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Changing nature of patents in Australia

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Abstract

The past decades have seen substantial changes to the innovation system of major economies, not the least due to a paradigm shift caused by the digital revolution. Whether smaller advanced economies such as Australia went through a similar shift or moved to fill the void left by other countries is unclear. I use Australian patent data and show that here has been a similar surge in patenting mainly driven by medical and digital technologies. Australia, however, is showing more strength in a few niche areas. At the same time, the scope of patents, as one measure of basicness, narrowed over the years. This move was driven by private companies opting for applied research and also refocusing their innovation efforts away from chemical and material technologies and onto digital technologies and other applied areas.

Keywords: Innovation, digital technology, patent scope, basic research
JEL codes: O31, O32, O34

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1 Introduction

The past decades have seen changes in the innovation system and patenting patterns of major economies. The advent of digital technologies and their pervasive application to other fields, such as telecommunication and medical technologies, has been one important factor. (WIPO, 2022a) reports an exponential rise in patents related to digital technologies and semiconductor. The number of those patents globally grew 172 per cent faster than patents in other areas just within the period from 2015 to 2020. The shift came at the expense of falling innovation in more traditional areas such as engines, motors and mechanical apparatus.

As in the US, Hicks et al. (2001) use patent data and detect a shift in patenting activity towards information and health technologies. Furthermore, they find that centre of gravity for innovation moved from the east to west coast of the country as digital technologies gained in value and importance. Similar trends, more or less, can be observed across other major patent offices, with patents related to digital, computer and medical technologies generally showing the strongest growth (WIPO, 2022b).

Most topical studies, however, focus on larger economies for the obvious reason that they are the main force behind global changes. There is very little attention on how innovation might be impacted in smaller economies such as Australia. The close trade relations between Australia and major economies encourages Australia to move in the same direction to make use of those lucrative markets. On the other hand, the fast pace and dominance of digital innovations in those economies could also push the innovation system in Australia and other small economies into other niche areas.

I use patent data provided by Intellectual Property (IP) Australia to gain an insight into the nature of changes to Australia's innovation system as manifested by patent records. In doing so, I go beyond merely looking at the changes in technology field and also look at the change in the origin and scope of patents.

The results suggest that a paradigm shift indeed took place in Australia. As is the case in other patent offices, the number of patents granted by IP Australia increased over the years, even as the probability of an application being rejected also rose during the same period. Most of the increase in patenting is associated with medical, pharmaceutical and computer technologies at the expense of patenting activity in chemical and mechanical fields.

At the same time, a very large proportion of patents (almost 85 per cent of them) have foreign origins, positioning Australia as a net importer of innovations. Compared to foreigners, Australian innovators have traditionally been more active in areas related to civil engineering, mechanical technologies and machinery. The shift towards medical and digital technologies has been shared among both foreign and Australian innovators.

In particular, Australian innovators have gained a strong presence in information technologies specialised to specific applications such as administration, management and finance. This observations is a hint that Australians are harnessing a few niches to exert themselves and claim their own markets.

Another revelation is in regards to international collaborations, defined as patents with both Australian and foreign applicants. There are very few of them in the patent data. International collaborations facilitate the spilling over of knowledge from foreign sources. They are the essence of catching up with the global frontier. Australia has a natural disadvantage owing to its remote geographic location, which is probably the main factor for the observed lack of international collaboration.

It also turns out that most Australian doing research with American innovators are inclined to register their patents in the US rather than in Australia. A similar outward-looking attitude is possibly emblematic of Australians doing joint research with innovators from other countries. As a result, patents in Australia grossly under-estimate the scale of international collaborations that are taking place in the country.

Another major shift happens in the scope or breadth of patents. In this context, scope is defined as the number of four-digit International Patent Classifications (IPC) associated with a patent. Scope of a patent is generally a sign of its basicness and quality. The scope of patents in Australia dropped, especially post 2000, where patents with foreign origin exhibit the largest and most abrupt drop. It seems that with the advent of digital revolution, the focus of innovation switched towards fast-yield and applied inventions.

A more detailed analysis of this narrowing of scope offers more insight into what took place. Specifically, two forces were at play to narrow down patents. First, innovation in most fields became narrower and more applied. This move is observed across most technology fields but to various extents. Then, there has been a shift from more basic areas of research, such as chemistry and material sciences, and towards other fields such as civil engineering, medical technology and digital technologies, which are inherently more applied in their nature.

The shift has almost wholly been driven by industry and corporate entities. There is very little change in scope where universities and research institutes are involved. It is fair to say that the corporate world is opting for applied and fast-yield innovations while happily leaving universities and government to cop the burden and costs of basic research and fundamental innovations.

The remainder of the paper is organised as follows: in Sections 2, I introduce the data and detail its composition. In Sections 3 to 6, I investiagte various changes that have happened to different aspect of patenting including changes to their technology field, origin, the composition of applicants, and their scope. I quickly touch on innovation patents as a subgroup of patents offered by IP Australia with more applied nature in Section 7. I conclude the paper in Section 8.

2 Analysis Data

Information about patents and applications are sourced from the Intellectual Property Government Data (IPGOD) provided by IP Australia. The data is publicly avilable through Australian government's data portal.[1] The data used in this study is the 2021 vintage.

The IPGOD provides information on all patent applications, whether accepted, rejected or pending. There is an extra field that indicates the status of application. The status is missing for most applications prior to 1980. The year of application and the year patent status is granted is also provided. I use the year of application because it is better aligned with the time the innovation came to fruition.

Other useful information such as the name and country of applicants and their type (whether the applicant is an organisation or an individual) are available, too. The country of applicant, in particular, helps to make distinction between the changes that are driven by innovators in Australia versus those coming from outside.

The data further reports the list of International Patent Classifications (IPCs) assigned to a patent and additionally identify the primary IPC that classifies the patent. I particularly

[1] Search for IPGOD in https://www.data.gov.au.

