# Innovation, Patenting and Appropriability: Survey Evidence from a Nationally Representative Sample of U.S. Firms

Filippo Mezzanotti and Timothy Simcoe*

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We document a series of stylized facts about how firms seek to protect the rents from innovation, using a large nationally representative survey of U.S. businesses over the period 2008-2015. Just 1.4 percent of firms obtain patents, but these patenting firms account for 87 percent of R&D investment. Firms consider utility patents less important than other forms of IP protection, like trade secrets, trademarks, and copyrights. Firm industry and size are strongly correlated with firms' use of all types of intellectual property, but firm age is not. Implications for innovation research and policy are discussed.

* Filippo Mezzanotti is at Kellogg School of Management, Northwestern University. Timothy Simcoe is at Questrom School of Management, Boston University and NBER. Any views expressed are those of the authors and not those of the U.S. Census Bureau. The Census Bureau's Disclosure Review Board and Disclosure Avoidance Officers have reviewed this information product for unauthorized disclosure of confidential information and have approved the disclosure avoidance practices applied to this release. This research was performed at a Federal Statistical Research Data Center under FSRDC Project Number 1874. (CBDRB-FY21-P1874-R9007, CBDRB-FY23-P1874-R10272). We thank Nikolas Zolas, Elizabeth Perlman, Mark Schankerman, Cesare Righi, Nicolas Crouzet, Ben Jones, David Pérez-Castrillo, Pere Arque-Castells, and the conference participants at the NBER Innovation Summer Institute, Kellogg Science of Science Meeting, Barcelona Summer Forum 2022, IP Day at BU, USPTO Chief Economist Seminar for the helpful comments. We thank Davin Wang, Alvin Lumbanraja and Ayush Sinha for the excellent research support. We also thank Frank Limehouse and Lanwei J. Yang of the Census Bureau for help and advice along the whole process. The Technology & Policy Research 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 social returns exceed private returns to R&D. At the firm level, this gap between private and social returns is often framed as an "appropriability problem" wherein the relationships among R&D investment, innovation outcomes, and profitability depend upon both firm strategy and intellectual property policy.

Although there is a vast literature on innovation, it offers a limited perspective on the appropriability problem. The main issue is measurement: aside from patents, it is hard to observe how firms protect innovations.[1] Much of what we do know about appropriability comes from 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 capturing value created by their innovations. Yet these surveys are now over 20 years old, and new evidence suggests that the locus of R&D investment and innovation for U.S. firms may have changed (Foster, Grim and Zolas 2020; Ozcan and Greenstein 2013).

This study revisits the broad question of how firms seek to appropriate the benefits of innovation using data from the Business R&D and Innovation Survey (BRDIS) collected by the US Census between 2008 and 2015. BRDIS asks about firms' use of patents, trade secrets, trademarks and copyright protection, as well the level and composition of their R&D investments. Because the survey is based upon a large representative sample – encompassing firms of different size, age, and industry – we can produce estimates that are representative of the population of US businesses.

The BRDIS data allow us to extend the prior literature in several directions. First, we check whether previous findings continue to hold in a more recent nationally representative sample. Second, we validate survey measures of the perceived importance of intellectual property (IP) protection, at least for patents, by showing they are highly correlated with actual patenting. Third, we examine how patent propensity varies with firm-age, complementing previous analyses that examine the link between size and patenting. Finally, building on our analysis of patenting over

[11] In his review of the literature on patent statistics, Griliches (1990) notes that, "In this desert of data, patent statistics loom up as a mirage of wonderful plenitude and objectivity."

the firm life cycle, we examine the link between IP strategy, employment growth and exit rates for newly founded firms.

Our analysis reveals that many previously documented patterns, such as the strong relationship between firm-size and the use of formal IP protection, continue to hold true. We also generate some new findings, such as the absence of a relationship between firm-age and IP protection. This short paper is organized around five stylized facts that we introduce here and elaborate 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 unweighted BRDIS sample, which skews heavily toward large firms that perform R&D, only 25% of companies are patenting firms. This small group of patenting companies nevertheless accounts for more than 90% of private-sector R&D investment.

Second, respondents do not consider patents the most important means to capture the benefits of innovation. For the nationally representative sample, 95% of firms report that utility patents are not important. For the unweighted BRDIS sample, around two-thirds of firms report that utility patents are not important. In relative terms, patents are rated less important than trade secrets, (and to a lesser extent) copyrights and trademarks.

Third, IP strategies vary substantially across industries. Companies in high-tech industries consistently report that all forms of IP protection are more important.[2] Although Life Sciences companies consistently indicate that patent protection is very important, the relative importance of different types of IP protection does not vary across industries. Outside of high-tech, manufacturing, and retail, the perceived importance of IP is very low.

Fourth, firm size is strongly correlated with IP strategy. In particular, 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 patents, the importance of firm size persists when controlling for a wide variety of other observable characteristics, and is strong enough that it eliminates much of the inter-industry variation among the largest group of firms.

[2] 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).

Finally, there is no systematic relationship between firm age and either the stated importance of IP or firms actual propensity to patent. This result holds in both the nationally representative (weighted) sample and the unweighted BRIDS 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 strategy could 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).

This study contributes to a broad literature on the determinants of innovation activity,[3] and more specifically to research that uses firm-level survey data to study the appropriability problem. Hall et al (2014) and Sampat (2018) review this literature which, in addition to the Yale and Carnegie surveys, includes pioneering work by Scherer (1959) and Mansfield (1986), numerous studies based on the European Community Innovation Survey (e.g., Veugelers and Cassiman 1999), and the more recent Berkeley Patent Survey (Graham et al 2009) focusing on small early-stage companies.[4] Although we address similar questions to these prior studies, two key contributions of this paper are to combine observational with qualitative response data, and to bring a host of important facts together in one place, using a single nationally representative sample of U.S. firms. One limitation of the Census data, however, is that it does not include questions about "informal" modes of IP protection, such as product development lead time or complementary capabilities. These strategies were included in the Carnegie survey, and may become more important when formal IP protections is weak (Teece 1986, Gans and Stern 2002).

Our findings on firm size and formal IP protection are also relevant to an emerging literature that links intangible capital to increasing concentration and low investment by US firms (Crouzet and

[3] 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; Babina, et al. , 2024, 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.

[4] 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; Duguet and MacGarvie, 2005; Mohnen et al., 2006).

