Business Dynamics of Innovating Firms: Linking U.S. Patent Data with Administrative Data on Workers and Firms

Presented by Elisabeth Perlman

This represents the work of a great number of people including:

David Dreisigmeyer, Nathan Goldschlag, Matthew Graham, Stuart Graham, Cheryl Grim, Tariqul Islam, Marina Krylova, Alan Marco, Javier Miranda, Wei Ouyang, and Elisabeth Perlman

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Additions to the Business Dynamic Statistics (BDS)

Several new projects:

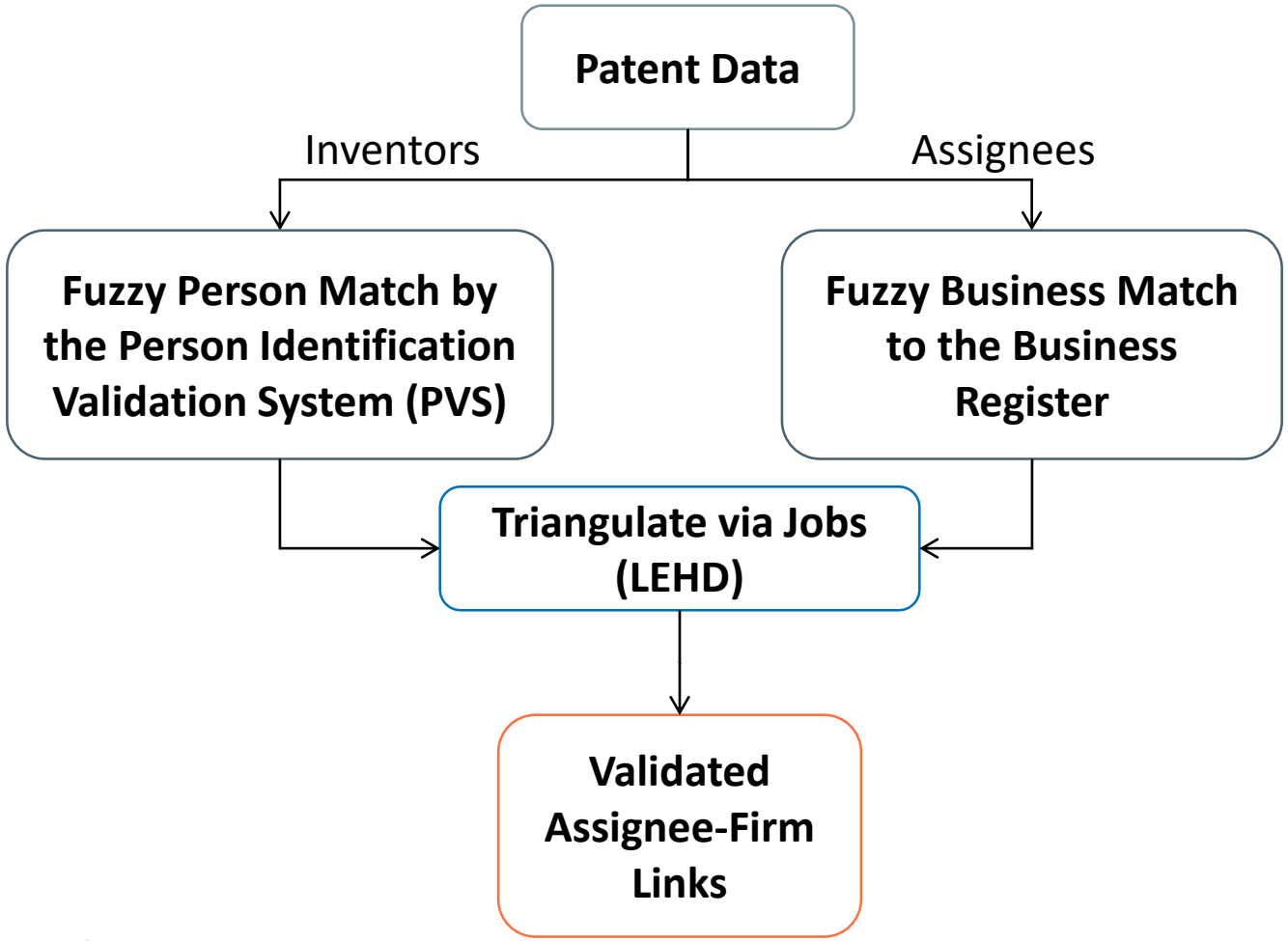
- Linking with administrative data for richer firm characteristics:
  - Export-Import data
  - Trademark data (public use)
  - Patent data (public use)
    - Objectives: Role of innovative firms in economic growth; Characteristics of innovative firms

- New privacy methods
  - New challenges for privacy when using public data
  - Implemental differential privacy (formally proven privacy)

Data inputs:
USPTO Data, Census Restricted-Use Data

- USPTO Custom Bibliographic Patent Data Extract (PTMT) (public use)
- USPTO Bulk Download Data (public use)
  - All granted patents between 2000 and 2015 (about 3 million patents)
- U.S. Census Bureau Business Register List (BR) and the Longitudinal Business Database (LBD)
  - Business list of all non-farm employer establishments with firm identifiers
- Longitudinal Employer Household Dynamics Employment History Files (LEHD-EHF)
  - List of employees covered by unemployment insurance provided by states.

