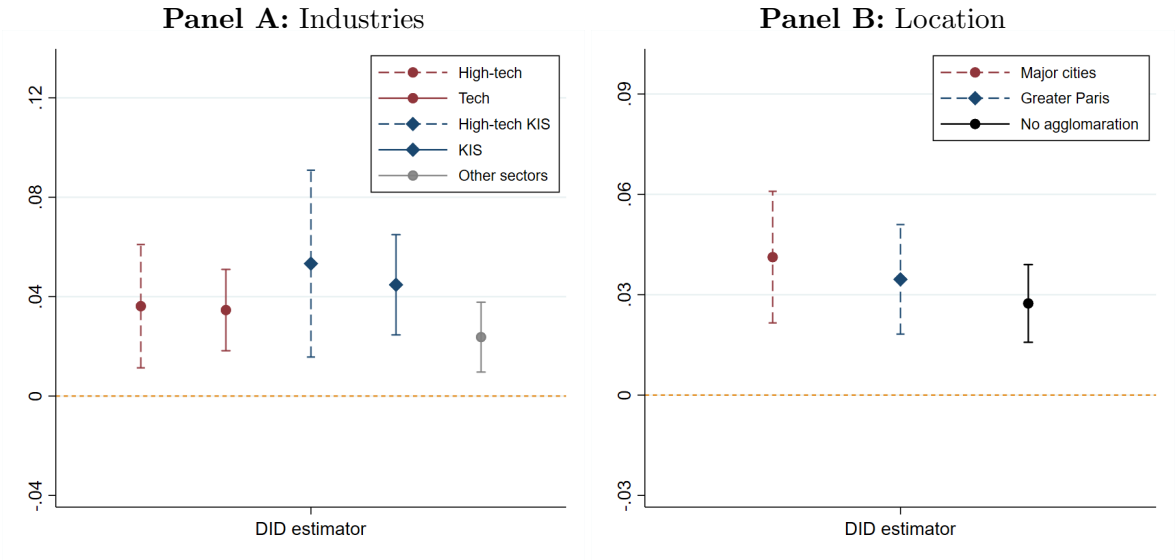


Panel B: Event-study regression design: distinguishing trademark and patent pledges



Notes: The figure provides results from complementary analyses on the baseline estimations in Section 5.2. Panel A plots the coefficients for the baseline specification that are similar to Figure 4, only here the matched group of non-pledging firms is specified differently. In the matching procedure, we omit the selection on the closest neighbors of the IP- pledging firms but instead keep all firms that satisfy the matching criteria defined in Section 5.1. Panel B also redraws Figure 4, only here, the estimation is separately run for i) firms that pledge at least one trademark and those that pledge at least one patent. These groups are not mutually exclusive. In both panels, the whiskers span the 90 percent confidence intervals.

Figure IA6: Sectoral and geographical differences in the baseline results



Notes: The figures plot the DID estimator of variants of the baseline regressions. Here, regressions are run on subsamples according to the sectoral affiliation of firms and the location of their headquarters. In Panel A, we use five different groups of sectors, by following the classification scheme of industries as proposed by the European Statistical Office, Eurostat: 1) high-tech sectors, 2) tech sectors, 3) high-tech knowledge intensive services, 4) knowledge intensive services, and 5) all sectors not classified in 1-4. In Panel B, we separate firms according to the location of their headquarters intro three groups: firms located in 1) Paris, Lyon, or Marseille; 2) the Greater Paris area; and 3) locations not classified in 1-2. In both panels, the whiskers span the 90 percent confidence intervals.

Internet Appendix C : Perfecting IP loans in France

Establishing the contract: In France, IP pledges are governed by the combination of the general security law concerning incorporeal property in the Code Civil (CC) and the Intellectual Property Code (IPC). A pledge of IP is defined by CC article 2355 as the allocation of a movable or of a set of movable properties as security for an obligation. It provides the lender, who accepts the respective IP as collateral, the right to receive payment on the collateral in case of default (Séjean and Binctin, 2020). In this context, it is explicitly stated by law that it is possible to pledge different types of IP as collateral, including patents (L. 613-8 CPI), trademarks (L. 714-1, CPI), designs (L. 513-2 and L. 513-3, CPI), and copyrights (L. 131-2, CPI). Excluded from pledgable IP are collective trademarks, that is, trademarks owned by a group of associated firms and that indicate they belong to the respective associations, such as alliances in the airline industries.

For all loan agreements, the contract must contain a written description on the quantity, type, designation and nature of the collateral in order to legally establish the loan agreement (CC 2336). In the explicit context of IP-backed loans, it is further necessary to include a detailed description of the IP collateral. Unless otherwise specified, the borrower is obliged to carry out due maintenance of the IP collateral. Maintenance entails, for example, the obligation to pay the annual renewal fees at the respective IP offices as long as the loan agreement is not terminated. Further, in case of right infringement, the original owner of the IP has to defend its ownership right in court.