Eberly, 2019). That literature 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 of more aggressive use of formal IP protection by large firms. 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 a 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 patenting is strongly correlated with employment growth – a result that echoes recent findings of Guzman and Stern (2020), and is consistent with the evidence in Sterk et al. (2021).

# 2 Data

Our data come primarily from the Business R&D and Innovation Survey. Each year BRDIS sampled over 40 thousand for-profit, nonfarm businesses with five or more employees operating in the United States. The survey instrument contains questions related to R&D activity, use of intellectual property, and firm-level demographic information. Although BRDIS is one of the main inputs used to construct aggregate R&D statistics for our study period, use of the disaggregated firm-level data remains limited (Driver, Kolasinski, and Stanfield, 2020; Foster, Grim and Zolas 2020; Mezzanotti and Simcoe, 2023).

This BRDIS data have two key features that are important for our analysis. First, the survey covers a large group of firms and includes sampling weights that allow us to construct nationally representative statistics. Second, the survey instrument is designed to produce comparable measures of a variety of different innovation activities. For example, we analyze a set of qualitative response questions that ask whether various types of IP protection (utility patents, design patents, trade secrets, copyrights, and trademarks) are "very important", "somewhat important", or "not important" to a firm.[5] These questions allow us to examine strategies (e.g., trade secrecy) that are normally hard to observe, and facilitate comparisons across firms and strategies without having to control for differences in scale, scope, or industry, as we would do for actual behavior.

The analysis sample is constructed by combining eight waves of the BRDIS survey between 2008 and 2015, excluding non-respondents and foreign-owned firms. We link this sample to the Longitudinal Business Database (LBD), which provides information on firm-age and employment, and to administrative data on granted US patents (via the procedure developed by Dreisigmeyer et al., 2018). Appendix A.1 provides more details on data construction.

Although our main results use sampling weights to make the statistics nationally representative, we also conduct several unweighted analyses. Because BRDIS over-samples companies that are known to perform R&D, the unweighted statistics provide insights into the strategies of companies more directly engaged with innovation activity. To illustrate, consider the share of firms that obtain patents (within a 5-year window centered on the survey year) or report any R&D (in the survey year). In the unweighted BRDIS sample, 53% of firms perform R&D, and 25% obtain patents. If sampling weights are used, however, around 6% of firms report R&D and only 1.4% obtain patents.[6] In general, although the levels of IP use and R&D investment decline dramatically when sampling weights are used, the cross-sectional relationships that we report below are not sensitive to the use of weights.

# 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 uncommon, but R&D is concentrated among patenting firms.

[5] 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?" 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.

[6] Appendix Figure 2 provides the joint distribution of the R&D and patenting indicators for both samples.

As we have just described, only 1.4% of all non-agricultural firms with five or more employees in the US economy obtain patents. Even within the unweighted sample, just one quarter of all firms obtain a patent within two years before or after the year when they are surveyed. Conditional on reporting R&D, the share of firms that patent increases to 25 percent (or 42 percent in the unweighted sample).[7] The bottom line, therefore, is that even among innovative firms most do not patent.

Patenting firms nevertheless account for a large majority of R&D activity. Figure 1 shows that around 87% of all private sector R&D is performed by patenting firms, and that figure increases to 91% in the unweighted sample.[8]

### 3.2 Patenting is not the most important strategy for capturing innovation rents.

We use the qualitative response questions in BRIDS to assess the relative importance of utility patents, design patents, trade secrets, copyrights, and trademarks. Respondents are asked whether each type of IP protection is "very important", "somewhat important", or "not important." A standard concern with this type of information is that firms may not understand the scale or fail to report truthfully. For patents, however, we can compare self-reported preferences with actual behavior. This reveals an economically large and statistically significant association between the self-reported importance of patents and firms' actual propensity to patent (measured as either an indicator for patenting, or the number of patents obtained per dollar of reported R&D).[9]

Figure 2 uses the sample weights to illustrate the relative importance of various type of IP protection for U.S. businesses. None of the appropriability strategies considered in BRDIS was rated "somewhat" or "very" important by more than 15% of firms. For example, trade secrets are considered very or somewhat important by 14% of firms, trademarks for about 14%, and copyrights for about 11% of firms.[10] Utility patents are considered somewhat or very important by just 5% of companies, making it the least important IP strategy among those considered.

[7] 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.

[8] See Appendix Figure 3.

[9] Details of our efforts to validate the patent question are provided in Appendix A.2.

[10] 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.

In the unweighted sample, firms assign greater importance to all forms of IP protection, but the relative importance of each strategy is quite similar.[11] For example, 35% of firms indicate that patents are either somewhat or very important, and 52% indicate that trade secrets are somewhat or very important.[12] We find similar results when focusing on firms that report R&D during the survey year.

At this point, it is natural to ask how the importance of these different strategies relate to each another. We find a strong positive correlation in the stated importance of all types of IP protection.[13] This suggests that firms do not "specialize" by focusing on a particular type of IP, and that companies cannot easily substitute one type of IP protection for another.

Altogether, the survey evidence indicates that firms view trade secrecy as more useful than patents, but often see none of the IP strategies considered by BRDIS as important. The fraction of firms that view patents as important increases as we focus on companies that are more engaged with innovation and R&D, but even in the best-case scenario, about two thirds of companies claim patents are not at all important.

### 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 (Hall et al., 2014). We start by dividing the sample of firms into five groups based on their industry classification: Life Science and Drugs, Information Technologies (IT), Manufacturing, Retail, and Others (the residual category).[14]

Figure 3 shows the relative importance of the different IP strategies across these industry groups using the sampling weights. Firms in high-tech industries (Life Science and IT) report that all types

[11] See Appendix Figures 4 and 5.

[12] Another example is trademark, with 50% of firms saying that they are important. 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.

[13] See Appendix Table 1.

[14] 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.

of formal IP are relatively more important, whereas firms in the residual "Other" category consistently rank at the bottom in terms of stated importance.

Focusing on Life Science firms, we find that around 53% report patents to be either very or somewhat important, which is significantly higher than for IT (15%), manufacturing (13%), retail (5%), and other (2%). This rank ordering remains the same for all forms of IP. For instance, if we look at trade secrets, Life Science again ranks first with 63% of firms reporting this strategy to be at least somewhat important, followed by IT (38%), manufacturing (31%), retail (15%), and other (9%). In terms of rank ordering, the results of this analysis for the unweighted BRDIS sample are remarkably similar.[15]

Overall, industry significantly influences the perceived importance of IP protection. High-tech firms generally prioritize all IP protection mechanisms, whereas non-high-tech sectors, such as manufacturing and retail, consider IP protection less crucial. The stable ordering of perceived importance by industry, across all types of IP protection, suggests once more that firms do not see these strategies as close substitutes.

