Innovation and Appropriability: Revisiting the Role of Intellectual Property

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June 2023

It is more than 25 years since the authors of the Yale and Carnegie surveys studied how firms seek to protect the rents from innovation. In this paper, we revisit that question using a nationally representative sample of firms over the period 2008-2015, with the goal of updating and extending a set of stylized facts that has been influential for our understanding of the economics of innovation. There are five main findings. First, while patenting firms are relatively uncommon in the economy, they account for an overwhelming share of R&D spending. Second, firms consider utility patents less important on average than other forms of IP protection, like trade secrets, trademarks, and copyrights. Third, industry differences explain a great deal of the level of firms' engagement with IP, with high-tech firms on average being more active on all forms of IP. Fourth, we find no significant differences in the use of IP strategies across firms at different points of their life cycle. Lastly, unlike age, firms of different size appear to manage IP significantly differently. On average, larger firms tend to engage much more extensively in the protection of IP, and this pattern cannot be easily explained by differences in the type of R&D or innovation produced by a firm. We also discuss the implications of these findings for innovation research and policy.

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Initiative at Boston University provided financial support for this project. All errors are ours. For questions, filippo.mezzanotti@kellogg.northwestern.edu or tsimcoe@bu.edu.

1 Introduction

Economists generally view innovation as the most significant driver of long-run productivity growth, and knowledge spillovers as main reason why the social returns exceed the private returns to R&D. At the firm level, however, our understanding of the relationship between intellectual property (IP) protection, R&D investment, and innovation outcomes has long been hampered by measurement problems and a lack of data. In particular, although a large literature uses patents to measure innovation outcomes, relatively few studies consider the decision to patent, or how that decision interacts with other business characteristics.

The two most notable exceptions to this gap in our knowledge about private innovation incentives are the Yale and Carnegie surveys, conducted by Levin et al (1987) and Cohen et al (2000), which asked R&D managers about their firms' strategies for appropriating the value of their innovations. Yet these surveys are now more than 20 years old, and evidence has started to accumulate suggesting that the locus of R&D investment and innovation for U.S. firms has changed during this period (Foster, Grim and Zolas 2020; Ozcan and Greenstein 2013).[1] Furthermore, for practical reasons the Yale and Carnegie surveys focused on large firms in manufacturing industries, leaving us with relatively little knowledge about the incidence of R&D or the importance of intellectual property in smaller companies and other sectors.

We revisit the broad question of how firms appropriate the benefits of innovation using survey data collected by the US Census between 2008 and 2015. Our results suggest that many patterns uncovered in previous literature have persisted. For example, most US firms indicate that trade secrecy is the most important tool for protecting innovation. The perceived importance (and actual use) of utility patents and other types of formal intellectual property protection varies greatly across industries.

[1] In addition to these surveys, Nicholas (2011) matched data on R&D performing firms from a pair of surveys conducted by the National Research Council in 1921 and 1938 to historic patent records. Nicholas' results suggests that pre-war R&D performers were more likely to use the patent system than those surveyed at the time of the surveys by Levin et al (1987) and Cohen et al (2000). This evidence may in part reflect the larger importance of innovation conducted by independent inventors before the Great Depression (Babina, Bernstein, and Mezzanotti, 2021).

Our analysis also generates some new stylized facts about IP and innovation. For example, although a majority of US firms that perform R&D do not patent, it is patenting firms that perform the vast majority of reported R&D. Perhaps surprisingly, firm age is not strongly correlated with the importance of various forms of IP. Firm size, on the other hand, is an important predictor. Larger firms show significantly more interest than small firms in all forms of IP protection, and firm size generally explains more variance in patenting than any other observed characteristic. This size effect cannot be easily explained by other differences in the quality or intensity of R&D inputs, type of innovative output, or a firm’s strategy in the use of IP. Altogether, the survey evidence highlights disparate use of intellectual property protection by the broad cross-section of US firms.

Our data comes from the Business R&D and Innovation Survey (BRDIS). This survey is conducted annually by the Census Bureau in collaboration with the National Science Foundation's National Center for Science and Engineering Statistics and aims to provide a representative picture of R&D activity conducted by for-profit, nonfarm businesses with five or more employees operating in the United States. As a result, the survey targets a sample of more than 40 thousand firms a year and asks questions about R&D activity, use of intellectual property, and other demographic information.

Two features of the BRDIS data are particularly important for our analysis. First, unlike the earlier Yale and Carnegie surveys, BRDIS covers a large representative sample of firms. This allows us to compare the use of IP across firms of different size, age, and industry, encompassing firms that are both active and inactive in R&D, and to produce estimates that are representative of the population of US firms. Second, the survey combines quantitative measures of IP use (e.g., patent counts) with qualitative variables that report the perceived importance of different forms of IP protection strategies by a company. The qualitative measures facilitate comparison of preferences across different firms and allow us to explore business practices (e.g., trade secrets) that are intrinsically hard to observe and quantify. To address concerns related to the presence of biases in reporting these qualitative assessments, we show that self-reported preference measures line up well with firms’ actual behavior.

Using these data, we examine how US firms engage in IP protection from two complementary angles. First, we analyze the behavior of firms surveyed in the BRDIS data without any sampling adjustment. Because the survey oversamples companies that perform R&D, this approach allows us to examine IP strategy at a sample of the most innovative firms. Second, we repeat the same analyses applying the sampling weights constructed by the Census in order to generate statistics representative of the average US firm. These two approaches target different populations of interest for economists.[2] Despite important differences in the absolute level of engagement with IP across the two samples, most of the cross-sectional associations that we report will hold consistently across the two samples.

The paper is organized around five stylized facts that we introduce here and discuss below. First, patenting firms are relatively scarce within the US economy. Less than 2% of all companies are patenting firms according to our definition. Even within the BRDIS sample, just 25% of companies are patenting firms. This small group of patenting companies is particularly important, however, because they perform over 90% of US R&D investment.

Second, we show that patents are generally not considered the most important tool for appropriating the benefits of an innovation. In absolute terms, around two-thirds of surveyed firms report that utility patents are not important. For the nationally representative sample, around 95% of firms report utility patents are not important.[3] In relative terms, patents are consistently considered significantly less important than trade secrets, (and to a lesser extent) copyrights and trademarks. This result holds consistently in both sets of analyses.

Third, we show that IP strategies vary substantially across industries. Companies that operate in the high-tech sector consistently report that all forms of IP protection are more important.[4] In general, the relative importance of different types of IP does not vary significantly by industry (with the outsized importance of patents to Life Science firms a notable exception). Outside of high-tech, manufacturing, and retail, however, the importance of IP is extremely low. For example, almost 90% of the surveyed firms from outside those three sectors report that patents are not at all important.

[2] For instance, a scholar developing a model that seeks to explain an aggregate variable in the economy is more likely to be interested in knowing how an average firm uses patent protection, and would therefore focus on the weighted estimates. In other cases, the focus may be on innovative firms, making the unweighted statistics more useful.

[3] This number for design patents is even higher, as discussed in the paper.

[4] As discussed below, our definition of "high tech" includes information technology and life sciences, and is comprised of a somewhat broader set of NAICS codes than those used in the Census' Business Dynamic Statistics of High-Tech Industries dataset (Goldschlag and Miranda, 2020).

Fourth, we examine how the importance of IP changes over the life cycle of a firm, comparing survey responses and actual behavior across different age cohorts. Surprisingly, we find no systematic relationship between firm age and our measures of IP strategy. This result holds in both the weighted and unweighted sample, and is robust to controlling for industry effects, firm size, R&D intensity, and other factors. One way to interpret this finding is that a firm's IP policy might be modeled as a state-variable that is determined at founding and remains constant over the life of the business. Consistent with this idea, we show that early decisions of a firm regarding R&D and patenting strongly predict future growth, as in Guzman and Stern (2020).

Fifth, we find that firm size is an important determinant of IP policies. Larger firms consider all types of formal IP – patents, trade secrets, copyrights, and trademarks – to be more important. This relationship is monotonic and economically significant. For instance, within the BRDIS sample, a firm in the largest size bucket considers patents three times more important than those in the smallest bucket. Moreover, the relationship between firm size and patenting is not easily explained by differences in other observable characteristics. In particular, we find similar results when controlling for industry, age, R&D investment, innovation output, expertise in the market for technology, and the use of other types of IP. In fact, the correlation between size and the importance of IP is so strong that it eliminates much of the inter-industry variation among the largest group of firms.

This study contributes to a broad literature on the determinants of innovation activity,[5] and more specifically to research that uses survey evidence to study how firms utilize IP to protect the profits generated through innovation. Sampat (2018) reviews this literature which, in addition to the Yale and Carnegie surveys discussed above, includes pioneering work by Scherer (1959) and Mansfield (1986), as well as the more recent Berkeley Patent Survey (Graham et al 2009) focusing on small

[5] To cite some of the papers in this large and growing literature, scholars have examined how innovation is affected by immigration (e.g., Kerr and Lincoln, 2010; Moser et al., 2014), taxation (e.g., Akcigit et al. 2017), intellectual property laws (e.g., Moser, 2005; Mezzanotti, 2021, Mezzanotti and Simcoe, 2019), disclosure (e.g., Graham and Hedge, 2015; Hedge and Luo, 2018; Hedge et al., 2023), examination process (e.g., Alcacer and Gittelman, 2006; Alcacer et al., 2009), government investments in R&D (e.g., Gross and Sampat, 2020; Moretti et al., 2019), the relationship with basic scientific knowledge (Arora et al, 2018; Arora et al, 2021), bank credit (e.g., Bai et al., 2018; Huber, 2018), competition (e.g., Aghion et al., 2005), boundaries of the firm (e.g., Seru, 2014; Frésard et al., 2020), and early-life experiences (e.g., Bell et al., 2019), among other things.

early-stage companies.[6] Although we address similar questions to prior studies, we extend the analysis in a number of directions by combining observational with qualitative response data, and by relying on a representative sample of all US firms, as opposed to just manufacturing firms or those with R&D laboratories.

Our finding that firm size plays an important role in the decision to use formal IP may also be relevant to the literature concerned with the role of intangible capital in explaining the increase in concentration and low investment by US firms (Crouzet and Eberly, 2019). Recent research has begun to investigate determinants of the economic advantages of large firms in developed economies (Autor, et al., 2020; Gutiérrez and Philippon, 2019). In this context, Arora et al. (2023) argues that part of this advantage may stem from large firms' superior ability to extract value from inventions. Our work complements Arora et al. (2023) by providing direct evidence on one of the possible mechanisms that may explain this result: a more aggressive use of IP protection among large firms. Specifically, our analysis shows that – even after adjusting for differences in product market, the quantity, and quality of R&D – large firms systematically use patents more extensively. This suggests that the way intangible capital is managed and protected may play an important role in understanding the rising importance of large firms in the US economy.

