Exploring Innovation Pathways: An Insight Into The Drivers Of Patenting Among Australia's R&D Firms

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Disclaimer

- The views expressed in this study are those of the authors, and do not necessarily reflect those of IP Australia.

Introduction

- Innovation plays a crucial role in driving economic growth in a knowledge-based economy.

- For R&D firms, securing intellectual property through patenting activities is often a strategic step to protect their innovations, gain a competitive edge, and unlock potential revenue streams.

- Understanding the key drivers that influence patenting activities among Australian R&D firms is crucial for policymakers, industry stakeholders, and researchers alike.

Literature Review

- The literature examining the relationship between firms performance and patenting activities is extensive (Arundel et al. (1998), Brouwer et al. (1999), Mahlich (2010), Czarnitzki and Kraft (2010), Sandner and Block (2011), Nicholas (2011), Balasubramanian et al. (2011), Holgersson (2013), Agostini, Caviggioli, Filippini et al. (2015)), Huang et al. (2015), Ambrammal and Sharma (2016), Maresch, Fink and Harms (2016), Chandrashekar et al. (2019), Wang, Lu, Kweh et al. (2020), and Zhao and Tan (2021)).

- However, existing studies often focus on factors such as firm size or the level of R&D expenditure. Our study addresses this gap by examining *sources of funding, collaboration networks*, and *complementary investment*. We also highlight the role of *R&D Expenditure efficiency* as a key driver of firm-level patenting performance.

Data

- 34,592 R&D firms uniquely identified over 14 years (2005-2020)

- Business Expenditure on Research and Development (BERD): 2005-2020, Business Characteristic Survey (BCS): 2006-2020, BAS, PAYG, and IPLORD

- Missing data: BERD data is collected biennially from 2012, BCS started from 2006, missing data in all the data modules used. Addressed by linear interpolation.

Methodology

- NBER model is selected in the following form:

$$\log(\lambda_{it}) = \beta_0 + \beta_1 RD_{it} + \beta_2 RD_{it}^2 + +\theta D'_{it} + \sum_{m=1}^{20} Industries'_{itj}\,\gamma + \sum_{n=1}^{8} States'_{jtk}\,\delta + \sum_{q=1}^{3} FirmSizes'_{itl}\xi + \varepsilon$$

where $\lambda_{it} = \alpha + X'\beta + \varepsilon_i = E(Patentcount_{it}|X_i, \varepsilon_i)$, X' is the vector of independent variables

'i': firm, 'j': industries, 'k': states, 'l': firm sizes , and 't' :years

RD: R&D expenditure

D' denotes a vector of binary dummy variables indicating selected drivers of patenting performance (*Funding sources, Collaboration networks and Complementary investment*)

Methodology (continued)

- *Dependent variable*: # of legally enforceable patents held by a R&D firm.
- *Regressors*: R&D expenditure, quadratic term of R&D expenditure, funding sources, collaboration network and complementary investment, binary dummies for industries, states, firm size (employment)
- At *firm level*: 4 models (*Linear-Linear OLS, Log-Linear OLS, Poisson regression and Negative Binomial Regression-NBER*)
- Model selection: continuity and negativity of dependent variable, discrete countable variable, AIC, BIC, variance and mean comparison, LR test for alpha

