Australian Government
Department of Industry, Innovation and Science
IP Australia

A Patent Analytics Report on the Australian Research Sector

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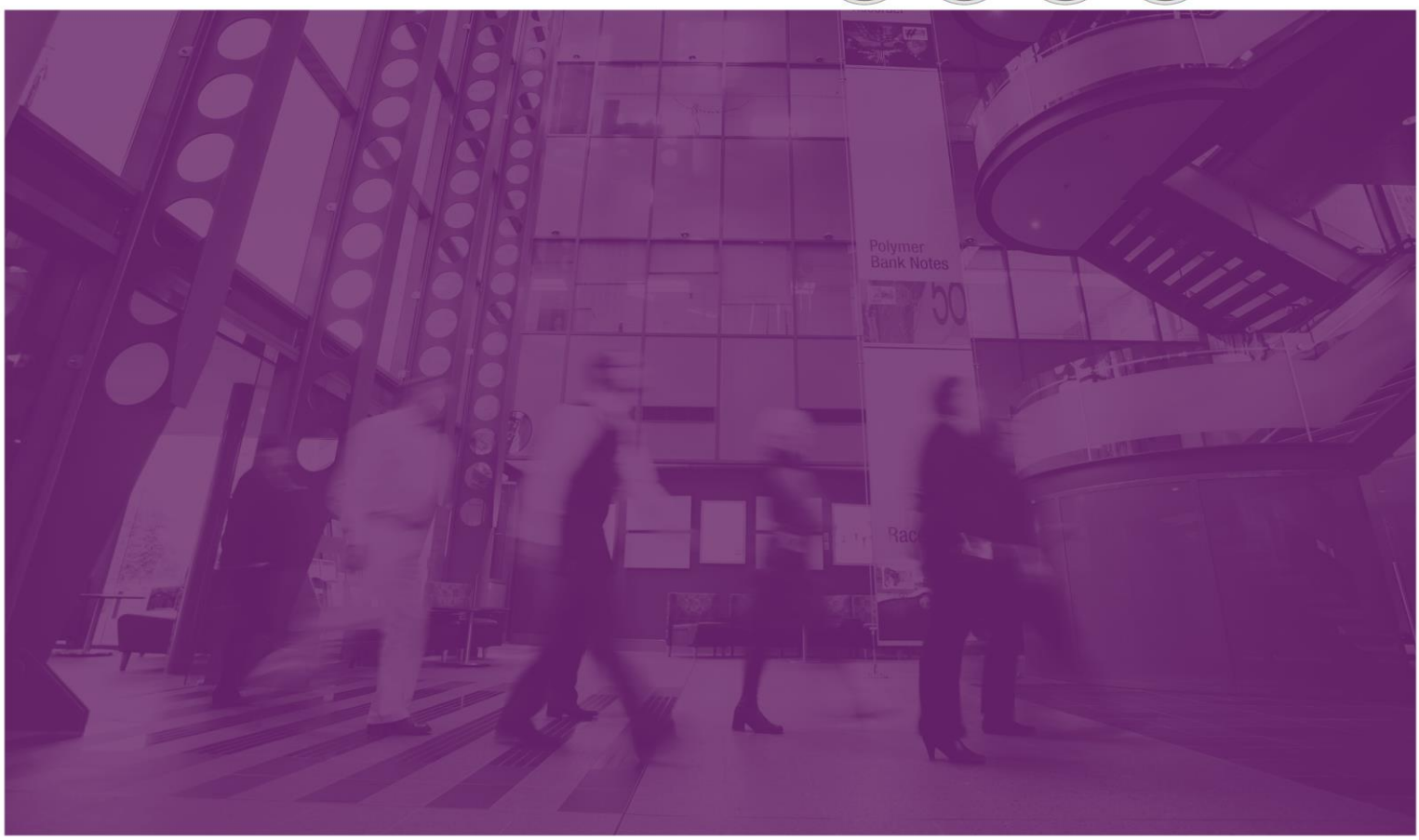

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Enquiries
National Patent Analytics Hub
Email: analytics@ipaustralia.gov.au

Contents

Glossary

ABN	Australian business number
ADC	Australian designs classification
AIMS	Australian Institute of Medical Scientists
ANSTO	Australian Nuclear Research and Development Organisation
ATN	Australian Technology Network
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DOCDB	EPO master documentation database
DSTO	Defence Science and Technology Organisation
EPO	European Patent Office
Go8	Group of Eight universities
HAN	OECD harmonised applicants' names
INPADOC	EPO worldwide legal status database
IP	Intellectual Property
IPC	International Patent Classification
IPGOD	Intellectual Property Government Open Data
MRI	Medical research institute
NCL	Nice classification
NICTA	National ICT Australia
NPE	National-Phase Entry
NSRC	National Survey of Research Commercialisation
PATSTAT	EPO worldwide patent statistical database
PBR	Plant breeder's right
PCT	Patent Cooperation Treaty
PFRO	Publicly Funded Research Organisation
PFRA	Publicly Funded Research Agency
PSS	Internal IP Australia administrative data
QIMR	Queensland Institute of Medical Research
RSI	Relative Specialisation Index
UQ	University of Queensland
WEHI	Walter and Eliza Hall Institute of Medical Research
WIPO	World Intellectual Property Organization

1 Introduction

This report analyses the intellectual property (IP) rights holdings of publically funded research organisations (PFROs) in Australia and provides an overview of innovation originating from the Australian research sector. These organisations take part in the National Survey of Research Commercialisation (NSRC). In 2014–15 the survey was reviewed to help strengthen and streamline the data collection, and to ensure the survey aligns with current and emerging objectives for research commercialisation in Australia and abroad. As part of data collection streamlining and reducing the burden upon survey respondents, the Patent Analytics Hub at IP Australia extracted IP data related to the PFROs. This data covers four IP rights governed by IP Australia—patents, trade marks, designs and plant breeders rights.

The purpose of the report is twofold: to provide benchmark metrics on the current state of the commercialisation practices of the research sector; and to provide examples of metrics that could be used to gain a greater understanding of impact.

This report is a follow-up to the 2013 report "Research Performance of University Patenting in Australia: A Pilot Assessment".[1] Compared with the previous report, which included only 12 universities, this report has a greater scope, updated metrics and an explanation of why we have chosen not to pursue some previously used methods of analysis.

1.1 IP Rights

1.1.1 Patents

A patent is a right that is granted for any device, substance, method or process that is new, inventive and useful. Australian patent rights are legally enforceable and give the owner exclusive rights to commercially exploit the invention for a period of up to 20 years.

Provisional applications are normally the first step in applying for a standard or an innovation patent and establish a priority date for the invention. A provisional patent application is not examined and is not an enforceable right, but allows applicants 12 months to determine if they will seek further patent protection for their invention.

If further protection is sought there are two major filing routes for patent applications: international and direct.

The international route involves filing a Patent Cooperation Treaty (PCT) application, which establishes a filing date in all 148 contracting states.[2] A PCT application allows preliminary examination of a patent application, but also provides time for the applicant to defer large costs while assessing the viability of the invention disclosed in the patent application. In order to secure patent rights in any given country, an applicant must lodge individual applications in countries, referred to as national-phase entry (NPE). A PCT application must enter the national phase to proceed towards grant. A patent can only be enforced once it has been granted. It is necessary to pay fees to each country in which patent protection is sought.

Direct, or convention applications, are only lodged in the countries of interest. These applications will be examined before proceeding to grant. After grant, the patent may be enforced.

Applications generally relating to the same invention but lodged in different countries are known as *patent families*. Patent families enable us to analyse inventive activity regardless of the number of countries in which protection is sought. We use patent families according to the INPADOC patent

[1] IP Australia, Research Performance of University Patenting in Australia: A Pilot Assessment, 2013

[2] WIPO, List of PCT Contracting States

family definition. An INPADOC patent family is defined as comprising all the documents sharing directly or indirectly (e.g. via a third document) at least one priority. This includes all the patent documents resulting from a patent application submitted as a first application with a patent office and from the same patent application in any country.[3]

1.1.2 Trade marks

A trade mark is a right that is granted for a letter, number, word, phrase, sound, smell, shape, logo, picture and/or aspect of packaging. It is a distinctive sign that identifies a product or service. A registered trade mark is legally enforceable and gives the owner exclusive rights to commercially use, license or sell it for the goods and services under which it is registered. The holder of the trade mark can prevent unauthorised use of the trade mark or a confusingly similar mark, so as to prevent consumers and the general public from being misled. Trade mark registration can be extended indefinitely, as long as it is in use. Trade marks can be associated with both high- and low-technology products.

1.1.3 Designs

Industrial designs protect the appearance of products which have industrial or commercial use. A design specifically refers to the features of shape, configuration, pattern or ornamentation which give a product a unique appearance, and must be new and distinctive. Industrial designs are broad and cover many sectors including digital media, fashion design, furniture design, graphic design and textile design.

Design rights are only enforceable once examined and certified. A certified design gives the owner the exclusive right to commercially use, licence or sell their design. The maximum term for design protection is 10 years.

1.1.4 Plant Breeder's Rights

A plant breeder's right (PBR) is a legally enforceable registration which provides its owner with the exclusive right to commercially produce, propagate, use, sell or distribute a new plant variety. The variety must be new, exploited within the past 12 months or derived from directly from an existing protected varietal.[4] PBR protection of the varietal is for a period of 25 years from the date of grant.

1.2 Intellectual property as an indicator of research performance

Each IP right can be used as an indicator of research and innovation, although they reflect differing aspects.[5] Patents and plant breeder's rights (PBRs) are more likely to reflect a significant technological innovation, whereas a trade mark or design is more likely to reflect a product coming to market.

It is a requirement of patent law that patent documents are published and that they fully disclose inventions. As a result of the disclosure requirement, patent documents reflect developments in science and technology. Patent documents include other useful information, such as International Patent Classification (IPC) marks, and information about inventors and applicants.

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[3] European Patent Office, Patent families

[4] IP Australia, Plant Breeder's Rights

[5] Griliches, Z. (1998), 'Patent Statistics as Economic Indicators: A Survey', R&D and Productivity: The Econometric Evidence, University Chicago Press

Schautschick, P. & Greenhalgh, C. (2013), 'Empirical Studies of Trade Marks: The Existing Economic Literature', Melbourne Institute Working Paper No. 25/13

Through the extraction and analysis of data associated with patent documents, it is possible to measure aspects of inventive activity such as scope, intensity, collaboration and impact. These metrics can be developed across technology sectors and by various units of measurement, such as individuals (inventors), institutions (applicants), regions and countries.

Similarly, a PBR may be used as in indicator of research and innovation in plants. Once an application for a PBR is finalised, the application data and a photograph are published. This data, together with the plant's end use classification information provide and insight into edible and non-edible plant developments.

Trade marks and designs data are also published and, like patents, can provide information about applicants and technology areas. Whilst patents are proxies for innovation in high-technology industries, they are not necessarily associated with innovation in low-technology industries, or industries that have a high product turnover.[6] In these industries, such as clothing or furniture, trade marks and designs may be more relevant markers of innovation.

1.3 Databases

The data was compiled from the following sources:

- EPO Worldwide Patent Statistical Database (PATSTAT), European Patent Office, Spring 2015 edition. PATSTAT is a snapshot of statistics relating to the EPO master documentation database (DOCDB) with worldwide coverage, containing 20 tables including bibliographic data, citations and family links. It is designed to be used for statistical research.
- Intellectual Property Government Open Data (IPGOD), IP Australia, 2015 edition. IPGOD is the database of IP Rights administered by IP Australia comprising patents, trademarks, designs and plant breeders' rights, linked by applicant and which is matched to firm level data including Australian Business numbers, geocoding and firm size.
- Internal IP Australia administrative data (PSS), accessed October 2015. Unlike IPGOD, which is a publicly available extract of IP Australia data, PSS is an internal database of all of IP Australia's administrative data relating to IP rights. PSS is not publicly available.
- EPO worldwide legal status database (INPADOC), European Patent Office, Spring 2015 edition. INPADOC contains information on legal events that occurred during the life of a patent, either before or after grant.
- OECD citations database, which provides information on patent and non-patent literature citations found in patent documents.[7]

A more detailed explanation of the databases can be found in Appendix B.

1.4 Who is this report about?

This report covers the IP rights for a range of Australian PFROs. There are 40 universities, 52 medical research institutes (MRIs) and five publicly funded research agencies (PFRAs) included in our analysis. For the purposes of this report, controlled entities were not included, with the exception of technology transfer offices associated with universities. Hospitals were not included in the list of MRIs. A full list of the applicants that were included is provided in Appendix A.