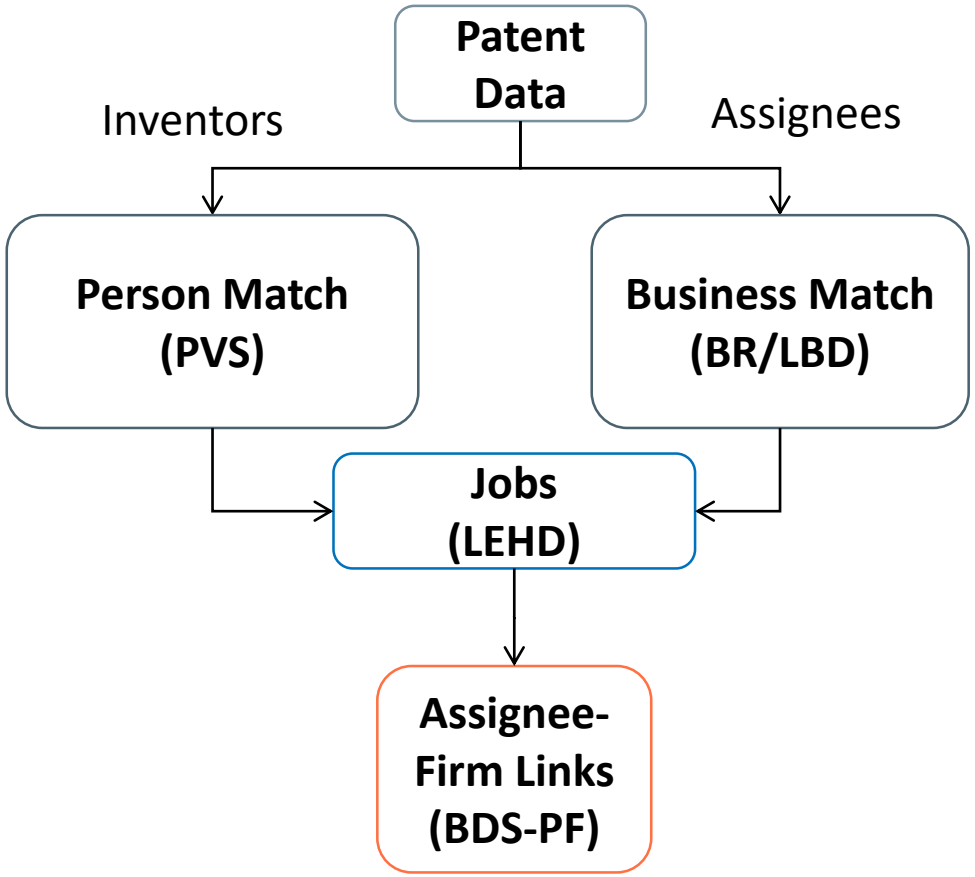
New Matching Strategy --- Triangulation



New Matching Strategy --- Triangulation

Triangulation of data allows:

- More precise matches
  - US assignee precision about 92%, foreign about 96%
- Higher match rates (closer to a true frame of patent holders)
  - US assignee match rate greater than 90%, foreign about 60%
- Validation of large number of matches
  - Fully triangulated matches have the highest precision



