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SCIENCE & ENGINEERING INDICATORS 2024

Innovation

Invention, Knowledge Transfer, and Innovation

Technical Appendix

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This publication is part of the 2024 edition of the *Science and Engineering Indicators (Indicators)* suite of reports. *Indicators* is prepared under the guidance of the National Science Board by the National Science Foundation's National Center for Science and Engineering Statistics. The *Indicators* suite consists of a summary report called *The State of U.S. Science and Engineering*, more-detailed thematic reports with supporting data, and a data tool that provides state-level indicators.

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Technical Appendix

Survey and Alternative Data Used in This Report

This **technical appendix** supplements the *Indicators* report "[2024] Invention, Knowledge Transfer, and Innovation" with additional information on the data used in the thematic report, including fitness for use and construction of the indicators. Quality considerations for both survey data and alternative data include three domains: utility, objectivity, and integrity (Dworak-Fisher et al. 2020). Identified quality dimensions within utility are relevance, accessibility, timeliness, punctuality, and granularity. Accuracy, reliability, and coherence are the dimensions of objectivity. Integrity consists of scientific integrity, credibility, computer and physical security, and confidentiality.

Invention Indicators

Inventors around the world obtain protection for inventions through national and regional jurisdictions. The Patent and Trademark Office (USPTO) is the federal agency responsible for handling patent and trademark applications and issuing patent and trademark registrations in the United States. It grants utility patents, plant patents, design patents, and trademarks (USPTO n.d.). USPTO patents protect inventions in the U.S. market. Utility patent data, design patent data, and trademarks are used in this report.

Patent registration data include records for the inventor and for the party to whom legal rights are assigned. Patents have inventors (one or more) and grantees, in which the latter become the owners of the intellectual property (IP) covered by the patent. Both types of information are used in this thematic report. The notes for tables and figures specify the approach for each indicator.

Contributors to U.S. Patent Activity

Patent data used throughout this report are based on the administrative records of the legal authorities granting patents, accessed through publicly available databases. USPTO records are accessed through the USPTO's PatentsView database. The National Center for Science and Engineering Statistics (NCSES), SRI International, and Elsevier/Science-Metrix prepared the tabulations from the PatentsView database for most of the USPTO data presented in this thematic report. Patent-level data were downloaded from the PatentsView data analysis and visualization platform maintained by the USPTO in collaboration with other federal agencies and academic institutions. In PatentsView, USPTO patent data are parsed and structured into a relational database. PatentsView assigns patents to their relevant technology fields based on different classification schemes, including internationally agreed-on technology fields from the World Intellectual Property Organization (WIPO).

PatentsView applies statistical techniques to match and link inventor names and locations. This matching of names and locations, known as *inventor and location disambiguation*, enables analyses of patterns and trends in patenting activity in the United States and abroad. For the USPTO patents by economic sector (Table SINV-1), patents are shown based on the sector of the owner, which can be different from the inventor. When USPTO patents are shown by geography, this corresponds to the residence of the inventor. Detailed technical documentation for the data collection, curation, fractionization, and tabulation, along with the classification of the CHIPS and Science Act and environmental sustainability patents, is found in the 2024 report commissioned by SRI International, *Patent and Trademark Indicators for the* Science and Engineering Indicators 2024*: Technical Documentation*, prepared by Science-Metrix (2024).

Geographical Distribution of Patent Activity in the United States

The underlying data for the county-level presentation of USPTO patents are prepared by NCSES, SRI International, and Science-Metrix. Patent data are drawn from the USPTO's PatentsView database, described earlier in the section **Contributors to U.S. Patent Activity**.

Figures presented in the report show *patent intensity*, defined here as the number of patents issued to inventors residing in the county divided by the total population in that county. For patents awarded to inventors in multiple locations, this report uses fractional counts of patents to avoid double counting. With fractional counts, a county receives partial credit for a patent in proportion to the number of named inventors who reside in that county divided by all named inventors.