Finally, we contribute to the literature that seeks to disentangle the role of age and size in firm dynamics and economic growth. Haltiwanger, Jarmin and Miranda (2013) launched this stream of research by highlighting the importance of young (as opposed to small) firms for job creation. Goldschlag and Miranda (2020) focus on a set of High-Tech industries and show that while job creation rates remain higher at young firms, the gap between young and older firms declined significantly in the aftermath of the late 1990s technology boom. Our study complements this line of research by showing that size, rather than age, explains firms' reliance on patents and other types of formal IP. At the same time, for a sample of newly established firms, we show that

[6] In Europe, survey data on innovation has been used extensively to study inventors (e.g., Giuri et al, 2007; Meyer, 2000; Tijseen, 2002) or firms (e.g., Blind et al., 2022; Belderbos et al., 2004; Mohnen et al., 2006). However, on top of the different geographical setting, our paper is unique in its focus on understanding differences in appropriability strategies in the cross-section, and its emphasis on size and age as important mediators.

patenting is strongly correlated with employment growth – a result that echoes recent findings of Guzman and Stern (2020),[7] and in consistent with the evidence in Sterk et al. (2021).

2 Data

2.1 The Business R&D and Innovation Survey

Our data come primarily from the Business R&D and Innovation Survey (BRDIS). This survey was the successor of the Survey of Industrial Research and Development (SIRD), and it was organized in partnership between Census Bureau and the National Science Foundation's National Center for Science and Engineering Statistics.[8] The survey was conducted annually from 2008 until 2016 and aimed to provide a representative outlook of R&D activity conducted by for-profit, nonfarm businesses with five or more employees operating in the United States. The survey targets a sample of more than 40 thousand firms each year, and it contains a variety of questions regarding the R&D activity of the company surveyed, their use of intellectual property, and other demographic information. For the period covered by our study, BRDIS is one of the main inputs used for the construction of aggregate statistics on R&D in the US. However, the use of this data at disaggregated level remains limited (Driver, Kolasinski, and Stanfield, 2020; Foster, Grim and Zolas 2020; Mezzanotti and Simcoe, 2023).[9]

This BRDIS data has two key features that are important for this study. First, it covers a large and representative sample of firms, thereby allowing us to compare innovation and the use of intellectual property (IP) across a wide variety of firms in a consistent manner. Thanks to this data, we can study differences in behavior across companies of different size, age, and industry, encompassing firms that are both active and inactive in R&D. The representativeness of the sample gives us a crucial advantage relative to the past literature, which had to rely on smaller surveys

[7] These results support the use of a firm's early-stage actions (e.g., patents) to identify in real time high-quality entrepreneurship in the economy (Andrews et al., 2022).

[8] BRDIS was deprecated in 2016. More information on the survey can be obtained on the website of the NSF: https://www.nsf.gov/statistics/srvyberd/prior-descriptions/overview-brdis.cfm

[9] Foster, Grim and Zolas (2020) uses BRDIS combined with SIRD to understand how the type of firms investing in R&D has changed between 1992 and 2011, while Driver, Kolasinski, and Stanfield (2020) uses BRDIS to compare how public versus private firms differ in the type of research they conduct (i.e., research versus development). Mezzanotti and Simcoe (2023) focuses on the activity of large, public firms companies around the 2008 financial crisis and study the effect of a funding shock on R&D investments.

generally focused on large firms active in R&D intensive industries (e.g., Levin, Klevorick, Nelson and Winter, 1987; Cohen, Nelson and Walsh, 2000).[10]

Second, the sample allows us to consistently measure innovative activity across firms. In addition to collecting information on innovation inputs and outputs, the survey asks firms to rate the importance of several forms of IP protection: utility patents, design patents, trade secrets, copyrights, and trademarks.[11] Specifically, firms are asked to indicate whether each type of IP is very important, somewhat important, or not important.[12] These qualitative response questions are very useful for several reasons. First, they allow for comparisons across firms and strategies without any adjustment to control for differences in scale, scope, or industry, as we would do for actual behavior.[13] Second, because every firm is asked the qualitative questions, we can measure underlying preferences without conditioning on outcomes. And thirdly, they allow us to examine strategies (e.g., trade secrecy) that are normally hard to observe. Of course, one standard concern with qualitative response data is that firms (or more generally, survey respondents) may not truthfully report their preferences. As discussed below, we address this issue by showing that stated preferences are strongly correlated with actual behavior.

We construct our sample by combining the eight waves of the survey between 2008 and 2015. From this version of the data, we then exclude non-respondents as well as foreign-owned firms.[14] A considerable amount of work was performed to ensure that survey variables are comparable throughout the sample period.[15] While core variables are constructed from questions asked in all

[10] This is also an advantage relative to Graham et al. (2009), which surveys a sample of high-tech startups in the biotechnology, medical device, IT hardware, software, and Internet sectors.

[11] The survey also asks about mask works. We exclude this measure from our study because the relatively small numbers of firms involved with this strategy may create concerns with disclosure.

[12] These questions are generally contained in the "Intellectual Property" Section. For instance, in 2009 the question asked "During 2009, how important to your company were the following types of intellectual property protection?"

[13] For instance, even if we had actual data on the behavior of a firm in trade secrets, patents, and copyrights, it would be difficult to compare the importance of the three activities between each other.

[14] We identify foreign-owned firms as firms with a foreign majority ownership using the flag reported in the Standard Statistical Establishment Listing (SEEL). The key issue with foreign-owned firms is that they are asked to report information on activity conducted within the US, therefore excluding substantial R&D operation conducted abroad. Instead

[15] One minor problem with the survey is that in some cases multiple establishments within the same firm are surveyed in the same year. We keep the data at firm level using the following process. First, if there are multiple establishments within the same firm, we notice that in most cases only one actually responds to the survey. As a result, as first step, we drop all non-respondents when at least one firm has responded to the main questions (i.e. sales, R&D spending, IP,…). Second, for the very few cases that are left after step 1, we keep the establishment reporting the highest firm's sale, under the assumption that this establishment is more likely to have the most

survey years, the exact way a measure is reported may differ across waves. To facilitate disclosure and analysis, we construct the final sample by only keeping those firms that consistently report all variables used in the study.

We present analyses both with and without re-weighting the sample to make the statistics nationally representative. In fact, we believe that each set of analyses (i.e., weighted, and unweighted) targets a different population of interest for scholars. The unweighted statistics provide insights about the use of appropriability strategies for companies more directly engaged with innovation activity (because BRDIS over-samples companies that are known to perform R&D). Consistent with this idea, we show that use of intellectual property in the unweighted sample is very similar to what we observe for R&D performers. On the other hand, weighted statistics allow us to assess the IP strategies used by an average firm in the US economy.[16] While the overall level of engagement with IP and R&D differs across the two samples, we show that our key cross-sectional relationships generally hold for both approaches.

Finally, we match the core BRDIS data set to several other resources. In particular, we link our sample of firms to the Longitudinal Business Database (LBD), which provides more detailed information on age, as well as longitudinal data on employment, and to administrative data on granted US patents via the matching procedure developed by Dreisigmeyer et al. (2018). While the survey contains information on patenting in the year of the survey, matching the full patent data set allows us to also observe patenting also in years that are different from the survey years. Additional details on the construction of specific variables are provided as they appear in the text.

2.2 Validating the Measure of IP Importance

Before turning to the main analysis, we address a key concern with the use of self-reported measures of the importance of different IP strategies: firms may not truthfully report their preferences. To address this concern, we compare self-reported preferences with actual behavior, and show that they are strongly correlated. For this analysis, we focus on patents, because for that outcome we observe both stated preferences and actual behavior.

comprehensive responses. Given the relatively small number of firms with this issue, results are almost identical if we do not do any adjustment.

[16] To be precise, the sample weights provided in the Census aim to make the sample representative for the population of for-profit non-farm businesses with at least five employees in US.

The results are reported in the two panels of Appendix Figure 1. Across the two panels, we examine two distinct measures of patenting behavior, which separately capture the importance of patenting at the intensive and extensive margin. In the left panel, our main measure of patenting behavior is a dummy variable ("Any patent") that identifies firms that have applied for at least one granted patent in the five-year window around the survey year (i.e., between two years before and two years after). In the right panel, we employ a measure of patent intensity, which is constructed as the number of patent applications filed in the five-year window around the survey relative to the amount of worldwide R&D performed in millions of dollars in the year of the survey.[17]

For both panels, we then plot the sample mean of each variable conditional on a firm's stated importance of patents. We consistently find that firms' stated preference for patenting is strongly and positively associated with their actual patenting behavior, at both the intensive and extensive margin. Firms that consider utility patents "very important" are around five times more likely to have patented during the five-year period around the survey than firms that report patents are not important. Similarly, on the intensive margin, firms reporting patents to be "very important" obtained more than four times as many patents per dollar of R&D than firms indicating that patents were not "important." Importantly, the relationship between self-reported importance and behavior is monotonic.

While not surprising, these results provide some validation for the self-reported measures of IP importance that we use below. For patents at least, stated preference and observed behavior seem to line up quite clearly.

3 Intellectual Property at U.S. Firms

We now present a set of five stylized facts that illustrate how US firms use intellectual property protection.

3.1 Patenting is relatively uncommon in the economy, but most R&D is concentrated among patenting firms.

[17] These variables are the same used later in the regression analysis. The patent intensity measure is winsorized at 5% to exclude that any of our results is affected by the presence of outliers.

To start, we examine the joint distribution of patenting and R&D. We define a firm as a patenting firm if it applied for at least one (later granted) US patent in the 5-year window around the survey year. A firm is active in R&D if it reports that it performed any amount of R&D in the survey year. Using these two indicator variables, we report the share of the sample in each of the four groups defined by the cross-tabulation between R&D and patenting.

In Figure 1 panel (a), we start by presenting the raw statistics, without any adjustment using sampling weights. Just over one half of the surveyed firms (53%) perform R&D, and one quarter (25%) of obtain patents. Conditional on conducting R&D, the patenting share increases to around 42 percent.[18] In fact, we observe that while 22% of firms perform R&D and obtain patents, almost 31% conduct R&D without patenting. Thus, although a substantial share of firms uses the patent system, it is not the norm even among those that invent in R&D. Interestingly, there is also a non-trivial number of companies that patent without conducting R&D – about 2% of the overall sample, or 9% of the patenting firms.[19]

Next, we examine the same set of statistics after applying sampling weights in Figure 1 panel (b). As expected, R&D and patenting are much less common in the overall population of US firms compared to the firms in the BRDIS sample. This result is consistent with the description of the survey approach, which oversampled companies that are more likely to be active in R&D. In fact, companies doing R&D are roughly 6% of the overall population, which is far lower than what we found for the set of sampled firms.