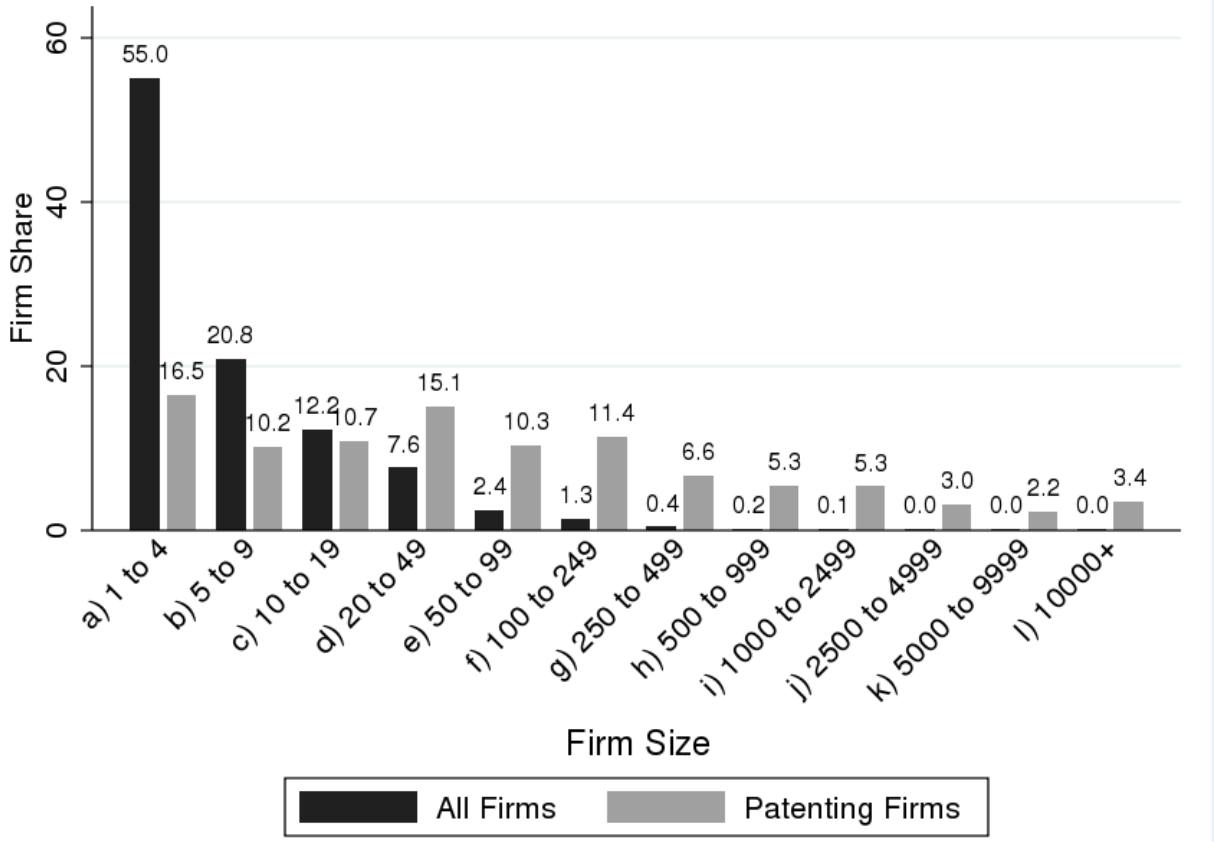
BDS Patenting Firms

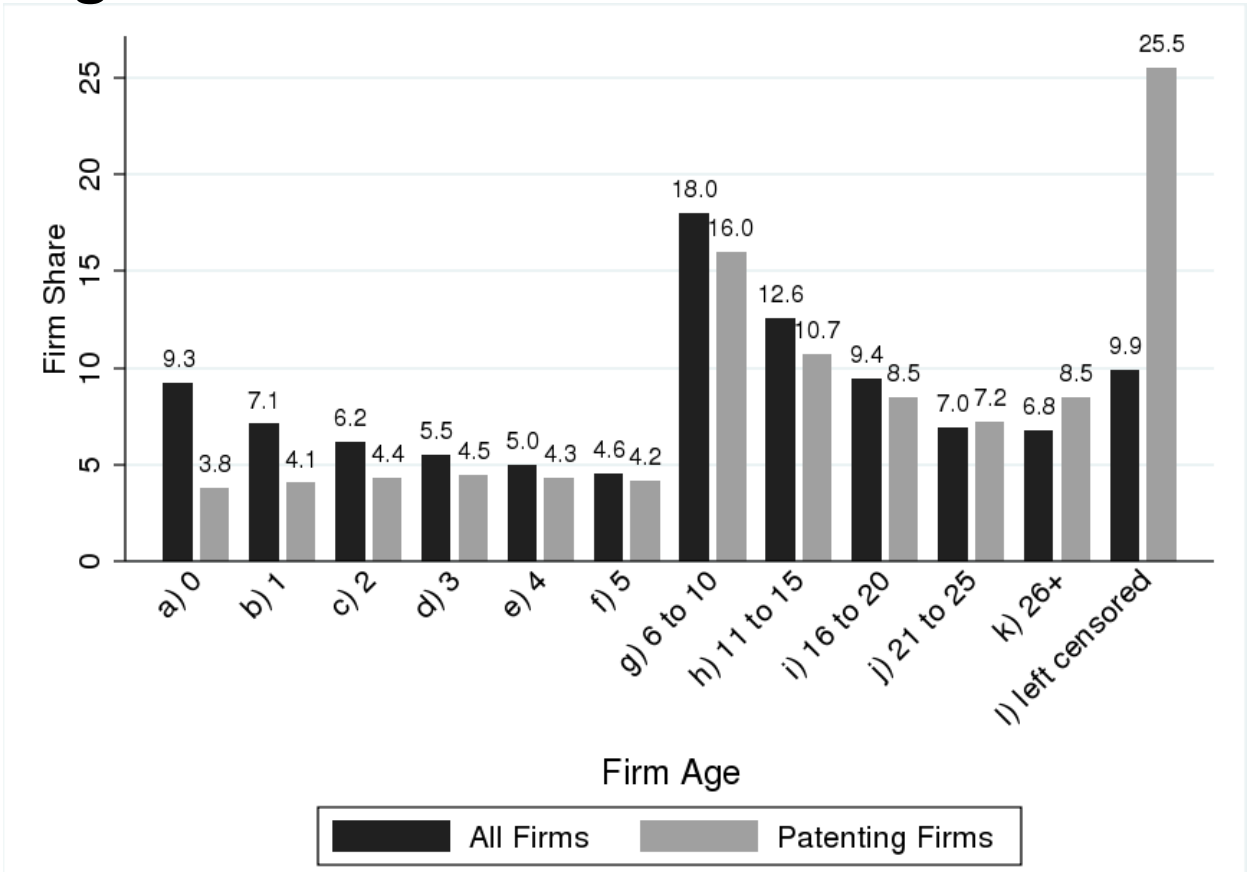
Data outputs

- Confidential longitudinal firm microdata: accessible through the U.S. Federal Statistical RDCs
  - Graham, S. J., C. Grim, T. Islam, A. C. Marco, and J. Miranda (Forthcoming) "Business dynamics of innovating firms: Linking US patents with administrative data on workers and firms," Journal of Economics and Management Strategy.
  - Dreisigmeyer, D., N. Goldschlag, M. Krylova, W. Ouyang, and E. Perlman (2018) "Building a Better Bridge: Improving Patent Assignee-Firm Links," CES Technical Notes Series, CES-TN-2018-01.
- Eventually public use tables, BDS of Patenting Firms (with new privacy methods)

Some Cross-Sectional Characteristics

Patenting firms are older and larger than firms as a whole.





What's Next in Addressing Privacy Concerns?

- We have been implementing rules of thumb to protect privacy (e.g. suppress any cell with fewer than N observations)
- How do you protect privacy when the list of entities (i.e. patenting firms) is known?
- Use methods that are formally proven

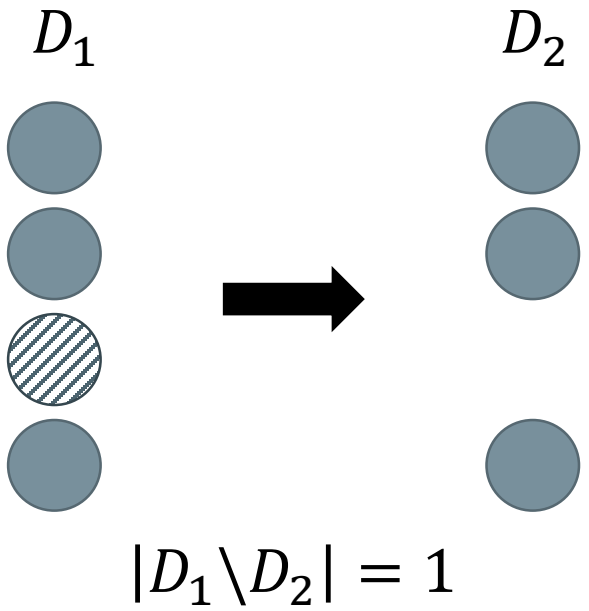
Differential Privacy (Formally Proven Privacy)

- This quantifies an upper-bound on what a person could learn from a given data release
- In doing so it provides data producers with a quantifiable trade-off between producing accurate statistics and protecting privacy
  - Improving one of these necessarily means decreasing the other.
- Thus data producers can work with a formal privacy-loss budget; an amount they can “spend” on a data release

Differential Privacy

- Privacy means that output of a Differential Privacy algorithm is insensitive to the addition/removal of one element

- Assume a worst case scenario attacker, knows every element but one
- After seeing the data how sure is the attacker about the element not in the data they already have?