First, the patent documents used in the analysis are drawn from the USPTO's PatentsView database in the late spring 2023 and are updated, along with the population data, in late summer 2023. The county population data are the 2022 vintage of Census Bureau data, located at **https://www.census.gov/data/tables/time-series/demo/popest/2020s-counties-total.html#v2022.**

The methodology for the county-level patent data in this report builds on two main sources. First, the Patent Technology Monitoring Team within the USPTO prepared and released state, county, and metropolitan regional patent data for several years, with tables covering the years 1998–2015 (USPTO 2021). This approach was extended for *Science and Engineering Indicators 2022* and updated for *Indicators 2024*. An early challenge in this work was *geocoding*, or the assignment of geographical information to a data set. For use in regional economic analysis, Carlino, Chatterjee, and Hunt (2007) use geocoding to extend the information reported in patent documents, allowing assignment to a location.

Second, for the detailed tables by technology area in this report, patents are classified under WIPO's classification of technology areas. This report uses International Patent Classification (IPC) reformed codes to prepare the patent data; these codes incorporate changes made with the eighth revision of the WIPO classification in 2006. Patents can be tagged with multiple codes and can fall under multiple WIPO technology areas. This thematic report uses fractional counts of patents to avoid double counting across sectors and technology areas.

Patent documents include inventorship and ownership information, and both are used in this thematic report. This allows two different kinds of analysis: one based on where inventors live, and one based on where the ownership rights have been assigned, which can be a workplace or a residence of the patent owner. The public-use files accompanying this thematic report show county patent intensity for 2022 based on the location of the inventor. These files contain U.S. county-level data for total patents, patents by technical field, and unassigned patents for the years 1998–2022.

Detailed technical documentation for the preparation and evaluation of these prototype statistics is found in the 2024 report commissioned by SRI International, *Patent and Trademark Indicators for the* Science and Engineering Indicators 2024*: Technical Documentation*, prepared by Science-Metrix (2024).

Global Patenting Trends

The analysis of global patenting trends in this thematic report is based on international patent applications filed under the Patent Cooperation Treaty (PCT); these applications are commonly referred to as *PCT applications*. The purpose of this treaty is to assist applicants in seeking international coverage for their ideas, with a single PCT application providing a streamlined initial step in gaining patent protection in multiple jurisdictions. A PCT application thus represents an applicant's interest in protecting an idea beyond the applicant's own country.

There are three elements that form the analysis of global patenting trends: time, technology, and country. The time element is based on the publication year of PCT applications and covers the period from 2000 to 2022. Meanwhile, the technology categories are based on the concordance of IPCs to technology categories published by WIPO. Details of the concordance are available at **https://www.wipo.int/ipstats/en/**, with the concept and methodology for the concordance available in Schmoch (2008). The first IPC of each PCT application is used to match it to a technology category.

The country assigned to a PCT application is based on the *receiving office* for that application; in 95% of cases, this receiving office is the national patent office where the inventors reside. For example, the very first PCT application covered by the analysis (Publication #WO2000000001) has the application number CH1999/000488 because it was filed via the Swiss Federal Institute of Intellectual Property. It is thus allocated to Switzerland in the analysis of global patenting trends.

The remaining 5% of PCT applications are filed directly with WIPO, using WIPO's International Bureau (IB) acting as the receiving office. As such, the receiving office information does not indicate the country of origin for these IB PCT applications. Instead, the *priority country* is used, which is based on the country of the earliest priority document in the same patent family (i.e., the first application filed for the invention, not counting any IB PCT applications).

There are a small number of cases where multiple priority documents share the same earliest priority date. If this happens, and these earliest priority documents are from multiple countries, each country gets equal fractional credit. For example, if there are three U.S. priority documents and one German priority document, each country still gets 0.5 credit, rather than 0.75/0.25 (because the latter would favor the United States, which tends to generate more priority documents in a given patent family due to its use of continuation and divisional patent applications).

Approximately 10% of IB PCT applications (i.e., 0.5% of the total number of PCT applications) have only an IB priority document. These applications are excluded from the analysis.

There are two country groupings used in the analysis of global patenting trends. The European Union (EU-27) consists of the countries in the EU after 2020, namely, Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden. The Rest of World group consists of all countries with PCT applications, excluding the United States, China, the EU-27, Japan, and South Korea. Hong Kong is included with China. Taiwan is not a signatory.