However, our conclusion that patenting is unusual is (if anything) only reinforced when looking at these statistics. Patenting firms represent around 1.4% of all non-agricultural firms with five or more employees in the US economy. Furthermore, only about 18% of companies that conduct R&D are categorized as patenting firms. Patenting firms nevertheless account for a large majority

[18] This number is consistent the evidence in Goldschlag and Perlman (2017), which also uses BRDIS to study the business dynamics of innovative firms. While an exact comparison is difficult given the different definition of a patenting firm, they report that around 34% of R&D firms in their sample are also patenting.

[19] Obviously, some of these firms may have conducted R&D in a year different than the surveyed ones. Since for most firms are in the data only once, we cannot check how common this is. However, looking at the sample of firms reporting in multiple years, we find that normally companies that do some R&D in one year, are also doing R&D in all other years.

of R&D activity. For example, if we compare the share of R&D performed by patenting and non-patenting firms, we find that 91% of R&D is performed by firms that patent (Figure 2).[20]

These results provide a first glimpse of the data on IP strategies. Patenting is rare in the economy, and remains relatively uncommon even when focusing on those firms in the BRDIS sample that are more likely to engage in R&D. Nevertheless, patenting firms account for a large majority of all private US R&D investment. Below, we explore this selection process by examining life-cycle factors and size differences across firms.

3.2 Patenting is not the main strategy to protect IP

Our next step is to examine the importance of patenting compared to other types of IP protection. As described above, firms are asked to report a qualitative assessment of the importance of utility patents, design patents, trade secrets, copyrights, and trademarks across three categories: very important, somewhat important, and not important.

In Figure 3, we report the share of firms in each of the three response categories for the different IP strategies. We start by reporting unweighted statistics, which therefore characterize the behavior of firms that are more likely to engage in R&D activity. If we rank the various types of IP protection according to the share of respondents who indicate that they are important or very important, then trade secrecy (considered very or somewhat important by more than 52% of firms) and trademarks (around 50% of firms) appear to be the most useful, followed by copyrights (slightly less than 39% of firms).[21] Around 24 percent of U.S. companies report that utility patents are very important, and another 11% report them as somewhat important. Only design patents, whose use is more concentrated to specific types of firms, are consistently reported to be less important than utility patents.[22]

These rankings do not change significantly when we apply sample weights (Appendix Figure 2). In absolute terms, none of the IP strategies assessed in BRDIS survey are seen as having any

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[20] The number reported refers to the unweighted statistic. The equivalent weighted statistic is however, very similar. Both quantities are reported in the two panels of Figure 2.

[21] This comparison between patents and trademarks is consistent with the evidence in Dinlersoz et al. (2018), that finds that trademarks are more common than patents among R&D firms over the past two decades.

[22] While BRDIS survey does not ask about specific types of appropriability mechanisms (e.g., lead-time advantages, manufacturing or sales and service capabilities), our finding that trade secrets are generally viewed as more important than patenting is broadly consistent with the results of the Yale and Carnegies surveys.

importance by more than 20 percent of the firms in the US economy. Utility patents are considered either very or somewhat important for 5% of companies. In relative terms, utility patents are less important than any of the other IP strategies surveyed. For instance, trade secrets are considered very or somewhat important by 14% of firms, trademarks for about 14%, and copyrights for about 11% of firms.

A potential concern with this analysis is that it does not focus on the right population to assess the importance of patenting. Even if patenting is not very important on average, it could still play a central role for companies that undertake R&D investments. To be clear, our first set of analysis (i.e., using unweighted statistics) should partially address this issue.

However, to further address this concern, in Appendix Figure 3, we repeat the same analysis as before but now focusing only on companies actively conducting R&D when they responded to the survey. Despite this extra filter, our conclusions are unchanged. In fact, these results are generally similar – in both absolute levels and relative behavior - to the unweighted statistics discussed earlier (i.e., Figure 3). As mentioned in Section 2, this evidence further supports the idea that unweighted analyses are likely to capture the behavior of companies more likely to engage with innovation.

Finally, we can investigate whether our results may partly reflect firms "specializing" on certain types of IP protection. In other words, we want to understand whether the low level of utilization of one form of protection (e.g., patents) is generally connected with a higher level of importance of others (i.e., trade secrets). To examine this issue, we estimate the partial correlation between different strategies. Results are reported in Appendix Table 1. Across all combinations, we find that the stated importance of IP strategies are positively correlated. While descriptive, this evidence suggests that companies do not (or cannot) substitute one type of IP protection for another. If anything, different forms of IP protection complement each other, as companies that engage in one IP strategy tend to also find other forms of protection more important.

Altogether, this evidence suggests that patenting does not represent the main form of protection for US firms. In absolute terms, utility patents are consistently reported to be somewhat or very important by only a minority of companies. This fraction clearly increases as we focus on companies that are more engaged with innovation and R&D, but even in the best-case scenario we find that about two thirds of companies claim patents are not at all important. In relative terms, trade secrets are generally reported as significantly more important than patents.

3.3 Importance of IP Varies with Product Market Characteristics

A natural follow-up to the previous analysis is to examine whether differences in the importance of various types of IP protection stem from differences in product market characteristics, as potentially captured by a firm's industry. We start by dividing the sample of firms into five groups based on their industry classification within the Census. Specifically, we categorize firms into five sectors: Life Science and Drugs, Information Technologies (IT), Manufacturing, Retail, and Others (the residual category).[23] Figure 4 reports the (relative) importance of the different IP strategies across industries using the unweighted statistics.

Across all IP strategies, we find that industry plays an important role in explaining firms' responses. First, there is a clear "level effect" across industries, as some industries consistently care more about all forms of IP protection. In particular, high-tech industries (i.e., Life Science and IT) report that formal IP is relatively more important, while firms in the residual category (i.e., "Other") consistently rank at the bottom in terms of stated importance.

Focusing on Life Science firms, we find that around 70% report patents to be either very or somewhat important, which is significantly higher than for IT (44%), manufacturing (36%), retail (30%), and other (11%). Almost all the other IP protections share the same ranking. For instance, if we look at trade secrets, Life Science again ranks first with 76% of firms reporting this strategy to be at least somewhat important, followed by IT (67%), manufacturing (58%), retail (45%), and other (25%). The only notable exception to this pattern is copyright, where 59% of IT firms reporting copyrights to be at least somewhat important, followed now by Life Science (50%), retail (38%), manufacturing (37%), and lastly other firms (25%).[24]

[23] Our broad industry definition is the following. Using NAICS code as input, we define IT as 3341, 3342, 3344, 3345, 3346, 3353, 5112, 5141, 5171, 5172, 5179, 5182, 5191, 5413, 5414, 5415, 5416, 5142, 5187, 5133, 5177; we define Life Science as 3254, 3391, and 5417; we define retail as 42, 44, 45; we define manufacturing as all the codes contained in 31, 32, and 33 that are not already included in IT and Life Science. Lastly, the group Others is a residual group.
[24] Another less notable exception is design patents, where other manufacturing firms report roughly the same level of importance as IT and Life Science.

Altogether, industry explains a great deal of the variation in reported importance of IP protection across firms. While all IP protection mechanisms are generally important for high-tech firms, the opposite is true outside. For other manufacturing firms and companies in retail, the protection of IP is perceived as a second-order problem, with a very low reported importance of all the IP tools. Across all sub-samples, the group of firms in the "other" category ranks very low in both absolute and relative terms.

Furthermore, the relative ranking across different forms of IP protection remains stable across industries. In particular, utility patents are never the form of IP protection reported as important by the most firms. Across every industry, utility patents are always ranked after trade secrets. Except for firms in Life Science, utility patents are also perceived as less important than trademark and copyrights. These results suggest that, while there is a level difference across industries, the relative importance of different forms of protection is fairly stable.

Similar conclusions can be reached looking at weighted statistics (Appendix Figure 2). Given the nature of the sampling, results for the high-tech groups look remarkably similar across the weighted and unweighted analyses. For the other industries, the level of engagement in intellectual property protection is on average lower than reported above. However, we still find the same relative rankings between industries as well as the same ranking within industry across IP strategies.

Overall, this evidence confirms that product market differences captured by industry are an important determinant of the overall level of IP engagement.

3.4 Importance of IP Does not Change as Firms Age

We now examine whether the stated importance of IP protection varies over the life cycle of firms. While our data does not allow us to systematically follow the same firm over time, the sample covers a very wide range of firms at different points the firm-age distribution. Thus, we can examine whether firm age explains a significant amount of variation in IP importance and behavior.

To address this question, we divide our sample into five groups based on a company's age constructed from the LBD.[25] In particular, the group of younger firms (group 0) contains companies still at the start-up phase (0-2 years), while the group of older firms (group 4) contains firms that have been active for over three decades.[26] Using these categories, we then replicate the same examination of the importance of different forms of IP protection splitting across these groups.

The unweighted results are reported in Figure 5. Across the various types of IP, we consistently find little or no difference between firms of different age: older firms do not systematically differ from younger firms across any dimension. For instance, looking at patents, 25% of start-ups in the data reports that patents are very important, and the same statistic is also 25% for the older group of firms. With some small variation across different sub-groups, the same similarities hold across the rest of analyses.

This lack of differences across age groups is confirmed in two other sets of analyses. First, in Figure 5 in Appendix, we find the same pattern when applying sampling weights. Second, we find the same results using a regression framework (Appendix Figure 6). The regression analysis also allows us to address two potential concerns with this finding. First, firm entry and average life could be different between industries, and this may be an important confounding factor in our setting. To address this issue, we include industry fixed effects (4-digit NAICS) interacted with year dummies so we can compare the importance of age within industry-year pairs. Second, the lack of response in the self-reported measures may reflect some differences in reporting errors in self-reported measures across age groups. We deal with this potential issue by focusing on patents, and reporting the same results with both the self-reported measure as well as the two measures based on patenting (i.e., intensive and extensive margin). Appendix Figure 6 reports the coefficient on the different age groups, normalizing the coefficient for the youngest group of firms to zero.[27]

[25] We define a firm's age as the age of its oldest establishment in the LBD.
[26] The five groups are defined as followed: (1) 0-2 years; (2) 3-9 years; (3) 10-19 years; (4) 20-29 years; (5) 30+ years.
[27] We estimate this analysis on a sample of about 53 thousand firms reporting positive R&D in the year, since we need positive R&D spending to construct the patent intensity measure. We cluster standard errors by firm to account for the fact that some firms are sampled multiple times in the sample.

The supplemental results generally confirm the previous observations. Across both the self-reported measure and actual patenting behavior, we fail to identify any consistent relationship between age and the perceived importance of patents. While some coefficients are statistically different from zero, the magnitudes of the effects are generally small and more importantly there is no consistency across outcomes and groups, making it hard to identify any pattern in the data.[28]

Altogether, differences in age do not explain much variation in IP activity between firms, both in absolute and relative terms. In Section 4, we return to this question and attempt to link our finding to the literature on firm-level dynamics.

