Uncovering Hidden Innovators: Linking administrative and big data to develop comprehensive measures of firms' innovation

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Introduction

Limitations of Current Innovation Metrics

- **Limitations of current official metrics** to provide clear picture of innovative activities of firms:
  1. **Measures shortcomings**: Focus on narrow definition of innovation (e.g. R&D investment, Frascati definition, patents, etc.);
  2. **Limited scope**: Limited and non-representative samples of firms (e.g. surveys, large firms, HQs), with extensive heterogeneity hidden behind aggregate statistics;
- Filling these 2 gaps crucial to **strengthen data and analytical capacity** to provide comprehensive evidence-based policy suggestions.

Introduction

Measures Shortcomings

- **Shortcomings** of standard **measures of firms innovation**, like R&D investment, employed researchers, patents, etc. (NESTA, 2007);
  - Traditional metrics based on specific model of **science-based innovation** led by formal R&D that is increasingly less relevant;
  - Particularly inappropriate for economies with lower reliance on manufacturing and **greater importance of services**;
- **Majority of innovations** are not based on the latest scientific or technological knowledge, but on exploiting the existing one (Bender and Laestadius, 2005; Arundel et al., 2008).
- Many sectors are more dependent on "**hidden or latent innovation**" than on traditional science-based innovation (Barge-Gil et al., 2011; Goetz and Han, 2020):
  - Incremental innovation;
  - Design and trademarks;
  - Adoption of new technologies and processes;
  - Intra-value chain collaboration;
  - Employees training;

Introduction

Limited Scope

- Limited focus on certain types of innovative activities (e.g. R&D investment and patents) leads to focus on a **narrow (biased?) set of businesses**:
  - **Large firms** operating in manufacturing and/or **high-tech** industries, clustered in densely populated **urban areas**;
- This is also due to **data collection constraints**:
  - Limited information on innovation from balance-sheet data;
  - Need to rely on surveys, with all related limitations:
    - Focus on easily collectable variables;
    - Prone to measurement error;
    - Limited samples representative only at very aggregated level (e.g. broad regional OR industrial classifications);
    - Cross-sectional data or with attrition issues;
- **New alternative unstructured data** sources which could **better represent** businesses innovation:
  - Limited, partial, or sector specific coverage (e.g. GitHub, crowdfunding, web-scraping, etc.)
  - Used in isolation - difficult data linking;
  - Noisy data prone to measurement error.

Aims

Project Objectives

- Develop **new comprehensive measures** of business R&D and innovation activities to identify **hidden innovators** not captured by traditional survey data:
  1. **Different types** of innovative activities (beyond R&D investment & patents);
  2. **Broader coverage** including entire business population (e.g. also SMEs, low-tech industries, peripheral/rural areas);
- **Map**, **gather**, and **link** official **survey** statistics with **administrative** datasets and other **alternative** data sources to create most extensive micro-level database on firms innovative activities.

Benefits

Project Contribution

1. Map **data sources** available, **variables definition** and **comparability** to analyse business innovative activities.
2. Create new **comprehensive database** for business innovation and R&D activities in the UK (and blueprint for other OECD countries).
3. Shed a light on innovation activity of hidden innovators, in line with national statistical offices' initiatives of **transforming R&D and innovation statistics**.
4. Enhance **sampling strategy** and lowering costs for future R&D and innovation surveys.
5. **Strengthen data and analytical capacity** for academic and policy analysis of business innovation.
6. Provide evidence to develop effective **innovation policies** to support businesses.
7. Encourage **engagement and cooperation** between statistical office and government departments enabling future data sharing (e.g. ONS, HMRC, UKRI, Devolved Nations, etc.).

Data

Data on Firms Innovation

- Link longitudinal micro-level data on a broad range of **different businesses R&D and innovation activities**;
- What type of data sources on business R&D and innovation activities can we consider?
  1. **Business R&D Official Surveys** [SRV];
  2. **Administrative Data on Public R&D Support and IPRs** [ADM];
  3. **Alternative Data Sources on Businesses' Innovative Activities** [ALT].

Data

Data Sources UK

Sources of micro-level data on **different UK businesses R&D and innovation activities** between 2015-2020:

1. **Official Surveys Data** [SRV]:
   - Business Enterprise Research and Development [BRD];
   - UK Innovation Survey [CIS];
2. **Administrative Data** [ADM]:
   - HMRC R&D Tax Credit [HMR];
   - National UKRI & Innovate UK Research Funding & Support [GTR];
   - National Catapults Support for Technological Adoption [CAT];
   - Regional Research Support (SMART Wales, Invest NI, Scottish Enterprise, HIENT, INTERFACE) [REG];
   - IPO Intellectual Property Rights (patents, design, trademarks) [IPO];
3. **Alternative Data Sources** [ALT]:
   - DataCity web-scraped innovation index [DCT].