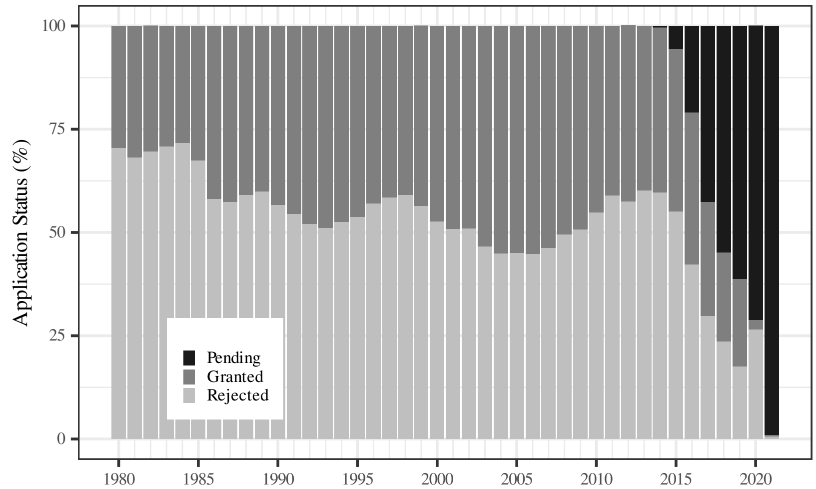


Figure 1: The status of applications lodged with IP Australia by year.

use the number of different four-digit IPCs assigned to a patent – also called the breadth or scope of a patent – as a measure of its value and quality. Using a sample of US patents, Lerner (1994) shows that broader patents, those with a larger number of different four-digit IPCs, receive more citations by other US patents. Firms holding those patents are also more valuable. Similarly, Strumsky et al. (2012) study US patents and show that patents with broader scopes tend to embody more complex and more novel innovations, hence, are more valuable.

The literature also emphasises the number and diversity of citations made to or by a patent as a measures of quality (Trajtenberg et al., 1997; Hall et al., 2005). The bad news is that the Australian data does not provide any information on citations, hence, eviscerating chance of a headway on this front.

There is one last consideration in the usage of patent data: towards the last years, the status of most patents is pending. This trend is illustrated in Figure 1. The share of pending patents is especially high starting from 2016.

For conformity with other similar studies, I am focusing on granted patents. For that reason, I restrict the window of analysis to years 1980 to 2015 to use the most reliable portion of the data. Within this window, almost all applications lodged with IP Australia are known to have either been rejected or granted a patent status.

As the last comment, I would like to mention that from 2001 to 2021, IP Australia offered a class of patents called *Innovation Patents* as opposed to normal patents that are now termed as *Standard Patents*. Innovation patents were predominantly targeted at small and medium sized firms by offering a simpler granting process but also a shorter grant term. Participation, however, was paltry. Only 4.7 per cent of all patents since 2001 are of Innovation type. By the end of 2021, IP Australia phased out Innovation Patents altogether owing to their unpopularity. In the remainder, I will pool all patents, Innovation or Standard, without making the distinction. In Section 7, however, I come back to Innovation Patents and present a few facts about them.

3 Patenting Activity

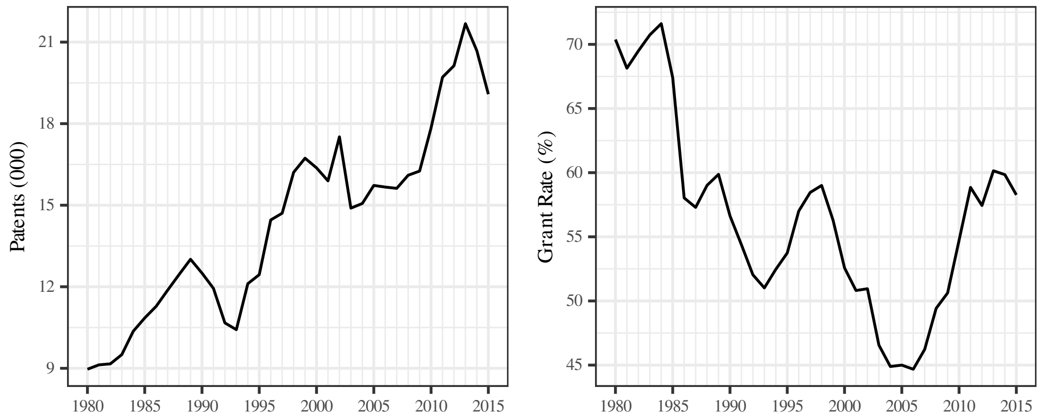
I begin by looking at the simple count of patents. It is now well documented that there has been a surge in the number of patents and applications across several patent offices around the world (Fink et al., 2016; WIPO, 2022a,b). The size of the surge varies from office to office. In the United States, the number of patents rose by almost five times from 1980 to 2015, whereas the increase has been about four times in Japan over the same period.[2] The numbers in China and Korea have gone up exponentially over the past two decades. In 2011, China overtook the US in the number of patents filed and granted by its patent office (Hu et al., 2017; WIPO, 2022b).

Australia has moved in the same direction, though the increase in patents here has not been as dramatic as those for the countries mentioned above. Figure 2(a) shows the number of patents granted in Australia from 1980 to 2015. The number increased by about 2.4 times during the period, a substantial increase, yet modest in its magnitude compared to several other countries.

This increase in the number of patents in Australia is despite a fall in granting rate. Figure 2(b) shows the grant rate in Australia, defined as the proportion of applications granted a patent status from the total number of applications.

There has been an early drop in granting rate. The grant rate went from 70 per cent in 1980s down to 45 per cent in 2005 and stayed at that low for a few years. The grant rate

[2] The source of numbers is WIPO's Patstat dataset: https://www3.wipo.int/ipstats/.



(a) Patents

(b) Grant Rate

Figure 2: Count of patents and the patent grant rate in Australia.

surged in the years that followed, but still remains just below 60 per cent.

The decline in granting rate is not exclusive to Australia. Scrutinising the patent process in the US, accounting for re-appeals and patent families, Carley, Hedge & Marco (2015) find that in 2000 the patent examination process was tightened. They also demonstrate that the granting rate declined within all technology groups and all types of applications in the US as a result.

This surge in patenting has not been ubiquitous across technology classes. Only a few technologies have been behind the surge. Table 1 lists the number of patents by technology class and the implied growth rate to support this point.[3]

Medical and bio-technologies are two fields that show the largest increase. Together, their share from granted patents has gone from less than 4 per cent in 1980 to almost 20 per cent in 2015. Pharmaceuticals has also gained ground, with its share of patents going from 1.4 per cent in 1980 to 5.7 per cent in 2015. The share of Computer Technology grew from 0.9 per cent of patents in 1980 to 4.7 per cent.