3.5 Larger firms are systematically more active in IP protection, across all forms of protection

Using the same empirical strategy as above, we now examine whether differences in firm-size help explain variation in the importance of IP protection. We divide firms into five groups based on worldwide sales. The group containing the smallest firms has sales below $10 million (group 0) while the group with largest firms (group 4) has over $1 billion in sales.[29] We then repeat the same analyses as we have done for age, splitting the responses to the IP questions across these sub-groups.

As usual, we start by presenting the unweighted statistics (Figure 6). Size appears to have a very clear effect on the overall IP importance. Across all the outcome measures, we find that larger firms report higher importance for each form of IP protection, and the increase appears to be monotonic in the size groups. To gauge the magnitude of these differences, it is useful to compare a few metrics between the smallest and largest firm-size groups. For instance, 69% of the largest firms consider patents to be important (either very or somewhat) but this percentage is only around one third that size (24% of firms) for the group containing the smallest firms.

This positive relationship between size and the importance of IP is not unique to patents. In general, similar effects can be identified for all the other types of IP protection included in BRDIS, with similar magnitude across categories. This evidence suggests that IP protection is increasingly

[28] We also reproduce the same regression results with sampling weights (Table 2 in Appendix). We discuss them more in details in Section 4.
[29] The group construction is the following: (1) 0-10 million; (2) 10-25 million; (3) 25-100 million; (4) 100-1000 million; (5) 1000+ million. All values are in US dollars nominal terms.

important for larger firms, and this effect holds across all types of protection examined. Furthermore, this consistent behavior across all forms of IPs is in line with the idea that the level of engagement across different forms of IP protection is positively correlated (Appendix Table 1).

Our conclusions do not change if we use sampling weights (Figure 7 in Appendix). Although the average reported importance of IP strategies is lower when sampling weights are applied, the differences between companies of different sizes remain substantial. For instance, the share of firms reporting patenting to be somewhat or very important is eight times larger for the largest group of firms compared to the smallest. The persistence of this result implies that the importance of size in explaining the utilization of intellectual property is not unique to more innovative firms, but also holds when looking at a nationally representative sample.

At this point, there are two extra results that we would like to point out. First, we can replicate the size effects in a regression framework, and we can also check for similar results based on actual patenting behavior (Appendix Figure 8).[30] We will discuss these regressions in Section 4, but for now, we simply want to note that the size effects are robust to controlling for industry-by-year fixed effects and various controls for firm age and R&D intensity.

Second, the quantitative importance of size for explaining the importance of IP is clear when examining how differences across industries hold between larger and smaller firms. In the two panels of Appendix Figure 9, we examine how the importance of each type of IP varies across industries, but now splitting the sample between firms above and below $100 million in worldwide sales. Interestingly, the difference in the importance of IP across industries is more pronounced for smaller firms than larger ones. In particular, for smaller firms (top panel) we find a pattern across industries that is the same as the one identified in the full sample (Figure 4). For larger firms (bottom panel), the gap across industries is substantially smaller.[31]

Overall, the descriptive evidence suggests that the management of IP is significantly different across smaller versus larger firms, with the latter group being more active across all fronts.

[30] We also reproduce the same regression results with sampling weights (Table 2 in Appendix). We discuss them more in details in Section 4.
[31] In Appendix Figure 10, we show that a similar pattern holds when we repeat the same analysis using sampling weights, albeit the pattern is generally less strong.

4 The Role of Size and Age

This section explores the findings about age and size in more detail and provides some informed speculation about potential causes.

4.1 IP and Firm Age

As described above, we find no clear relationship between age and intellectual property strategies. That is, firm age does not appear to play an important role in determining how firms use various forms of IP. This result holds across several different analyses: for instance, the regression analysis suggests that this result does not simply capture differences across industries. At first sight, this result may appear surprising, since various theories would suggest a connection between IP strategies and age. For instance, younger firms may lack alternative appropriability mechanisms to protect new products or technologies, and might therefore be more reliant on legal protections.

Although age does not seem to predict reliance on IP, it is possible that after conditioning age, IP use predicts firm level outcomes. For example, Guzman and Stern (2015) measure various actions taken in the early life of an entrepreneurial company (e.g., patenting, trademark, corporate registrations) and find that these actions are informative regarding future growth. This suggests that firms do not pursue a specific type of IP strategy as a result of changes in business conditions (e.g., inventing a new product), but rather as a pre-determined choice that a firm makes at founding based on expected future opportunities. Following a similar approach, we can examine whether differences in the use of IP early in the life of a firm systematically predict future behavior.[32] If the absence of "age effects" in IP use reflect forward-looking decisions made by the firm, we should expect that initial use of IP explains future growth. We implement this test by looking at a sample of firms that answered the BRDIS survey in the first year of life, and we examine whether their future growth is associated with their initial survey responses regarding R&D activity and patenting.[33]

The findings of this analysis are reported in Table 1. We divide the sample into three groups: firms with no R&D or patenting (omitted category), firms that conduct R&D but do not patent, and firms

[32] Since most of the firms in our data are surveyed only once in the period covered (and this is particularly true for younger firms), we cannot directly test whether there is persistence in the reported importance of IP in our sample.
[33] To be specific, we only consider firms that answer the survey in year 0 or 1 and that have less than 50 employees in the survey year.

that are active in both R&D and patenting, and we test for differences in growth, always controlling for industry-by-year fixed effects.[34] The results show that firms that do both R&D and patenting start larger and experience significantly higher employment growth than firms that perform R&D without patenting, and the latter group, in turn, is larger and faster-growing than the reference group that does neither. This evidence confirms that the initial decision to patent contains significant information about the future behavior of firms.

In recent years, research in entrepreneurship has highlighted the risks of introducing policies that focus on a generic definition of "young firms," while failing to distinguish between those with the potential to become high growth companies (i.e., gazelle) and the rest (e.g., Sterk et al., 2021). Our findings reinforce that conclusion by showing that age *per se* does not necessarily tell us a lot about how a company uses IP, suggesting that this variable in isolation may not provide useful information for policy makers. At the same time, IP use seems to provide relevant information about the growth prospects of young firms.

4.2 IP and Firm Size

Another clear finding above is the strong connection between size and the importance of intellectual property. Unlike age, size systematically correlates with the use of IP: larger firms report all forms of IP to be relatively more important. The relationship appears to be largely monotonic, and it is not driven by a specific point of the size distribution. Furthermore, the same result also holds when examining actual behavior in patenting. As we show in Appendix Figure 8, this result also holds in a regression framework where we control for industry-by-year fixed effects as well as when we augment this specification for differences in age between firms and R&D intensity.[35] Moreover, incorporating sampling weights does not significantly affect this result (see Appendix Table 2).

There are several possible interpretations for the robust relationship between size and IP importance. A baseline explanation is that this increasing importance of IP for larger firms is exactly what we should expect given the nature of intellectual property (e.g., Gilbert and Newey,

[34] We conduct this analysis by matching our sample with the LBD to recover firm level employment in year five of the firm life (Fairlie et al., 2019). The act of conducting R&D and patenting is defined consistently with the previous analyses in the paper.

[35] We control by age by including the five dummies dividing firms based on age that were discussed earlier. We control for R&D intensity by measuring the amount of R&D performed scaled by sales worldwide.

1982, Argente et al., 2020, Crouzet and Eberly, 2019, Haskel and Westlake, 2017). In general, investments in intangible assets such as IP should not exhibit decreasing returns to scale. For instance, the value of a patent should be (at least) scalable as the firm's size grows, and a similar argument can be made for the other forms of IP protection discussed earlier (i.e., copyrights, trade secrets, trademarks). In this context, it is natural to expect that IP is relatively more important for larger firms.

However, large firms presumably differ from smaller firms in a variety of dimensions. This makes it hard to disentangle the previous explanation from alternatives. In principle, any factor that systematically differs across firm size and is also associated with the use of IP could explain the relationship found in the data. While excluding all possible alternative stories is beyond the scope of this study, we can use the richness of our data to exclude some leading alternative interpretations. In addition to the variables already discussed (i.e., industry, age groups and R&D intensity), we examine a variety of firm characteristics that are plausibly correlated with firm size and that may also explain their IP behavior.

First, we construct a proxy for the use of the market for technologies, under the assumption that larger firms may be more active in the market for technology, and also care relatively more about intellectual property. We specifically construct two dummy variables, one measuring firms that have used M&A to acquire IP and a second variable that specifically identifies firms that have been active in IP transfers.[36] Second, we control for the firm's investment in different type of R&D activities, in particular distinguishing R&D spent for basic research, applied research, and development (Cohen and Klepper, 1996, Coad et al., 2023).[37] In principle, firms of different size may tend to specialize more on some activities, and this specialization could shape their IP strategies. Third, we include variables that measure the type of innovation that the firm has produced. In our data, firms are asked to report their innovation across different dimensions (e.g., product, process, logistics). Different types of innovation – for instance product versus process –

[36] The M&A IP dummy is equal to one if the firm received any IP by a spinoff, acquired a company for its IP, or acquired financial interest in a company for its IP. The Transfer IP dummy is instead equal to one if the firm has transferred IP to others directly, transfer IP though a spin-off, or have been engaged in cross-licensing. These variables are measured in the year of the survey.

[37] We essentially include control for the share of R&D that is spent in development, and share of R&D spent in basic research. The residual omitted portion is R&D spent for applied research.

may require different types of IP protection, and therefore influence the behavior of the firm.[38] Finally, we control for the presence of a specialized IP office in the firm. The management of IP may be characterized by a sizable fixed-cost component. To the extent that larger firms are more likely to have an internal IP department, this dimension may explain a large part of the variation.[39]

We then use our regression framework to test how results change when we include these variables as controls. The output is provided in Figure 7. In every specification, we always include industry-by-time fixed effects, R&D intensity, and age controls. Across all combinations of controls examined and for each outcome considered, we find an economically significant positive relationship between firm size and IP importance. While the inclusion of controls in some cases affect the relative magnitude, the basic relationship remains economically and statistically significant.

This analysis highlights how the positive relationship between firm size and IP does not simply reflect routine observable differences in the nature of R&D or the innovation process. In particular, our finding does not appear to capture differences in industry, firm age, R&D intensity and composition, innovative output, use of the market for technologies, or the presence of a specialized IP office. While this list is not comprehensive – there might be unobserved differences between large and small firm innovation processes that drive the importance of IP – the results do suggest a strong role for scale *per se*.