### 3.4 Importance of IP does not change as firms age

Although BRDIS does not track individual firms over time, it captures a broad spectrum of firms at various points in their age distribution. This allows us to study how the perceived importance and actual sue of IP changes over the firm life cycle.

To study this question, we divide the BRDIS sample into five groups based on age. The youngest firms (group 0) are still at the start-up phase (0-2 years), while the oldest (group 4) have been active for over three decades.[16] Figure 4 shows that there is little or no relationship between firm age and the perceived importance of any type of IP protection. We find similar results in the unweighted sample.[17]

To control for omitted industry-level factors that might confound the relationship between age and IP, we also estimate a regression that controls for industry fixed effects (4-digit NAICS) interacted

[15] See Appendix Figure 6.
[16] We define a firm's age as the age of its oldest establishment in the LBD. 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.
[17] See Appendix Figure 7.

with year dummies. For this analysis, we focus on patents because it is possible to observe not just stated importance, but also the likelihood of patenting (extensive margin) and the number of patents scaled by R&D performed (intensive margin).[18] Across both the self-reported measure and actual patenting behavior, we fail to identify any consistent relationship between firm age and patenting. While some coefficients are statistically different from zero, the magnitudes are generally small and more importantly there is no consistency across outcomes and groups.[19]

We conclude that differences in age do not explain much variation in firms' IP strategy. 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 more active in all forms of IP protection

We now examine whether differences in firm-size explain variation in the importance of IP protection. We divide firms into five groups based on their worldwide sales. The smallest firms (group 0) have sales below $10 million, while the largest (group 4) have sales over $1 billion.[20] Figure 5 shows a strong positive correlation between firm-size and the stated importance of all type of IP protection. For example, 34% of the largest firms find patents somewhat important, while only 3% of the smallest firms do. Similarly, 40% of large firms value trade secrets, compared to just 13% of the smallest ones. We find similar patterns for the unweighted data, and in regression analyses that control for industry, age, and R&D intensity.[21]

To quantify the relative importance of size, age, industry effects, we use R-Squared decomposition, which applies Shapley value logic to estimate the share of variance explained by different variable groups (Huettner and Sunder, 2012). Appendix B describes the method and results.[22] We find that

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[18] The results are reported in Appendix Figure 8 and Appendix Table 2 (using sampling weights). 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. Throughout the paper, the patent intensity measure is winsorized at 5% to exclude that any of our results is affected by the presence of outliers.

[19] It's not surprising that some coefficients differ from zero due to the numerous estimated parameters. However, (1) we don't observe a consistent relationship between the three outcomes; (2) the direction of effects often varies across outcomes (e.g., one age group has higher patent intensity but lower patent importance); (3) the average effect size is generally small, with over half of that estimated for firm size.

[20] 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.

[21] See Appendix Figure 9, Appendix Figure 10, and Appendix Table 2.

[22] See Appendix Table 4 for results. 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

firm size accounts for between 26% to 43% of the explained variance in the stated-importance of patents, which is similar in magnitude to industry effects.[23]

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. Furthermore, a firm's size appears to generally explain a significant share of the cross-sectional variance in IP importance.

# 4 Discussion

One novel element of the preceding descriptive analysis is our ability to examine the importance of different forms of IP across both firm age and size. This section offers some informed speculation about potential causes for our finding that size matters while age does not.

The absence of any correlation between age and IP strategy may seem surprising, as is quite easy to hypothesize a connection. For instance, younger firms may be more reliant on legal protections because they lack alternative appropriability mechanisms to protect new products or technologies. An alternative hypothesis that is consistent with the absence of age effects is that firms do not pursue a specific type of IP strategy because of changes in business conditions (e.g., inventing a new product or opening a new store), but rather as a pre-determined choice that a firm makes at founding based on expected future opportunities. Appendix Table 5 provides some evidence that is consistent with this hypothesis.

We focus on firms that were surveyed in their first year of life and divide the sample into three groups: firms with no R&D or patenting, firms that conduct R&D but do not patent, and firms that are active in both R&D and patenting. We then test whether early decisions around R&D and IP predict future growth.[24] 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

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.

[23] This evidence is consistent with the results presented in Appendix Figure 11 and discussed in Appendix B. This analysis shows that a firm's size trumps differences in industry: in other words, we find that the industry differences discussed earlier significantly shrinks when looking at large firms.

[24] 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. 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).

patenting, and the latter group, in turn, is larger and faster-growing than the reference group that does neither.

This evidence indicates that the initial decision to patent contains significant information about the future behavior of firms, consistent with the findings in Guzman and Stern (2015), and suggests that the absence of "age effects" may reflect forward-looking decisions made by the firm about IP. This interpretation is consistent with the recent research in entrepreneurship that 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.

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.

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, 1982, Argente et al., 2020, Crouzet and Eberly, 2019, Haskel and Westlake, 2017). 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).

Disentangling this hypothesis from every possible alternative is clearly challenging because large firms presumably differ from smaller firms in many dimensions. We can use the richness of our data, however, to exclude some leading candidates. Specifically, we can use a simple regression and examine how the effect of size on patent importance changes as we include more firm characteristics. On top of more baseline controls (i.e., industry, age groups and R&D intensity), we include measures that proxy for a firm's use of markets for technology (i.e., dummy variables for the use of M&A to acquire IP and for whether the firm is active in IP transfer); the breakdown of a firm's R&D investments between basic research, applied research and development (Cohen and Klepper, 1996, Coad et al., 2023); a set of dummies controlling for various types of innovation output produced by the firm (e.g., product, process, logistics); and the likely presence of an internal IP office.[25]

The inclusion of these controls – either separately or all together – does not change our basic result: across the enter firm-size distribution, larger firms report that patenting is relatively more important, and act is if this is true. This analysis highlights how the positive relationship between firm size and IP does not simply reflect routine observable differences in R&D or the innovation process, at least as measured here.

# 5 Conclusion

This paper uses new Census data to address an old question: how do US firms employ intellectual property protection? Our analysis presents five key findings: First, patenting is relatively rare, but patenting firms conduct about 90% of US R&D. Second, utility patents have limited relevance for most US firms; patents are generally considered less important than trade secrets, copyrights, and trademarks. Third, industry variations significantly influence IP usage, with high-tech industries (e.g., Computer and Life Science) employing more IP protection than other sectors, though the ranking of protection methods remains consistent across industries. Fourth, firm age appears to have little impact on IP significance. Fifth, larger firms place greater importance on and use IP more than smaller firms.