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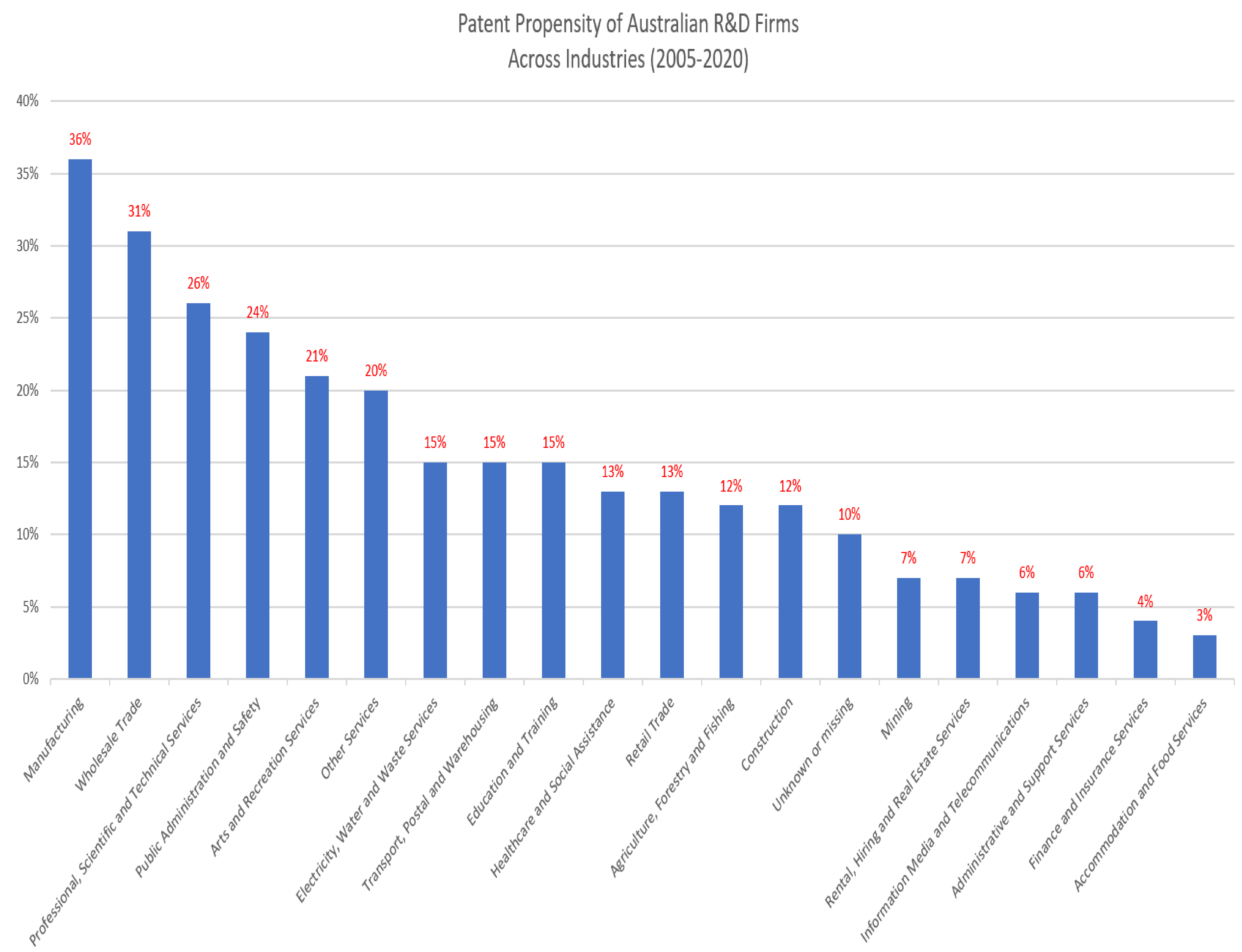
Descriptives

- ***Industry level patent propensity*** (percentage of patent holding firms relative to total number of firms count in each industry)
- This provides *a broad view* of patent propensity at the industry level (differences in firm count across industries may influence the comparability of the results)
- Top 5 industries with the *highest R&D expenditure* in 2019-2020 (ABS) differ from the top 5 industries with the *highest patent propensity*
- The level of R&D expenditure is not always directly correlated with a high level of intellectual property engagement.