Differential Privacy

- When dealing with counts of people, the addition or removal of one person changes counts by one

- But what if the statistic is biased on a firm's employment or people's wealth?
- How does one protect the existence of a very large firm?
  - Adding enough noise to keep the data from changing if that firm is inserted or removed will prevent statics about small firms from being meaningful

Differential Privacy

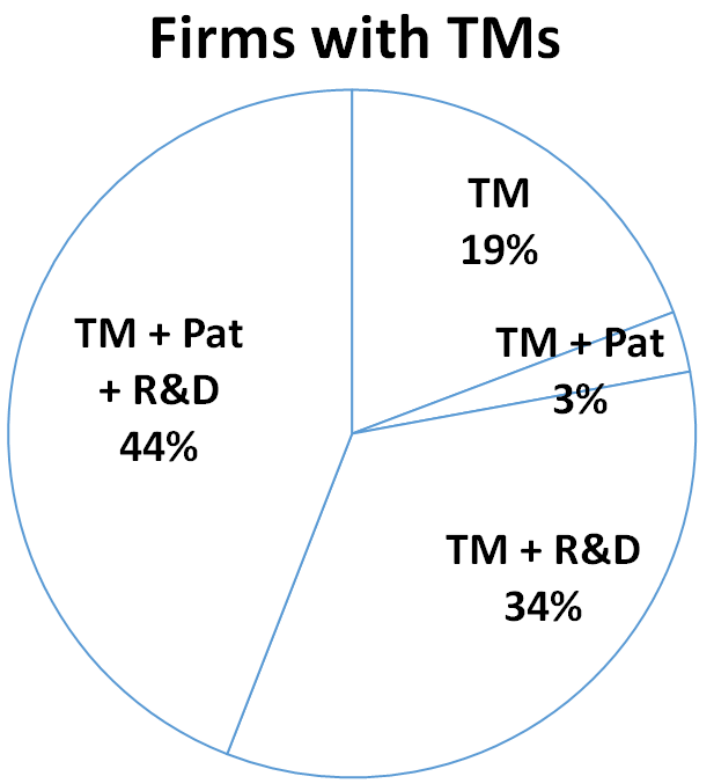
- One possible fix: worry about local sensitivity and infuse noise based the sensitivity on local areas of the data set (e.g. firm size)
  - E.g., firms with size 1-5 employees will receive noise that is scaled to a sensitivity of 5 and firms with 1000-5000 employees will receive noise that is scaled to a sensitivity of 5000
- However, if firms are aggraded geographically the existence of a single large employer in a small metro-area will not be protected, even if the particulars of that firm are
- Trade-offs are for data producers to decide

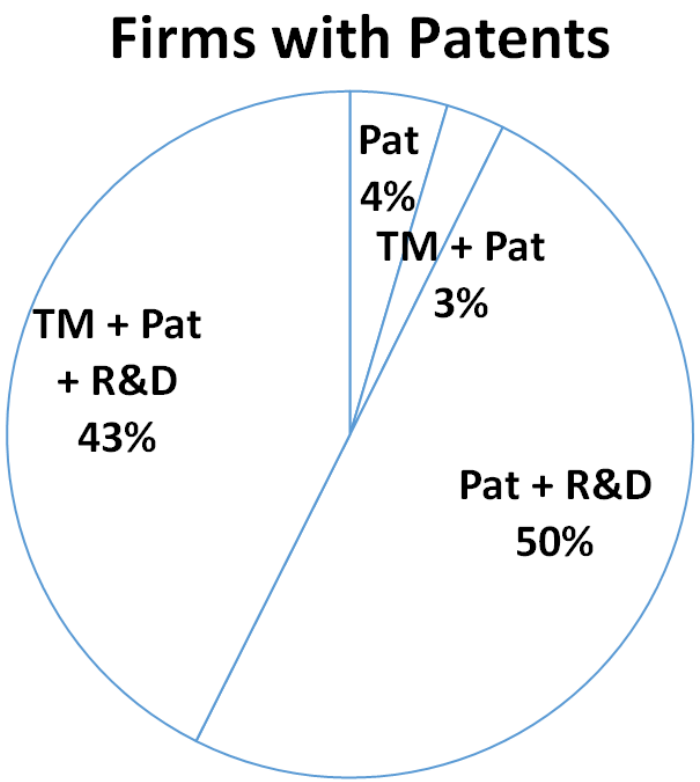
Questions?