Trends in Artificial Intelligence Patenting

The analysis of artificial intelligence (AI) technology examines trends over time in AI patenting across regions, countries, and economies. The universe of AI patents is defined using a filter consisting of patent classifications (both Cooperative Patent Classifications and IPCs) plus keywords and phrases. Details of this filter can be found at **https://github.com/georgetown-cset/1790-ai-patent-data/**.

To provide a more granular view of the AI patent landscape, the AI patents are categorized using a taxonomy containing three distinct dimensions: *AI Techniques* (How does the invention work?); *Functional Applications* (What does the invention do?); and *Application Fields* (Where is the invention designed to be used?). These dimensions of AI are taken from a broader computer science taxonomy developed by the Association for Computing Machinery (ACM), **https://www.acm.org/publications/class-2012**. They have been employed in previous studies of AI patenting by WIPO; see, for example, WIPO (2019).

Filters consisting of patent classifications and keywords and phrases are again used to allocate patents to different categories in the taxonomy. Details of these filters can also be found at **https://github.com/georgetown-cset/1790-ai-patent-data/**. Note that a patent may be included in more than one category within a dimension and also be classified along more than one dimension. For example, a patent describing a machine learning-based image processing tool for an autonomous vehicle will have entries in all three dimensions (i.e., AI Technique: Machine Learning; Functional Application: Computer Vision; Application Field: Transportation).

The analysis of AI patenting trends is designed to focus on *granted inventions*; it is thus based on granted patents while only counting the first granted patent in each patent family so as to avoid double counting the same invention. Note that only patent families containing at least one granted patent are included in the analysis.

As with patenting overall, there are three analytical elements presented in patenting trends in AI: time, technology, and country. The issue date of the first granted patent in each family is used in analyzing trends over time. Meanwhile, the AI patent taxonomy outlined above is used to allocate patents to technology categories.

Where possible, country data are based on the location of inventors, with fractional counting used to allocate credit to different countries. For example, if a patent has two inventors located in the United States and one inventor based in China, the United States is credited with two-thirds of the patent, and China with a third of the patent. That said, there are availability issues associated with inventor location data. Specifically, in the European Patent Office (EPO) PATSTAT (**https://www.epo.org/en/searching-for-patents/business/patstat**) and Global Patent Index (**https://data.epo.org/access-control/gpisubscription.jsp?lg=en**) databases, there are no inventor countries listed for patents issued by various countries, notably China, Japan, and South Korea.

A multistep process is thus employed to allocate granted inventions to countries. The initial step covers cases where the first granted patent in a patent family has inventor countries listed. For these cases, the countries are allocated based on the fractional count of inventors listed on this first granted patent. The next step covers cases where the first granted patent in a family does not have inventor countries listed (e.g., this patent was issued by the China National Intellectual Property Administration or Japan Patent Office), but there are other patent documents in the family that do list inventor locations (e.g., a U.S. or European patent document). For these cases, the country designation is based on the fractional count of inventor countries on the earliest patent document in the family that has inventor locations listed.

If no patent documents in the family have inventor countries listed, the priority country (i.e., where the first application in the patent family was filed) is then used to attach a country to the invention. For example, if the priority document was filed in China, the invention is counted as Chinese. Based on data from 2000–19, in 99.5% of these cases where the priority country is used, the patent family only contains documents from a single country, and this country matches the priority country (primarily China, Japan, or South Korea).

The data described in the report as international patents measure an original invention and its subsequent extensions as a family (or group) of related patents. A *patent family* refers to a group of related patents that share a single original invention in common. All subsequent patents in a family refer to the first patent filed, called the *priority patent*. The year the priority patent is granted is the year when the patent family is counted. The source data for international patent family data for this report come from the EPO's PATSTAT (**https://www.epo.org/searching-for-patents/business/patstat.html#tab-1**).