Key findings

- **Regression results**

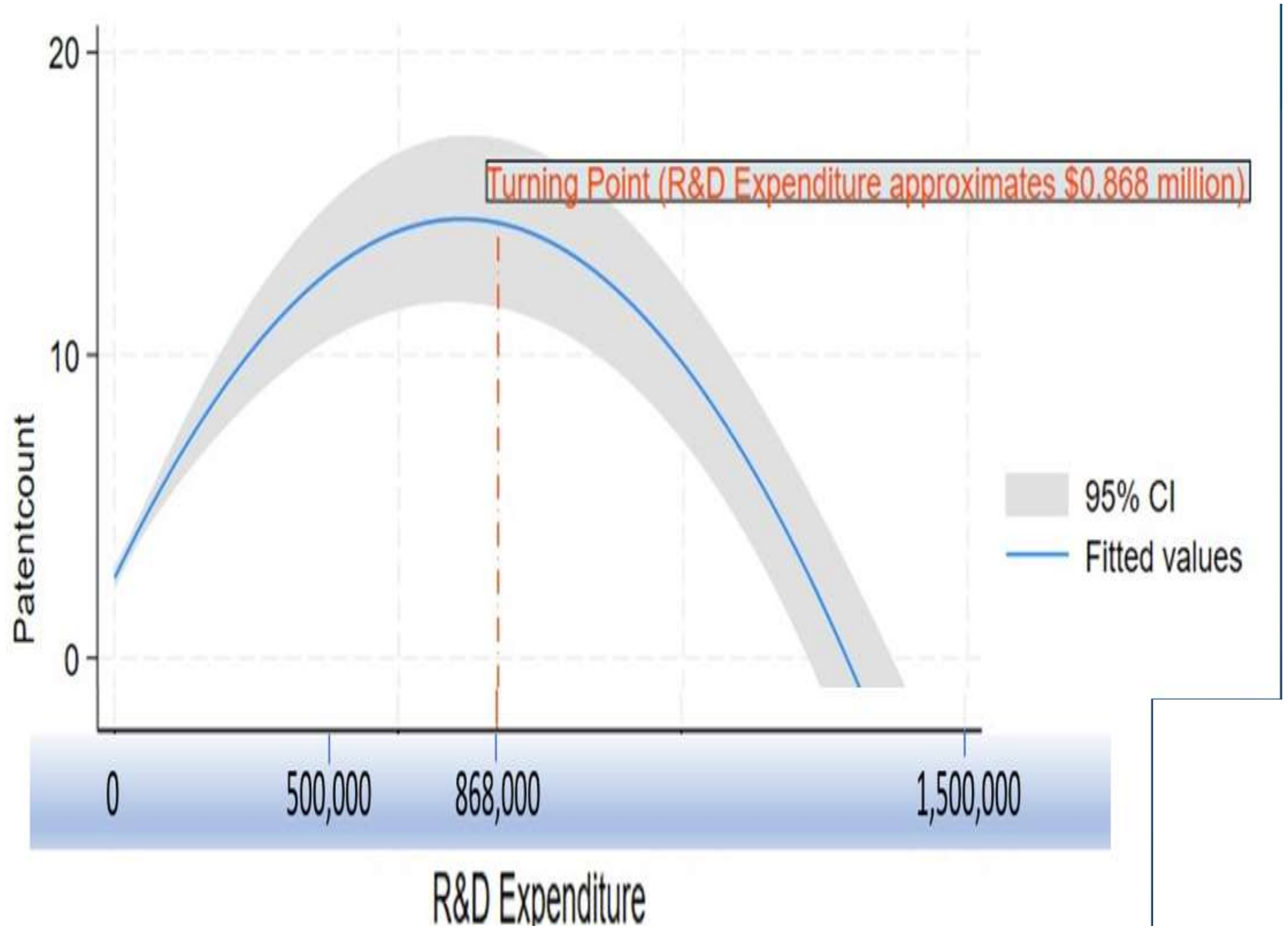
Linear-Linear, Log-Linear, Poisson and NBER models outputs

	(1) Linear-Linear	(2) Log-Linear	(3) Poisson	(4) NBER
R&D Expenditure	0.000348** (2.44)	0.0000150* (1.74)	0.0000354*** (4.08)	0.0000211*** (3.42)
R&D Expenditure (Sq)	-3.21e-10** (-2.45)	-2.99e-11 (-0.67)	-1.31e-10*** (-3.34)	-8.23e-11*** (-3.46)
State/territory funding	1.02e-08 (0.52)	4.53e-10 (1.19)	4.62e-10 (0.67)	1.03e-10 (0.18)
Issuing Equity	1.41e-08 (0.50)	-2.14e-09*** (-3.30)	4.17e-11 (0.03)	3.22e-09 (1.15)
Collaborative arra~n (R&D)	**3.528** (0.59)	**0.188** (1.17)	**0.311** (0.63)	**0.683***** (2.94)
Collaborative arra~n (Marketing)	**8.607** (1.62)	**0.241** (1.39)	**0.275** (0.69)	**0.198** (0.91)
Comp. Investment	7.29e-09 (0.36)	6.81e-11 (0.15)	7.85e-10 (1.33)	1.27e-09* (1.85)
Sub. Protection Methods	-9.83e-09 (-0.65)	1.40e-10 (0.27)	-3.72e-09 (-1.10)	-1.65e-09** (-2.51)

Key findings (continued)

- **Firm-level patent propensity**
- A \$1000 increase in R&D expenditure is associated with an approximately *0.02%* rise in the number of legally enforceable patents held by an R&D firm, all other factors being constant
- Rate of increase in the number of holding patents diminishes after surpassing the “turning point” of \$868,000 (linear-linear model)
- This suggests that SMEs have an advantage over large firms in terms of the efficiency of R&D expenditure.