Similar trends have also been observed across other major patenting offices (Hicks et al., 2001; WIPO, 2022b), with medical, digital and information technologies pushing the increase in patenting activity globally.

Civil Engineering is another area where patenting increased. Combined, the top five

[3]These technology classes are based on the IPC concordance table proposed by Schmoch (2008).

Technology class	Numbers 1980	Numbers 2015	Shares (%) 1980	Shares (%) 2015
Medical Technology	210	2,555	2.30	13.40
Biotechnology	109	1,148	1.20	6.00
Pharmaceuticals	124	1,079	1.40	5.70
Computer Technology	85	894	0.90	4.70
Civil Engineering	416	1,394	4.60	7.30
IT Methods for Management	1	380	0.00	2.00
Furniture, Games	162	676	1.80	3.50
Audio-visual Technology	179	689	2.00	3.60
Digital Communication	17	294	0.20	1.50
Other Consumer Goods	169	540	1.90	2.80
Control	65	264	0.70	1.40
Food Chemistry	114	375	1.30	2.00
Measurement	250	631	2.80	3.30
Transport	298	692	3.30	3.60
Electrical Machinery, Apparatus, Energy	326	706	3.60	3.70
Semiconductors	29	72	0.30	0.40
Micro-structure and Nano-technology	1	23	0.00	0.10
Analysis of Biological Materials	42	116	0.50	0.60
Environmental Technology	117	248	1.30	1.30
Optics	111	235	1.20	1.20
Telecommunication	117	254	1.30	1.30
Handling	325	654	3.60	3.40
Engines, Pumps, Turbines	173	262	1.90	1.40
Thermal Processes and Apparatus	164	256	1.80	1.30
Basic Communication Process	79	25	0.90	0.10
Surface Technology, Coating	199	215	2.20	1.10
Mechanical Elements	290	367	3.20	1.90
Textile and Paper Machines	200	177	2.20	0.90
Machine Tools	245	249	2.70	1.30
Other Special Machines	436	624	4.90	3.30
Organic Fine Chemistry	735	1,217	8.20	6.40
Basic Material Chemistry	523	750	5.80	3.90
Chemical Engineering	412	486	4.60	2.50
Micromolecular Chemistry, Polymers	338	201	3.80	1.10
Material Metallurgy	391	298	4.40	1.60

Table 1: The number of patents within various technology classes in the years 1980 and 2015 and their share of the total.

classes (in terms of growth in number of patents) increase their share of patents from 10.4 per cent in 1980 to 37.1 per cent of granted patents in 2015.

During the same period, patenting in several areas of chemical, material science, and machines and tools waned or grew only modestly. For comparison, the share of bottom five classes goes from 27 per cent of patents granted in 1980 to only 15.5 per cent in 2015.

4 Origin of Applicants

The increase in patents does not necessarily mean increasing innovative activity in Australia. Many of the applicants are foreign individuals or entities seeking protection in Australia. To get an idea about domestic versus foreign participation in patenting in Australia, I consider three types of patents:

Domestic: All applicants are from the home country.

Foreign: All applicants are from foreign countries. In this case, the innovation is understood not to have taken place in the home country.

Mixed: Applicants are a mix of domestic and foreign entities. The innovation is the result of international collaboration, with part of it taking place in the home country or sourcing knowledge from the home country.

One point to notice is that patents registered by the Australian subsidiaries of foreign firms (e.g. Ford or Toyota) are classified as Australian. This classification is intentional, as the research and innovation took place in Australia, possibly with foreign collaboration. The number of these patents is quite small, about a few per year on average. Their classification either way does not seem to sway the conclusions.

With this background, I am showing the distribution of patents by the origin of their applicants in Figure 3.

As the chart shows, a substantial number of patents granted in Australia have foreign origins. More than 85 per cent of patents registered in recent years have been fully foreign, firmly positioning Australia as a net importer of innovation. IP Australia (2021) identifies the main foreign patentees as originating from the US and China, with Japan and the European block standing in the next places.

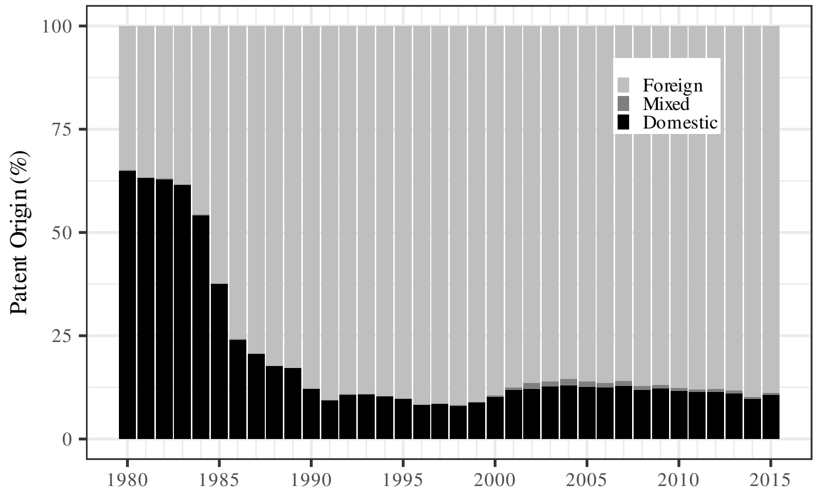


Figure 3: The origin of patent applicants by year. Only granted patents are included.

International collaborations, defined as patents having both Australian and foreign applicants, appear to be a very small part of the picture. The number of patents with mixed origins is less than one per cent of the total, though the number seems to be slightly larger towards the more recent years.

Various reasons can be put forth as for the small part played by international collaborations. One factor is perhaps Australia's remote and isolated geographic location that impedes on collaborative research over long distances. Localised nature of knowledge spillovers from patenting has already been evidenced for the US patents (Jaffe et al., 1993). There is no reason to believe Australia is an exception.

There is, however, another subtle reason for this supposed lack of international collaboration. Most Australian inventors collaborating with an overseas innovator are inclined to patent their innovations not in Australia but in the other country (e.g. the US), especially if the other country is larger and competition there is more intense.