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[6] Jensen, P.H. & Webster, E. (2009), 'Another look at the relationship between innovation proxies', Australian Economic Papers,48(3), 252–69

[7] Webb, C., Dernis, H., Harhoff, D. & Hoisl, K. (2005) 'Analysing European and International Patent Citations: A Set of EPO Patent Database Building Blocks', STI Working Paper 2005/9, OECD, Paris

1.5 Time frame for analysis

Intellectual property rights with an application or lodgement date between 1 January 2000 and 31 December 2014 were used in this analysis. We used application date, the date on which a patent application is received by an office, for the time series graphs as this coincides with how the NSRC data is presented. Another relevant method for presenting time series is data is by the earliest priority date (EPD). This represents the first time that a patent application for a particular invention has been lodged anywhere in the world.

1.6 Methodology

The first step was to capture as many variations as possible of applicant names which were provided as NSRC survey recipients. These names, as well as any ABN information, later formed the basis of our search strategy for the identification of IP rights applicants in the various IP rights databases referenced above. In the case of universities this also includes their technology transfer offices. A full description of the methodology used to capture IP rights records that form the data set is included in Appendix C.

2 Analysis of patents over time

2.1 Comparison of provisional and PCT applications

Provisional and PCT applications can be viewed as a proxy for inventions and the beginning of the process that can lead to commercialisation. Figures 1-3 show a comparison of provisional patent applications over time compared to PCT applications based on application year for each group of research organisations: universities, publicly funded research agencies and medical research institutes (MRIs). This metric requires combining data from IP Australia's patent administration database (PSS), which records provisional patent filings, with PCT applications from the PATSTAT database and comparing the two different application types to gain an understanding of the patenting strategies employed by the three sectors.

We have chosen to plot the metric on application year, however earliest priority year can also be used for PCT applications. It is the earliest date recorded on patents and therefore allows the comparison of dates unaffected by administrative variations or delays.

It should be noted that there may not be a one-to-one link between provisional applications and PCTs. Not all provisional applications result in a PCT application, as some may have gone through the convention route or been allowed to lapse. Convention applications make up a small percentage of international applications. In addition, some PCT applications may be based on more than one provisional application or on provisional applications filed in other jurisdictions. For the PCT applications analysed below, between 5 and 20 per cent had priority applications from jurisdictions other than Australia each year.

2.2 Universities

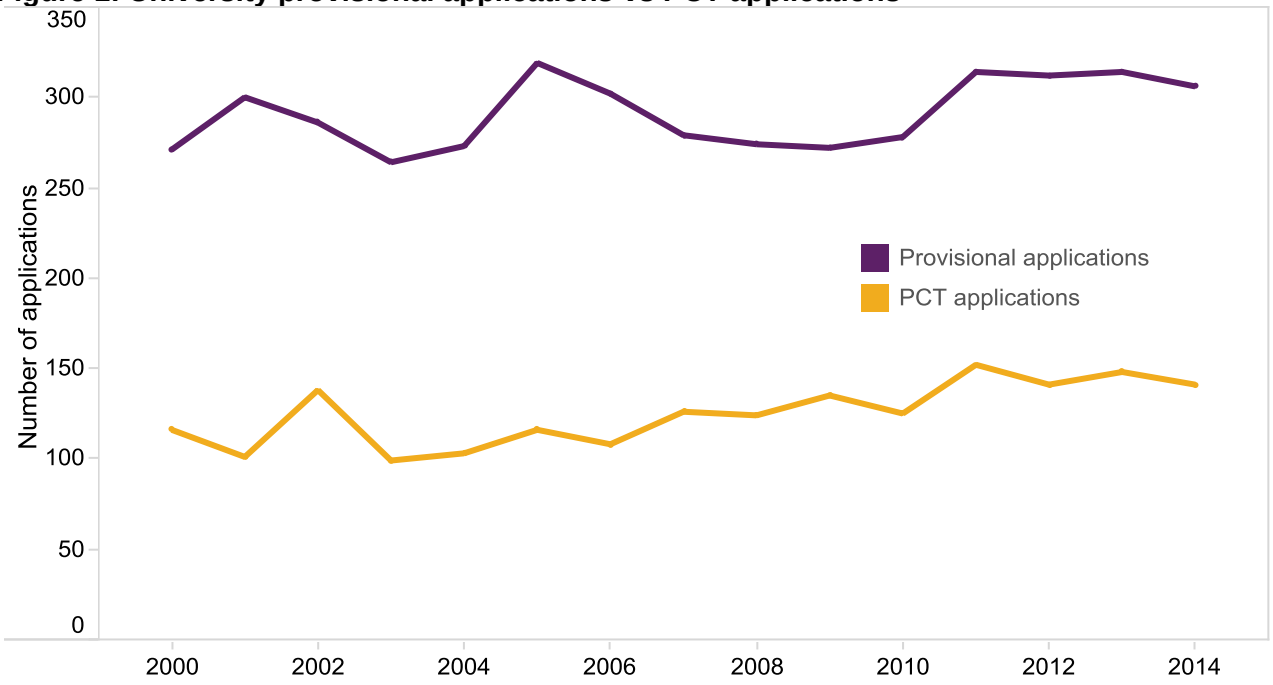
The university sector shown in Figure 1 lodged a total of 4363 provisional applications and 2429 PCT applications from 2000–14. There has been a small, but gradual increase in the number of PCT applications over the period. Peaks in provisional applications generally precede an increase in PCT applications, suggesting that applying provisional patent applications followed by a PCT application is a conventional filing strategy.

Given the difference in the numbers of provisional and PCT applications, Figure 1 suggests that universities, as a whole when compared to PFRAs and MRIs, are more likely to lodge a provisional in order to buy time to explore the value of the invention. This is perhaps not surprising, as most inventions from the sector are at a very early stage and it difficult to predict commercial interest that stage of development.

2.3 Publicly Funded Research Agencies

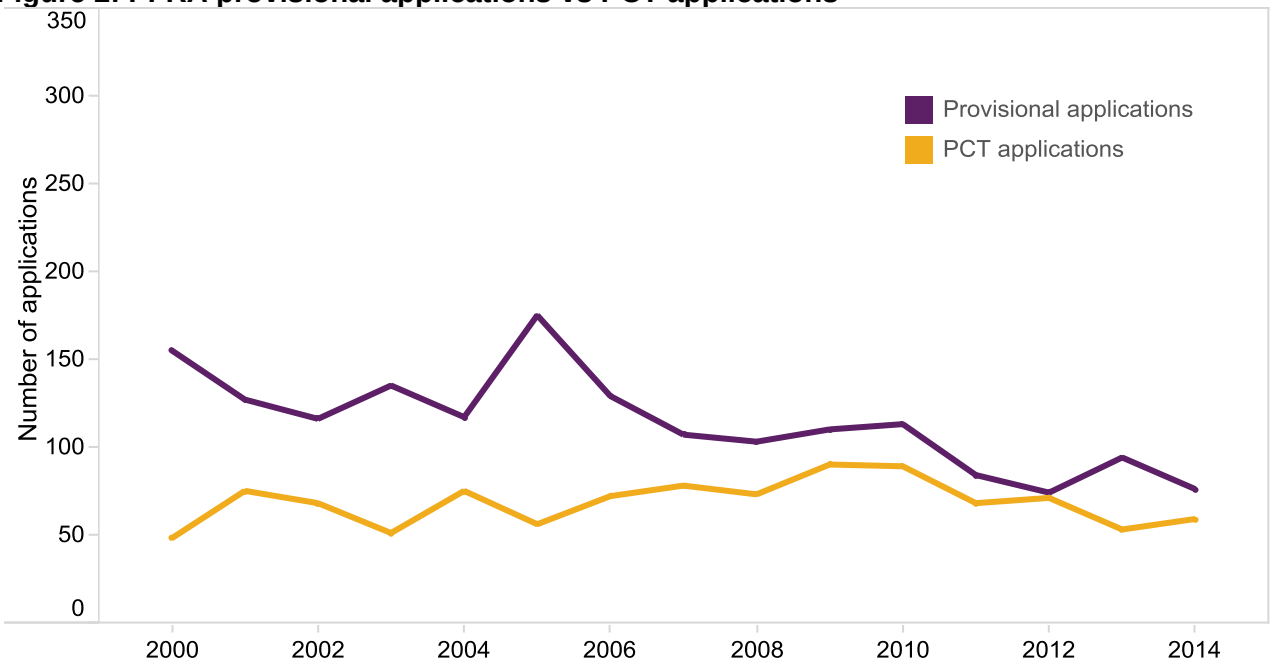
Figure 2 shows the same comparison for the publicly funded research agencies (PFRAs). Over the period they lodged 1715 provisional applications and 1026 PCT applications. The majority of these applications were field by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), with approximately 80 per cent of PCT applications and 83 per cent of provisional applications. Since a peak in provisional applications in 2005 there has been a decrease, whilst the numbers of PCT applications have remained steady. This may represent a change in approach to patenting by PRFAs, for example where provisional patent applications are lodged only when it is likely that further patent protection will be pursued.

Figure 1: University provisional applications vs PCT applications



Source: PATSTAT Spring edition 2015 and IP Australia's internal patent administration database

Figure 2: PFRA provisional applications vs PCT applications

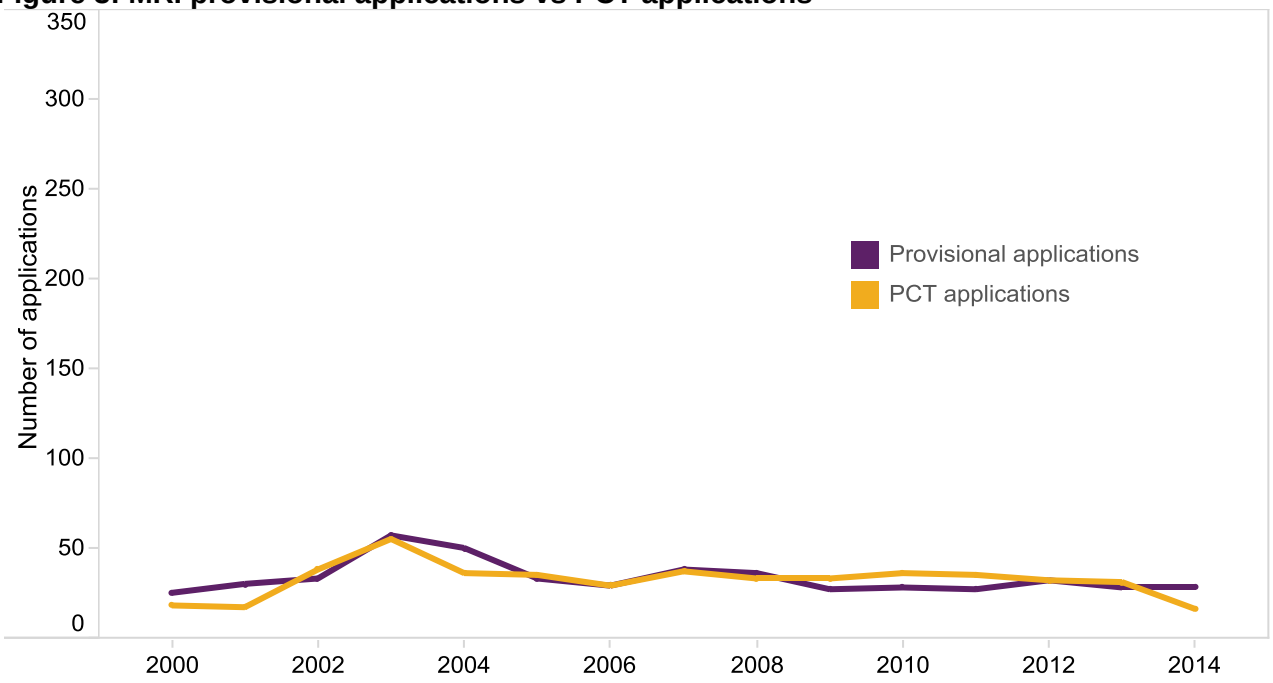


Source: PATSTAT Spring edition 2015 and IP Australia's internal patent administration database

2.4 Medical Research Institutes

Figure 3 shows that the Medical Research Institutes (MRIs) file similar numbers of provisional applications (501 applications) and PCT applications (481 applications). This patenting strategy is different to the universities who appear to file a large amount of provisional applications protecting any potential IP and then selecting only the most valuable of these inventions to file through the PCT route. When compared to PFRAs, the 52 MRIs file only half as many of each type of patent applications.