As an indicator, patent families provide a broad, unduplicated measure of global invention. Patenting standards vary with the jurisdiction. According to the international patent documentation, PATSTAT assigns patent families to geographic locations based on patent inventorship information found on the priority patent. As is done with USPTO patents, PATSTAT allocates patent families among regions, countries, or economies using fractional counts based on the residences of all named inventors.

Using these PATSTAT data from EPO, international patent families are tabulated by building on a methodology proposed by a team of researchers from academia and the Organisation for Economic Co-operation and Development (OECD). This method uses information within patent families to fill in gaps regarding inventorship for patent offices where data are not complete, looking at related patents in other offices when information is not available for a patent. When information on inventorship cannot be retrieved from any office, the approach relies on the assumption that inventors are frequently from the same country as the assignees who requested the patent, using all available patents within the family to fill remaining gaps. As a final step, for the remaining priority patents with missing information, the country of the patent authority is projected as the country of inventorship because, in most cases, patents without any information and no related patent at the world level will be the fruit of local inventors. Overall, the level of precision is high when dealing with large-scale analyses such as the one prepared for this project.

One limitation of the method described above that emerged is that some valid patents are overlooked, leading to an undercount for some countries, including the United States. A published patent may mention an earlier priority document that is not existent in the EPO data set. Such a document may be missing if the office where it was filed has not published it or if the priority document is not a patent of invention. *Artificial priority patents* contain only scarce information, including patent office, date, and type of applied document. Critical missing information includes names, addresses of applicants

and inventors, and IPC codes. A large share of artificial patents come from *provisional patents*, which are patent applications often used in the United States and other markets to quickly protect an invention at low cost in the hope of later filing a patent application for a utility patent in the same market. These missing patents account for about 15% of the 2020 patent families.

To address the limitation related to artificial priority patents, instead of dropping patent families that first came to life through these artificial priority patents, the first utility patent in the family that was applied for after the artificial priority patent was selected as the replacement to act as the first priority patent in these cases. This then makes obtainable the relevant information for IPC codes and inventorship in the same manner as is done for other priority patents, following the approach designed by de Rassenfosse et al. (2013). The implementation of this correction leads to more complete information for a large number of countries around the globe, impacting most of all those that have a national patent office allowing for provisional patent applications or those where inventors often reach out to markets where these are available.

Women as Inventors on Patents

The analysis of patenting by gender is based on granted U.S. patents (i.e., patents granted by USPTO). Approximately half of U.S. patents are granted to domestic applicants and half to overseas applicants, so the focus on U.S. patents does not mean that the analysis is restricted to U.S.-based inventors only. The analysis uses fractional counting, so the credit for each patent is divided equally between the inventors. For example, if a patent has three inventors, two male and one female, this increments the male total by 0.67 patents and the female total by 0.33 patents.

The gender of inventors is determined using the World Gender Name Dictionary (WGND) version 2.0. This dictionary is produced by WIPO and is available at **https://github.com/IES-platform/r4r_gender/blob/main/wgnd/README.md** and **https://dataverse.harvard.edu/dataverse/WGND**. It contains more than 26 million records linking names to genders for 195 different countries and territories. The process for matching inventor names to genders is based on the WIPO guidelines described at **https://tind.wipo.int/record/45020?ln=en**. This process involves a number of steps. First, the country and first name of each inventor is matched to WGND.

Second, the total count of patents for each given name (e.g., Michael, Jane) is then calculated, based on fractional counting as outlined above. WGND does not include all inventor names because unusual names are excluded, as are names that are ambiguous in terms of gender (e.g., Taylor). An additional match to middle names is thus carried out in such cases, so Taylor Michelle Smith is mapped to female, while Taylor Michael Smith is mapped to male. In total, 91% of the total fractional count of inventors is matched to gender, leaving 9% unmatched. The analysis is based on these 91% of cases, which is the same approach suggested by WIPO.

Note that the WIPO guidelines suggest that the primary match should be to the wgnd_2_0_name-gender-country file, but a secondary match to the wgnd_2_0_name-gender_nocode file can be carried out where there is no match to name and country combinations. This additional step was also implemented, but it did not significantly change the results, either in terms of gender designated or percentage of inventor names matched.