[25] See Appendix B for a detailed discussion of the variable construction. The results are shown in Appendix Figure 13.

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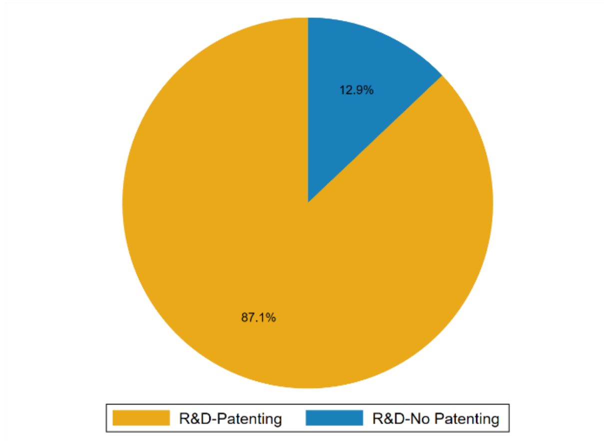
# Figures

## Figure 1. 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. We conduct this analysis incorporating the sampling weights from the raw BRDIS sample. The actual percentages per group are reported in the figure.




## Figure 2: Importance of Different IP Protection Strategies, All Firms

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. To facilitate the visualization of the output, we rescaled the baseline level of the histograms to 80%.

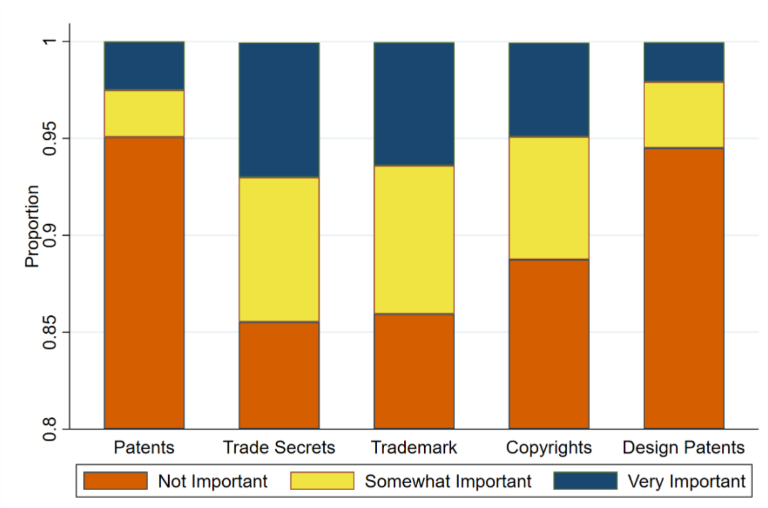
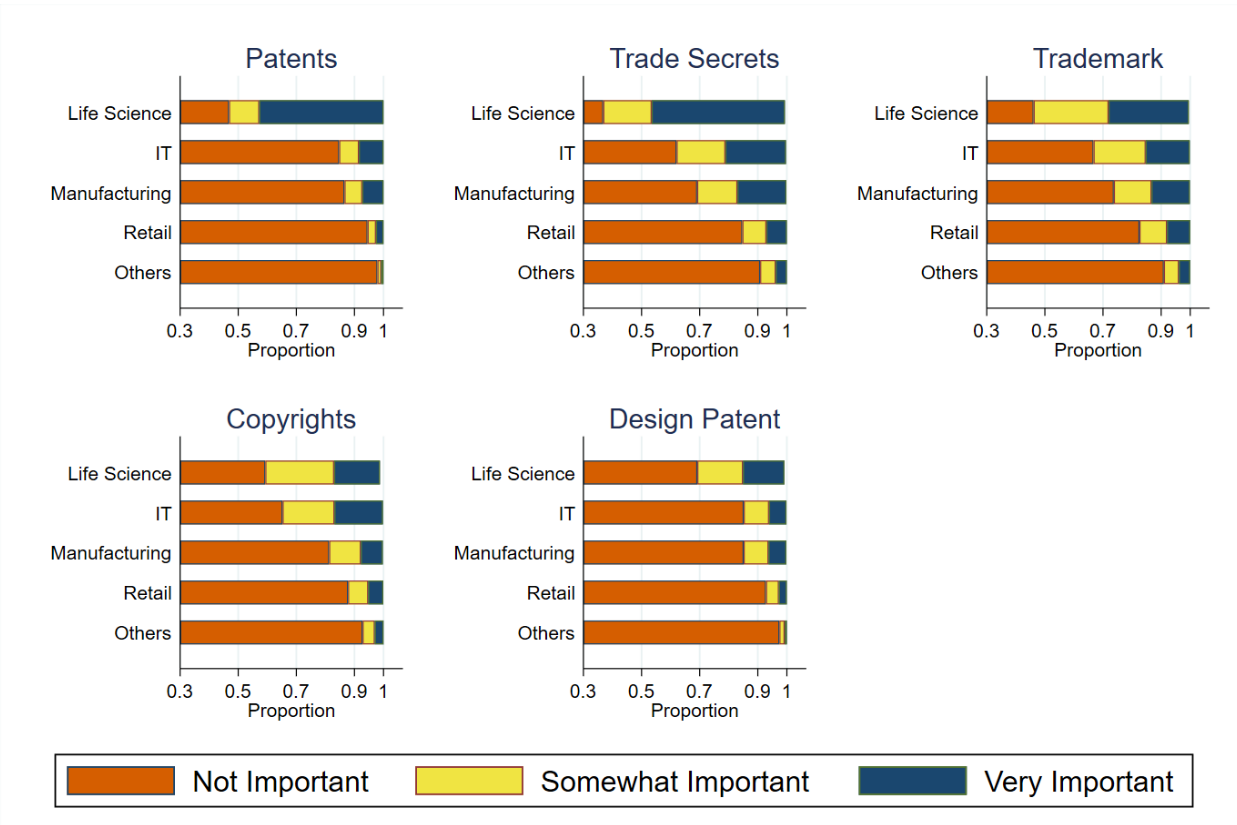