There are two other findings that are relevant to understanding the importance of firm size in explaining the importance of IP. First, firm size is quantitatively important to understand cross-sectionally differences in the use of IP. To illustrate the quantitative significance of firm-size, we implement an R-Squared decomposition, which exploits the logic of Shapley values to estimate the relative share of variance that is explained by different groups of variables (Huettner and

[38] We specifically can control for innovation that improved goods, services, methods, logistics, and support activities. Each of these measures is measured through a specific dummy variable in the model.
[39] We use patent data to construct a variable which is equal to one if the firm is likely to have an internal IP. We link the patent data to the list of lawyers. Within the official patent lawyers, we identify those that are working directly for a firm by fuzzy match the name of the institution for which the lawyer works and the firm name. We then define a firm to have internal IP office if the firm received at least a patent in the period considered that was filed by a lawyer working for the firm. As expected, we find that the presence of an internal IP is largely concentrated in larger firms.

Sunder, 2012).[40] Table 2 presents the results by reporting always the share of variance explained by industry, year, and size categories but also including separately each of the other variables discussed above (i.e., age, R&D intensity, etc…). We conduct this analysis on the self-reported importance of patents, patenting probability, and patenting intensity.

In general, the results in Table 2 suggest that the size groups explain a significant share of the variance across all outcomes. If we look at the self-reported importance of patents (columns 1, 4, 7, 10, 13, 16, 19), we find that the size groups explain between 26% and 43% of the variance. Furthermore, size appears to be the most important observable factor, possibly together with industry. For this outcome, in the one-to-one comparisons, the share explained by the size groups is higher than any other dimensions considered, with the exception of factors measuring the market for technology. Size generally explains more variance when looking at actual patenting behavior at the extensive margin (i.e., "Any Patent"), and less when looking at patent intensity. Even in the latter case, however, size plays a significant role in explaining variation in the importance of IP.

Second, the relationship between size and patenting importance holds even for firms that do not conduct R&D. In Appendix Table 3, we replicate the same regression analysis focusing only on those firms without any R&D in the year of the survey.[41] The findings are consistent with those generated on R&D sample: larger firms tend on average to report higher importance of patents and also show a similar response in terms of behavior. This evidence suggests that the importance of IP for companies extends beyond the simple need of protecting the output of R&D activity, and therefore is consistent with the "scale" hypothesis discussed earlier.

Overall, our results show that firm size is an important variable when studying how firms use IP. On average, larger firms are more likely to self-report that various forms of IP protections – and in particular patents – are more important, and the same results hold for actual patenting behavior. This difference in behavior is not explained by observable differences across firms in industry, age, R&D investments, or innovative output. Furthermore, this effect holds on separately for both

[40] We implement this model using the command "rego" in Stata and using the same sample and variable definitions as the previous analyses. For computational reasons, our definition of industry in this analysis is broader and based on the two-digit classification. For the same reason, we also cannot include all variables at once but only sub-group by sub-group.

[41]This sample contains roughly 47,500 observations. Since these firms always have zero R&D, we cannot examine our measure of patent intensity for this group.

R&D and non-R&D firms, and it appears to explain a significant share of the cross-sectional of IP activities by firms.

5 Conclusion

This paper exploits novel Census data to revisit an old but important question: how do US firms use intellectual property protection? Our analysis focuses on documenting a set of five stylized facts. First, while patenting *per se* is relatively uncommon, patenting firms perform more than 90% of US R&D. Second, utility patents play a relatively small role for most US firms. On average, firms report that utility patents are not important, both for the economy as a whole and, more surprisingly, among the more innovative firms in the BRDIS sample. In relative terms, trade secrets, copyrights, and trademarks are reported as more important than patents. Third, industry differences play an important role in understanding the use of IP. In general, high-tech industries (Computer and Life Science) make greater use of all forms of IP protection than the rest of the manufacturing sector, retailers, and other firms. However, the relative ranking of different forms of protection remains stable across industries.

Fourth, our results highlight how age *per se* does not appear to play an important role in mediating the importance of IP. In general, there is no systematic relationship between firm age and IP, either in absolute levels (i.e., older firms do not care more about patents than younger ones) or across IP strategies (e.g. patents vs. trade secret). Fifth, unlike age, firms of different size appear to behave significantly differently on their use of IP. On average, larger firms tend to value and utilize IP much more than smaller firms. This result holds regardless of whether a firm performs R&D, and remains significant and large also when adjusting for differences across firms in R&D spending and innovation activities.

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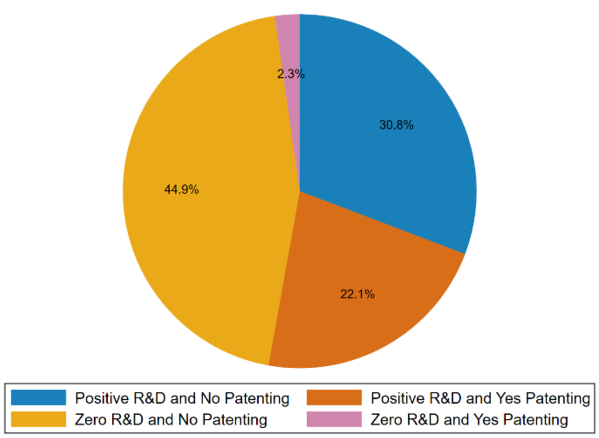
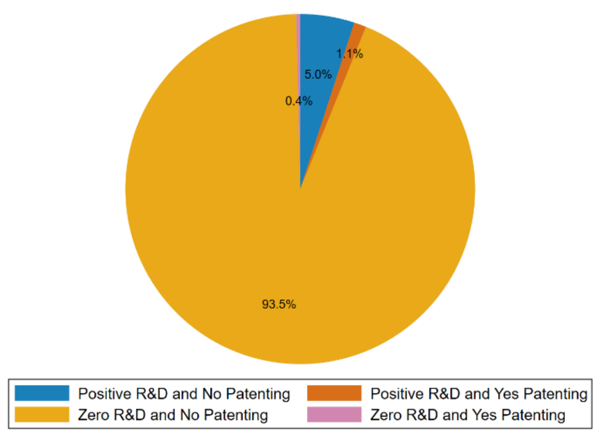
Figures

Figure 1. Composition of Firms by Patenting Activities and R&D Spending

This pie charts report the (unweighted) share of firms in the data used split based on whether the firm is conducting R&D in the year of the survey and whether the firm is labelled as patenting firm, following the usual definition. In panel (a), we conduct this analysis without any adjustment from the raw BRDIS sample, while in panel (b) we incorporate sampling weights. The actual percentages per group are reported in the figure.



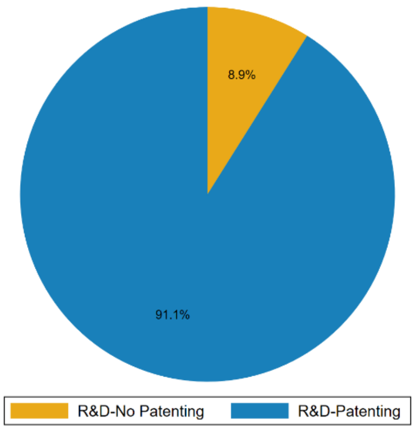
(a) Unweighted



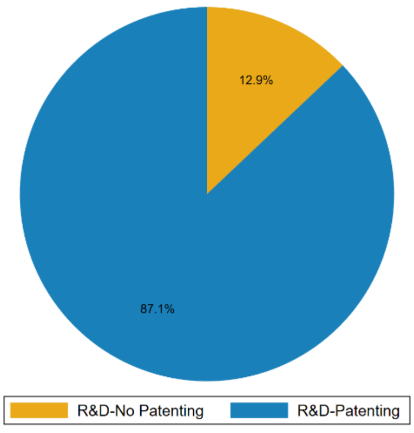
(b) Weighted

Figure 2. R&D Spending for Patenting and Non-Patenting Firms in the United States

This pie charts plot the share of R&D split between firms that patent and that do not patent, following the usual definition. In panel (a), we conduct this analysis without any adjustment from the raw BRDIS sample, while in panel (b) we incorporate sampling weights. The actual percentages per group are reported in the figure.



(a) Unweighted



(b) Weighted

Figure 3. Importance of Different IP Protection Strategies, All Firms

This bar graph reports the (unweighted) share of response by firm to the question: During this past year, how important to your company were the following types of intellectual property protection? This example question is modelled on the 2008 version. We consider five types of protections: patents, trade secrets, copyrights, trademark, and design patents.

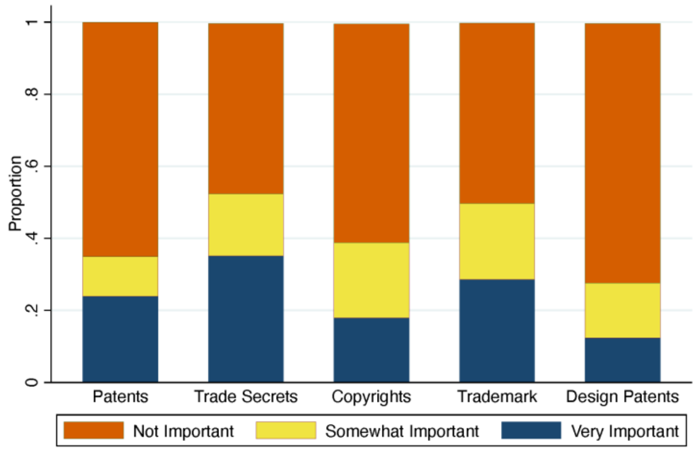


Figure 4. Importance of Different IP Protection Strategies by Industry

This set of bar graphs reports the (unweighted) share of response by firm to the question: During this past year, how important to your company were the following types of intellectual property protection? This example question is modelled on the 2008 version. We consider five types of protections: patents, trade secrets, copyrights, trademark, and design patents. Each panel focuses on a different form of protection and reports the share of responses in each category by macro industry classification. In particular, we split the sample in Life Science, IT, Manufacturing, Retail, and others (residual category).

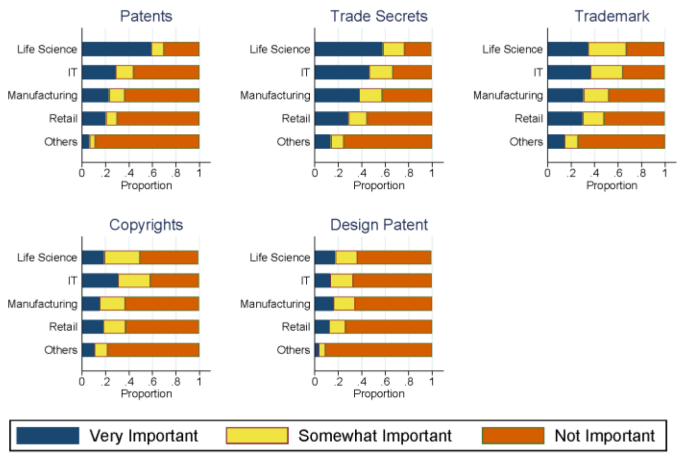


Figure 5. Importance of Different IP Protection Strategies by Firm Age Group

This set of bar graphs reports the (unweighted) share of response by firm to the question: During this past year, how important to your company were the following types of intellectual property protection? This example question is modelled on the 2008 version. We consider five types of protections: patents, trade secrets, copyrights, trademark, and design patents. Each panel focuses on a different form of protection and reports the share of responses in each category by groups of firm age. The five groups are defined as followed: (0) 0-2 years; (1) 3-9 years; (2) 10-19 years; (3) 20-29 years; (4) 30+ years.