As one example, Figure 4 shows joint US-Australian patents registered with the US Patent office (USPTO) and those registered with IP Australia. The numbers in Australia are only a tiny fraction of those registered in the US. About 700 to 800 joint patents filed with the USPTO are missing from IP Australia's records. This pattern is likely emblematic of Australian collaborations with other countries such as the EU and Japan.

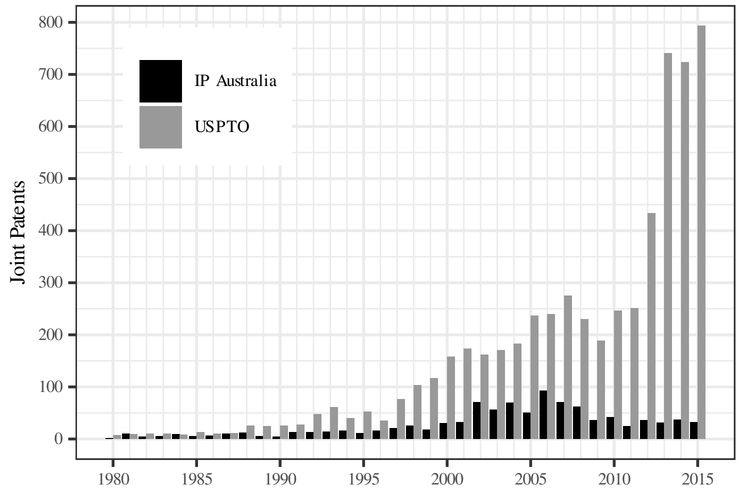


Figure 4: The number of joint patents registered with IP Australia and the USPTO by year. The USPTO data is sourced from patentsview.org.

This outward attitude of Australian inventors means that the count of mixed-origin patents in Australia under-represents its true level of international collaboration.

One important point of difference between Australian and foreign patents is their mix of technologies. The propensity to patent in each technology class can be quite different from foreign to Australia patents. To make this case, I compute an index of Relative Technological Advantage (RTA) for Australian versus foreign patents (Patel & Pavitt, 1997; Cantwell & Fai, 1999). The index is generally used to gauge the technological advantage of firms relative to each other. However, it can easily be adapted to do the same for applicants of different origin, now treating each origin as one whole entity. Put formally, the advantage of applicants from origin o in technology class c is defined as

$$RTA_{oc} = \frac{P_{oc}/\sum_o P_{oc}}{\sum_c P_{oc}/\sum_{o,c} P_{oc}}, \quad o \in \{Domestic/Mixed, Foreign\}. \tag{1}$$

The nominator in (1) is the share of patents in class c associated with origin o. The denominator is the share of patents from origin o and in all classes relative to total. A value larger than one shows an advantage, whereas a value lower than one indicates a disadvantage. The computed indexes by technology class and origin are illustrated in Figure 5.

Australia has relative advantage in several fields. IT Methods for Management are Aus-

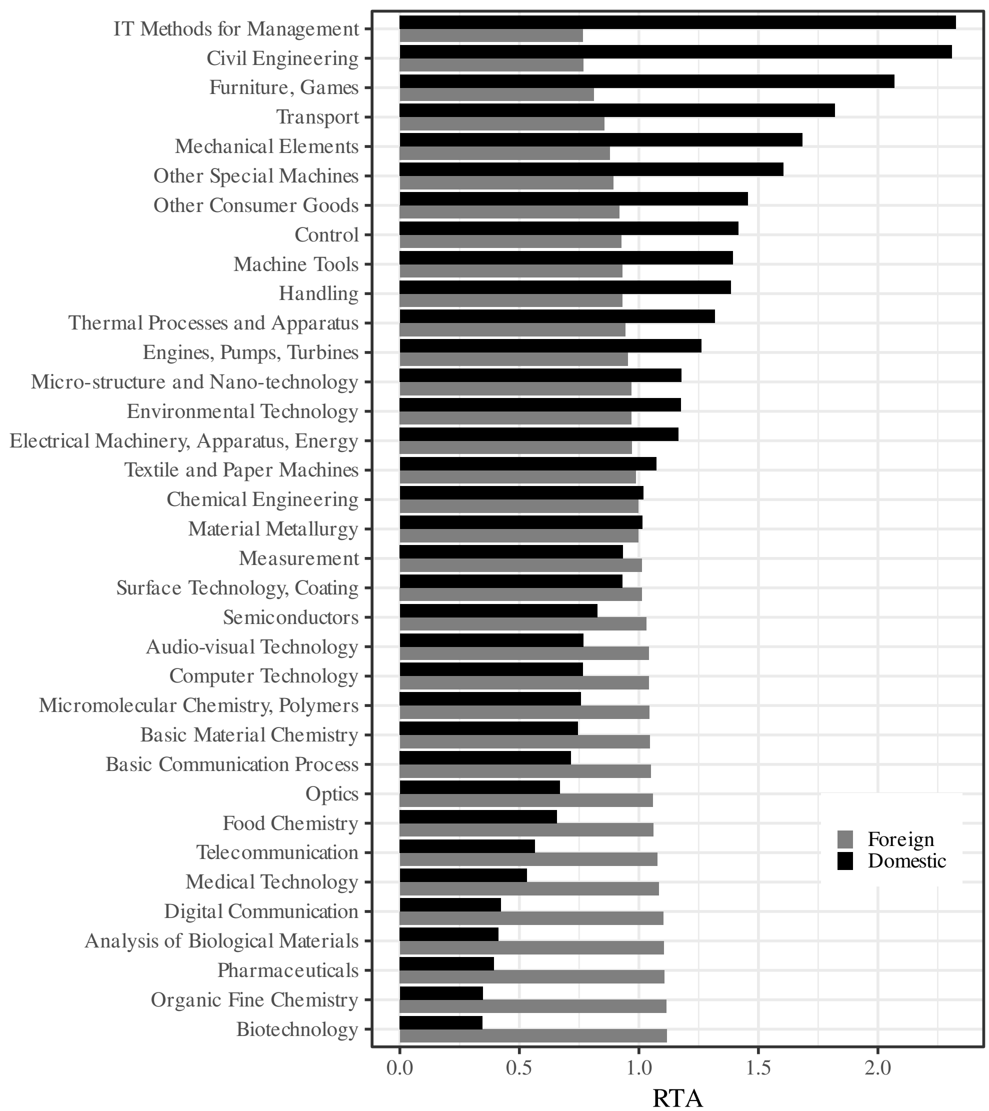


Figure 5: The Relative Technological Advantage (RTA) of domestic/mixed patents versus the foreign ones.

tralia's strongest point. These are digital technologies and methods specialised to certain applications such as management, commerce, or administration. Their strong position in Australia is in contrast to that in other patent offices where this particular field does not rank especially high (WIPO, 2022b). Australia appears to be targeting a niche area in the broader digital technology field.