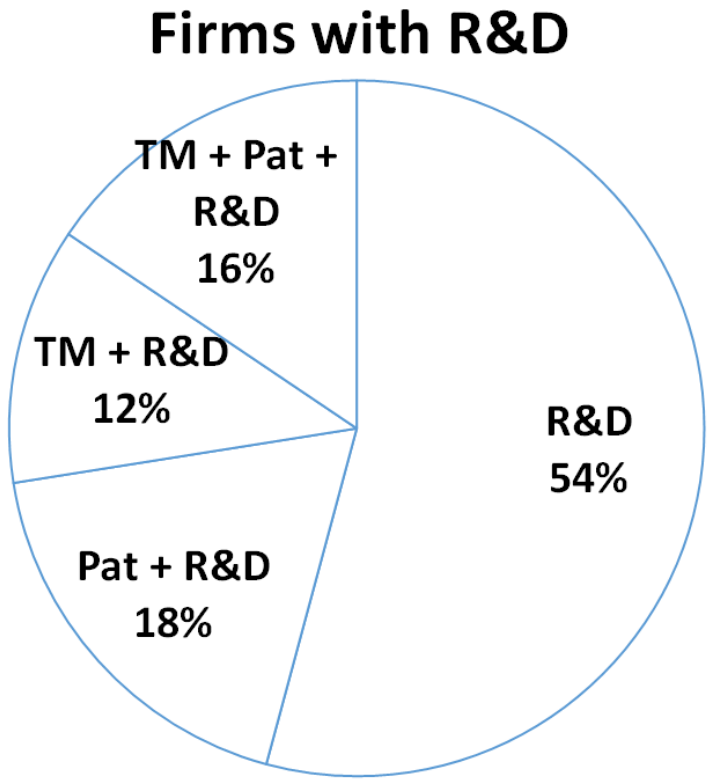
Differential Privacy

- One method for implementing differential privacy is adding Laplace-distributed noise.
  - This noise is not added to each entry in the dataset, but rather data aggregated to the smallest common cell that the data release requires
    - E.g. If we wish to release patenting firms by age and patenting firms by size as on slide 8, add noise to patenting firm cells broken by age X size
  - Noise must be scaled to the **sensitivity** of the query.
  - Sensitivity is generally the maximum amount a query can change if a single entity is added/removed from the underlying data.

Coincidence of Innovative Activities (BRDIS Sample)