- Complemented with firms balance-sheet data.

Data Analysis

Data Sources Overlap

Tab.1: Share of innovators identified across surveys, administrative and alternative data sources.

	BRD	CIS	DCT	GTR	HMR	IPO	REG
BRD	100.00%	31.27%	9.26%	28.72%	25.34%	11.78%	26.60%
CIS	15.75%	100.00%	2.61%	10.03%	8.37%	4.84%	12.20%
DCT	1.84%	1.03%	100.00%	3.90%	2.30%	1.69%	2.91%
GTR	15.12%	10.49%	10.32%	100.00%	10.59%	7.69%	22.19%
HMR	42.82%	28.09%	19.50%	34.00%	100.00%	19.56%	40.96%
IPO	19.85%	16.18%	14.33%	24.60%	19.49%	100.00%	28.34%
REG	2.16%	1.97%	1.19%	3.43%	1.97%	1.37%	100.00%

Data Analysis

Data Sources Overlap

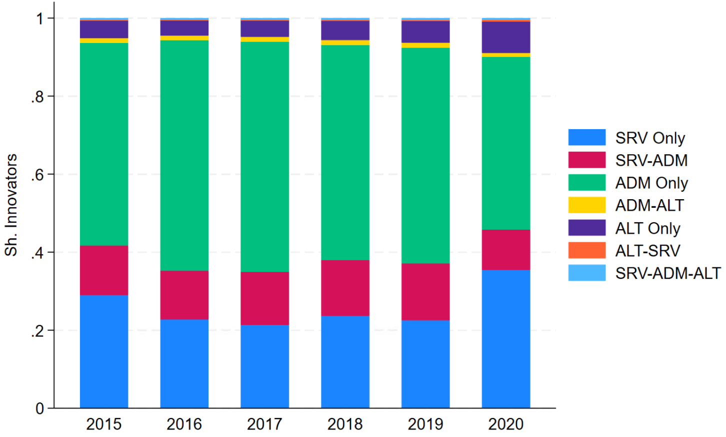
Tab.2: Correlation between innovators definition across surveys, administrative and alternative data sources.

	BRD	**CIS**	**DCT**	**GTR**	**HMR**	**REG**	**IPO**
BRD	1						
CIS	0.1356	1					
DCT	0.038	0.0096	1				
GTR	0.1677	0.0633	0.0496	1			
HMR	0.2634	0.0926	0.0647	0.1642	1		
REG	0.0284	0.0193	0.0087	0.0381	0.0476	1	
IPO	0.0962	0.0473	0.0248	0.092	0.113	0.0223	1

Data Analysis

Data Sources Overlap

Fig.1: Share of total innovators identified across surveys, administrative and alternative data sources.



Data Analysis

Data Sources Characteristics

Tab.3: Comparison between innovating firms characteristics across data sources and in comparison with firms also included in survey data.

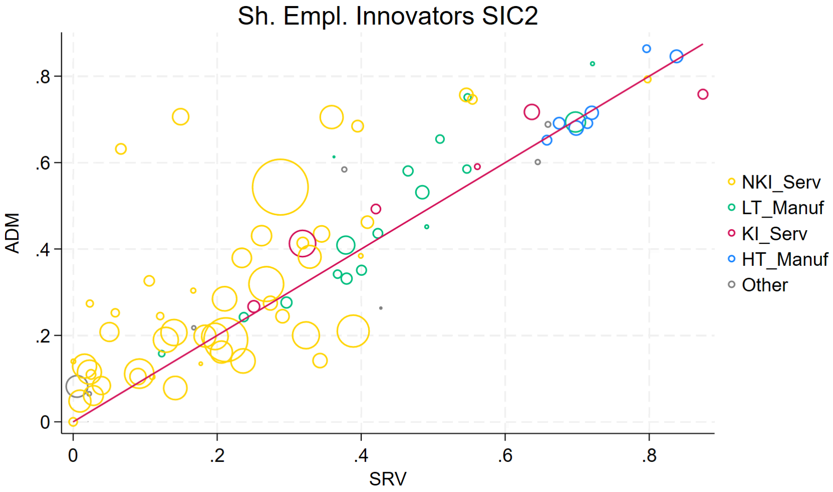
	HMR			IPO			GTR		
	No SRV	**SRV**	**Diff. T-test**	**No SRV**	**SRV**	**Diff. T-test**	**No SRV**	**SRV**	**Diff. T-test**
No. Firms	221,960	67,538		80,982	17,011		48,825	24,848	
Employment	87.20	230.15	15.51	197.00	616.67	13.81	308.01	529.40	6.48
Age	16.65	25.08	160.0	12.03	25.27	130.0	16.17	23.11	66.48
Group	28.33%	58.16%	150.0	27.53%	66.27%	100.0	39.69%	60.96%	55.93
For.Own.	3.79%	13.81%	96.59	5.07%	17.72%	58.79	14.22%	22.65%	28.93
Manuf.	19.74%	45.29%	140.0	12.58%	43.69%	100.0	15.60%	38.41%	71.62
HT Manuf	5.60%	22.28%	130.0	3.54%	21.12%	87.14	7.68%	23.32%	61.30
Service	78.22%	54.29%	125.4	86.68%	55.82%	98.39	81.47%	60.77%	62.54
KIS	18.79%	21.60%	16.17	10.81%	20.03%	33.33	20.63%	32.27%	34.97
Urban	76.95%	78.04%	5.92	81.08%	78.35%	8.17	77.65%	75.91%	5.27