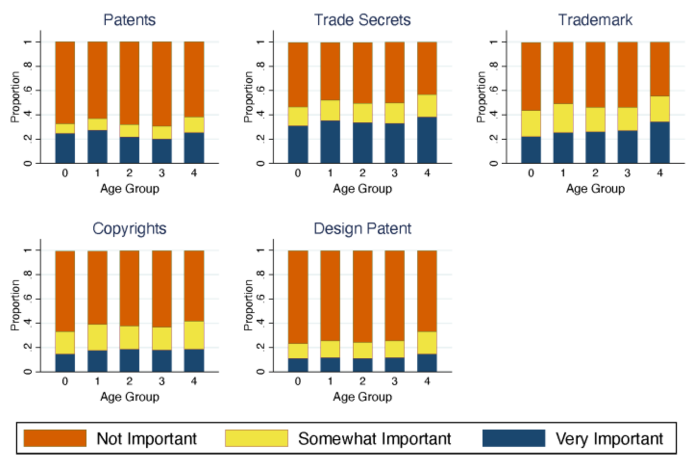


Figure 6. Importance of Different IP Protection Strategies by Firm Size Group

This set of bar graphs reports the (unweighted) share of response by firm to the question: During this past year, how important to your company were the following types of intellectual property protection? This example question is modelled on the 2008 version. We consider five types of protections: patents, trade secrets, copyrights, trademark, and design patents. Each panel focuses on a different form of protection and reports the share of responses in each category by groups of firm size (using worldwide sales as proxy). The five groups are defined as followed: (0) 0-10 million; (1) 10-25 million; (2) 25-100 million; (3) 100-1000 million; (4) 1000+ million. All values are in US dollars nominal terms.

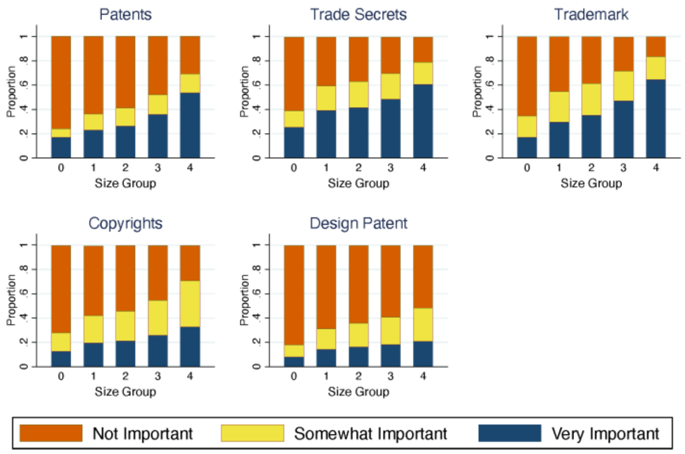
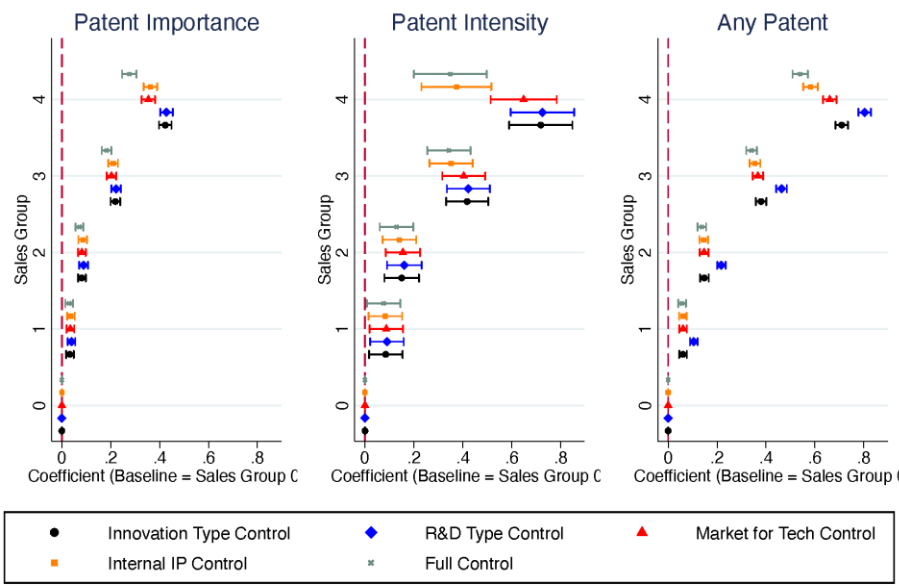


Figure 7. Estimates on Differences in Patent Importance, Intensity, or Patenting Status by Sales Group

These figures report the output of a regression model where we examine how size affects different proxy for importance of patent. In each case, the figure reports the coefficients on the effect of age for each group (i.e. (0) 0-10 million; (1) 10-25 million; (2) 25-100 million; (3) 100-1000 million; (4) 1000+ million.). The group zero is the reference group. The figure also reports the 95% confidence interval around the coefficient. The outcomes used are the self-reported measure of patent importance (i.e. dummy equal to one if the firm reported patents to be important or very important), patent intensity (i.e. patent count over R&D), and the variable any patent (i.e. dummy equal to one if the firm applied to any patent around the survey year). In each specification, we always include the (4-digit NAICS) by time (year) fixed effects, age controls, and R&D intensity controls. The different versions plotted, then report the effects as we include different types of control (as labeled). Notice that we also include one version where all controls are included together. Standard errors are clustered at firm-level.



Tables

Table 1. IP and R&D at Birth and Future Performance

This Table reports the results from a cross-sectional regression where we predict future growth with the responses of firms in the early part of its life. The sample contains all firms surveyed in the first two years of life by the BRDIS, which we were also able to match with LBD. The omitted group in the regression is the set of firms that did not do any R&D and did not patent early in life. At the bottom of the table, we also report the F-statistic for the difference between the two reported groups (R&D and patents versus R&D and no patents). Each specification includes industry (4-digit NAICS) by time (year) fixed effects. Heteroskedasticity-robust errors are provided in parenthesis.

	1{Active}	Ln(# Empl.+1)	Growth Emp (5yr)
R&D & Patent	0.037	0.507***	0.375***
	(0.058)	(0.126)	(0.087)
R&D & No Patent	-0.067	0.174**	0.161***
	(0.043)	(0.075)	(0.057)
Industry-Year FE			
r2	0.42	0.824	0.843
N	2000	2000	2000
Robust Errors			
F-statistics for the difference between “R&D & Patent” and “R&D & No Pat”	4.2	8.94	7.19

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2. Variance Decomposition

This Table reports the variance decomposition generated using the Shapley Value approach as in Huettner and Sunder (2012). Essentially, each column reports the share of the variance explained of the outcome by the characteristics reported in the first column. This decomposition is conducted by variable “group” rather than single variable. Each column should sum to 100 (net of rounding following the disclosure process). The analysis examines three outcomes, in line with the regression models. Across each column, we consider different combinations of controls. We always include the year, industry fixed effects (2-digit NAICS), and size groups.

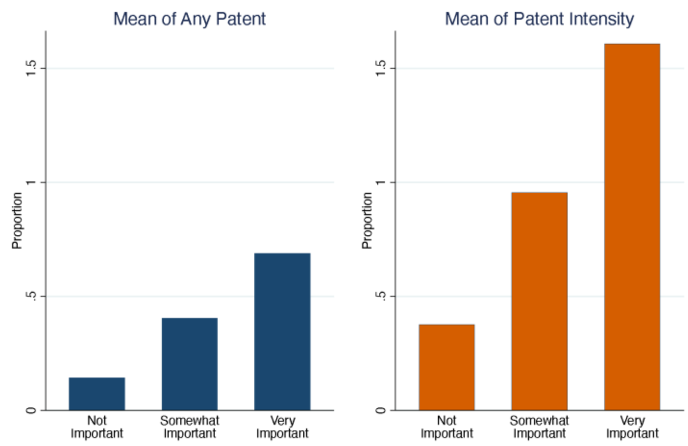
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variables	**1{Pat. Import.}**	**Pat. Intensity**	**1{Any Pat.}**	**1{Pat. Import.}**	**Pat. Intensity**	**1{Any Pat.}**	**1{Pat. Import.}**	**Pat. Intensity**	**1{Any Pat.}**	**1{Pat. Import.}**	**Pat. Intensity**	**1{Any Pat.}**
Size Groups	43.43	10.41	73.52	41.18	10.09	70.19	43.22	10.41	73.3	26.33	8.39	60.08
Industry	41.36	45.54	20.14	35.49	44.11	18.48	41.09	45.52	20.04	30.8	43.98	17.83
Year	15.22	44.04	6.33	12.53	41.96	5.83	15.08	44.03	6.3	12.06	42.74	5.77
Age Groups				13.23	3.82	5.48						
R&D Intensity							0.62	0.029	0.35			
Market for technology										30.81	4.88	16.31
Innovation Type												
Type of R&D spending												
Internal IP Office												

	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
Variables	**1{Pat. Import.}**	**Pat. Intensity**	**1{Any Pat.}**	**1{Pat. Import.}**	**Pat. Intensity**	**1{Any Pat.}**	**1{Pat. Import.}**	**Pat. Intensity**	**1{Any Pat.}**
Size Groups	34.64	8.97	68.68	38.39	10.28	69.42	28.24	5.28	47.7
Industry	34.07	35.86	19.09	38.12	45.41	19.21	34.13	36.05	15.05
Year	13.05	38.22	5.99	13.64	43.97	6.12	12.65	36.9	5.03
Age Groups									
R&D Intensity									
Market for technology									
Innovation Type	18.23	16.94	6.23						
Type of R&D spending				9.83	0.33	5.25			
Internal IP Office							24.97	25.21	32.21

Appendix Figures

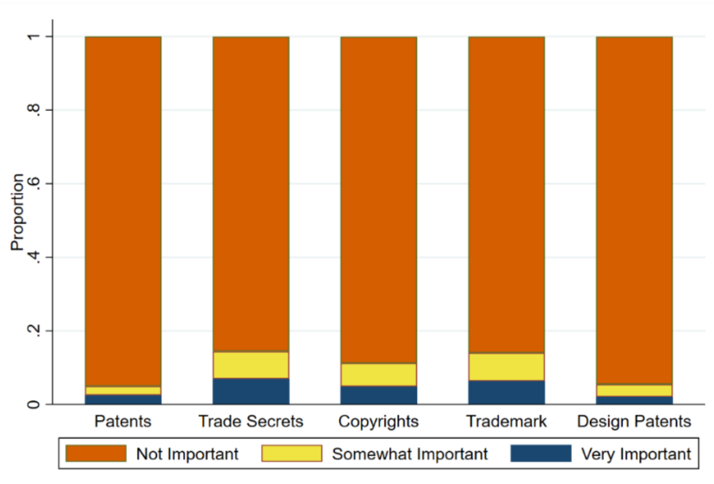
Appendix Figure 1. Patenting Behaviors of Firm Along Extensive and Intensive Margin

The two panels plot the mean of two measures of patenting behavior (y-axis) against the firm's response to the qualitative question (x-axis): how important for your company were there utility patents? In the first panel (left), the variable used to proxy patenting behavior is a dummy variable equal to one if the firm has applied to any panel in the 5-year window around the considered year in the survey. In the second panel (right), the variable used to measure patenting behavior is the ratio between the count of patents in same window as before scaled by R&D.