The analysis of patenting by gender includes results across technology categories. These categories are based on the concordance of IPCs to technology categories published by WIPO. This concordance is available at **https://www.wipo.int/ipstats/en/**, with the concept and methodology for the concordance available in Schmoch (2008). The first IPC of each patent is used to match the patent to a technology category.

Both the USPTO and WIPO have produced analysis on the role of women as inventors on patents. The indicators shown in Figure INV-9 and Figure INV-10 are the ratio of the number of patent applications with at least one woman listed as an inventor divided by all patent applications. Names on the patent documents are matched to a database matching names to sex based on a database containing 6.2 million names for 182 countries, created using country-level sets of name dictionaries. This database is compiled primarily from WIPO's annual IP statistics surveys (see link below) and data compiled by WIPO in processing international applications and registrations through the PCT, Madrid System, and Hague System. The WIPO working paper and the data set are available at **https://www.wipo.int/ipstats/en/**.

A primary limitation of either approach is matching of names to either women or men because this information is not generally captured in the patent documents. Identifying the accuracy of this matching method requires a training set in which sex has already been identified.

Another limitation of this ratio affects interpretation. The ratio is affected by both the composition of the named inventors and also by the size of the team. A single woman on a large team will count as a patent with a woman inventor. The women inventor rate shows the number of women named as patented inventors in a given year, divided by the total number of inventors.

Knowledge Transfer Indicators

Matching Citations to Nonpatent Literature

Patent applications filed with USPTO include citations to other patents. These citations show how a novel invention builds on and distinguishes itself from other patents within the existing technological ecosystem. Some patent applications also include citations to nonpatent literature (NPL), such as peer-reviewed publications. NPL citations show how knowledge flows into inventions. Matching these citations to peer-reviewed scientific publications helps assess the uptake of research in subsequent development efforts.

Science-Metrix matched the NPL citations from PatentsView to records in Scopus, Elsevier's abstract and citation database. An algorithm extracted and parsed the publication titles, years, author names, abbreviated names, volume and issue numbers, and page ranges of research journals and conference proceedings found in NPL citations. Science-Metrix then used statistical techniques to compare these extracted data with information extracted from the Scopus database to match NPL citations in PatentsView to cited publications appearing in Scopus.

Annual Business Startups: Business Dynamics Statistics

The data source for the overall level of annual business startups is the 2022 data set of Business Dynamics Statistics from the Census Bureau. This data set is created by linking separate annual data over time. The definition of startup for this data set is an establishment born within the last 12 months; the Census Bureau's description of the data set follows:

> The Business Dynamics Statistics (BDS) tracks these changes over time, providing annual measures of establishment openings and closings, firm startups and shutdowns, and job creation and destruction. These measures are available for the entire economy, and by industrial sector, 3-digit and 4-digit NAICS, state, MSA, and county. They are also available by firm and establishment size and age. The BDS is created from the Longitudinal Business Database (LBD), a confidential database available to qualified researchers through secure Federal Statistical Research Data Centers. The use of the LBD as its source data permits tracking establishments and firms over time. (Census Bureau 2021)

These data are available from Census Bureau (2023).

University Technology Transfer: AUTM Survey

The source of several of the university technology transfer indicators in this report is the AUTM survey. These data address a policy-relevant set of questions because the Bayh-Dole Act of 1980 (Patent and Trademark Act Amendments of 1980, P.L. 96–517) created a uniform patent policy among the many federal agencies that fund university research, allowing those institutions to retain ownership of inventions made under federally funded research programs. It has been widely regarded as having been an important stimulant for academic institutions to pursue technology transfer activities. The primary federal survey, the Higher Education Research and Development (HERD) Survey (**https://www.nsf.gov/statistics/srvyherd/**) focuses on research and development (R&D) expenditures rather than technology transfer.

In contrast, the AUTM survey provides data about the changes taking place in university technology transfer since the implementation of the Bayh-Dole Act. AUTM is a membership-based organization for university technology transfer professionals; they survey their members annually on invention, patenting, licensing, and other technology transfer activities. The survey data are collected in AUTM's Statistics Access for Technology Transfer (STATT) Database, which is available to members and for a subscription fee. *Indicators* reports have reported these AUTM survey data for several cycles as representative of academic technology transfer.