Diminishing effects of R&D expenditure on firm-level patenting activities



Key findings (continued)

- **Substitutive protection method**: Firms opting *secrecy/confidentiality agreements* to protect their IP over applying for a patent may experience a *decrease* patent propensity by nearly *2%**.

- **Collaboration networks:** Participation in *joint R&D collaborative arrangements* with partners is associated with a *0.7%* increase in innovation. Engaging in *marketing or distribution collaboration agreements* offer a chance to enhance patent propensity by *0.2%*.

- **Complementary investment:** Firms that engage in *complementary investment* (acquiring intangible IP assets such as licences, rights, patents, or other IP assets) are likely to experience a boost in innovation performance of more than *1%*.

- **Funding sources:** A firm is expected to have *1%* higher patent propensity when receiving financial assistance from *state/territory or local governments*, *3%* better if sought finance by *issuing equity* (shares issuance to shareholders or being listed on ASX)

*All compared with the R&D firms that did not engage in the above relevant factors.

Key findings

- **Marginal effects (absolute value)**
- The marginal effects of *collaboration networks*, far *outweighs* those from R&D expenditure, funding sources and complementary investment.
- "*Peaks*" of marginal effects in different industry segments such as Manufacturing, Wholesale Trade, Retail Trade; Professional, Scientific and Technical Services; and Arts and Recreation Services.
- Highest effects in *NSW*, and the lowest in NT and SA.
- *Medium-sized R&D firms*, on average, have approximately 15 patents fewer than large firms, while *small firms* have 14 patents less than large firms as illustrated in Figure 6.

Figure 3: Average Marginal Effects of R&D Expenditure and Binary Dummy Variables of NBER model (95% Confidence Intervals)[8]

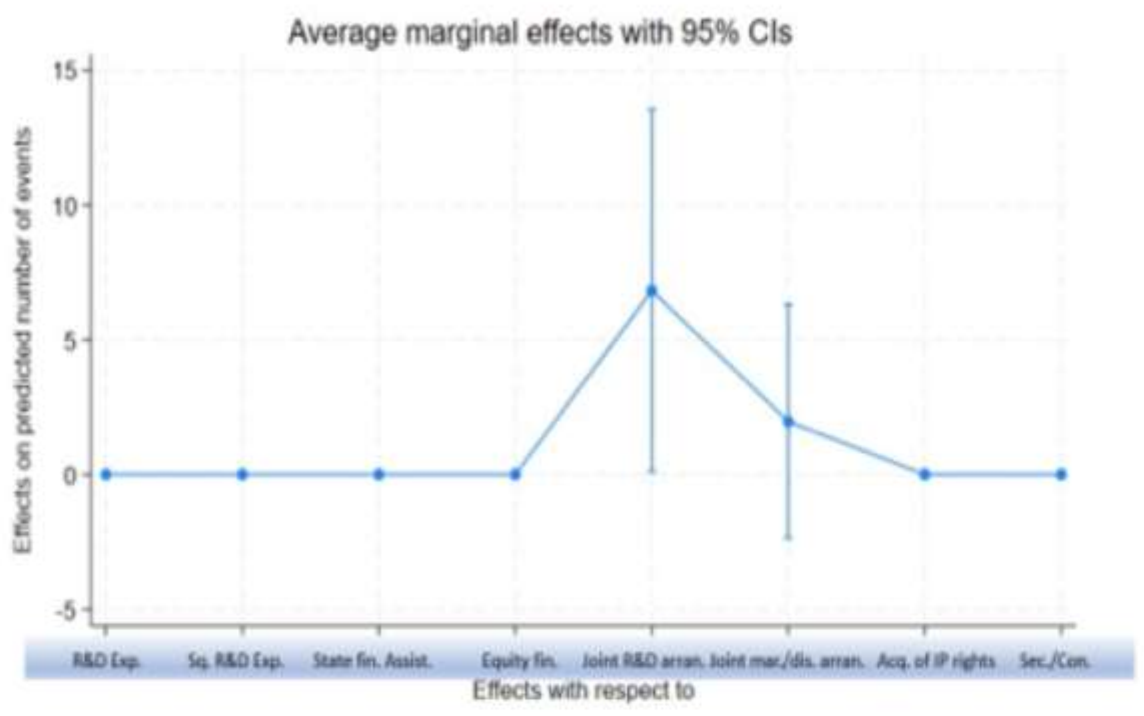


Figure 4: Average Marginal Effects of Various Industries of NBER model (95% Confidence Intervals)[9]