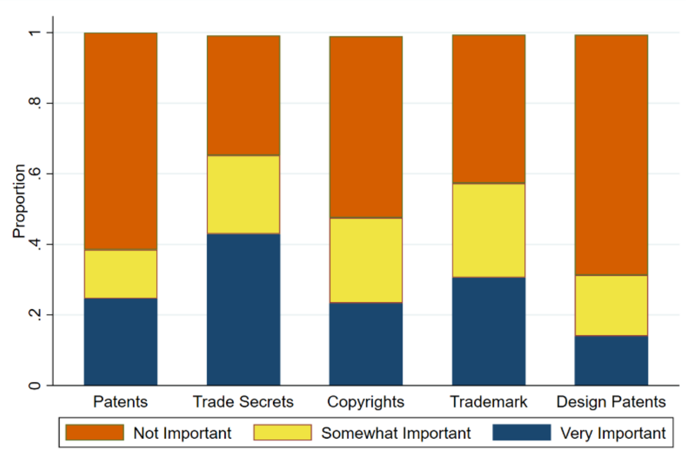
Appendix Figure 2: Importance of Different IP Protection Strategies, All Firms (Weighted)

This bar graph reports the (weighted) share of response by firm to the question: During this past year, how important to your company were the following types of intellectual property protection? This example question is modelled on the 2008 version. We consider five types of protections: patents, trade secrets, copyrights, trademark, and design patents.



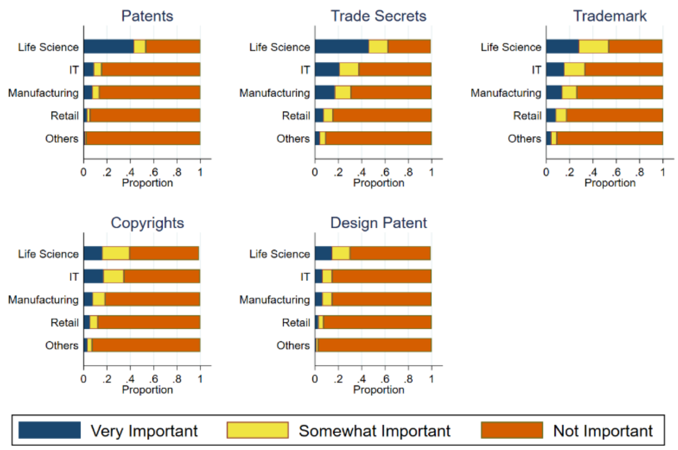
Appendix Figure 3. Importance of Different IP Protection Strategies, R&D Firms Only

This bar graph reports the (unweighted) share of response by firm to the question: During this past year, how important to your company were the following types of intellectual property protection? This example question is modelled on the 2008 version. We consider five types of protections: patents, trade secrets, copyrights, trademark, and design patents. In this analysis, we only consider the set of companies conducting R&D in the year of the survey.



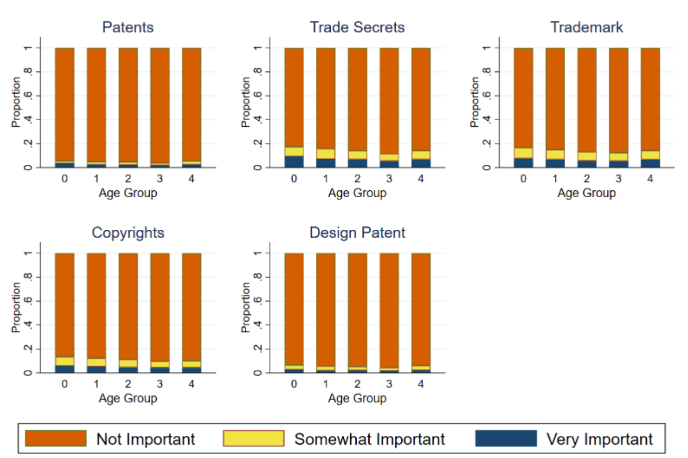
Appendix Figure 4: Importance of Different IP Protection Strategies by Industry

This set of bar graphs reports the (unweighted) share of response by firm to the question: During this past year, how important to your company were the following types of intellectual property protection? This example question is modelled on the 2008 version. We consider five types of protections: patents, trade secrets, copyrights, trademark, and design patents. Each panel focuses on a different form of protection and reports the share of responses in each category by macro industry classification. In particular, we split the sample into Life Science, IT, Manufacturing, Retail, and others (residual category).



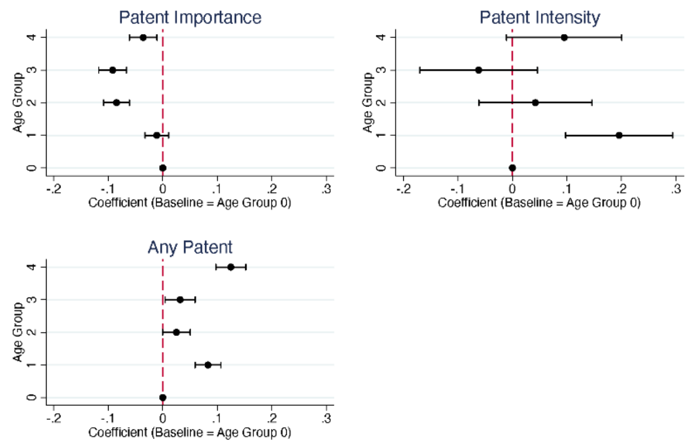
Appendix Figure 5: Importance of Different IP Protection Strategies by Firm Age Group (Weighted)

This set of bar graphs reports the (unweighted) share of response by firm to the question: During this past year, how important to your company were the following types of intellectual property protection? This example question is modelled on the 2008 version. We consider five types of protections: patents, trade secrets, copyrights, trademark, and design patents. Each panel focuses on a different form of protection and reports the share of responses in each category by group of firm age. The five groups are defined as follows: (0) 0-2 years; (1) 3-9 years; (2) 10-19 years; (3) 20-29 years; (4) 30+ years.



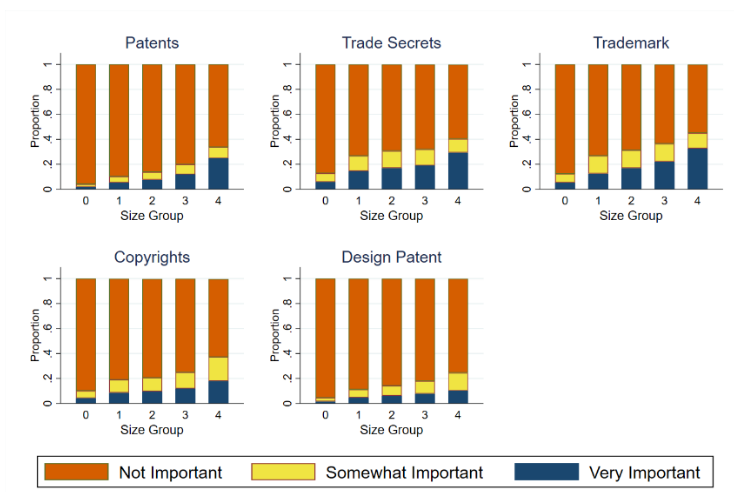
Appendix Figure 6. Estimates on Patent Importance, Intensity, or Patenting Status by Firm Age Group

These figures report the output of a simple regression model where we examine how age affects different proxy for importance of patent. In each case, the figure reports the coefficients on the effect of age for each group (i.e. (0) 0-2 years; (1) 3-9 years; (2) 10-19 years; (3) 20-29 years; (4) 30+ years). The group zero is the reference group. Each specification also includes industry (4-digit NAICS) by time (year) fixed effects. The figure also reports the 95% confidence interval around the coefficient. The outcomes used are the self-reported measure of patent importance (i.e. dummy equal to one if the firm reported patents to be important or very important), patent intensity (i.e. patent count over R&D), and the variable any patent (i.e. dummy equal to one if the firm applied to any patent around the survey year). Standard errors are clustered at firm-level.



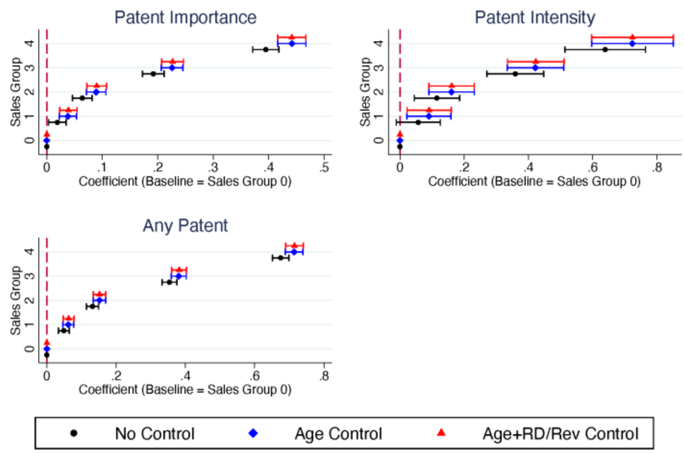
Appendix Figure 7: Importance of Different IP Protection Strategies by Firm Size Group (Weighted)

This set of bar graphs reports the (weighted) share of response by firm to the question: During this past year, how important to your company were the following types of intellectual property protection? This example question is modelled on the 2008 version. We consider five types of protections: patents, trade secrets, copyrights, trademark, and design patents. Each panel focuses on a different form of protection and reports the share of responses in each category by groups of firm size (using worldwide sales as proxy). The five groups are defined as follows: (0) 0-10 million; (1) 10-25 million; (2) 25-100 million; (3) 100-1000 million; (4) 1000+ million. All values are in US dollars nominal terms.