Figure 3: MRI provisional applications vs PCT applications



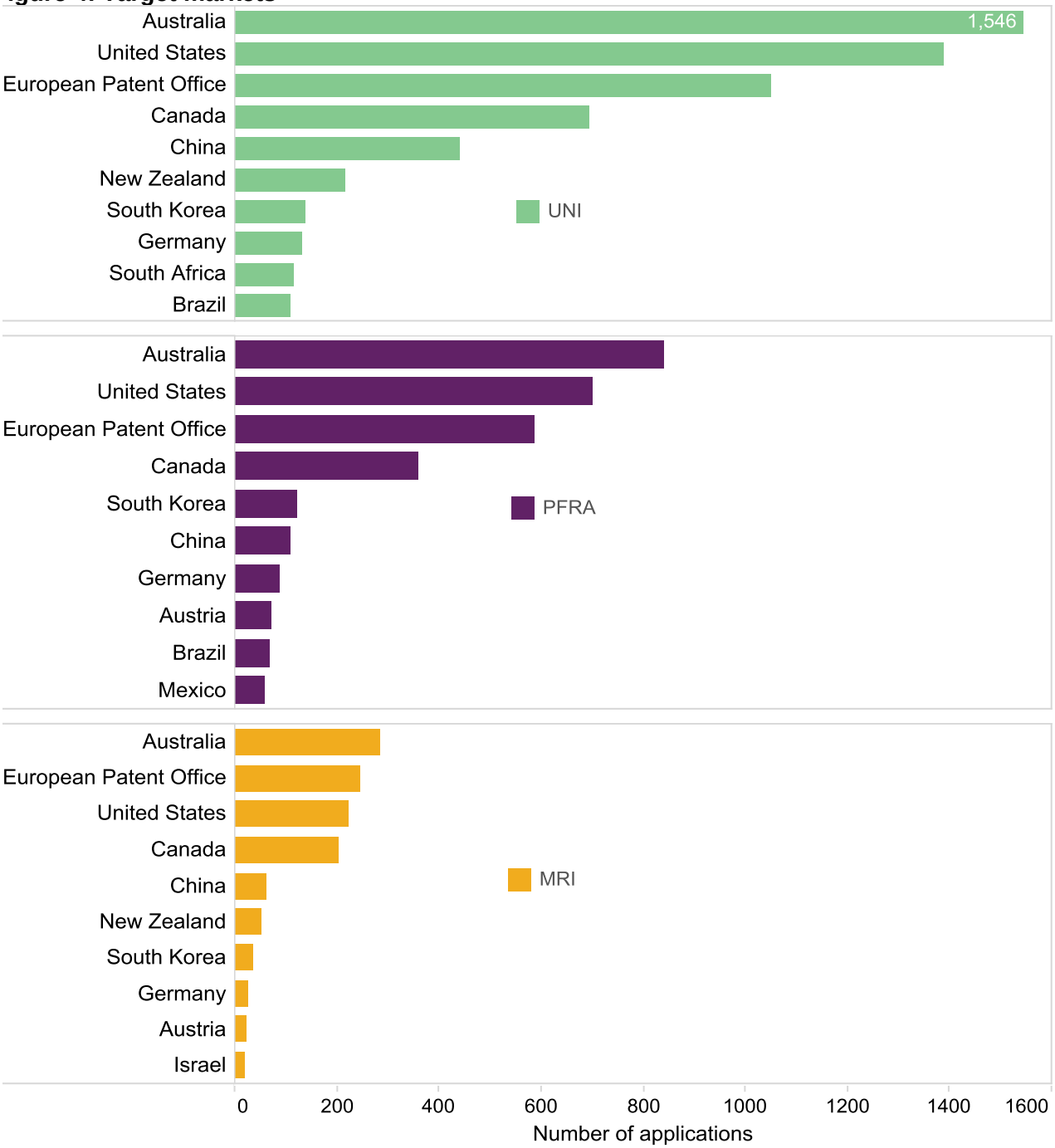
Source: PATSTAT Spring edition 2015 and IP Australia's internal patent administration database

2.5 Target Markets

In order to look at target markets of the inventions, we can look at the countries where research organisations in Australia elect to enter national phase.

The filing breadth for each of the research sectors is shown in Figure 4. Australia, the United States and Europe are the top three filing locations for all of the research sectors. China and South Korea also feature prominently. Japan, although a large market, does not make the top ten countries for any sector. The results in individual European countries represent member state patents which are generated when a European application is granted. Europe is a major filing destination, but once a patent is granted by the European Patent Office, the applicant must choose which countries to enter to gain an enforceable patent right. The major European markets are Germany, Austria and Spain. Brazil also appears as a target market for both universities and PFRAs.

Figure 4: Target markets

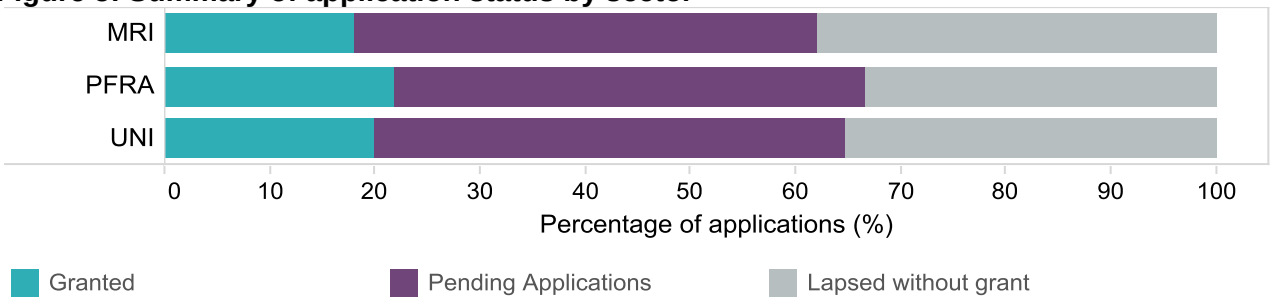


Source: PATSTAT Spring edition 2015

2.6 Granted Applications

Figure 5 shows the breakdown of granted patents, lapsed applications without grant and pending applications that have entered national phase across the research sector. There are no major differences between the sectors, with approximately 20 per cent of patents being granted and approximately 35 per cent lapsing without grant. The remaining applications are pending, which is due to the time it takes from entering national phase in a country to completing prosecution. This can take up to 5 years. The low percentage of applications proceeding to grant may highlight that the research sector is reliant on finding commercial partners for their inventions. Renewal fees across multiple jurisdictions are expensive and inventions are may be dropped if there is no commercial interest or that the invention is not commercially viable. Another reason that an application may be allowed to lapse is that it is not able to meet the legal criteria for grant.

Figure 5: Summary of application status by sector



Source: PATSTAT Spring edition 2015

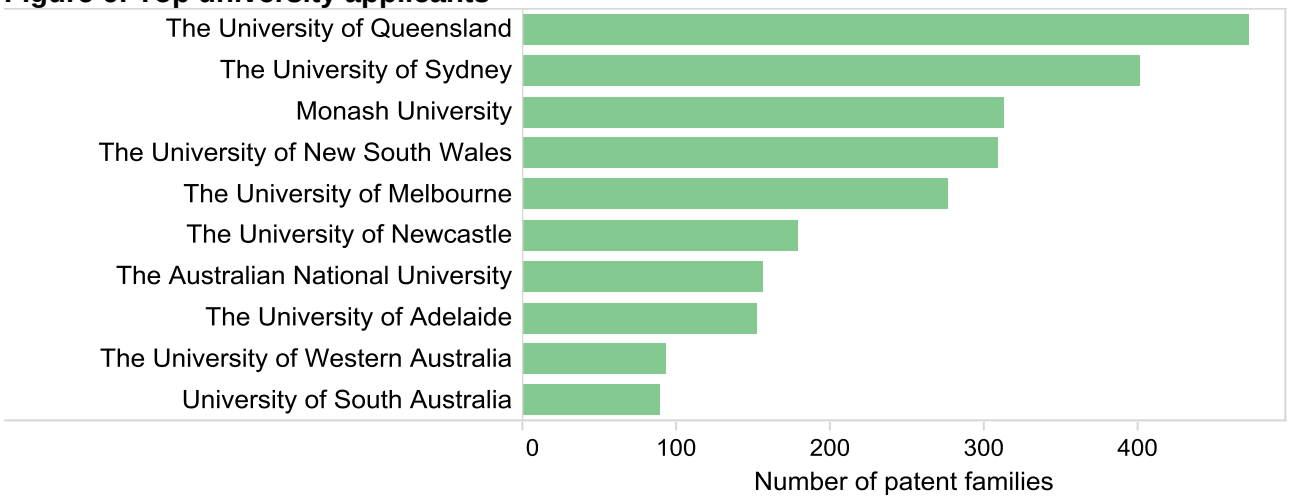
3 Patent Applicants

3.1 Top Patent Applicants

The top applicants over the period 2000–14 are shown for each of the research sectors, based on number of patent families. A patent family is made up of applications generally relating to the same invention but lodged in different countries. We used the INPADOC definition of a patent family. Using patent families provides an indication of the applicants that have the most patents in their research sectors without including any bias caused by an applicant applying for a patent for one invention in a large number of countries.

Figure 6 shows the top universities applicants. The majority of top university applicants are from the Group of Eight (Go8) universities, with the first non-Go8 applicant in sixth (the University of Newcastle). The University of South Australia is the first Australian Technology Network (ATN) University on the list in tenth place. ATN universities aim to be 'agile and innovative' in their approach to research and collaboration.[8] The other members of the ATN include RMIT University, The University of Technology Sydney, University of South Australia and Curtin University.

Figure 6: Top university applicants



Source: PATSTAT Spring edition 2015

The CSIRO dominates the PFRAs for the number of patent families, all of which are shown in Figure 7. This is unsurprising since the CSIRO is one of world's largest applicants of patents within the government sector.[9,10] National ICT Australia (NICTA), the Australian Nuclear Research and Development Organisation (ANSTO), Defence Science and Technology Organisation (DSTO)[11] and the Australian Institute of Medical Scientists (AIMS) have a combined total of 234 patent families. NICTA is a technology research institute specialising in computer vision, machine learning, mobile systems, optimisation technology and software systems.[12] NICTA recently merged with CSIRO to create Data61. This was after the time period for this report, which is why they appear as separate entities.

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[8] Australian Technology Network, About us

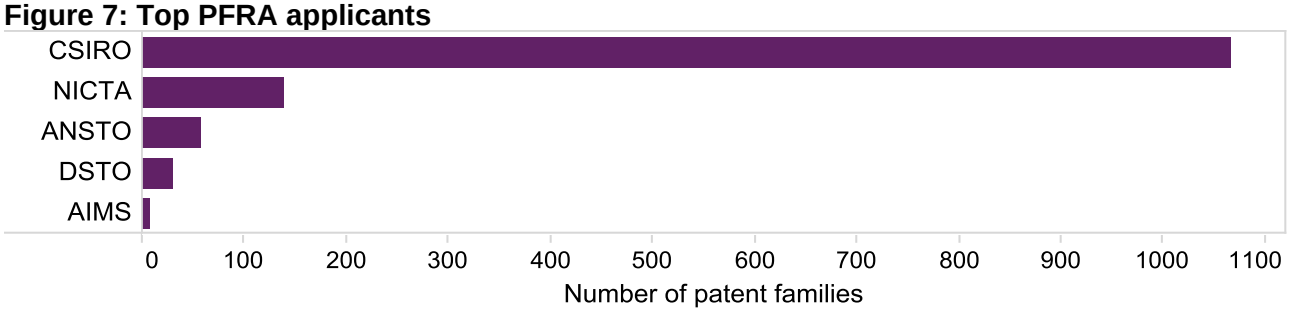
[9] Wells XE, Finch A, Johnson A and Emmanual C. (2014) 'CSIRO Science Health and Excellence Report 2013-2014', CSIRO, Australia

[10] Thomson Reuters, The Top 25 Global Innovators Government

[11] DSTO is now called the Defence Science and Technology Group (DST Group)

[12] NICTA, About NICTA

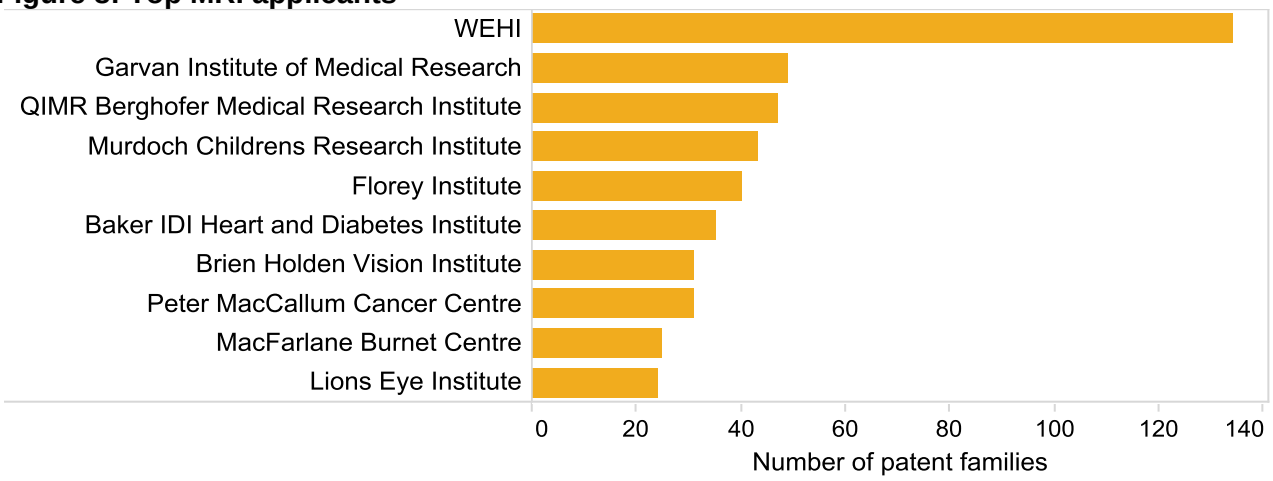
Figure 7: Top PFRA applicants



Source: PATSTAT Spring edition 2015

For the MRIs, the Walter and Eliza Hall Institute for Medical Research (WEHI) is the largest applicant, having 85 more patent families than the second largest applicant, the Garvan Institute of Medical Research (Figure 8). WEHI is Australia's oldest research institute and performs research into the prevention and treatment of various diseases including cancer, type 1 diabetes, arthritis and malaria.[13] The Garvan Institute of Medical Research, the second largest MRI applicant, focuses on the understanding of genes and cellular process for the treatment or prevention of diseases including cancer, diabetes and neurological disorders.[14]

Figure 8: Top MRI applicants



Source: PATSTAT Spring edition 2015

3.2 Patent Holdings

For each of the top applicants in each sector, patent families with at least one granted patent still in force (patent renewal fees have been paid) were determined. The payment of renewal fees to keep a patent in force is an indicator of the value of that patent to the applicant.[15] The summary of the in force patent families for each of the top applicants is shown in Figure 9 (universities), Figure 10 (PFRAs) and Figure 11 (MRIs).