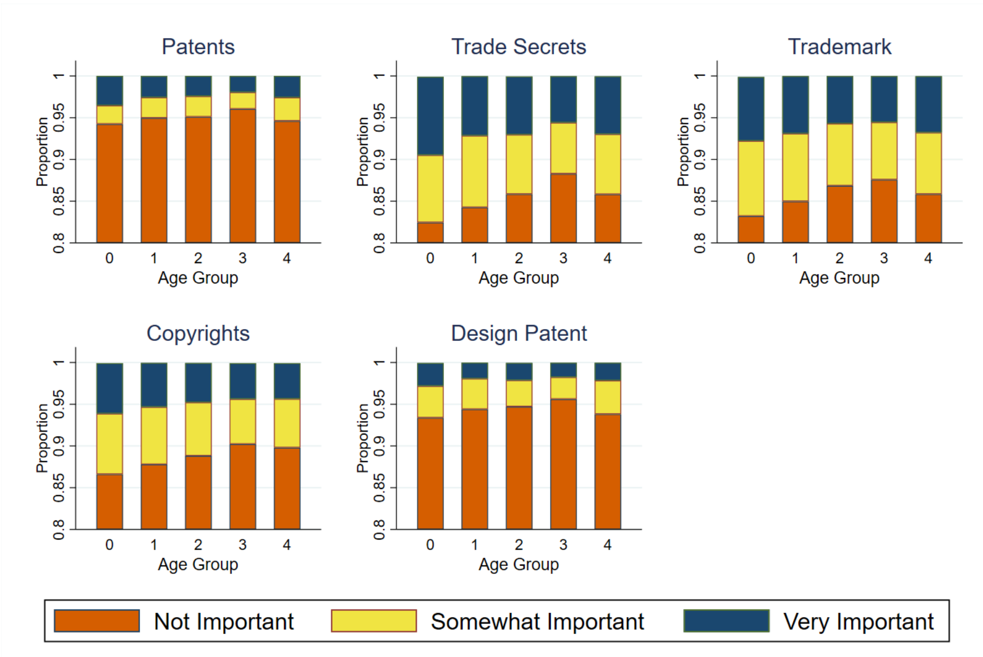
**Figure 3: Importance of Different IP Protection Strategies by Industry**

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). To facilitate the visualization of the output, we rescaled the baseline level of the histograms to 30%.



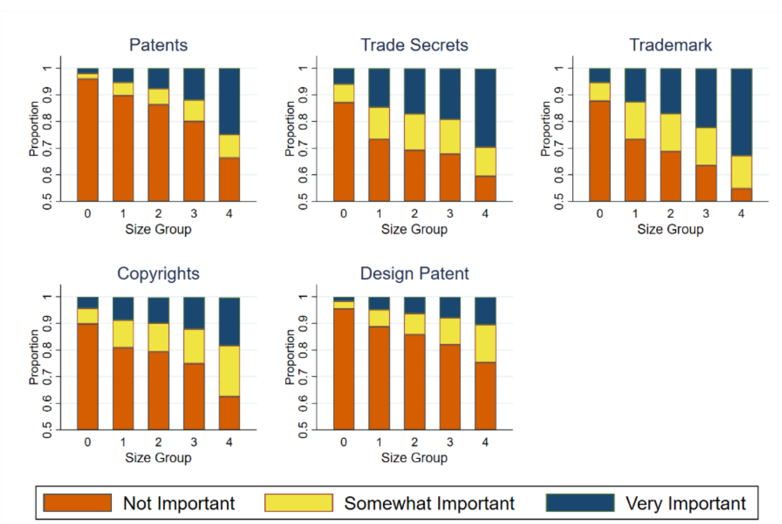
## Figure 4: Importance of Different IP Protection Strategies by Firm Age Group

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 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. To facilitate the visualization of the output, we rescaled the baseline level of the histograms to 80%.




## Figure 5: Importance of Different IP Protection Strategies by Firm Size Group

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. To facilitate the visualization of the output, we rescaled the baseline level of the histograms to 50%.



# Appendix - Innovation, Patenting and Appropriability: Survey Evidence from a Nationally Representative Sample of U.S. Firms

Filippo Mezzanotti and Timothy Simcoe

## Appendix A-Data

### A.1 The Business R&D and Innovation Survey

Our data comes 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.[1] The survey was conducted annually from 2008 until recently, when it was reorganized into the Business Enterprise Research and Development Survey (BERD). The BRDIS 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.[2]

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. The representativeness of the sample gives us a crucial advantage relative to past literature, which had to rely on smaller surveys generally focused on large firms active in R&D intensive industries (e.g., Levin, Klevorick, Nelson and Winter, 1987; Cohen, Nelson and Walsh, 2000).

[1] 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

[2] 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.

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.[3] Specifically, firms are asked to indicate whether each type of IP is very important, somewhat important, or not important.[4] 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.[5] 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. Below we discuss how we validate this qualitative data.

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.[6] A considerable amount of work was performed to ensure that survey variables are comparable throughout the sample period.[7] While core variables are constructed from questions asked in all 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

[3] 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.

[4] 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?"

[5] 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.

[6] 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.

[7] One minor problem with the survey is that, in some rare 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, because in most of these cases only one establishment responds ex-post, we drop all non-respondents when at least one establishment has responded to the main questions. For the few cases left after this step, we keep the establishment reporting the highest firm's sale, under the assumption that this establishment is more likely to have the most comprehensive responses.

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 the 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.[8] 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 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.

### A.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.

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

[8] 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 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.[9]

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.

### A.3 Sample composition

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 Appendix Figure 2 panel (a), we start by presenting the raw statistics, without any adjustment using sampling weights. Just over one half of the firms surveyed (53%) perform R&D, and one quarter (25%) of obtain patents. Conditional on conducting R&D, the patenting share increases to around 42 percent.[10] 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

[9] 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.

[10] 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.

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.[11]

Next, we examine the same set of statistics after applying sampling weights in Appendix Figure 2 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.

# Appendix B- Other Analyses

The second stylized fact discussed in the paper in Section 3 argues that patents are not the main force of IP protection in the economy. While the body of the paper describes the main findings, we discuss here in more detail two extensions to the core analysis. First, 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 5, 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., Appendix Figure 4). As mentioned in Section 2, this evidence further supports the idea

[11] 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, we think this concern is likely second order.

that unweighted analyses are likely to capture the behavior of companies more likely to engage with innovation.

Second, 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 is 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.