Resolving the contract: There are generally three possible scenarios for ending a loan agreement that each have different implications in the case of IP-backed loan contracts. First, the loan is repaid in full resulting in a release of any obligations attached to the IP collateral back to the original owner. Second, default of a loan without insolvency. In this case, the lender has the right to obtain a court order allowing the sale at auction (CC 2346) or to keep the respective IP as a form of payment (CC 2347). In practice, the latter case is unlikely, since the lender is typically a bank and, hence, with an unrelated business field compared to the borrower. Once the selling value in case of default exceeds the amount of the required, outstanding repayments, the borrower will receive the excess amount. In the third scenario, after default caused by an insolvency of the borrower, a collective proceeding is opened

aiming to satisfy the claims of all affected debtors, including the lender of the respective IP-backed loan. Depending on the seniority, the lender will be repaid or has to write-off the loan. In any case, the lender can no longer claim the exclusive IP ownership (Code de Commerce L.641-3), which is very similar to common other loan agreement resolutions.

Internet Appendix D : Monetization strategies of IP

There are three main strategies on how firms can monetize their IP, summarized in Table ID1. First, selling IP has the benefit of obtaining a lump sum fee that may help firms to cover financing demands on the spot. Selling is a rationale option if the transfer price exceeds the expected private return to its owner, Moreover, selling comes at particular costs, all of which are based on the irreversible loss of ownership of the IP: owners forgo the option to use the subject matter protected by the respective IP right.[23] If the selling firm operates on the downstream market, buyers are likely to be competitors. They can also be non-practicing entities (NPEs) that generate revenues from monetizing IP to practicing firms (see, Cohen *et al.*, 2019). A strategy to maintain the opportunity to use the IP even after transfer would be a sale-and-license back clause. Yet like in a sale transaction, tacit knowledge would have to be displayed and control rights are lost.

Second, IP owners (i.e. licensors) can grant a licensee to use the IP in exchange for payment. Licensing of IP is well-documented in the economic literature, in particular patent licensing (e.g., Arora *et al.*, 2004). The obvious benefit for the licensor is to maintain the monopoly right of exploiting the IP while satisfying financial needs. At the same time, in licensing agreements, the licensor often obtain royalty payments that accrue only over time and thus may not satisfy ad-hoc financing demands. Still, even if lump-sum royalties would be negotiated, disclosure of tacit knowledge is one key disadvantage of licensing that still remains. As such, licensing is explicitly not limited to granting the use of an IP, but on top of this tacit knowledge that is required for proper use of the right is transferred as well (Arora *et al.*, 2001). Hence, similar to IP right transfers, in licensing contracts the original IP owner obtains financing at the cost of displaying tacit knowledge, potentially of strategic importance. This is crucial, once licensees and licensors are competitors.[24]

Third, an IP owner can use the respective rights as collateral to obtain payment in the form of a loan from a creditor, typically a bank. Just like in any other form of loans, IP collateral may serve the classical functions to mitigate adverse selection issues in external

[23] See Serrano (2010) for more details on IP right transfers, in the context of patents.

[24] For example, licensees can be expected to pay royalties only for the actual use of the subject matter protected by IP rights and NPEs can only effectively exploit IP rights if they are actual owners. In fact, in a personal interviews the head of the R&D department of a large German multinational corporate revealed to us that his company does not sell or license their IP, since they "do not want to display strategic knowledge" to competitors. However, we acknowledge that licensing to competitors may even be beneficial for generating knowledge spillovers, as shown in the case of pharmaceutical patents (Kelchtermans *et al.*, 2022).

financing transactions by both providing asset values that can be liquidated in case of loan default and to act as signaling device for borrowers' willingness and capability to repay the debt (Holmstrom and Tirole, 1997; Jimenez *et al.*, 2006). Further, any loan agreement comes at the cost of paying interest on the granted loan, including a full repayment of debt at maturity. Unlike IP transfers and licensing, however, using IP as collateral in loan contracts combines the benefits of receiving lump-sum financing without suffering from the aforementioned costs of loss of ownership or tacit knowledge. Specifically, IP collateral does not require the borrower to display any tacit knowledge to other market participants, nor does it mean losing control and ownership. From this perspective, collateralization appears as a promising strategy to monetize IP rights.[25]

Table ID1: Options to exploit IP for financing purposes

	Monetizing strategy		
	Selling/transfer	**Licensing**	**Collateral**
Form of payment	Selling price	Royalty payment	External debt
Contracting partner	Competitor/partner /other firm	Competitor/partner /other firm	Loan provider (unlikely competitor)
Contracting term	Permanent	Temporary	Temporary (typically long-term)
Main costs	Loss of ownership	Loss of tacit knowledge	Interest payment
Main advantage	Lump sum payment	Maintain ownership, no repayment	Preserve tacit knowledge, lump sum payment

[25]Further, firms may exploit IP rights (via signaling) to obtain external equity financing, such as, venture capital investments. Typically, this strategy is relevant only for very young ventures and implies a dilution of the equity stake of the firm. In contrast, debt financing is a potential financing strategy for all firms (see Robb and Robinson, 2014) and does not affect the firms ownership structure.