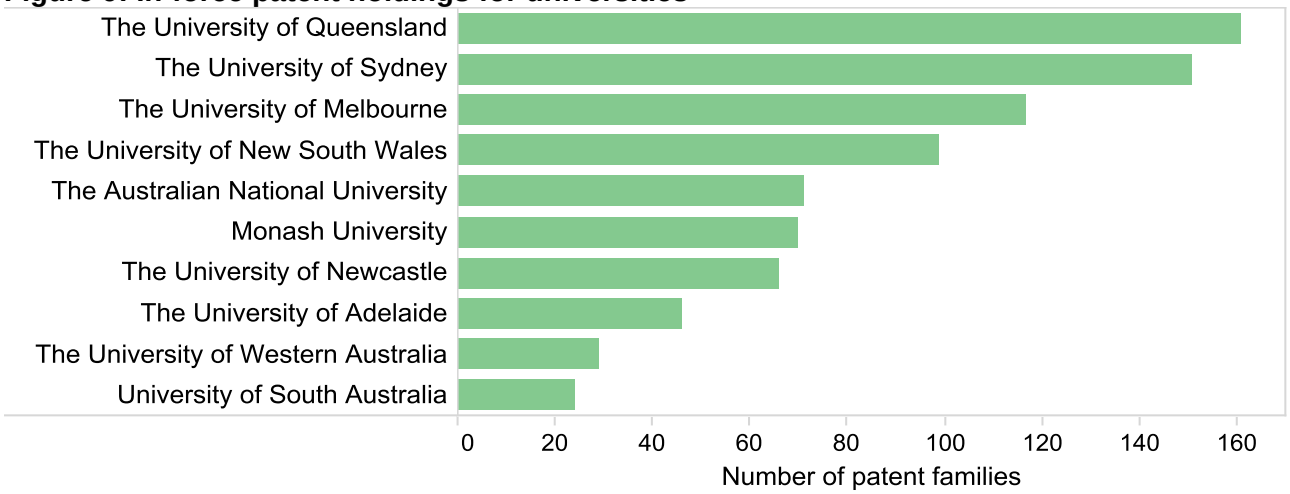
[13] Walter and Eliza Hall Institute, About

[14] Garvan Institute, About Us

[15] Lanjow, J. O., Pakes, A. & Putnam, J. (1998), 'How to Count Patents and Value of Intellectual Property: Uses of Patent Renewal and Application Data', Journal of Industrial Economics, 46(4), 405–32

In Figure 9, the University of Queensland (UQ) and the University of Sydney have the largest number of in force patents families with 161 and 151, respectively. The list generally follows the total numbers of patent families ranking seen in Figure 6, although the Australian National University has more in force patent families than Monash University and the University of Newcastle despite those institutions filing more patent families.

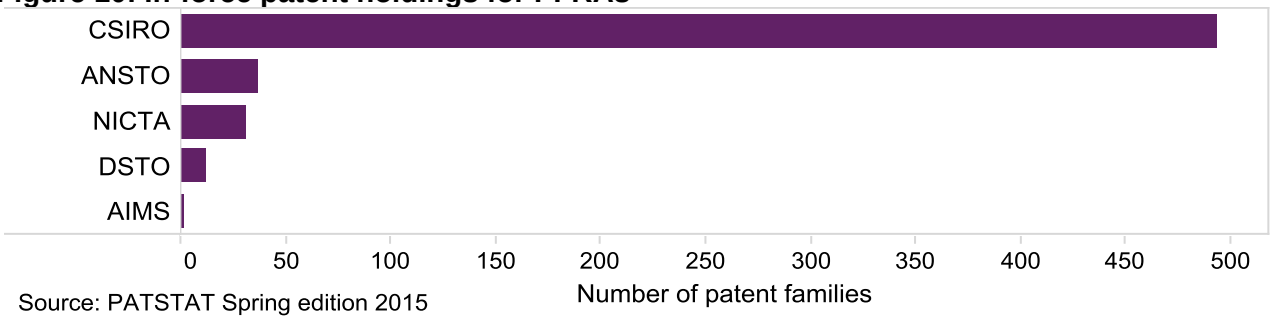
Figure 9: In-force patent holdings for universities



Source: PATSTAT Spring Edition 2015

Figure 10 shows granted, in force patent families for PFRAs. As expected, the CSIRO is the top applicant with 493 in force patent families. ANSTO has 66 in force patent families and NICTA has 31.

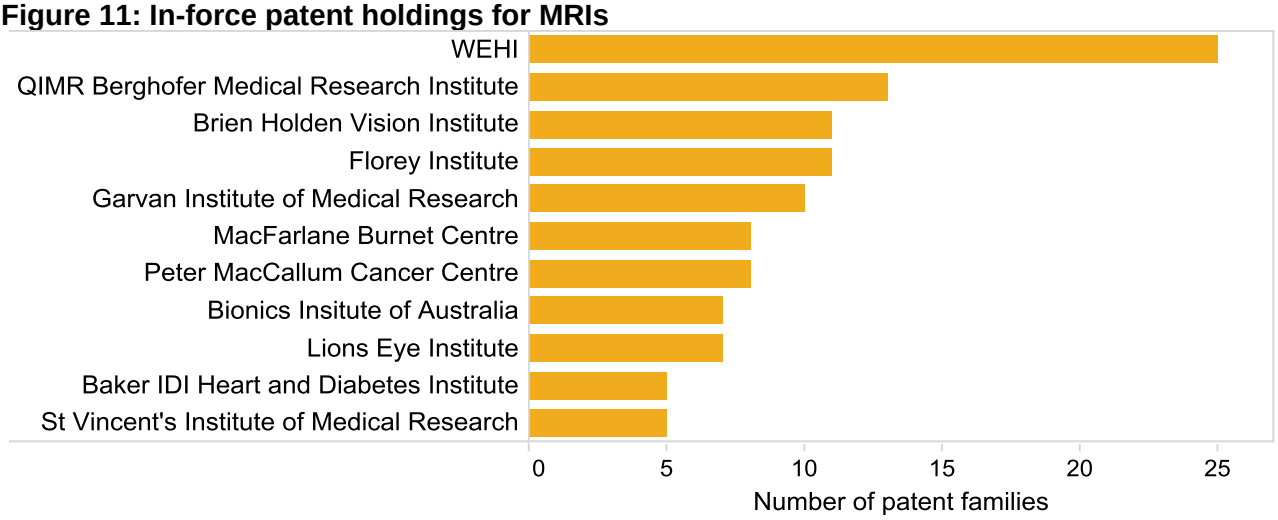
Figure 10: In-force patent holdings for PFRAs



Source: PATSTAT Spring edition 2015

Finally, the granted, in force patent families for MRIs is shown in Figure 11. WEHI leads the way with 50 in force patent families. QIMR, the Brian Holden Vision Institute and the Florey Institute are also major players.

Figure 11: In-force patent holdings for MRIs



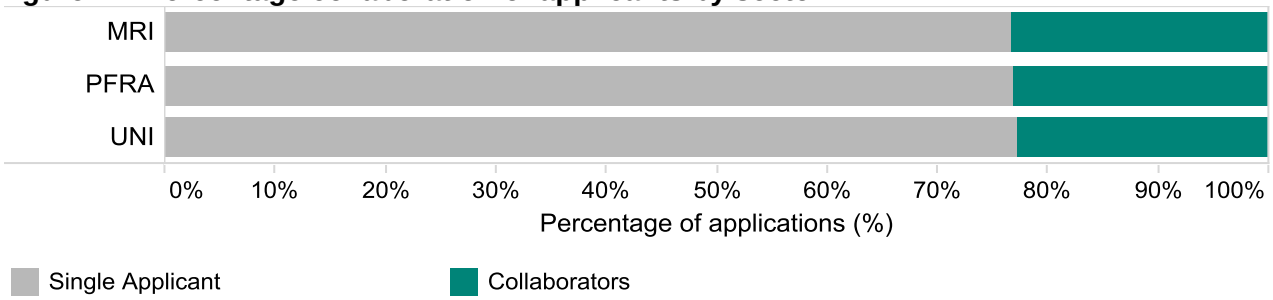
Source: PATSTAT Spring Edition 2015

3.3 Collaboration

One powerful component of the analysis of patent data is the ability to identify research partners collaborating on various inventions. Collaboration in this report is approximated by patent applications with two or more applicants.

Figure 12 shows the percentage of PCT applications with more than one applicant versus applications with a single applicant. All of the research sectors have similar levels of co-applicants, with between 23 and 25 per cent of applications having co-applicants. This includes university-university collaboration as well as university-industry collaboration. It should be noted that this is only a measure of a specific type of collaboration, other forms of knowledge transfer and links between entities are not represented, hence this may underestimate the total interactions that occur between entities.

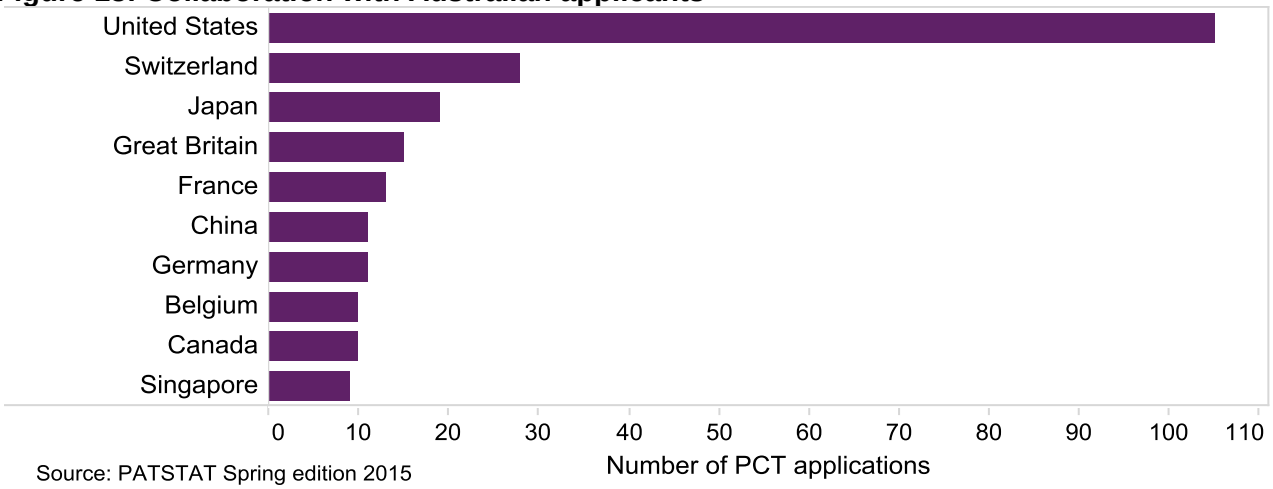
Figure 12: Percentage collaboration of applicants by sector



Source: PATSTAT Spring edition 2015

Countries collaborating with Australian research institutes can be measured by identifying Australian PCT applications listing more than one applicant and examining the country of origin of the other co-applicants. This distribution is shown in Figure 13. Mostly collaboration occurs domestically with 773 applications having Australian co-applicants (not shown). The top foreign applicants are from the United States followed by Switzerland, Japan, Great Britain and France.