Another interesting result pertains to the importance of size in explaining IP importance (stylized fact 5), and its quantitative importance relative to industry. In particular, 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 11, 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.[12]

In the paper, we also present several new analyses to try to better characterize the relationship between a firm's size and its IP use. We provide a more extensive discussion of the analyses presented in the paper. First, this section discusses Appendix Figure 13, where we estimate the effect of size conditional on several other measures capturing differences across firms in composition of their R&D activity, innovation output, and other characteristics that are likely relevant to IP. The idea behind this test is the following: in the paper, we argue that some of the effect of size may reflect the intrinsic properties of IP, which makes relatively more valuable with

[12] In Appendix Figure 12, we show that a similar pattern holds without weighting.

firm size. However, large firms presumably differ from smaller firms in a variety of dimensions. 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.[13] 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).[14] 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 – may require different types of IP protection and therefore influence the behavior of the firm.[15] 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.[16]

[13] 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.
[14] 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.
[15] 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.
[16] 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

The output is provided in Appendix Figure 13. 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.

The idea that the size effect may not simply capture heterogeneity in innovation is also partially confirmed by Appendix Table 3: in this analysis, we show that the relationship between size and IP is confirmed also within the sample of firms that do not conduct R&D activity.

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Goldschlag, Nathan, and Elisabeth Perlman. Business dynamic statistics of innovative firms. Working paper. 2017.

Levin, R., Klevorick, A., Nelson, R., Winter, S., Gilbert, R. and Griliches, Z. (1987). Appropriating the returns from industrial research and development. *Brookings Papers on Economic Activity*, 1987(3): 783-831.

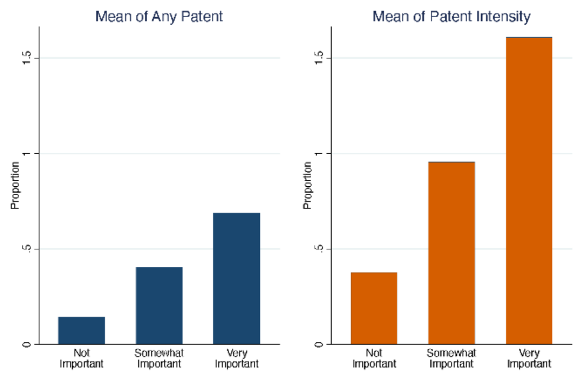
Mezzanotti, F., & Simcoe, T. (2023). Research and/or Development? Financial Frictions and Innovation Investment.

lawyer working for the firm. As expected, we find that the presence of an internal IP is largely concentrated in larger firms.

# Appendix Figures

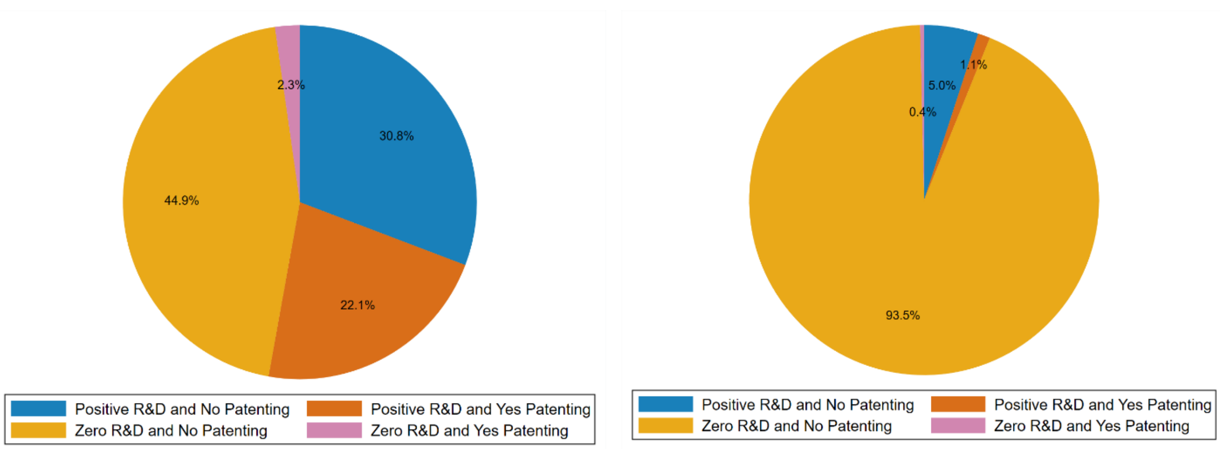
## Appendix Figure 1. Patenting Behaviors of Firm Along Extensive and Intensive Margin

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

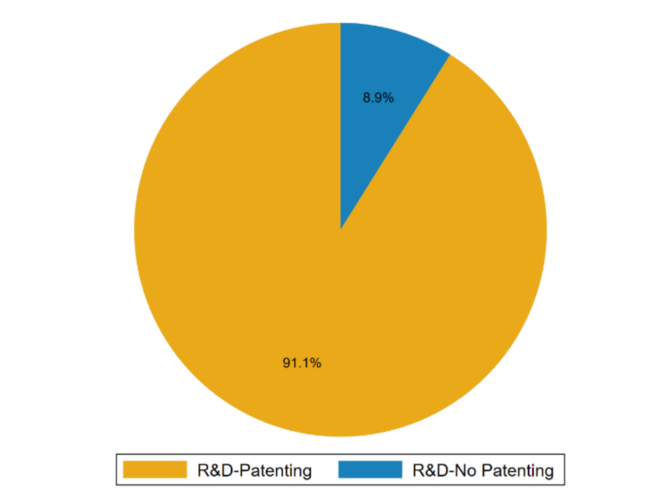
This pie charts report the (unweighted) share of firms in the data used split based on whether the firm is conducting R&D in the year of the survey and whether the firm is labelled as patenting firm, following the usual definition. In panel (a), we conduct this analysis without any adjustment from the 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

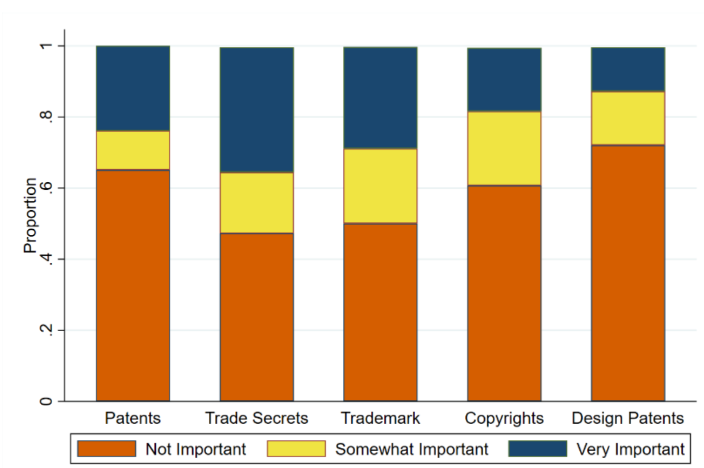
## Appendix Figure 3. R&D Spending for Patenting and Non-Patenting Firms in the United States (unweighted)