	REG			CIS			DCT		
	No SRV	**SRV**	**Diff. T-test**	**No SRV**	**SRV**	**Diff. T-test**	**No SRV**	**SRV**	**Diff. T-test**
No. Firms	3,751	1,051		3,734	2,981		44,142	4,184	
Employment	65.61	215.07	3.40	460.30	800.20	2.58	16.27	191.83	17.03
Age	16.18	17.45	2.64	15.35	23.55	22.89	10.74	17.31	45.72
Group	24.21%	40.91%	10.80	41.54%	63.07%	17.95	21.79%	47.49%	37.74
For.Own.	3.71%	10.85%	9.24	14.57%	22.31%	8.24	5.94%	12.67%	16.36
Manuf.	36.87%	39.58%	1.61	24.26%	44.15%	17.59	3.39%	11.45%	25.26
HT Manuf	11.14%	20.55%	8.01	10.34%	27.74%	18.90	1.79%	8.29%	26.72
Service	61.50%	58.99%	1.48	75.07%	55.32%	17.39	96.41%	85.88%	24.17
KIS	13.60%	27.02%	10.47	13.69%	32.77%	19.22	45.92%	62.93%	21.15
Urban	65.52%	68.89%	1.63	78.13%	77.28%	0.83	81.86%	82.27%	0.66

Data Analysis

Survey v Admin Data - Industries

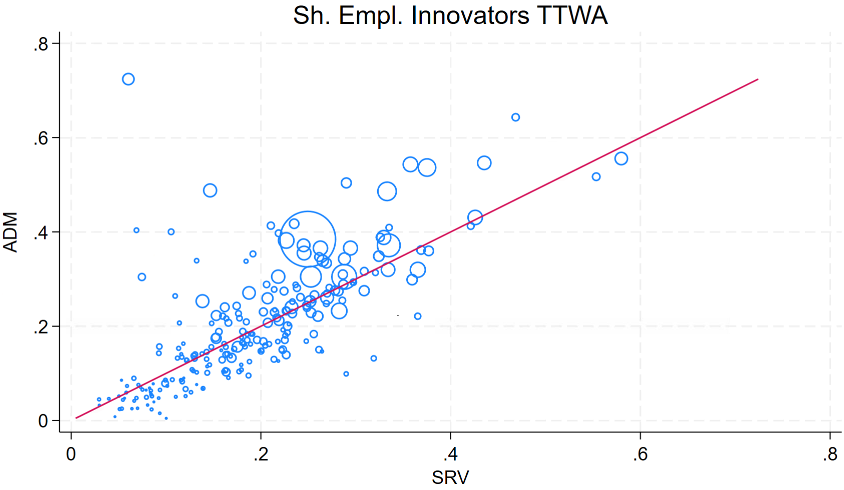
Fig.2: Share of innovators across Industries identified using Survey or Administrative data sources.



Data Analysis

Survey v Admin Data - Regions I

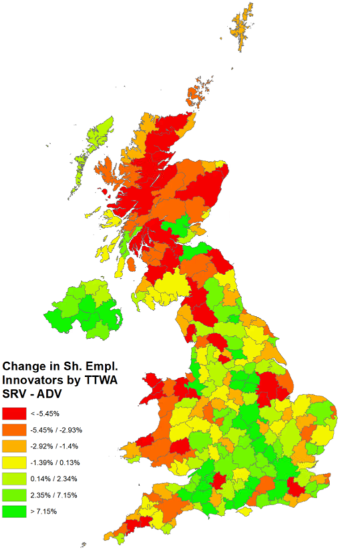
Fig.3: Share of innovators across TTWAs identified using Survey or Administrative data sources.