Figure 13: Collaboration with Australian applicants



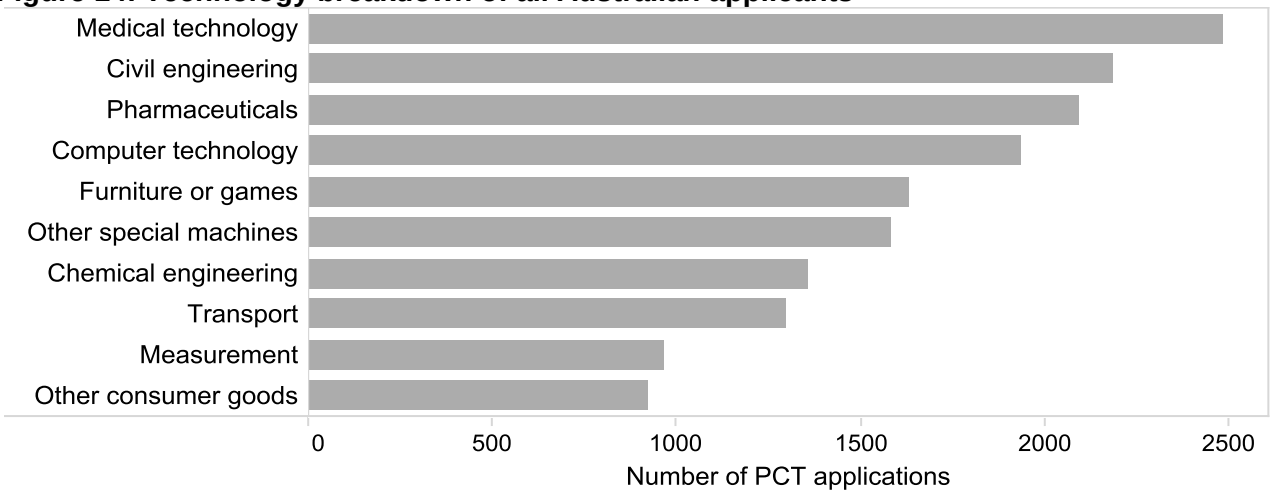
Source: PATSTAT Spring edition 2015

4 Looking at Technology

4.1 Technology

Figure 14 represents a breakdown of all Australian PCT applications filed between 1 January 2000 and 31 December 2014 by WIPO technology field.[16] WIPO technology fields provide a broad technology categorisation that each correspond to a series of IPC marks. Medical technology, civil engineering and pharmaceuticals and computer technology are the main technology areas.

Figure 14: Technology breakdown of all Australian applicants

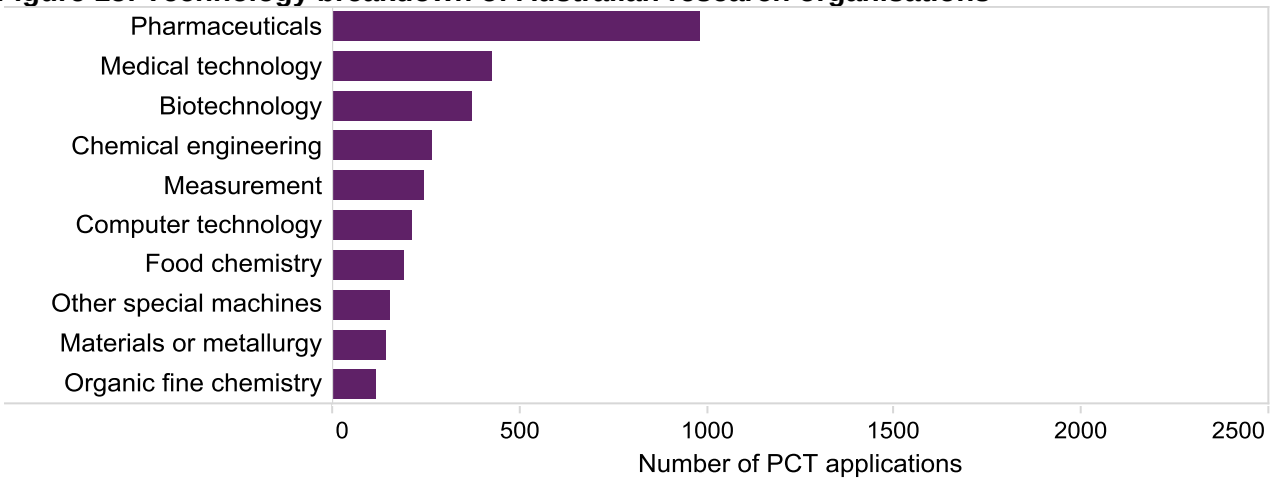


Source: PATSTAT Spring edition 2015

Figure 15 is a similar technology breakdown for the research institutions. Similar to all Australian applicants', pharmaceuticals and medical devices are a strong area of focus. It should be noted that pharmaceuticals is bolstered by the MRIs, whose major patent focus is in that area, though the universities and PFRAs also contribute to pharmaceuticals significantly. Civil engineering, furniture and games and transport all rank highly outside of the research sector but are not areas of focus within the research sector. Conversely universities, PFRAs and MRIs are more strongly focussed on biotechnology, materials and metallurgy and organic fine chemistry.

[16] Schmoch, U. 2008, 'Concept of a Technology Classification for Country Comparisons', Final report to the World Intellectual Property Organisation (WIPO)

Figure 15: Technology breakdown of Australian research organisations



Source: PATSTAT Spring edition 2015

4.2 Relative Specialisation Index (RSI)

The Relative Specialisation Index (RSI) is a metric used to determine how specialised a particular research organisation is in a particularly WIPO technology field. WIPO Technology fields are broad groupings which map patent classifications to technology clusters which are more easily comprehended. Only PCT applications were used to map the technology fields. The RSI is calculated to correct for research organisations that may file more than others. The RSI compares the fraction of technology patents from a particular university compared to fraction of patents originating from Australian applicants overall. The formula used is as follows:

$$RSI = \log_{10}\left(\frac{n_i/n_{total}}{N_i/N_{total}}\right)$$

where:

n_i is the number of patent applications filed in technology area **X** by research organisation **A**

n_{total} is the number of patent applications filed in technology area **X** by all research organisations

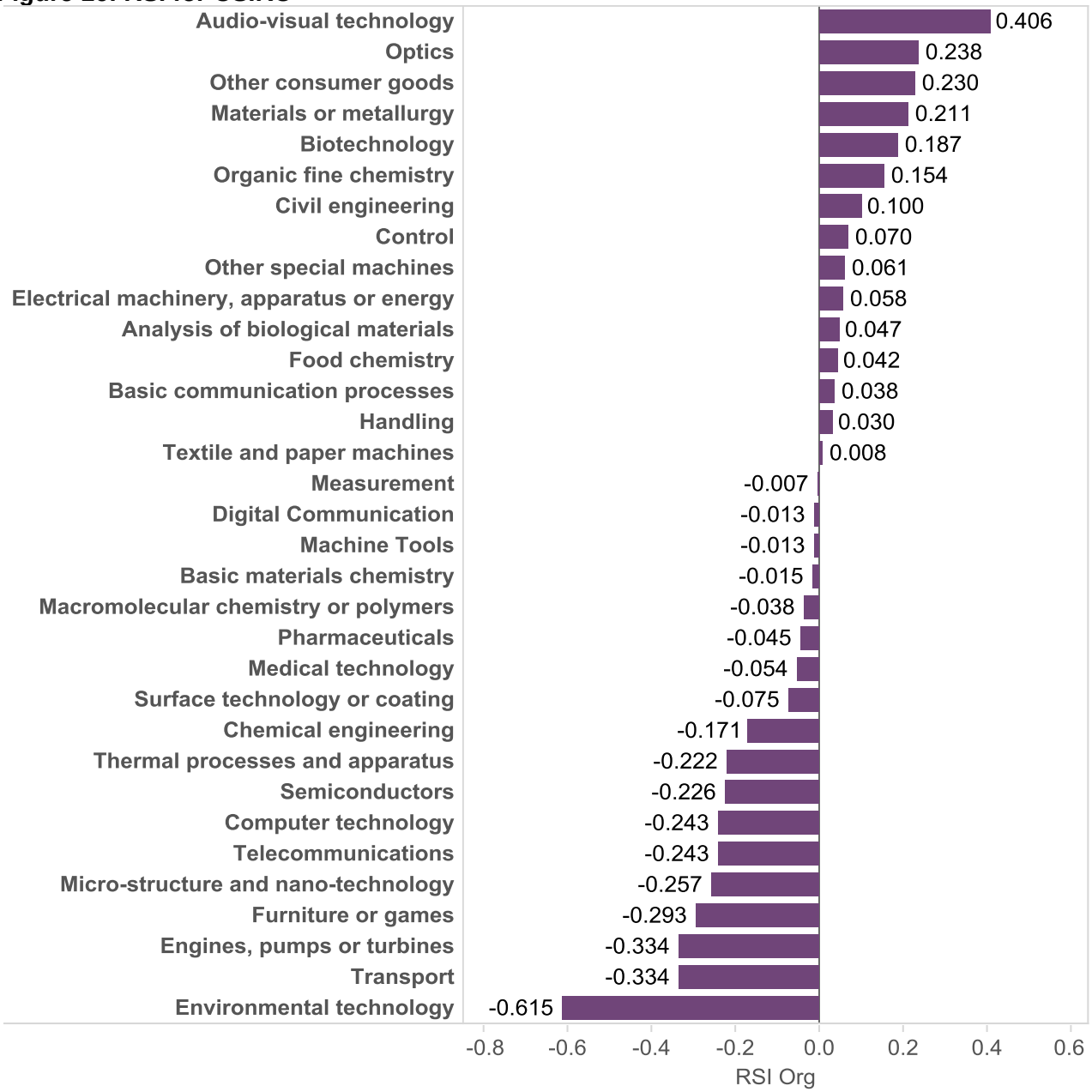
N_i the total number of patent applications filed by research organisation **A** and

N_{total} is the total number of patents applications filed by all research organisations

The effect of this metric is to demonstrate which technology areas a research organisation specialises compared to their peers. When a number is relatively largely positive (closer to 1) then this would imply that comparatively, a large amount of work in this area is done by that organisation, compared to other research organisations. If the number is strongly negative (closer to -1) then comparatively the research organisation files less applications in in this technology area.

A representative example of an RSI for a single organisation (CSIRO) is shown in Figure 16. Figure 16 shows some of the relative technology strengths of CSIRO including materials and metallurgy, biotechnology, and optics. A caveat of using the RSI is that areas with few patents can be seen to be overly positive. For example, the CSIRO is strongly positive in Audio-visual technology, but has only 4 patents in the area. There are only 8 total patents in Audio-visual technology in the entire sector. In comparison, the CSIRO has 46 patents in materials and metallurgy (RSI score of 0.211), but the technology is a more active area of research for the sector as a whole with 110 patents.

Figure 16: RSI for CSIRO



Source: PATSTAT Spring edition 2015, Thomson Innovation February 2016 and IP Australia internal calculations

4.3 Citation analysis

To begin a discussion of the value of using citations as a metric, it is important to define what is meant by a patent citation. In academia, a citation represents whether a document was included by the authors as a piece of relevant literature. For patents, citations are broadly categorised into two types for each patent application: citations to previous documents (backward citations) and citations of the patent application after its publication (forward citations).

Backward citations are taken from the prior art, so refer to information made publicly available before the filing date of a patent application and they are generally relevant to a patent's claims of novelty or inventive step. Backwards citations can include patent documents and non-patent literature. Forward citations are received by a patent application once it has been published. One of the main difficulties with forward citations is that they can come at any point in time, long after the cited patent was filed, granted, or even reached full term. Therefore, the effect of time

increases the probability for any patent to have been cited by subsequent patents. A second major difficulty with patent citations relates to the number of publications associated with each single patent.

A citation can be included by both the patent applicant and the examiner. Citations raised by examiners are related to the claims, which change over the course of the examination procedures. They are generally broken into three categories novelty (X), inventive step (Y) and general state of the art (A). Importantly, there is no consistent approach between jurisdictions, nor examiners, on how many relevant documents should be raised. In addition, patent office procedures can change overtime and can also differ between technologies.

Most jurisdictions also have little regulation around which patents are cited by applicants. There can be very few in main body of the patent document and there is no requirement they are particularly close prior art. The exception is the United States, which requires applicants to cite the most relevant documents.[17]

Some consider that forward citations are a good proxy for the value of a patent.[18] However, we hope that the limitations described above have demonstrated the many pitfalls of doing citation analysis. We recommend caution if you are planning to use citation analysis and that attempting to use citations as quantifiable indication of usefulness, importance or novelty is likely to be a very challenging activity.