Civil Engineering, Furniture and Games are the other areas where Australia has an advantage. There is also an Australian advantage in most areas related to machinery, transport and tools. These areas, again, do not rank high in other patent offices and point to niche technologies.

For foreign applicants, patents appear to be more evenly distributed across most technology classes. In contrast to domestic/mixed patents, the relative advantage for foreign patents are not very different from one (the average). Still, there are differences from field to field. Foreign patents have a relative advantage in areas related to Medical technology, Bio-technology and -materials, Pharmaceuticals, Organic Fine Chemistry and Digital Communication.

As for the areas that fall in the middle, such as Chemical Engineering, Measurement, and Semiconductors, Australian and foreign applicants are almost on par in their propensity to contribute.

5 Composition of Applicants

An important aspect of patents, with implications for their quality, is the type of their applicants. Involvement of a research institute is often a sign of quality. It signals a more fundamental approach to research and innovation, one that has high and enduring value, one with the possibility of instigating other innovations in very diverse fields owing to its level of basicness (Jaffe, 1989; Trajtenberg et al., 1997; Czarnitzki et al., 2009; Drivas & Economidou, 2013). It has been argued that these are the innovations behind the long-term productivity growth (IMF, 2021, Ch.3).

To look at this aspect of patents, I utilise the name of applicants. Implementing a text mining algorithm, I categorise an applicant as either an individual, a research institute, or from industry.[4] Government institutes with major research focus are classified as research, otherwise as industry. The main focus is on the presence of research institutes versus others.

The distribution of patents by the type and composition of their applicants is illustrated in Figure 6. I show one picture for domestic and mixed origin patents as representing innovation in Australia and separately show another for fully foreign patents for comparison.

For presentation, I am using the following classification:

Individuals Only: All applicants are individuals.

Industry+Research: At least one applicant is from industry (a corporation or a government department) and at least another is a research institute (e.g. a university or a research centre).

Research Institute: At least one applicant is a research institute. There are no industry applicants.

Industry: At least one applicant is from industry. There are no research institutes as applicants.

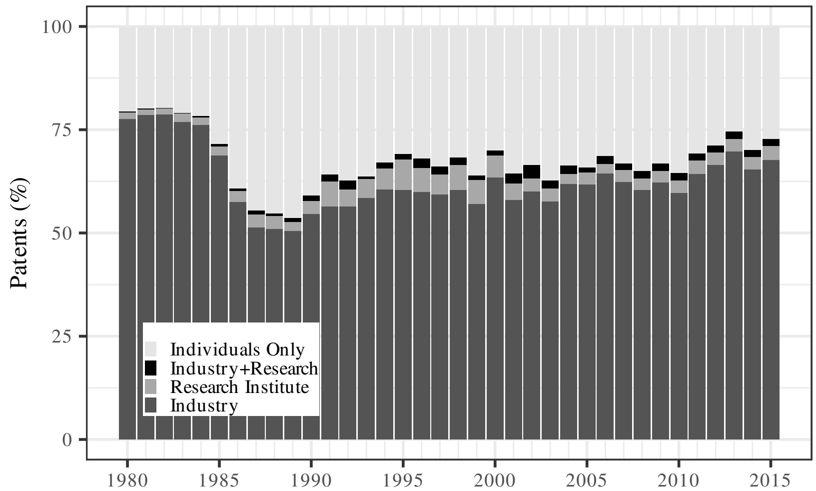
Patents associated with research institutes or industry (or both) can still have individuals as applicants, the individuals being the actual inventors. However, as the mix of applicants suggest, the invention came about as part of the firm's or institute's research program and not in isolation, hence the emphasis on the non-individual entity.

The majority of patents are of industry nature regardless of origin. The share of patents lodged by industry is, however, larger for foreigners. About 90 per cent of patents with fully foreign origin are lodged by the industry. For patents with at least one Australian applicant, this share hovers around 60 per cent.

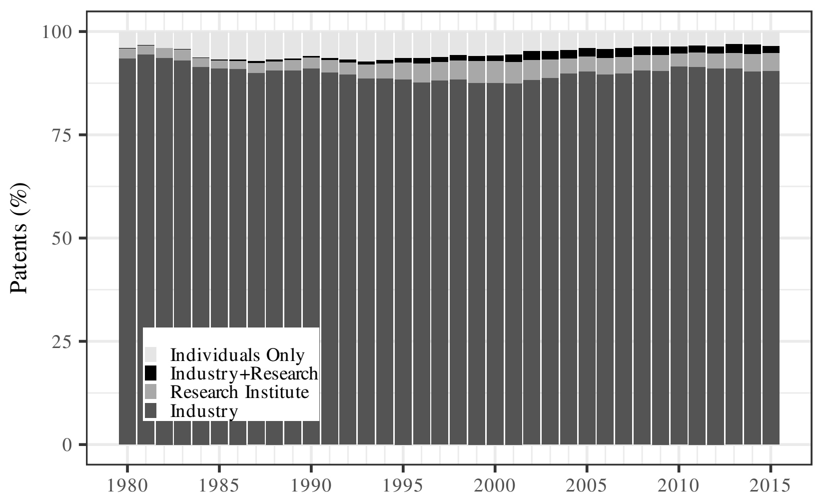
This observation is not totally unexpected, as lodging patent applications with foreign offices is generally more cumbersome and costlier than seeking a patent in home country. Only patents worthy of international markets are expected to be registered with multiple offices. These patents are dominantly associated with international firms and large corporations.

There is also a non-trivial presence of patents with at least one research institute as applicant among both foreign and domestic/mixed applicants. The share grows slowly over

[4] The code is available on request.