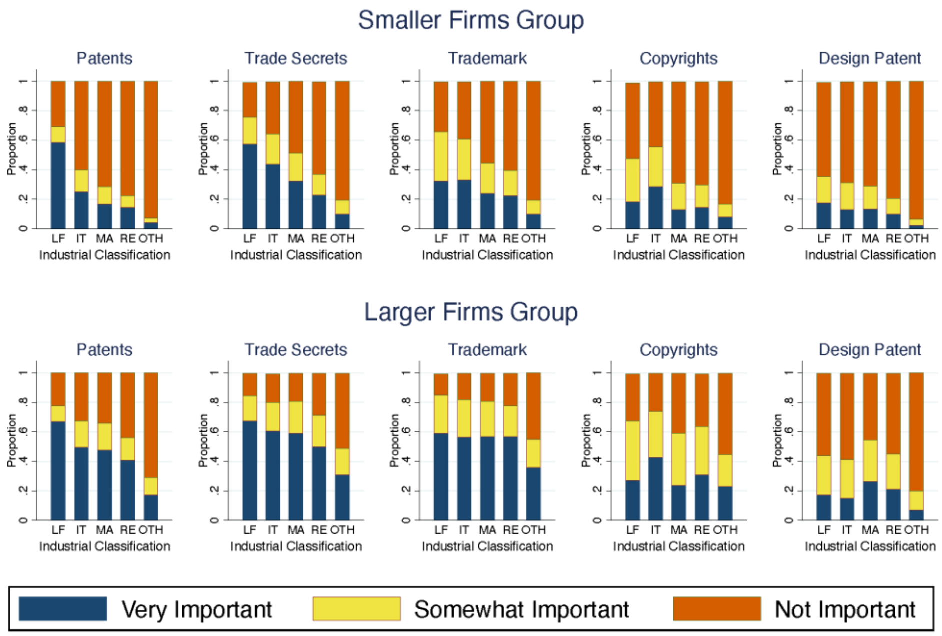
Appendix Figure 8. Estimates on Differences in Patent Importance, Intensity, or Patenting Status by Firm Size Group

These figures report the output of a regression model where we examine how size affects different proxy for importance of patent. In each case, the figure reports the coefficients on the effect of age for each group (i.e. (0) 0-10 million; (1) 10-25 million; (2) 25-100 million; (3) 100-1000 million; (4) 1000+ million.). Group zero is the reference group. The figure also reports the 95% confidence interval around the coefficient. The outcomes used are the self-reported measure of patent importance (i.e., dummy equal to one if the firm reported patents to be important or very important), patent intensity (i.e. patent count over R&D), and the variable any patent (i.e. dummy equal to one if the firm applied to any patent around the survey year). The outcome used is shown in the title of the specific panel. The black dots report the results when only (4-digit NAICS) by time (year) fixed effects are included. The blue square reports the result when also age dummies are included on top of the industry by year fixed effects. The red triangle reports the results when we also control for R&D intensity, on top of the age and industry by year effects. Standard errors are clustered at firm-level.



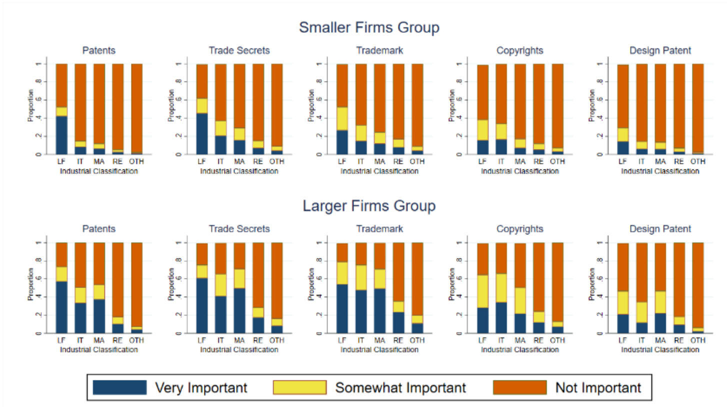
Appendix Figure 9. Importance of Different IP Protection Strategies by Industry for Large and Small Firms

This set of bar graphs reports the (unweighted) share of response by firm to the question: During this past year, how important to your company were the following types of intellectual property protection? This example question is modelled on the 2008 version. We consider five types of protections: patents, trade secrets, copyrights, trademark, and design patents. Each panel focuses on a different form of protection and reports the share of responses in each category by macro industry classification. In particular, we split the sample in Life Science, IT, Manufacturing, Retail, and others (residual category). The top graph reports the results for those firms that have less than $100 in sales. The bottom graph reports the same results for larger firms (higher than $100M in sales).



Appendix Figure 10: Importance of Different IP Protection Strategies by Industry for Large and Small Firms (Weighted)

This set of bar graphs reports the (weighted) share of response by firm to the question: During this past year, how important to your company were the following types of intellectual property protection? This example question is modelled on the 2008 version. We consider five types of protections: patents, trade secrets, copyrights, trademark, and design patents. Each panel focuses on a different form of protection and reports the share of responses in each category by macro industry classification. In particular, we split the sample into Life Science, IT, Manufacturing, Retail, and others (residual category). The top graph reports the results for those firms that have less than $100 in sales. The bottom graph reports the same results for larger firms (higher than $100M in sales).



Appendix Tables

Appendix Table 1: Correlation Between Different Forms of IP

This table reports the partial correlation between different forms of IP protection, as reported by sampled firms. As in the rest of the paper, we consider five forms of protection: utility patents, design patents, trademarks, copyrights, trade secrets. These measures take values between one and three, where a higher score signifies a higher importance of that form of IP. The table reports the partial correlation between the different measures, together with a measure of statistical significance of the parameter with respect to zero.

	Patent Importance	Design Pat. Importance	Trademark Importance	Copyright Importance	Trade Secret Importance
Patent Importance	1				
Design Pat. Importance	0.56***	1			
Trademark Importance	0.57***	0.50***	1		
Copyright Importance	0.46***	0.47***	0.73***	1	
Trade Secret Importance	0.58***	0.45***	0.67***	0.59***	1

*** p<0.01, ** p<0.05, * p<0.1

Appendix Table 2: Patent Importance, Size, and Age (Weighted)

This table reports the output of a weighted regression model where we examine how size and age affects different proxy for importance of patent. Consistent with the analyses shown before, we focus on the sample of R&D firms. The definitions of size and age groups is the same as before. To be precise, size is defined as: (0) 0-10 million; (1) 10-25 million; (2) 25-100 million; (3) 100-1000 million; (4) 1000+ million. Instead, age is defined as: (0) 0-2 years; (1) 3-9 years; (2) 10-19 years; (3) 20-29 years; (4) 30+ years. In both cases, the group zero is the reference group. The outcomes used are the self-reported measure of patent importance in the first three columns, the measure of patent intensity in columns 4 to 6, and the variable any patent in columns 7 to 9. We always include industry (4-digit NAICS) by time (year) fixed effects. For each outcome, we consider the effect of size alone, age alone, and both variables together. Standard errors are clustered at firm-level.

	(1) **1{Pat. Import.}**	**(2)** **1{Pat. Import.}**	**(3)** **1{Pat. Import.}**	**(4)** **Pat. Intensity**	**(5)** **Pat. Intensity**	**(6)** **Pat. Intensity**	**(7)** **1{Any Pat.}**	**(8)** **1{Any Pat.}**	**(9)** **1{Any Pat.}**
Sales Group=1	0.071***		0.087***	0.384***		0.425***	0.102***		0.111***
	(0.017)		(0.017)	(0.070)		(0.071)	(0.012)		(0.012)
Sales Group=2	0.123***		0.147***	0.353***		0.422***	0.166***		0.184***
	(0.020)		(0.021)	(0.050)		(0.050)	(0.011)		(0.010)
Sales Group=3	0.257***		0.290***	0.651***		0.734***	0.400***		0.423***
	(0.014)		(0.015)	(0.062)		(0.064)	(0.013)		(0.014)
Sales Group=4	0.465***		0.512***	0.905***		1.015***	0.740***		0.771***
	(0.015)		(0.017)	(0.070)		(0.075)	(0.013)		(0.015)
Age Group=1		-0.065**	-0.070**		-0.048	-0.067		0.025	0.018
		(0.029)	(0.029)		(0.110)	(0.109)		(0.018)	(0.018)
Age Group=2		-0.079***	-0.092***		-0.195*	-0.237**		-0.022	-0.040**
		(0.029)	(0.029)		(0.106)	(0.106)		(0.017)	(0.017)
Age Group=3		-0.083***	-0.117***		-0.239**	-0.344***		-0.003	-0.049***
		(0.030)	(0.031)		(0.113)	(0.113)		(0.019)	(0.019)
Age Group=4		-0.065**	-0.151***		-0.099	-0.326***		0.059***	-0.062***
		(0.028)	(0.029)		(0.109)	(0.111)		(0.018)	(0.018)
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
r2	0.267	0.248	0.272	0.136	0.127	0.139	0.274	0.197	0.278
N	53000	53000	53000	53000	53000	53000	53000	53000	53000

*** p<0.01, ** p<0.05, * p<0.1

Appendix Table 3. Patent Importance and Size, non-R&D firms

This table reports the output of a regression model where we examine how size affects different proxy for importance of patent. Unlike before, we only focus on firms without any R&D investment. In each case, the table reports the coefficients on the effect of size for each group (i.e. (0) 0-10 million; (1) 10-25 million; (2) 25-100 million; (3) 100-1000 million; (4) 1000+ million.). The group zero is the reference group. The outcomes used are the self-reported measure of patent importance (i.e. dummy equal to one if the firm reported patents to be important or very important) and the variable any patent (i.e. dummy equal to one if the firm applied to any patent around the survey year).We always include industry (4-digit NAICS) by time (year) fixed effects, and in even columns we also include control for age, using the same group as defined in the rest of the analysis. We cannot do this analysis for patent intensity since R&D is always zero for these firms. Standard errors are clustered at firm-level.

	1{Pat. Import.}	**1{Pat. Import.}**	**1{Any Pat.}**	**1{Any Pat.}**
Size Group 1	0.029***	0.031***	0.024***	0.023***
	(0.004)	(0.004)	(0.003)	(0.003)
Size Group 2	0.040***	0.043***	0.055***	0.054***
	(0.005)	(0.005)	(0.004)	(0.004)
Size Group 3	0.070***	0.075***	0.130***	0.128***
	(0.007)	(0.007)	(0.008)	(0.008)
Size Group 4	0.162***	0.171***	0.405***	0.401***
	(0.015)	(0.015)	(0.019)	(0.019)
Age	No	Yes	No	Yes
Industry-Year FE	Yes	Yes	Yes	Yes
r2	0.097	0.098	0.181	0.181
N	47500	47500	47500	47500

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1