Nevertheless, an example of a citation analysis is shown in Figure 17. This provides an overview of the number of times PCT applications from Australian research institutions have been cited in either an international (PCT) or European search and examination report.

The distribution is heavily skewed towards the lower end of the scale, with 74 per cent of PCT applications receiving two citations or less and 93 per cent having five citations or less. This skewed distribution and low number of citations makes any useful analysis difficult, as the data becomes very noisy and significantly reduces any confidence in conclusions that can be drawn.

[17] UKIPO, The Patents Guide, 2nd Ed., 2015

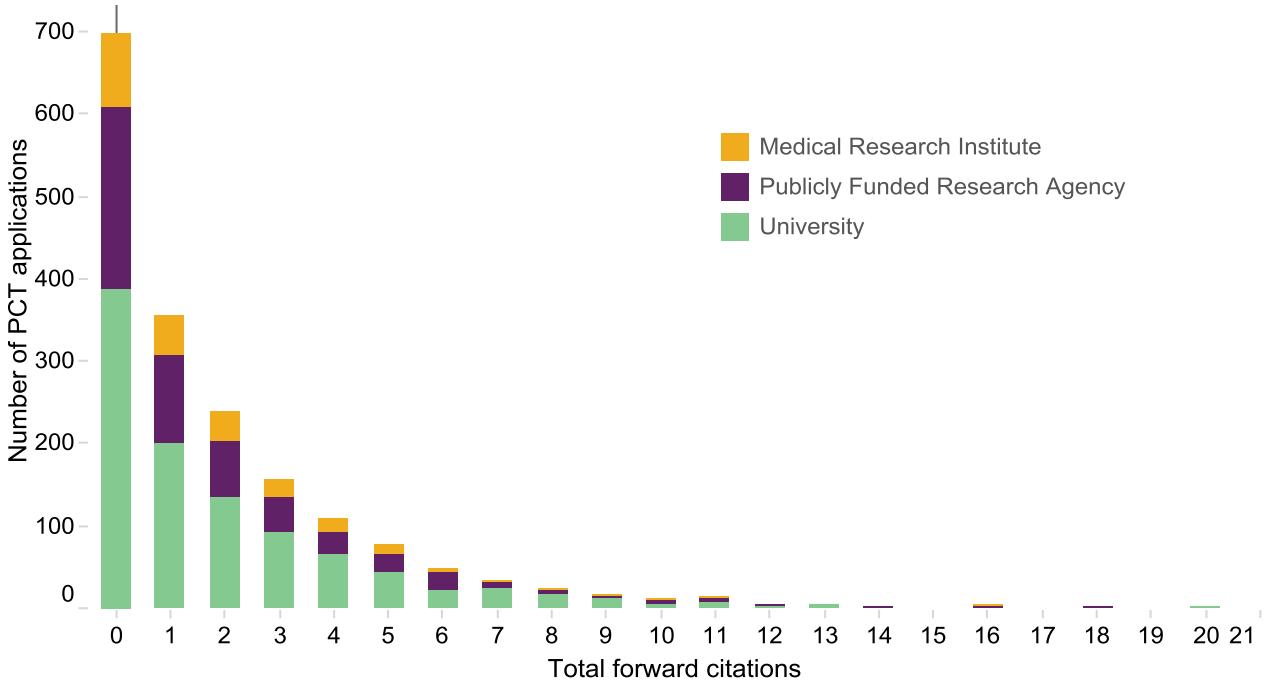
[18] Harhoff D., Scherer F. M. & Vopel K. (2002), 'Citations, Family Size, Opposition and the Value of Patent Rights', Research Policy, 32(8), 1343–63

Trajtenberg M. (1990), 'A Penny for Your Quotes: Patent Citations and the Value of Innovations', The RAND Journal of Economics, 21(7), 172–187

Jaffe A., Trajtenberg M., and Fogarty M. (2002), 'The Meaning of Patent Citations: Report on the NBER/Case Western Reserve Survey of Patentees', NBER Working Paper no. 7631

van Zeebroeck, N. (2011), 'The puzzle of patent value indicators', Economics of Innovation and New Technology, 20(1), 33–62

Figure 17: Forward citations received by PCT applications from Australian research organisations

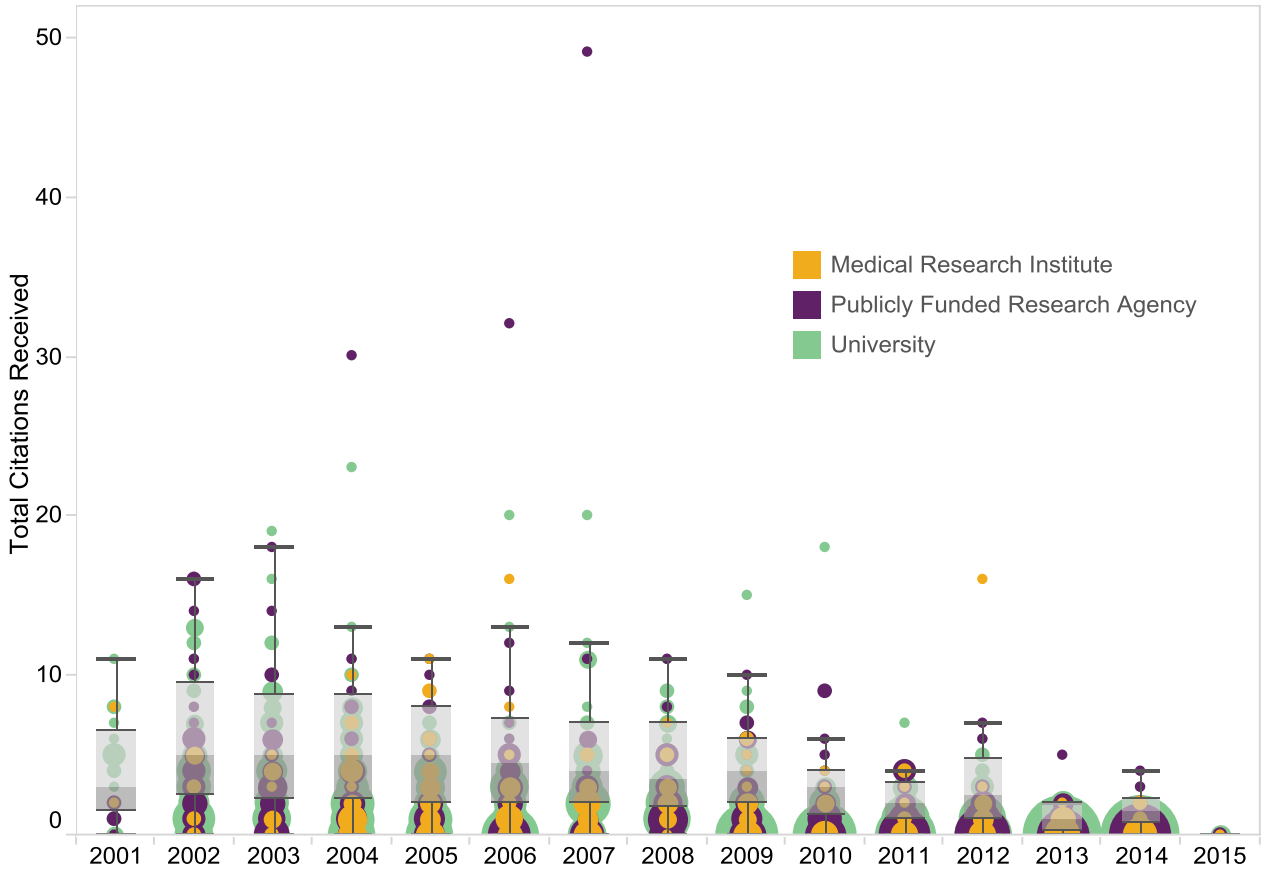


Source: OECD Citations September 2015, PATSTAT Spring 2015

Citation analysis can be a useful qualitative measure for highlighting patents which have received a large number of citations and can be considered a measure of impact. This sort of analysis was done in our recent report on Australian Pharmaceutical patents.[19] When doing this analysis it is important to group the patents by publication year, as applications tend to receive more citations over time. In this manner a direct comparison between patents with the same publication year can be made, which prevents new patents being swamped by older patents. Figure 18 is an example of a box and whisker plot which can be used to highlight patents with a large number of citations. For example, a PCT application published in 2007 from the CSIRO (WO 2007/015710) stands out as it has received 49 citations, whereas the median citation number of citations for that year is 4.

[19] IP Australia (2015), 'A patent analytics study on the Australian Pharmaceutical Industry'

Figure 18: Forward citations received by Australian research organisation PCT applications, by publication year



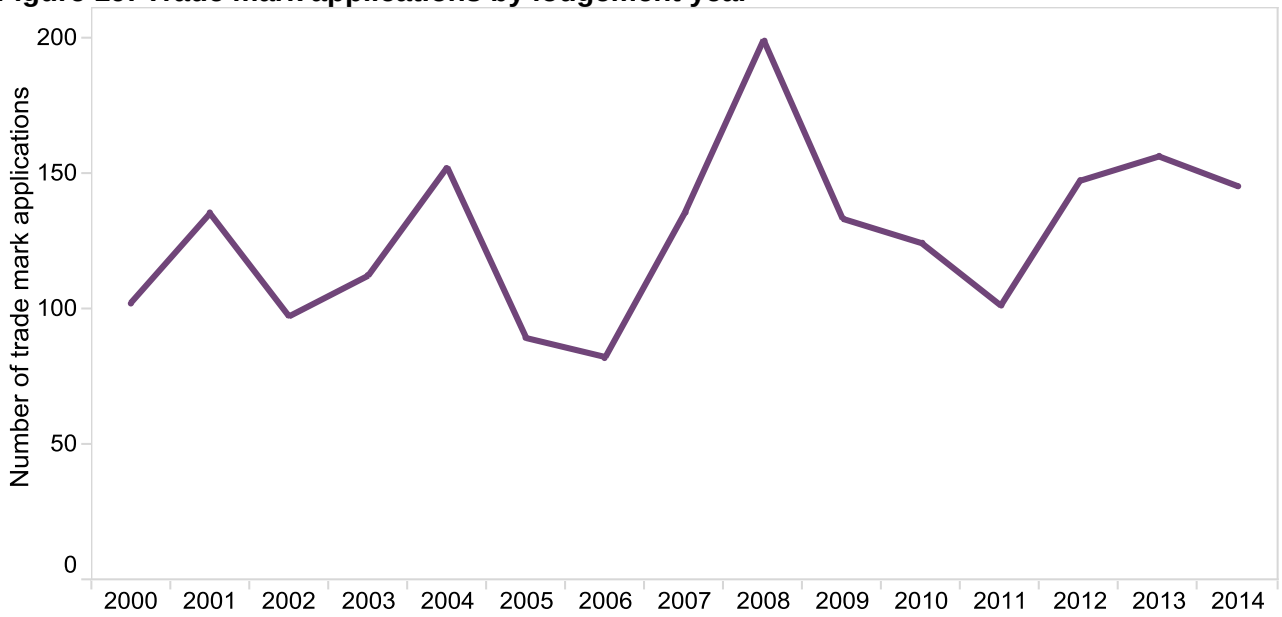
Source: OECD Citations September 2015, PATSTAT Spring 2015

5 Other Intellectual Property Rights

5.1 Trade marks

Trade marks are used to differentiate products and services of one trader from another. Figure 19 represents all of the trade marks applications lodged from 2000–14for the three research sectors. Applications peaked at 199 in 2008, and have generally remained above 100 per year for the period. There were 1909 total trade marks lodged. In contrast there were 6580 provisional patents and 3939 PCT applications for the research sector over the same period.