(a) Domestic or Mixed



(b) Foreign

Figure 6: The composition of patent applicants. Only granted patents are included.

time, especially for foreign patents. In the last year of data, about 5 per cent of foreign patents and about 6 per cent of domestic/mixed patents have at least one research institute as applicant.

6 Patent Scope

I define the scope or breadth of a patent as the number of distinct 4-digit IPCs assigned to it. As mentioned earlier, patents with broader scopes tend to be of higher quality. They embody more basic and complicated innovations, having drawn from a wide range of knowledge and technologies, and can equally spill over to as many fields of technology (Strumsky et al., 2012). An increase in patent scope over time signals a shift towards more complex and possibly basic innovations. An opposite move would suggest a growing appetite for simpler, faster-yield innovations.

Looking at Figure 7, the latter appears to be the case: the average scope of patents granted in Australia became narrower over the years. The fall in scope has been quite dramatic and abrupt for foreign patents. Between 1980 and 2000, the scope of foreign patents gradually increased, going from an average of five IPCs per patent to more than seven in 2000. Post 2002, however, the scope for these patents falls rapidly to a low of three IPCs per patent. The coinciding of this fall with the timing of digital revolution is very suggestive.

The changes for domestic and mixed patents have not been quite as dramatic, though the scope for those patents has also become narrower. In 1980s, a patent with at least one Australian applicant had an average of four to five IPCs assigned to it. By 2010, that scope had fallen to an average of two. Most of the drop in scope for domestic and mixed patents happened prior to 1990, followed by a more gradual decline after 2000.

These changes in patent scope can originate from a few sources. It can be that for the same class of technology, patents are getting narrower. It can also be that the distribution of patents is shifting away from technology classes with inherently broader scopes to those that have narrower ones. Table 1 already provides a preliminary evidence of such shift.

There is also another possibility that the type of applicants is changing. Universities are often associated with more basic and broader innovations. If patent applicants are increas-

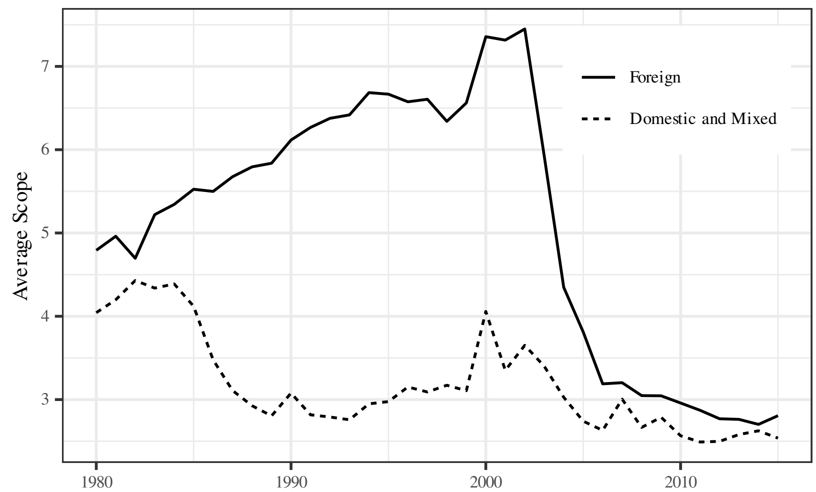


Figure 7: Change in the average scope of patents by applicant's origin.

ingly from, for instance, corporate circles, one would expect a drop in scope.

To emphasise the importance of technology class and applicant type in patent scope, I show, in Figure 8, how the average patent scope varies across these two characteristics. Technologies pertaining to chemistry and material science exhibit the broadest scopes. The average scope for patents in Organic Fine Chemistry is close to 10. Patents in most other chemical fields have an average scope of 4 to 10.

Digital technologies have lower scopes. Average scope for patents in Semiconductors and Digital Communication is around 4. Patents in Computer Technology and IT Methods for Management are even narrower in their scopes, with their average scopes sitting close to 2. Patents in Civil Engineering, one of the top achievers in Table 1, have an average scope of 3.

The other point evident in the picture is that the type of applicant matters for the scope of patents. In most technology classes, individuals are registering patents with the narrowest scopes. Patents registered by the industry have broader scopes than those with all individual applicants. Patents with the broadest scopes are generally associated with research organisations or a collaboration of research and industry. The ranking of scopes aligns well with what one expects of the basicness and quality of innovations from each type of applicants.

For a more rigorous investigation of how patent scope has fallen, I undertake a simple