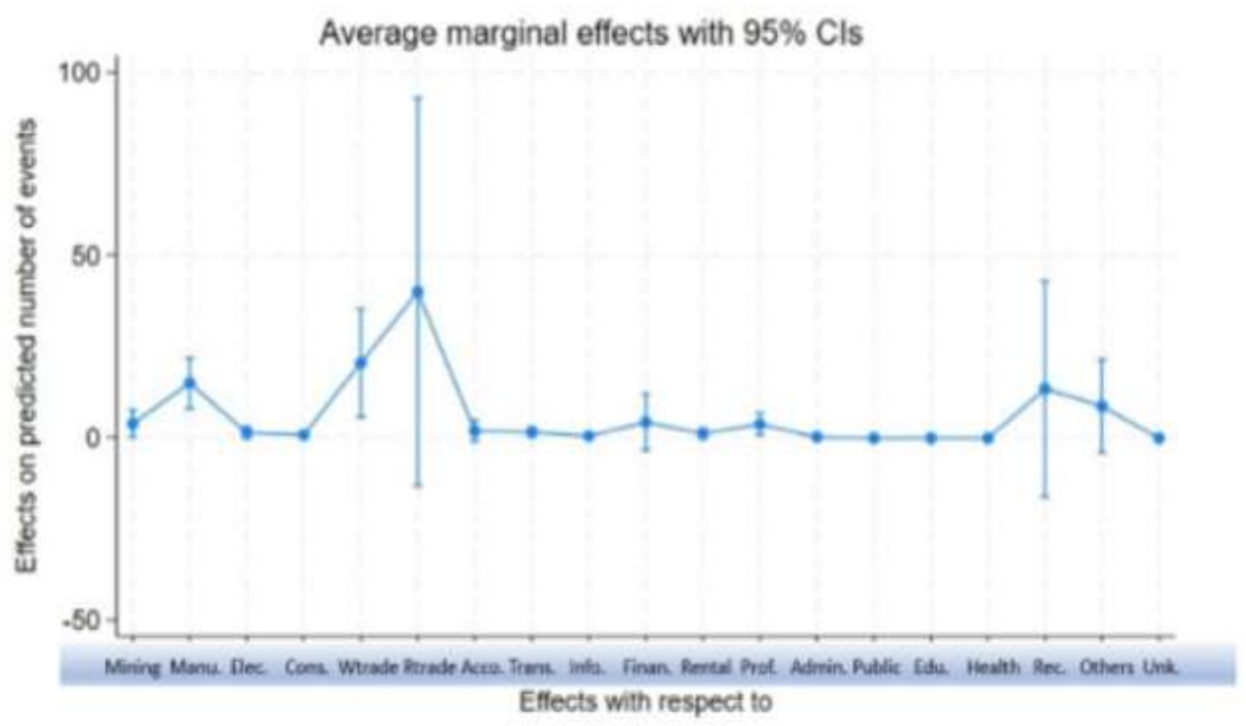


Figure 5: Average Marginal Effects of States/Territories of NBER model (95% Confidence Intervals)[10]