Figure 19: Trade mark applications by lodgement year



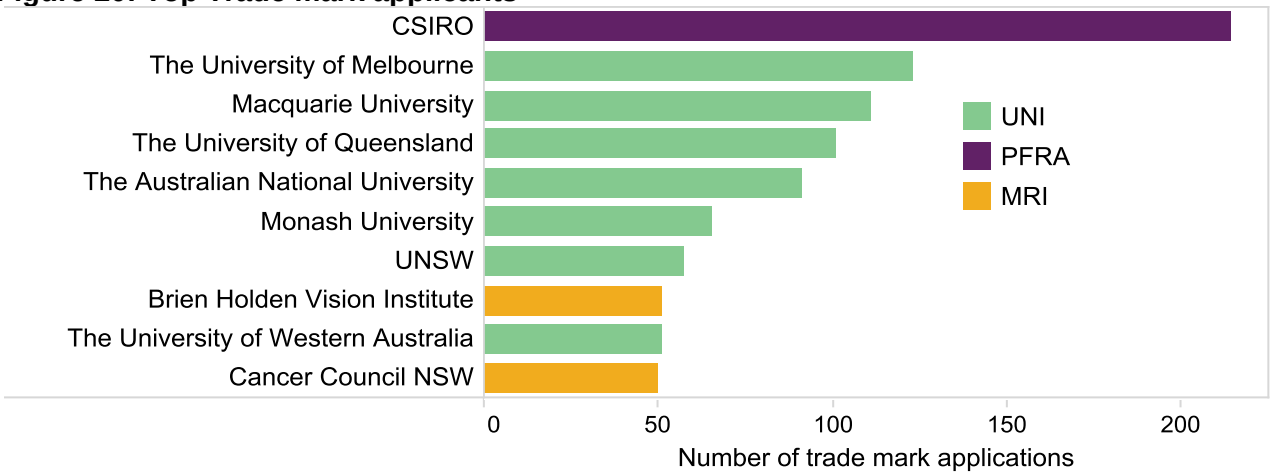
Source: IPGOD February 2016

Figure 20 shows the top trade mark applicants. CSIRO, with 214 applications, is by far the largest applicant of trade marks. The remaining top five applicants are all universities including the University of Melbourne (123), Macquarie University (111), the University of Queensland (101) and Australian National University (91).The only two MRIs in the top ten are the Brien Holden Vision Institute with 51 applications and the Cancer Council of NSW with 50 applications. The Brien Holden Vision Institute, through collaboration with research and industry organisations, seeks to develop innovative vision correction products for the treatment of most common eye disorders.[20] The Cancer Council of NSW helps fund cancer research and supports cancer patients, but is also involved with advocating cancer action and cancer prevention.[21] It is important to note this does not include trade mark applications from spin out companies originating from any of these research organisations.

[20] Brien Holden Vision Institute, Who we are

[21] Cancer Council of NSW, About us

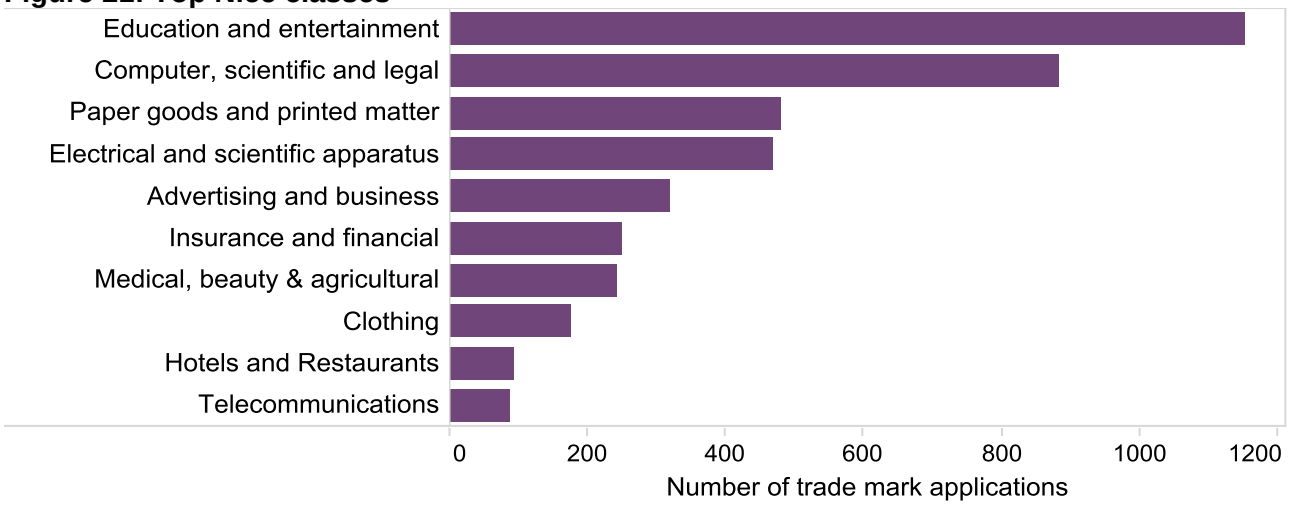
Figure 20: Top Trade mark applicants



Source: IPGOD February 2016

Under Australian legislation, a single trade mark application may relate to goods or services in one or more of the 45 classes within the Nice Classification system.[22] The top Nice Classification (NCL) descriptors are shown in Figure 21 where multi-class applications are counted multiple times. The type of trade mark protection is primarily in the field of education and entertainment with 1154 applications, representing 60 per cent of the total applications. This is likely the research organisations applying to protect images and 'catch-phrases' which are used to market their respective institutions and highlights a major difference between trade marks and patents. Whilst patents can be considered as markers of innovation, trade marks can be given for both innovative products and for branding purposes. The next largest trade mark area is in is the computer, scientific and legal sector with 883 applications and rounding out the top is three, paper goods and printed matter (481).

Figure 21: Top Nice classes



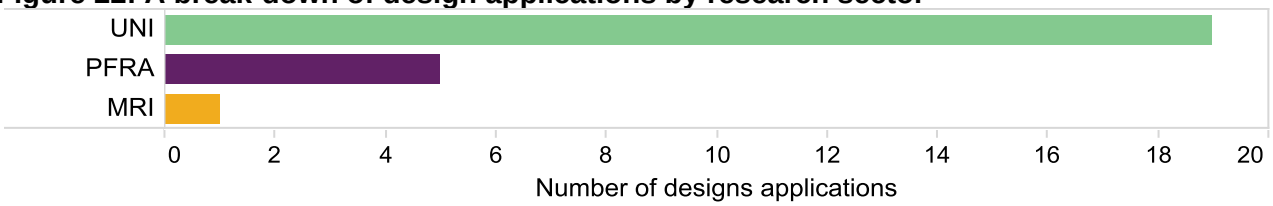
Source: IPGOD February 2016

[22] IP Australia, Apply for a trade mark: Classes of goods and services

5.2 Designs

Figure 22 shows the break-down of design applications by research sector. There are very few design applications, a total of only 25, with universities being the largest applicant group. The major university applicant was Monash University with 7 applications. CSIRO lodged 4 design applications and the Murdoch Children's Research Institute filed the lone design by an MRI for an electrical connector. We used the Australian designs classification (ADC) codes to classify designs. The ADC is substantially the same as the Locarno classification system used internationally. The ADC and Locarno systems can be used interchangeably as they share the common broad classes. The distinction between these two classifications occurs only in the lower subclasses in which the ADC has its own unique alphabetical codes. The top of category for design applications was apparatus and equipment for doctors, hospitals and laboratories (7 applications). No other category had more than 2 applications.

Figure 22: A break-down of design applications by research sector



Source: IPGOD February 2016

5.3 Plant Breeder's Rights

A total of 189 plant breeder's rights (PBR) applications were lodged by research organisations in 2000–14, compared with a total of 5242 PBR applications lodged in Australia over the same period.

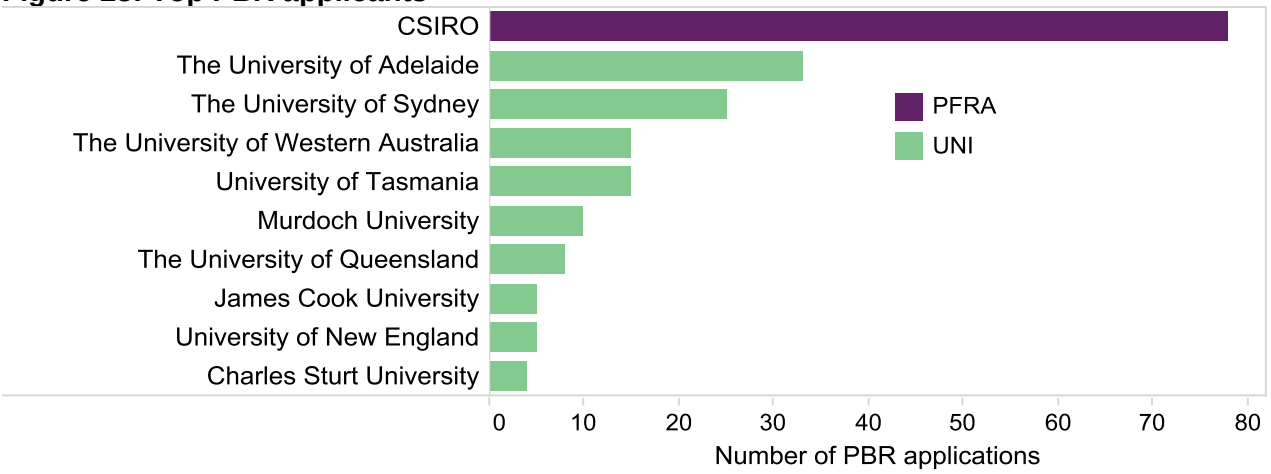
CSIRO is the top applicant with 78 applications, as shown in Figure 23. Some of the new plant varieties bred by the CSIRO include cotton, grapes, sugarcane, wheat and barley.[23] The University of Adelaide is ranked second in PBR applications, and with 33 applications has the most PBRs of any of the universities. The University of Adelaide's Waite Campus specialises in plant breeding, including barley, wheat and faba beans.[24] The University of Sydney ranks third with 25 applications., The University of Sydney's Plant Breeding Institute concentrates on plant breeding including wheat, mustard and pulse as well as running an environmental and ornamental horticulture program.[25] The remaining universities have lodged fewer than twenty applications each.

[23] CSIRO, Plant Science

[24] University of Adelaide, Plant Breeding

[25] University of Sydney, Plant Breeding Institute

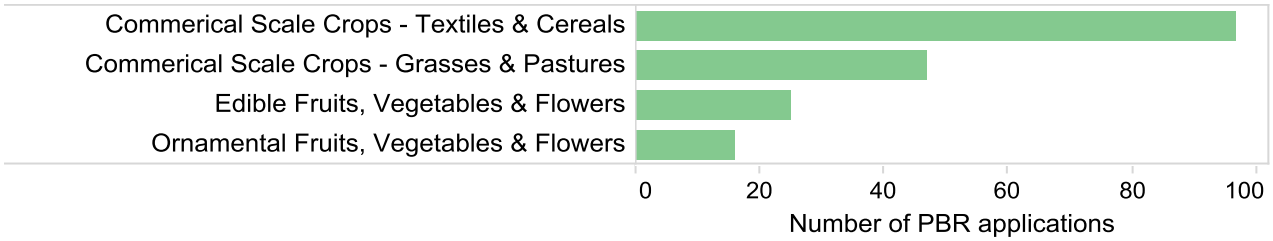
Figure 23: Top PBR applicants



Source: IPGOD February 2016

Figure 24 shows the type of plants for which protection is being sought. On the whole research organisations are investing in commercial large scale crops, in particular cereals. These type of crops are known in the industry as 'broad-acre'.

Figure 24: PBR applications by plant type



Source: IPGOD Database February 2016 and internal classifications

6 Conclusion

This report provides an overview of the intellectual property landscape for Australian universities, PFRAs and MRIs.

We identified 6580 provisional applications and 3903 PCT applications from the Australian research sector from 2000 to 2014. The major target markets for the inventions, after Australia, were the United States, Europe and Canada. This was consistent across universities, PFRAs and MRIs. China and South Korea are also major target countries.

The organisations have co-applicants on 23-25 percent of applications, which is an indicator of collaboration. The majority (77 percent) are with other Australian applicants. Applicants from the United States are the major foreign collaborators making up 10 per cent of collaborations, followed by Switzerland, Japan and Great Britain.

The top university patent applicants were the University of Queensland, the University of Sydney and Monash University. The CSIRO, the top overall applicant, applied for significantly more patents than the next highest PFRA applicant - NICTA. The top MRI applicants were the Walter and Eliza Hall Institute of Medical Research, the Garvan Institute and the Queensland Institute of Medical Research.

Similar to all Australian applicants', pharmaceuticals and medical devices are a strong area of focus for the research sector. Civil engineering, furniture and games and transport all rank highly outside of the research sector but are not areas of focus within the research sector. Conversely universities, PFRAs and MRIs are more strongly focussed on biotechnology, materials and metallurgy and organic fine chemistry.

The report also highlights caveats and difficulties in using and interpreting some available data—particularly citations.

Research organisations also make use of other intellectual property rights. We identified 1909 trade marks, 25 design applications and 189 plant breeder's rights.

Trade mark protection is primarily in the field of education and entertainment, representing 60 per cent of the total applications. This is likely the research organisations applying to protect images and 'catch-phrases' which are used to market their respective institutions and highlights a major difference between trade marks and patents. Whilst patents can be considered as markers of innovation, trade marks can be given for both innovative products and for branding purposes.

Plant breeder's rights are a focus for some of the research organisations. CSIRO is the top PBR applicant, followed by the University of Adelaide and the University of Sydney. These organisations have an interest in developing new commercial scale crops.