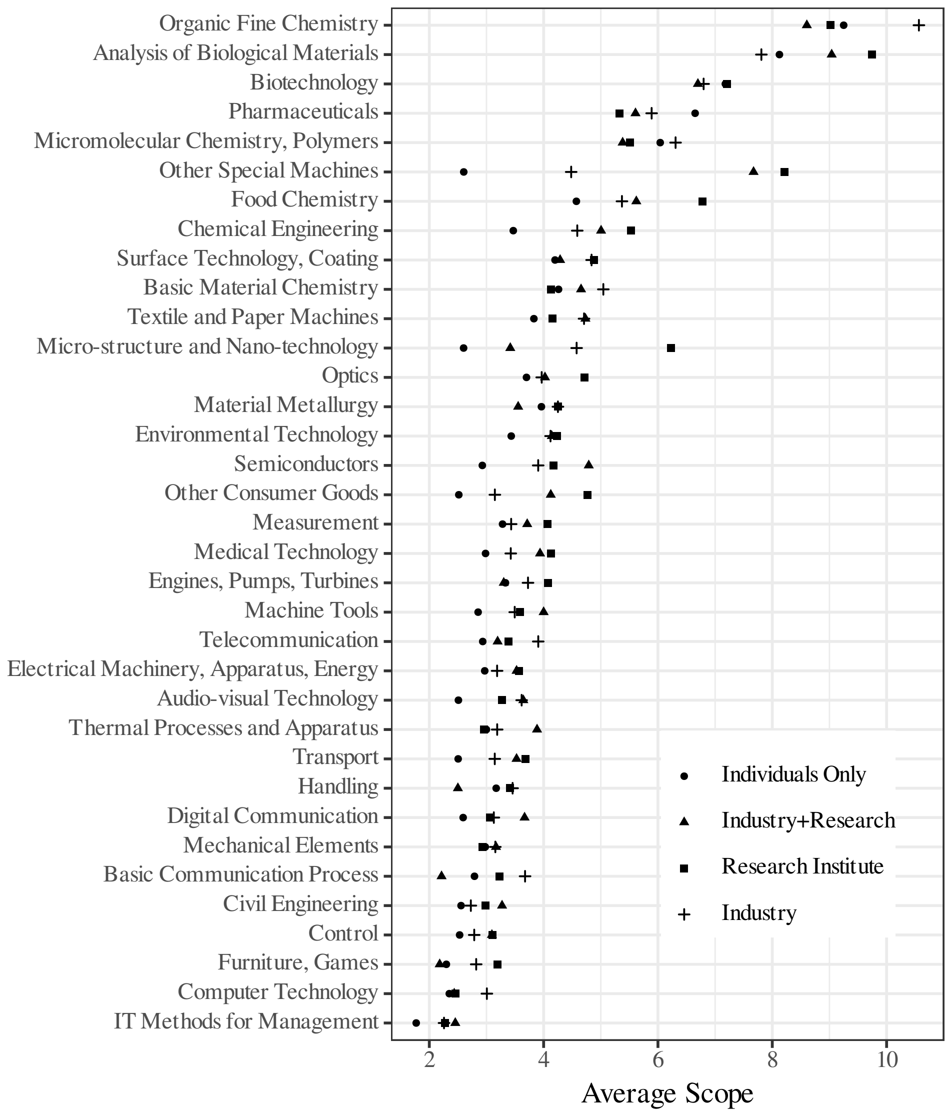


Figure 8: Average scope of patents by technology field and applicant type.

decomposition exercise. Let the scope of patent p in technology class c be indicated by S_{pc}. As such, change in average patent scope from period 1 to period 2 can be written as

$$\Delta S = \bar{S}_2 - \bar{S}_1 = \sum_{c=1}^{C} \left(\frac{P_{c,2}}{P_2} \bar{S}_{c,2} - \frac{P_{c,1}}{P_1} \bar{S}_{c,1} \right), \tag{2}$$

where

$$\bar{S}_{c,t} = \frac{1}{P_{c,t}} \sum_{p=1}^{P_{c,t}} S_{pc,t}. \tag{3}$$

In the above, $P_{c,t}$ is the total number of patents in technology class c in period t. The total number of patents in a period is, then, $P_t = \sum_{c=1}^{C} P_{c,t}$.

With some manipulations, (2) can be transformed into

$$\Delta S = \sum_{c=1}^{C} \left[\underbrace{\frac{P_{c,1}}{P_1} (\bar{S}_{c,2} - \bar{S}_{c,1})}_{\text{Scope Change}} + \underbrace{\left(\frac{P_{c,2}}{P_2} - \frac{P_{c,1}}{P_1} \right) \bar{S}_{c,2}}_{\text{Distribution Change}} \right] \tag{4}$$

For each technology class, equation (4) is made up of two components. The first component, *scope change*, formulates the change in average scope coming from change in the scope of class c, keeping the distribution of patents by classes fixed. The second component, *distribution change*, accounts for change in average scope as a result of change in the distribution of patents across classes, keeping patent scope in each class fixed.

To explore where the changes have taken place, I compute the two components above separately for each technology class c. The total change in scope would, then, be the sum of all these terms. I set time period 1 as years 1980 to 1990 and time period 2 as years 2005 to 2015. The inclusion of multiple years in each period helps to suppress short-term fluctuations and to produce a more balanced picture of innovation in each era.

In Figure 9, I show the computed components by technology class separately for domestic and mixed origin patents. The first thing to note is that the scope of patents has narrowed across almost every technology class. The drop in scope is more nuanced in chemical fields such as Organic Fine Chemistry, Molecular Chemistry and Polymers, and Basic Material Chemistry.

In parallel, there has been a shift in the distribution of patents away from chemical and