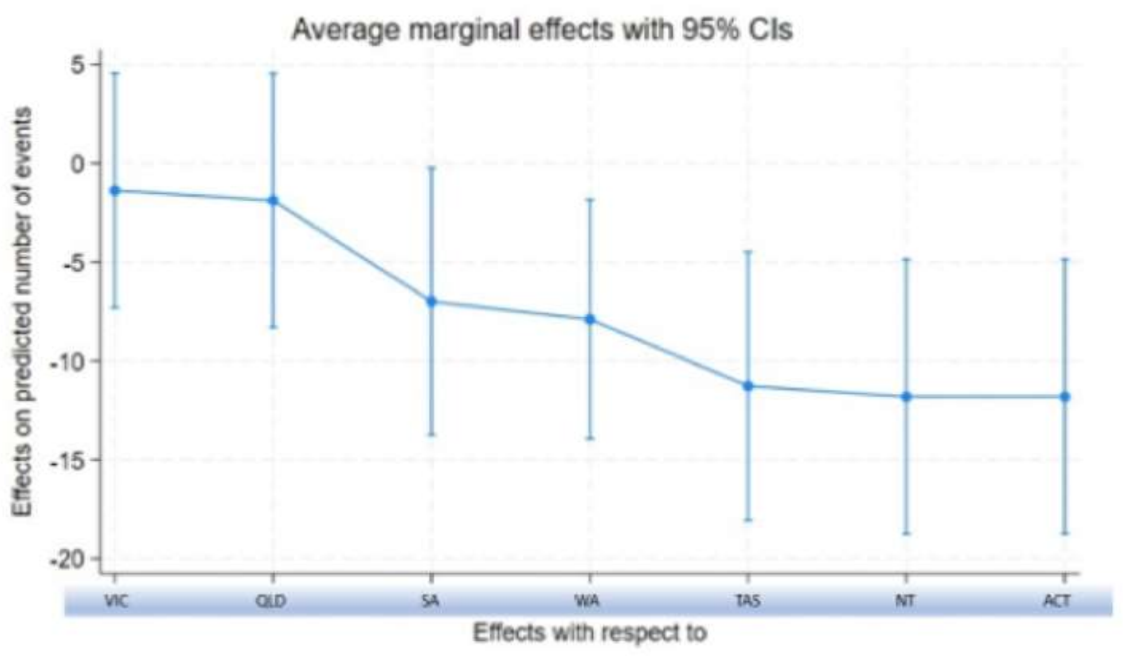
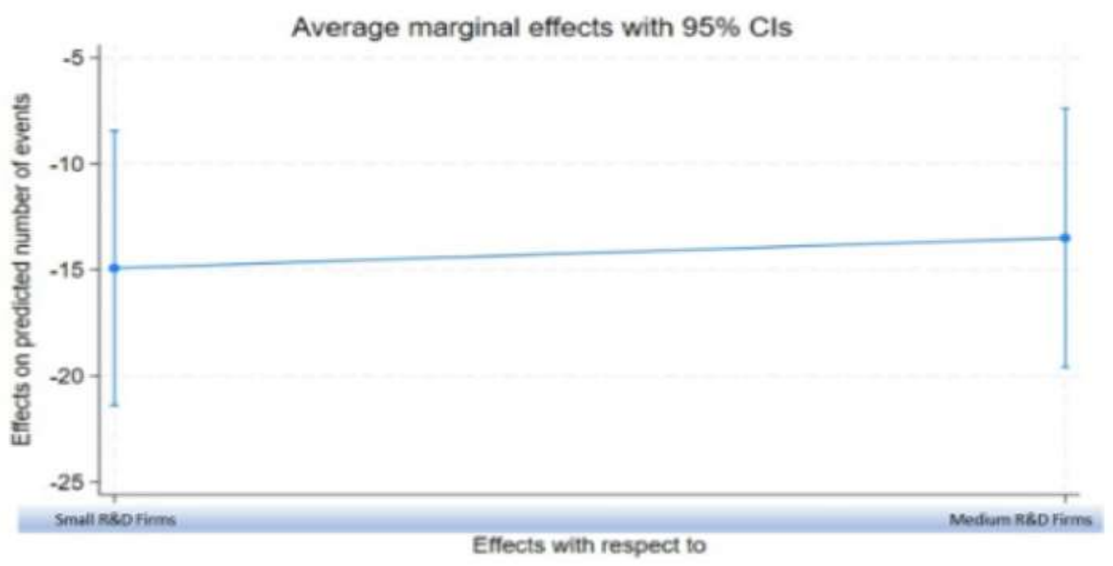


Figure 6: Average Marginal Effects of Small and Medium R&D Firm of NBER model (95% Confidence Intervals)[11]



Policy implications and recommendation

- There are currently concerted efforts of the Government to lift R&D performance by lifting R&D expenditure. However, economic policy to enhance innovation depends not only on lifting R&D expenditure, but also appropriately targeting R&D expenditure efficiency.

- Importance of collaboration, funding sources and technological transfer (complementary investment) as key drivers of innovation performance in Australia

- Policies targeted at increasing R&D expenditure in the most efficient sectors/industries.

Avenue for further research

- Investigating the interaction with external environmental influences could provide a more comprehensive understanding of innovation dynamics.
- Analysing R&D intensity by dividing patent count by the number of employees or revenue could yield deeper insights into firms' innovation strategies.
- Exploring alternative methods of appropriation beyond patenting such as confidentiality/secrecy agreements could shed light on the broader intellectual property landscape in which R&D firms operate.

Thank you for your attention!

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