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



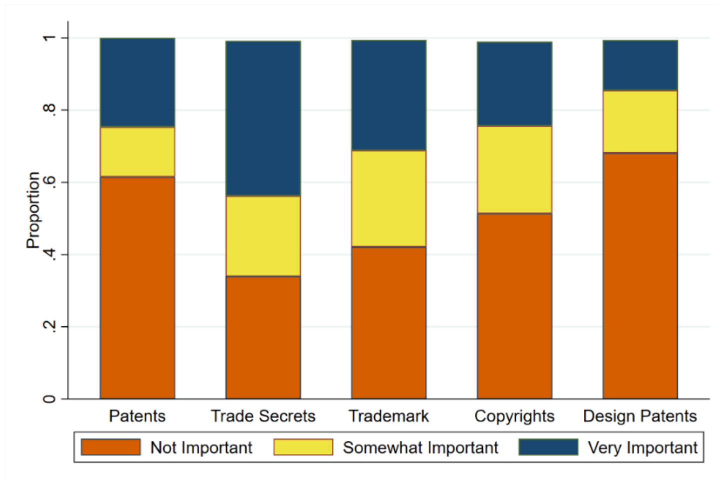

## Appendix Figure 4. Importance of Different IP Protection Strategies, All Firms (unweighted)

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.



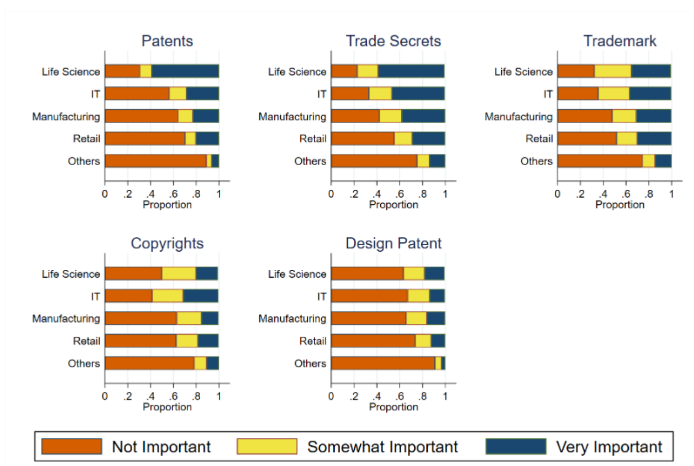
### Appendix Figure 5. Importance of Different IP Protection Strategies, R&D Firms Only

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.



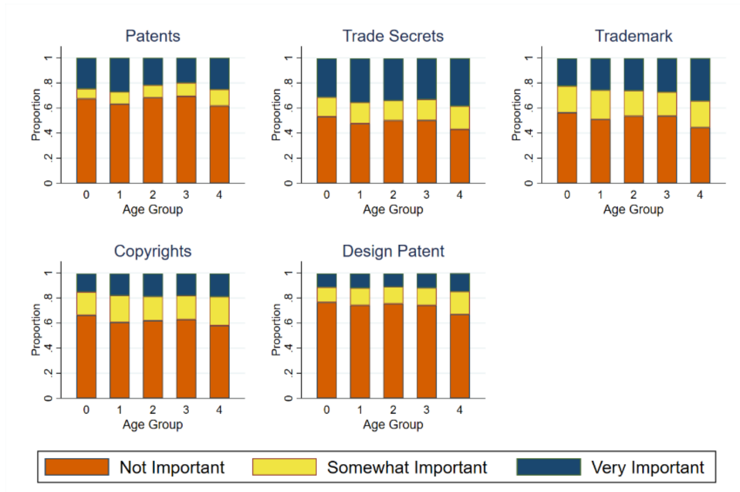

### Appendix Figure 6. Importance of Different IP Protection Strategies by Industry (unweighted)

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).



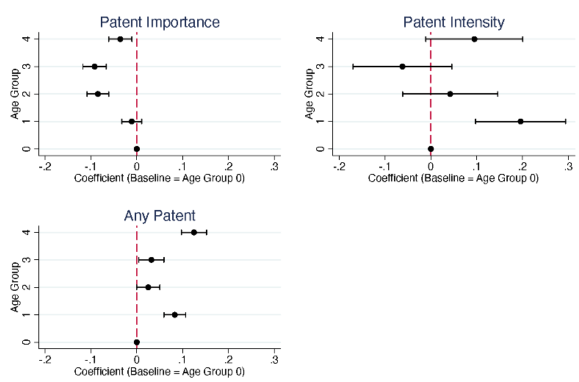
## Appendix Figure 7. Importance of Different IP Protection Strategies by Firm Age Group (unweighted)

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.



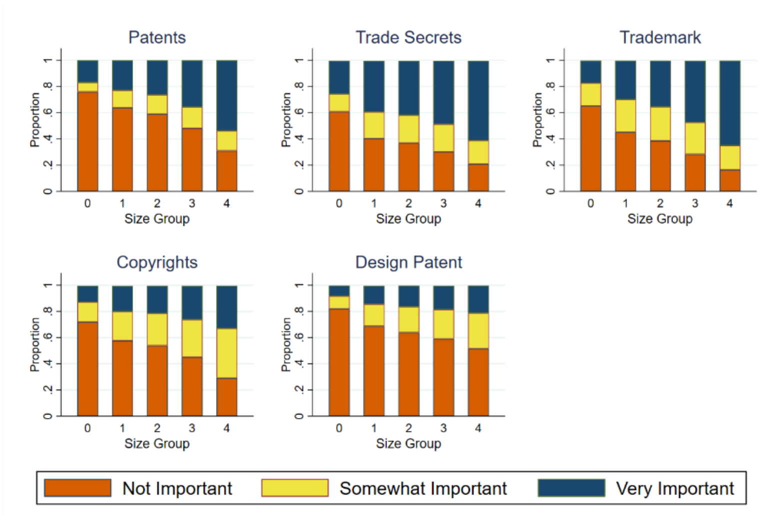

## Appendix Figure 8. Estimates on Patent Importance, Intensity, or Patenting Status by Firm Age

These figures report the output of a simple regression model where we examine how age affects different proxies 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). 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.