As a measure of all academic technology transfer, the AUTM data appear to undercount at least some aspects of technology transfer activity. The AUTM survey reports patents granted based on university technology, reporting 5,204 patents issued in 2019 and 5,704 in 2020. Based on the analysis of USPTO utility patents described in this report, the count of academic patents was 7,781 in 2019 and 7,834 in 2020.

In this context, the response rate to the AUTM survey has fallen over the course of several cycles. Correspondence with AUTM reports a response rate for 2019 of 57.9%, or 179 out of 312 member institutions. The response rate of the survey in 2017 was 61.9%. As a result, more of the covered population was imputed in 2019 compared with in 2017. Data are subject to revision; however, data from more than 2 years prior are not updated and are considered part of the historical record (AUTM 2021).

An example of the use of AUTM data appears in Aksoy AY, Beaudry C. 2021. How Are Companies Paying for University Research Licenses? Empirical Evidence from University-Firm Technology Transfer. *Journal of Technology Transfer* 46:2051–2121. Available at **https://doi.org/10.1007/s10961-020-09838-x**. Accessed October 2023.

Federal Technology Transfer Annual Reports to Congress

The National Institute of Standards and Technology (NIST) is the agency given legal authority for establishing technology transfer policies affecting all government agencies and reporting to Congress on federal activities. Federal policy supports the transfer of federally owned or originated technology to state and local governments as well as to the private sector and requires that this activity be reported to the president and Congress on an annual basis (Title 15 of U.S. Code, Section 3710(g)(2)). The Stevenson-Wydler Technology and Innovation Act of 1980 (P.L. 96–480) directed federal agencies with laboratory operations to become active in the technology transfer process. It also required these agencies to establish technology transfer offices (termed Offices of Research and Technology Applications) to assist in identifying transfer opportunities and establishing appropriate arrangements for transfer relationships with nonfederal parties.

This statutory report prepared by NIST incorporates data reported by the federal laboratories' parent agencies to the Office of Management and Budget. The compilation of annual data by NIST for annual reporting purposes provides cross-category comparability of reported indicators by agencies. The metrics collected in these annual reports and their definitions can be found in the guidance prepared by the Technology Partnerships Office at NIST (DOC 2022).

Public Science Data

This topic was new in *Indicators 2022* and updated for *Indicators 2024*. The federal agency data presented in this thematic report are the part of this activity organized and presented by the U.S. government at **CitizenScience.gov**. In this thematic report, we title the activity "public science" to make it clear that the activity includes noncitizens as well as citizens. The activity is defined at CitizenScience.gov as "a form of open collaboration in which individuals or organizations participate voluntarily in the scientific process in various ways, including enabling the formulation of research questions; creating and refining project design; conducting scientific experiments; collecting and analyzing data; interpreting the results of data; developing technologies and applications; making discoveries; and solving problems."

The extensive academic literature in this area is outside the scope of this thematic report. However, there are grants from the National Science Foundation and other funders for academic projects that have "citizen science" in the title or abstract. These grants are not included here.

Innovation Indicators

Small Business Innovation Research and Small Business Technology Transfer Metrics

The Small Business Administration coordinates and helps implement the Small Business Innovation Research (SBIR) and Small Business Technology Transfer programs. Data for this report are released by the Small Business Administration. The data set includes annual award counts, firm counts, and the amount of the award or obligation (for years before 2015). Data dimensions include participating agency and program phase, Phase I and Phase II. Phase I awards are intended to establish the potential viability of a project, while Phase II awards focus on continuing the R&D activities initiated in Phase I. As noted in the thematic report, only Phase II awards are included in the analyses presented here. The database is updated continually by fiscal year and described and accessed from the SBIR program website (**https://www.sbir.gov/reports**).

An example of analytic work with SBIR data appears in Audretsch DB, Link AN, Scott JT. 2002. Public/Private Technology Partnerships: Evaluating SBIR-Supported Research. *Research Policy* 31(1):145–58.