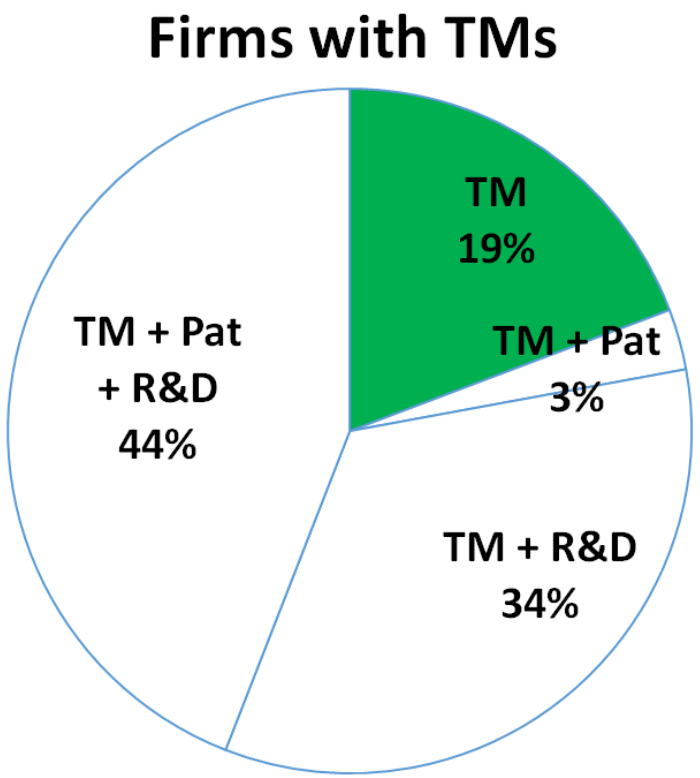


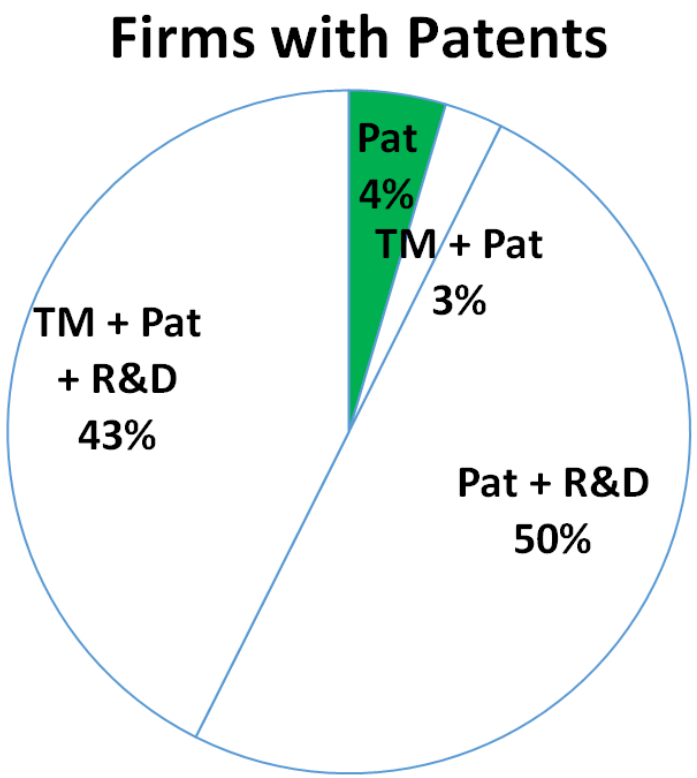


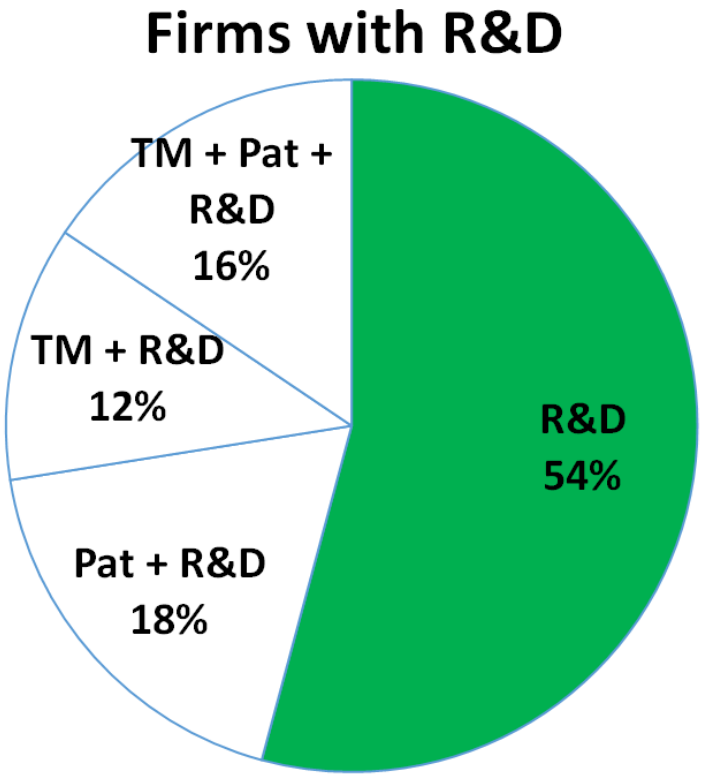


Coincidence of Innovative Activities (BRDIS Sample)

Only one activity







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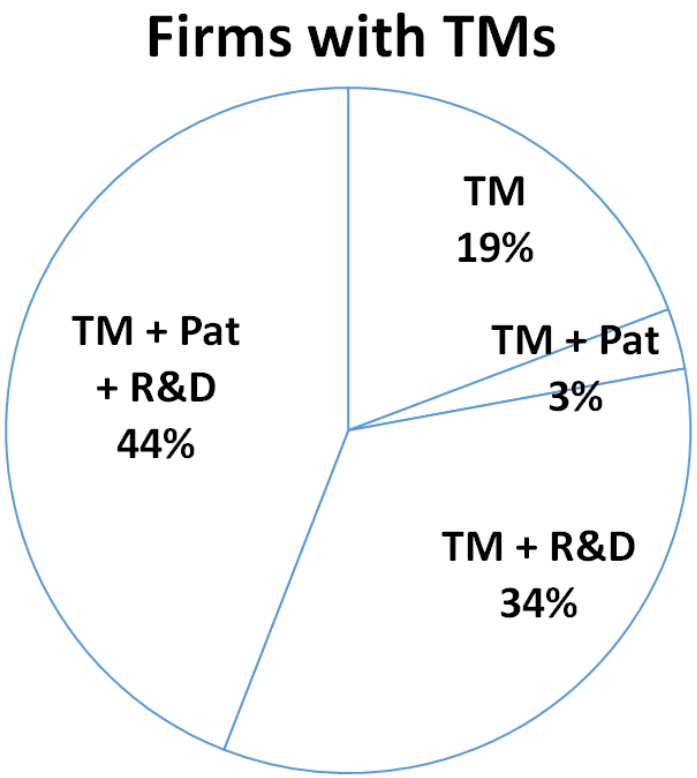
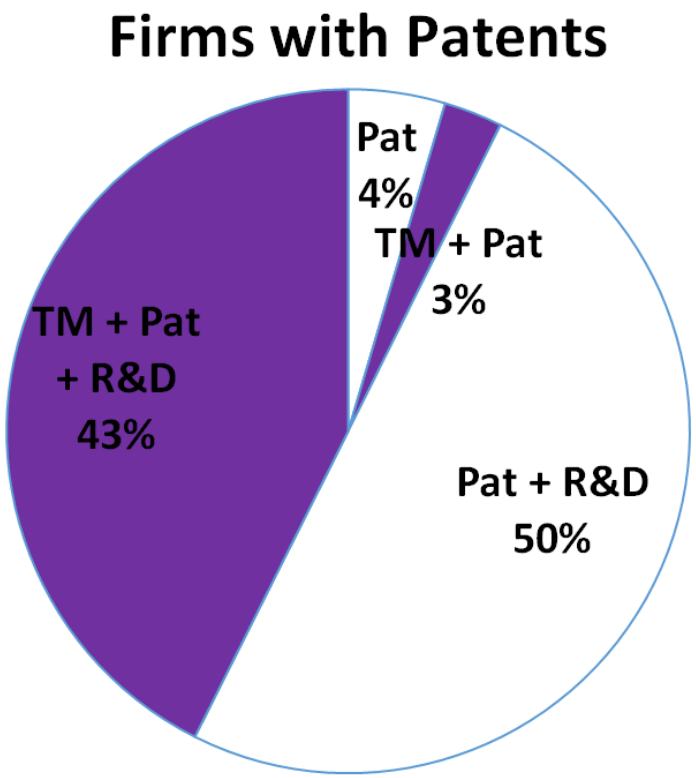
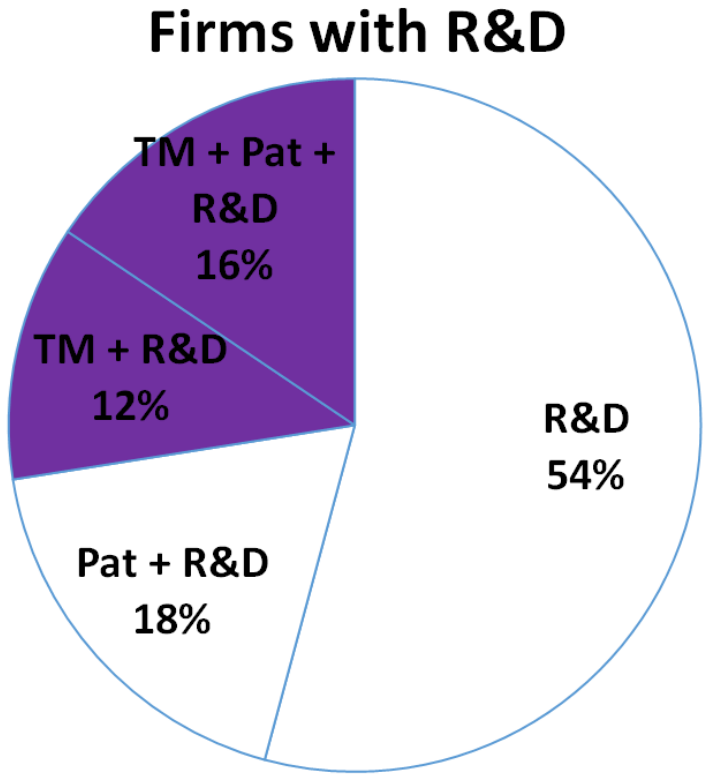
Coincidence of Innovative Activities (BRDIS Sample)