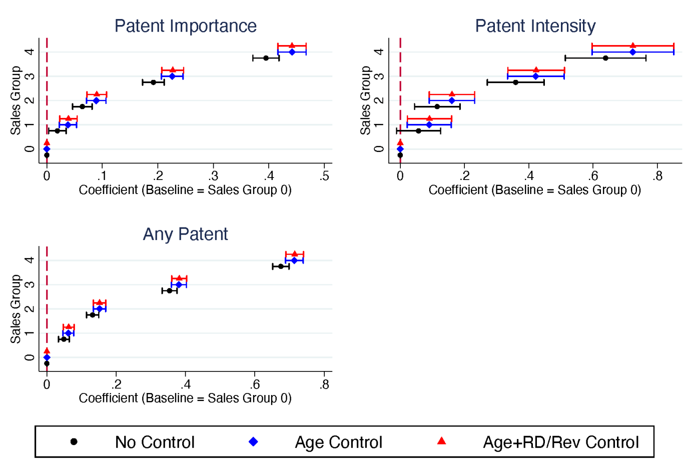
## Appendix Figure 12. Importance of Different IP Protection Strategies by Firm Size Group

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.



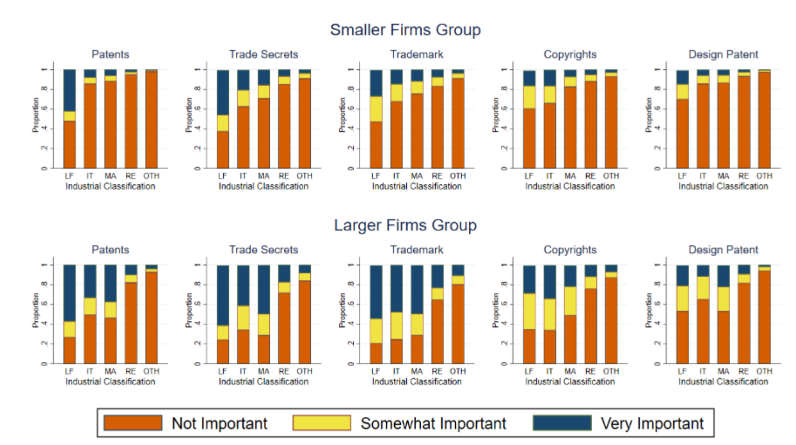

## Appendix Figure 10. Estimates on Differences in Patent Importance, Intensity, or Patenting Status by Firm Size Group

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.



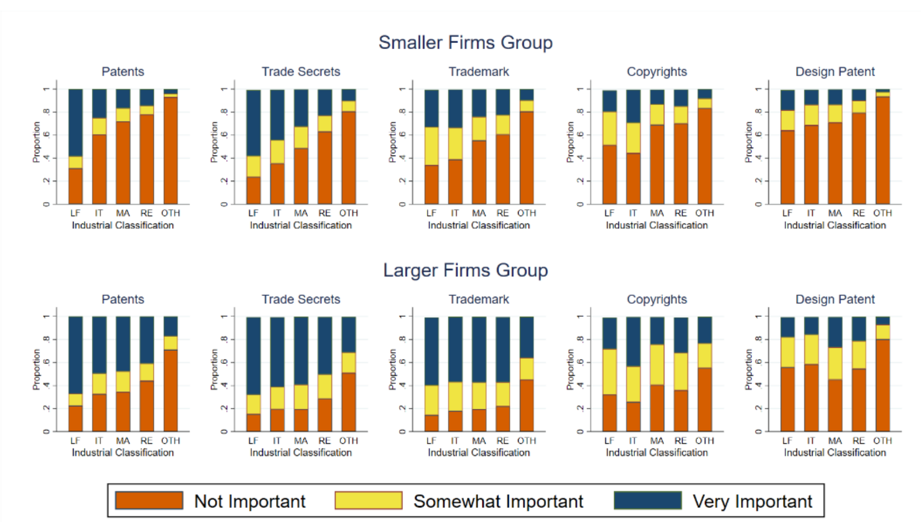
## Appendix Figure 11: Importance of Different IP Protection Strategies by Industry for Large and Small Firms

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).



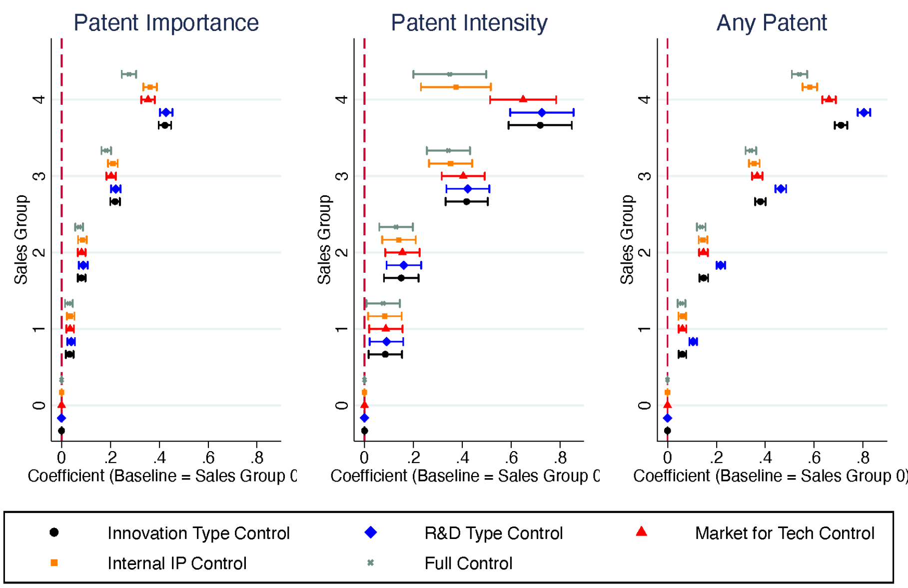

## Appendix Figure 12. Importance of Different IP Protection Strategies by Industry for Large and Small Firms (unweighted)

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 13. 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.



# 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)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** |
|---|---|---|---|---|---|---|---|---|---|
| | **1{Pat. Import.}** | **1{Pat. Import.}** | **1{Pat. Import.}** | **Pat. Intensity** | **Pat. Intensity** | **Pat. Intensity** | **1{Any Pat.}** | **1{Any Pat.}** | **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 proxies 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

## Appendix Table 4. 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 Table 5. 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