Venture Capital Data

The venture capital (VC) data used in this report shed light on trends in market-driven innovation and entrepreneurship. Venture investors tend to invest in companies and industries with products they believe have a significant likelihood of achieving market success. In this regard, data on U.S. and global VC investment trends can be viewed as leading indicators of the innovative output. The data used in Figure INV-19, Figure INV-20, and Figure INV-21 have been accessed from the proprietary database PitchBook (**https://pitchbook.com/**).

VC presented at the country level is classified based on the location of the company headquarters. The search terms used are Deal Type: All VC Stages, Ownership Status: All Ownership Statuses, Backing Status: VC-backed, and Business Status: All Business Statuses. PitchBook uses multiple methods for classifying the industry or market served by a firm. The most granular classification is the Primary Industry Code (PICs), which is a customized adaptation by PitchBook of the Global Industrial Classification Standard and includes over 200 unique industries. The industry classifications shown in Figure INV-21 are aggregates of multiple PICs, as shown in Table SINV-34.

An example of use of the PitchBook database for VC analysis appears in Lerner J, Nanda R. 2020. *Venture Capital's Role in Financing Innovation: What We Know and How Much We Still Need to Learn.* Working Paper 27492. Cambridge, MA: National Bureau of Economic Research. Available at **http://www.nber.org/papers/w27492**. Accessed September 2023.

USPTO Trademarks

Trademarks, which protect original symbols, are issued by national and regional offices. Trademark data used in this report come from USPTO. Trademarks are classified under the 11th edition of the Nice Classification of goods and services, which classifies trademarks under 34 categories of goods and 11 categories of services (**https://www.wipo.int/classifications/nice/en/**).

In this thematic report, trademarks are assigned to geographic locations based on the country of residence of the trademark holders. To avoid double counting, this report uses fractional counts for trademarks shared by holders in multiple locations; a country receives partial credit for a trademark based on the number of trademark holders who reside in that country, divided by all of the trademark holders for the particular trademark. Fractional counts are also used to assign trademarks to the corresponding categories under the classification.

Unlike the county patent data described in this thematic report's section **Invention Indicators**: Protecting Useful Ideas, the subnational trademark data presented in this report have been developed using existing techniques but without an existing benchmark. The primary matching strategy uses ZIP Codes, which allows for a cross-reference of county-level U.S. ZIP Codes to U.S. counties. The USPTO trademark data are more complete than the USPTO patent data; thus, the address matching is of higher accuracy.

An example of analytic work using trademarks appears in von Graevenitz G, Graham SJH, Myers AF. 2022. Distance (Still) Hampers Diffusion of Innovations. *Regional Studies* 56(2):227–41. Available at **https://www.tandfonline.com/doi/full/10.1080/00343404.2021.1918334**. Accessed October 2023.

Business Innovation Survey Data

The *Oslo Manual*, prepared by OECD and Eurostat, provides a definition for firm-level innovation activity that countries and economies have widely used to enhance comparability of international data (OECD/Eurostat 2005). This framework guides the collection of survey data, including, notably, the Community Innovation Surveys from the European Union Statistical Office and the Business Research and Development and Innovation Survey from NCSES and the Census Bureau. Following the *Oslo Manual*, these surveys define innovation as the "implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organizational method" (OECD/Eurostat 2005:46–7). The *Oslo Manual* and its definition of innovation were revised in 2018 (OECD/Eurostat 2018). These revisions will guide future surveys and data collection.

Annual Business Survey

Statistics on the introduction of new products by U.S. industries were self-reported by companies through the Annual Business Survey (ABS). This survey is conducted by the Census Bureau in accordance with an interagency agreement with NCSES and represent an estimated 4.6 million U.S. for-profit companies with one or more employees. The ABS is a mandatory, confidential sample survey that collects data on innovation, R&D activity, technology, IP, and business owner characteristics. Firms are identified from the Business Register, the database of U.S. business establishments and companies that is created by integrating data from business tax returns with data collected in the Economic Census and other Census Bureau surveys.

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