Also trademarking







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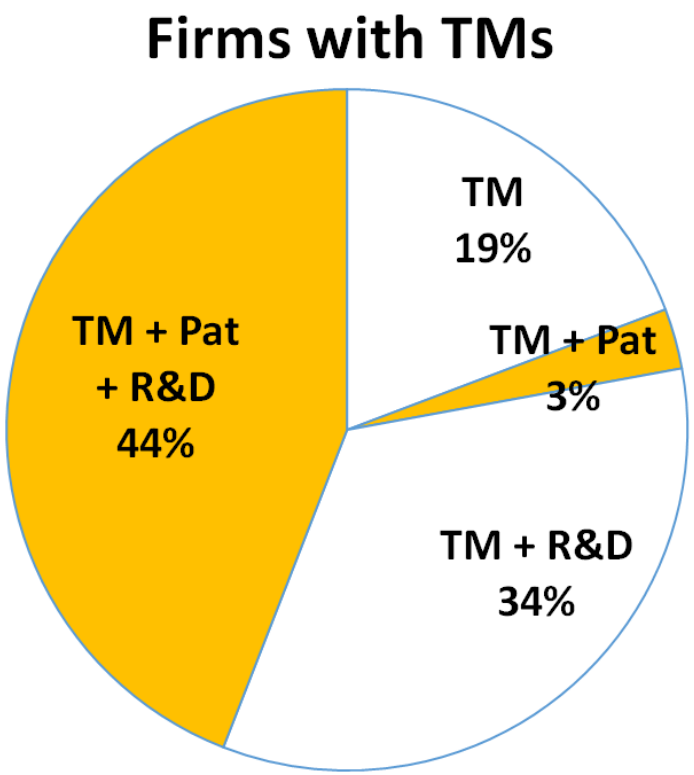
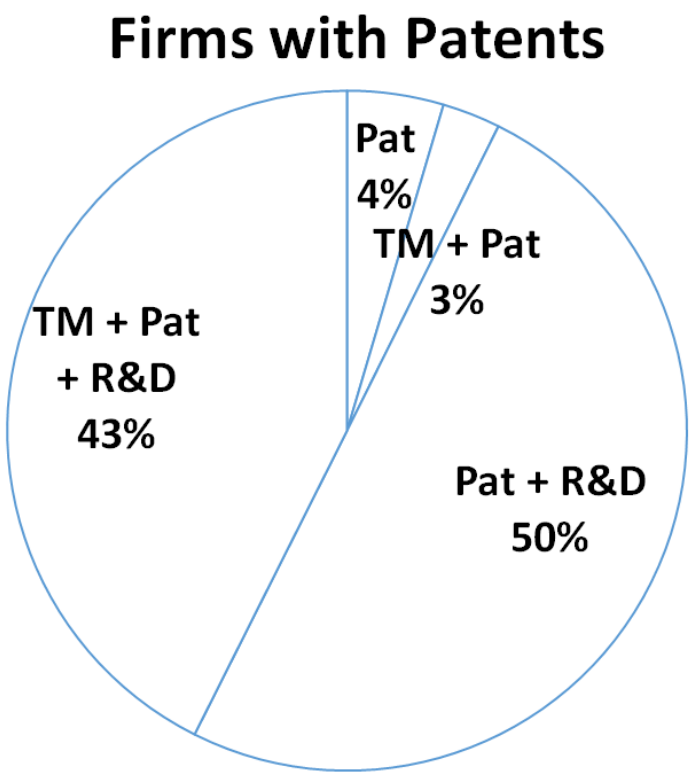
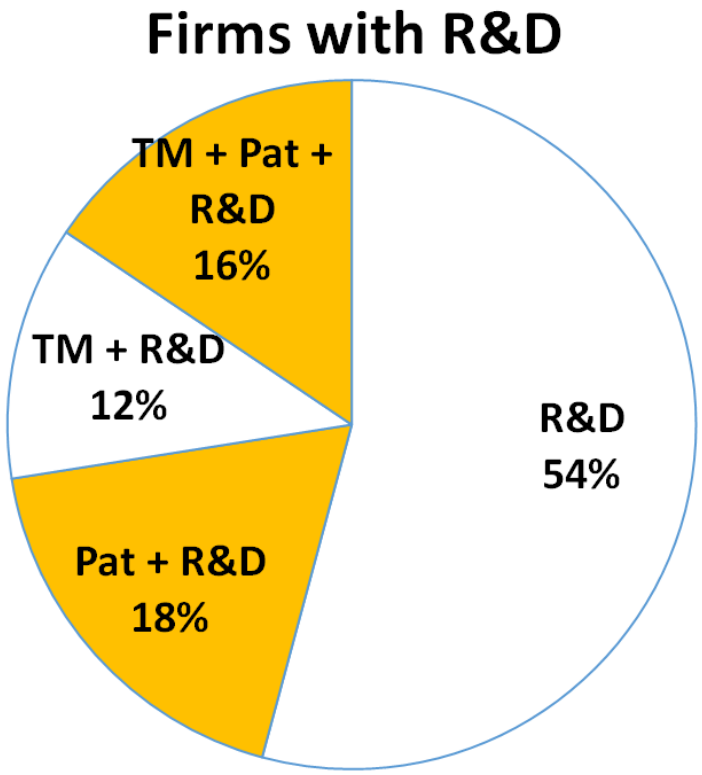
Coincidence of Innovative Activities (BRDIS Sample)