The metrics in this report they can be used to provide a greater understanding of the innovation and commercialisation practices of the Australian research sector.

Appendix A: Research Organisations

Table 1: Universities

University	University
Australian Catholic University	The Australian National University
Bond University	The University of Adelaide
Central Queensland University	The University of Canberra
Charles Darwin University	The University of Melbourne
Charles Sturt University	The University of New England
Curtin University of Technology	The University of New South Wales
Deakin University	The University of Newcastle
Edith Cowan University	The University of Notre Dame Australia
Federation University of Australia	The University of Queensland
Flinders University	The University of South Australia
Griffith University	The University of Southern Queensland
James Cook University	The University of Sydney
La Trobe University	The University of Tasmania
Macquarie University	The University of the Sunshine Coast
Monash University	The University of Western Australia
Murdoch University	The University of Western Sydney
Queensland University of Technology	The University of Wollongong
Royal Melbourne Institute of Technology	Torrens University Australia
Southern Cross University	University of Technology, Sydney
Swinburne University of Technology	Victoria University of Technology

Table 2: Medical Research Institutes

Medical Research Institute	Medical Research Institute
Anti-Cancer Council of Victoria	Institute For Respiratory Health
ANZAC Research Institute	Lions Eye Institute
Asbestos Diseases Research Institute	Ludwig Institute of Cancer Research*
Australia New Zealand Gynaecological Oncology Group	Macfarlane Burnet Centre for Medical Research
Australian Regenerative Medicine Institute	Mater Medical Research Institute
Baker IDI Heart and Diabetes Institute	Melanoma Institute Australia
Bernard O'Brien Institute of Microsurgery	Murdoch Children's Research Institute
Bionics Institute of Australia	National Ageing Research Institute
Black Dog Institute	National Heart Foundation of Australia
Brien Holden Vision Institute	Neuroscience Research Australia

Cancer Council NSW	Orygen Youth Health Research Centre
Cancer Council Queensland	Parenting Research Centre
Centenary Institute	Peter MacCallum Cancer Centre
Centre for Cancer Biology	QIMR Berghofer Medical Research Institute
Centre for Eye Research Australia	Queensland Children's Medical Research Institute
Children Youth and Women's Health Service	Queensland Eye Institute
Children's Cancer Institute Australia	Sax Institute
Children's Medical Research Institute	Schizophrenia Research Institute
Ear Science Institute Australia	St Vincent's Institute of Medical Research
Florey Institute of Neuroscience and Mental Health	Telethon Kids Institute
Garvan Institute of Medical Research	Trans Tasman Radiation Oncology Group
George Institute for Global Health	Translational Research Institute
Harry Perkins Institute of Medical Research	Victor Chang Cardiac Research Institute
Heart Research Centre	Walter and Eliza Hall Institute of Medical Research
Heart Research Institute	Wesley Research Institute
Hudson Institute of Medical Research	Western Australian Neuromuscular Research Institute
Hunter Medical Research Institute	Westmead Millennium Institute for Medical Research
Illawarra Health and Medical Research Institute	Women's and Children's Health Research Institute
Ingham Institute of Applied Medical Research/Kolling Institute of Medical Research	Woolcock Institute of Medical Research
Institute for Breathing and Sleep	

Table 3: Publicly Funded Research Agencies

Publicly Funded Research Agency
Australian Institute of Marine Science
Australian Nuclear Science and Technology Organisation
Commonwealth Scientific and Industrial Research Organisation
Defence Science and Technology Organisation
National ICT Australia Limited

*Note: The Ludwig Institute of Cancer Research is not included in the report due to difficulties in assigning their patents. This will be rectified in future reports.

Appendix B: Data sources

IPGOD

The Intellectual Property Government Open Data (IPGOD)[26] set includes over 100 years of IP rights administered by IP Australia comprising patents, trade marks, designs and plant breeder's rights. The data is highly detailed, including information on each aspect of the application process, from application through to granting of IP rights. An important feature of the IPGOD is the ability to match IP administrative data with firm-level business characteristics for Australian companies such as ABN information or entity size.

The IPGOD includes geospatial data such as the state/territory and postcode of the applicant, and a geocode of the applicant address, as well as a marker indicating the quality of the geocoding. We used this data to identify Australian trade marks and designs.

In this project IPGOD was used to determine trade marks, designs and plant breeders rights associated with NSRC recipients. Each applicant in the IPGOD can be identified by their assigned unique identifier which extends across all the different intellectual property rights tables. For example, all of the patents, trade marks and designs owned by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) have the same identifier. If the identifier was not sufficient in identifying the applicant ABN data was used.

PSS

Internal IP Australia administrative data (PSS) is the database on which IPGOD is based, however it includes administrative data relating to IP rights that is not publicly available. We used PSS to determine provisional patent applications.

PATSTAT

PATSTAT is the European Patent Office's database containing bibliographic data relating to worldwide patent filings with more than 90 million records.[27] The type of bibliographic data that this relational database contains includes applicant name, origin, patent filing, classification and publication dates and legal status changes.

PATSTAT was our primary data source for determining patent filings for our applicants.

INPADOC

The EPO worldwide legal status database (INPADOC) contains information on legal events that occurred during the life of a patent, either before or after grant. We used this to determine the status of patents and patent families.

OECD Citations Database

The EPO worldwide legal status database (INPADOC) contains information on legal events that occurred during the life of a patent, either before or after grant. We used this to determine the status of patents and patent families.

The OECD Citations database provides information on patent and non-patent literature (NPL) citations (or references) found in patent documents. Data covers citations made in patents filed at the European Patent Office (EPO) or via the Patent Co-operation Treaty (PCT), and now includes citations made in patents filed at the United States Patent and Trademark Office (USPTO). If the same patent has been published by several patent offices (EPO, WIPO, USPTO, JPO, etc.) any of

[26] Government Open Data, IPGOD 2015

[27] European Patent Office, PATSTAT

the corresponding published document can be cited in patents. For this reason, a table of patent equivalents of the cited patent documents is provided for the three publishing authorities considered. Equivalents help to better account for citations received by particular patents and thus assess, for example, the relative value of inventions.

Appendix C: Methodology

Identification of research organisations

In order to find all the IP rights associated with the research organisations of interest, we aimed to produce a comprehensive list of all the applicant and person identifiers associated with the research organisations in our databases. These included name variations and Australian Business Number (ABN). We then used this data to determine the unique identifier of each of the organisations provided by the Department of Industry, Innovation and Science within IPGOD, PATSTAT and PSS. The unique identifier was cross-referenced in each of the IP databases to retrieve the relevant IP rights.

We attempted to find all name and applicant identifier variations associated with each research organisation and controlled entity, but due to data entry errors it possible not all variations have been located. For instance, data entry errors can cause names to be misspelled in patent records and as such missed during data retrieval.

IPGOD

Where possible, the Australian Business Number (ABN) was used to identify organisations in the firm information tables in IPGOD (tables 102, 202, 302 and 402). This enabled us to find the IPA_APPLICANT_ID(s) associated with each organisation in these tables. The IPA_APPLICANT_ID is an identifier of the group that an applicant belongs to within IPGOD. All applicants with the same identifier are believed to be the same applicant. If the ABN was not provided for the organisation, the organisation names were searched in the Australian Business Register (ABR) to find ABN. If no ABN was found, the research organisation name was searched as applicant name in the firm information tables to identify the IPA_APPLICANT_ID(s). Each applicant name associated with the IPA_APPLICANT_ID(s) was extracted in order to search databases where there are not applicant identifiers present.

PATSTAT

With the name and IPA_APPLICANT_IDs extracted from IPGOD, the Australian patents assigned to the organisations were cross-referenced with entries for the same patents in the PATSTAT database to extract the applicant identifiers and names therein.

PERSON_ID is a stable ID that does not change between different PATSTAT editions. A unique person identifier is assigned in PATSTAT for each unique combination of PERSON_NAME and PERSON_ADDRESS and PERSON_CTRY_CODE. The PERSON_NAME is the name as delivered by the patent office that provides the data to the EPO. A disadvantage of the PERSON_ID is that there will be several PERSON_IDs available for each research organisation but through the capture of all known name variations we hoped to include every PERSON_ID associated with the research organisation.

A stable data structure was develop to store the applicant information extracted from IPGOD and PATSTAT which were then used to find the IP rights associated with each research organisation. This data structure was designed to be reusable for every survey release.

Patent data

The data includes all patent information for universities and their technology transfer offices, publicly funded research organisations and medical research institutes, from 1 January 2000 to 31 December 2014 inclusive.

The information regarding provisional patent applications and innovation patents is limited to Australia.

Table 4: Data sources for patent information

Intellectual Property Right	Databases Accessed
Patent	PATSTAT IPGOD PSS

Granted patents

Granted patents were determining using the field PUBLN_FIRST_GRANT field in the TLS211_PAT_PUBLN table in PATSTAT. If an application has a publication with PUBLN_FIRST_GRANT = 1 then it can be concluded that the application has been granted. In all other cases, the application is still pending.

Information in regard to EP grants has been included in addition to US and AU grants. This decision was based on the fact that applicants often do not file in European convention counties until the EP application has been granted.

Filing Location

All IP rights in IPGOD are filed in Australia.

The PUBLN_AUTH field in PATSTAT table TLS211_PAT_PUBLN was used to determine filing location for other jurisdictions

Dates

In the case of patent grants, the date of publication was used as the filter. In the case of other patent counts the application filing date was used.

Provisional patents

Provisional patent applications were retrieved from the internal IP Australia (PSS) database by locating patent application numbers having the PATENT_TYPE of 'Provisional'.

Provisional applications are not published but serve as a means to provide the applicant with a priority date.

Innovation patents

Innovation patents were retrieved from the internal IP Australia (PSS) database by locating patent application numbers having the prefix ‘201x1’, where ‘201x’ indicates the year of filing and ‘1’ being dedicated to innovation patents.

Innovation patents are a second tier patent in Australia, similar to utility models used in other jurisdictions.

PCT applications

PCTs were identified using APPLN_KIND = 'W' in the TLS201_APPLN table in PATSTAT.

National phase entries

National phase applications, i.e. patent applications lodged in Australia via the PCT route, were searched within IPGOD by identifying those applications that had a patent type of 'NPE' or included a national phase entry date that was not null.

Convention applications

Convention applications were identified by subtracting all the NPEs, PCTs and divisionals from the TLS201_APPLN table in PATSTAT, with from the application INTERNAT_APPLN_ID = 0 and a PRIOR_APPLN_ID that was not null, indicating that the application was claiming priority from a prior filing.

Status

The legal event code descriptors from the TLS802_LEGAL_EVENT_CODE table in PATSTAT (part of the INPAODC database) were used to determine whether a patent has lapsed, expired or had been withdrawn. Patents are identified as no longer being in force if in the last year there was a legal status action of 'lapsed' or 'withdrawn' or 'expired'. In the case of a PCT application if more than 3 years had passed and it did not enter the national phase in any of its elected countries the application was considered also to no longer in force.

A patent is considered ‘granted’ if it has an associated grant (as determined above) and if its most recent PATSTAT legal status code does not indicate that it has been lapsed or withdrawn or expired.

Patent holdings

The total number of holdings were calculated as follows: a patent family was considered ‘Pending’ if it does not have an associated grant (PUBLN_FIRST_GRANT is 0 in PATSTAT TLS211_PAT_PUBLN) and if its most recent PATSTAT legal status code does not indicate that it has been lapsed or withdrawn or expired. A PCT application is considered ‘Pending’ for three years after its filing date, to approximate the time period to enter national phase.

The total number of families for which held at least one granted application was still in force were counted for each of the research organisations to determine their holdings.

RSI

The RSI was calculated using Thomson Innovation to determine the primary IPC mark for each application.

Other IP rights data

Trademark, design and plant breeder's rights data is limited to Australian filings in the period from 1 January 2000 to 31 December 2014 inclusive.

Table 5: Data sources for patent information

Intellectual Property Right	Databases Accessed
Trade mark	IPGOD
Plant Breeder's Right	IPGOD
Industrial Designs	IPGOD

All the trademark, design and plant breeder's rights information were extracted from the IPGOD firm information tables (IPGOD_202, IPGOD_302 and IPGOD_402) based on either ABN data or IPA_APPLICANT_IDs. Additional filing information was then extracted from IPGOD summary tables (IPGOD_201, IPGOD_301, IPGOD_401).

For PBRs we included additional information about the legal status of the application. A status of 'granted' is indicates the PBR has been accepted and 'received' indicates that it is pending. Specifically the following status codes were interpreted as:

Table 6: PBR legal status

Status	Definition
Received	No examination (yet)
Accepted	Examined
Granted	sealed after period for opposition
Withdrawn	withdrawn by applicant before grant
Refused	grant refused in examination
Terminated	withdrawn by applicant after grant
Expired	Term of PBR is up after grant