Data Analysis

Survey v Admin Data - Regions II

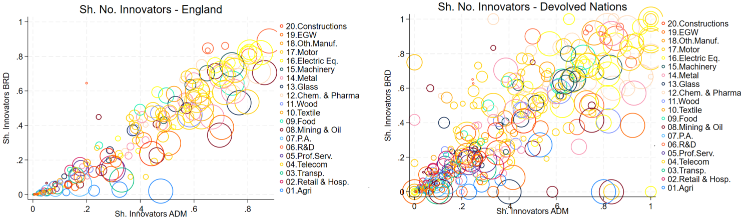
Fig.4: Change in share of innovators across TTWAs identified using Survey or Administrative data sources.



Data Analysis

Survey v Admin Data - Size, Nations & Industries

Fig.5: Share of innovators across industry and firms size groups identified using Surveys or Administrative data sources – England and Devolved Nations.



Data Analysis

Hidden Innovators Characteristics

Tab.4: Regression analysis estimating probability of being an hidden innovator based on firms' characteristics.

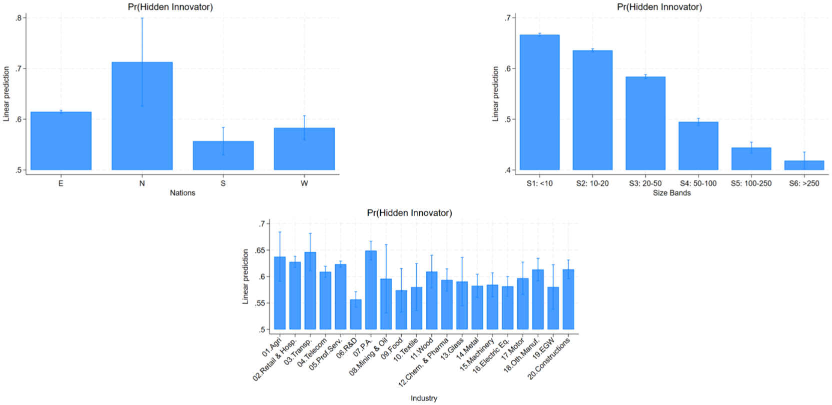
	pr(Hidden Innovator)
Size	-0.0435***
	(-0.00122)
Devolved	-0.0426***
	(-0.00959)
Service	0.0721***
	(-0.0092)
High-Tech	-0.0258***
	(-0.00436)
Firm FE	Y
Year FE	Y
Observations	504,095
R-squared	0.896

Notes: Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Data Analysis

Hidden Innovators Characteristics

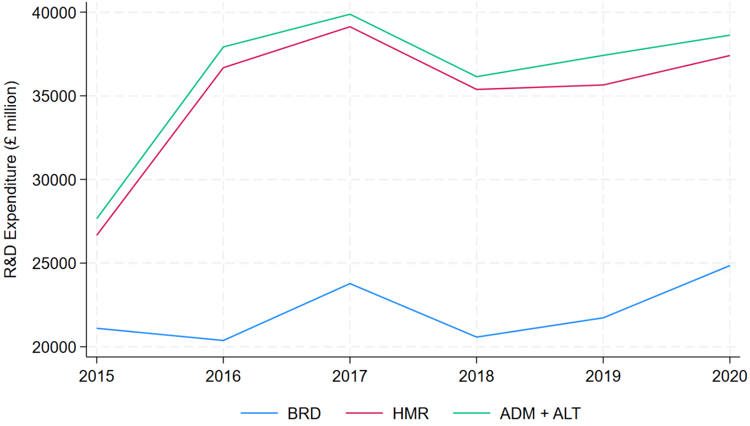
Fig.6: Probability of being an Hidden Innovator by nation, size category, and industry.



Data Analysis

Hidden R&D Expenditure

Fig.7: R&D expenditure estimated using Surveys or Administrative data sources.



Conclusions

Summary & Insights

- Some overlap between SRV and ADM data, mainly through HMR data.
- SRV capture 40% of innovators → 65k new hidden innovators identified using ADM+ALT data.
- Hidden innovators very different from SRV: younger, smaller, single plant, domestic, in low-tech, and services (except for REG).
- ADM data much better at identifying hidden innovators in low-tech services industries and in larger metropolitan areas.
- In England ADM and SRV yield consistent results, very large discrepancies in devolved nations.
- Not because of location, but because fo their characteristics: smaller, services, low-tech firms in England and NI more likely to be hidden innovators.
- SRV data significantly underestimates business R&D expenditure: about £10b more using HMR data, + £1/2b more using otehr ADM+ALT data.
- Value for money in integrating ADM and SRV data for analysis and policymaking.

Thank you

Feedback & Questions?

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