Also patenting

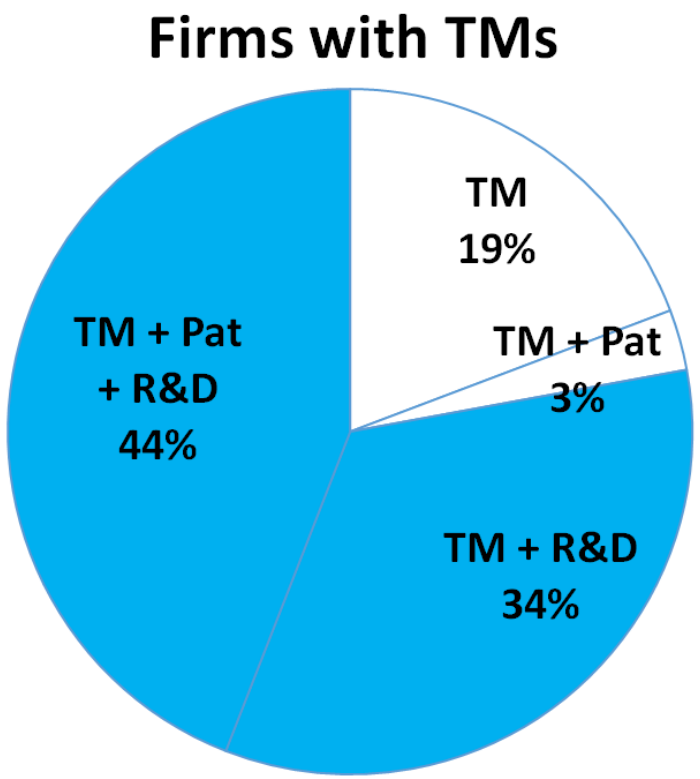


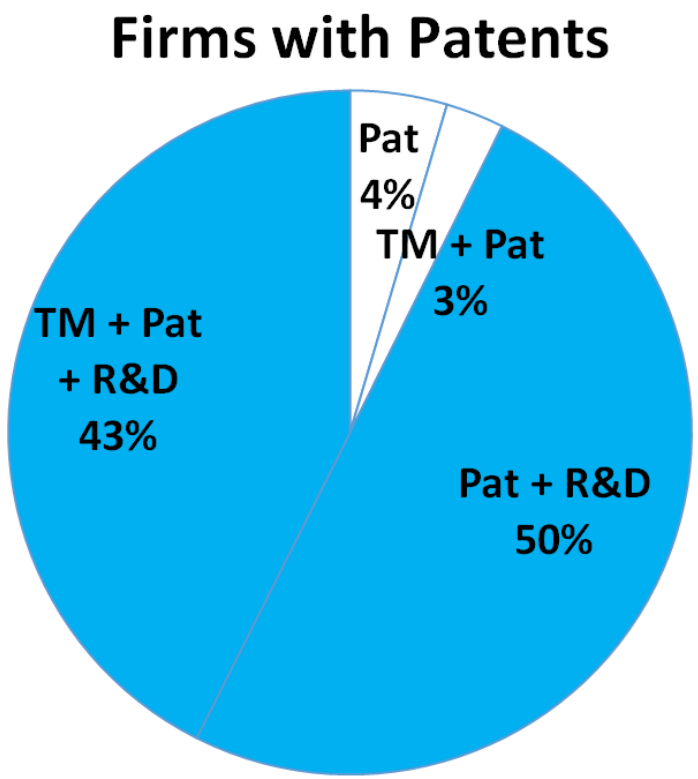


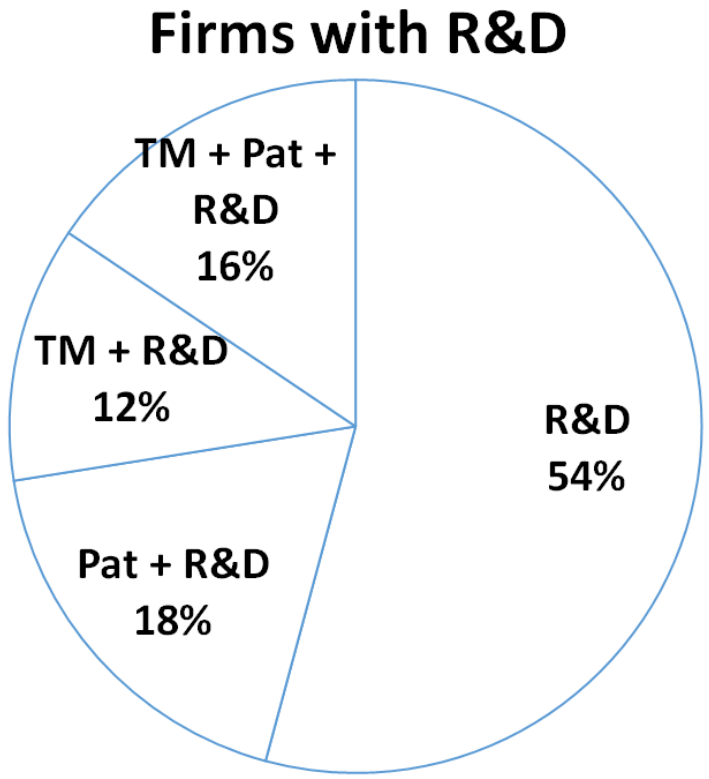


Coincidence of Innovative Activities (BRDIS Sample)

Also R&D







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