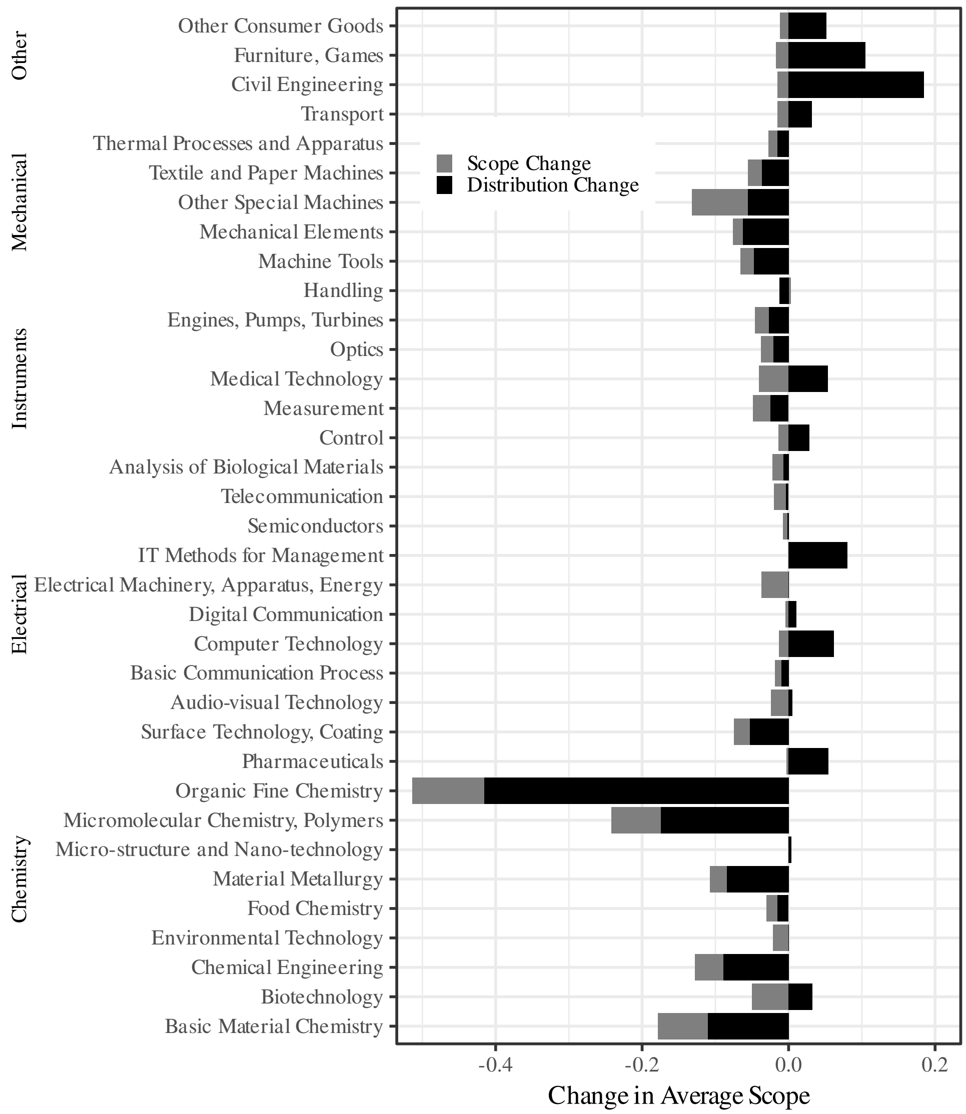


Figure 9: Changes in scope and distribution of domestic and mixed origin patents by technology class from 1980–90 to 2005–15.

material fields and towards certain areas in digital and medical technologies but also civil engineering and consumer goods.

The largest drops in patenting, keeping scopes fixed, are among Organic Fine Chemistry, and Micromolecular Chemistry and Polymers. These are also two areas with the broadest scope (Figure 8). Other areas of chemistry such as Chemical Engineering, Material Metallurgy, and Basic Material Chemistry also experience sizeable drops.

On the other hand, the share of patents in Civil Engineering, Furniture and Games, and Other Consumer Goods is increasing. Pharmaceuticals, Medical Technology, IT Methods for Management and Computer Technology are also other areas that see large gains. As has been evident throughout this work, there is an increasing appetite for innovation in IT Methods for Management among Australians as compared to other digital technologies.

Carrying out the same exercises for patents with foreign origin shows similarities and also differences with domestic patents. The estimated changes for foreign patents are shown in Figure 10.

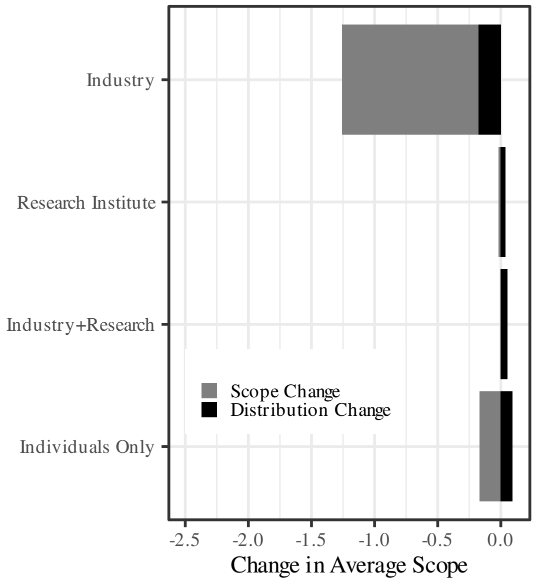
As is the case with domestic and mixed patents, foreign patents are also getting narrower across most technologies. However, the scale of decline in scope among foreign patents is much bigger than that among domestic and mixed patents, which explains the dramatic drop in scope observed in Figure 7. Foreign patents in chemical fields are especially experiencing dramatic falls in their scopes.

The shifts in the distribution of foreign patents is also similar to those for domestic and mixed patents. Specifically, the share of patents in chemical and material sciences is declining in favour of Medical Technology, Pharmaceuticals and Biotechnology. There are also increase in the share of patents for Computer Technology and Civil Engineering.

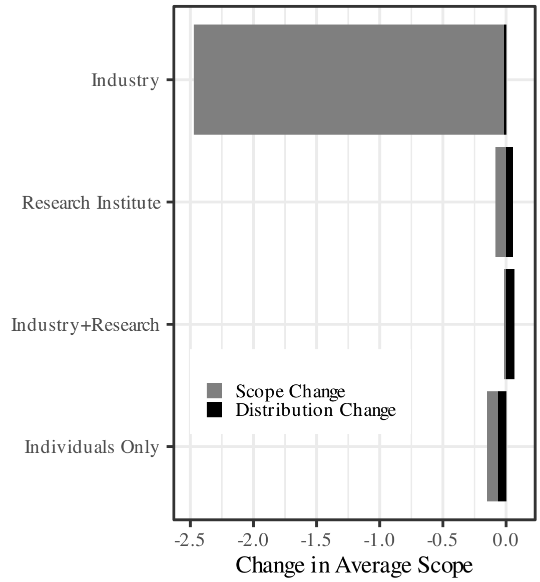
Lastly, as discussed in the beginning of this section, a change in the distribution of patents by their type of applicants can also have implications for patent scope. The decomposition method of (4) can be adapted to study the role of applicant type simply by letting c to index type of applicants instead of technology class. The computed decomposition for domestic and mixed patents versus foreign patents is illustrated in Figure 11.

With both domestic and foreign patents, industry is leading the way in narrowing down the patents. Industry patents registered by domestic applicants has gotten narrower to the

Figure 10: Changes in scope and distribution of foreign patents by technology class from 1980–90 to 2005–15.



(a) Domestic and Mixed



(b) Foreign

Figure 11: Changes in scope and distribution of patents by the type of applicant from 1980–90 to 2005–15.

tune of 1.25 fewer IPCs. The drop for foreign patents of the same kind has been almost double that amount: scope for these patents has lately been about 2.5 IPCs fewer.

There are also changes in the share of applicants by types. The distribution component shows a small drift towards patents involving research organisations and individuals. However, these changes are too small in magnitude compared to the other shifts.

7 Innovation Patents

From 2001 to 2021, IP Australia offered a class of patents called *innovation patents*. These patents were mainly marketed to small and medium enterprises by offering a simpler and faster application process but also a shorter protection period. However, this type of patents never really caught on. Innovation patents were eventually abolished due to lack of interest.

Figure 12 shows the proportion of innovation patents from total number of granted patents by their year of application. The share of innovation patents grew slowly over the years, though its share remained persistently around 7.5 per cent.

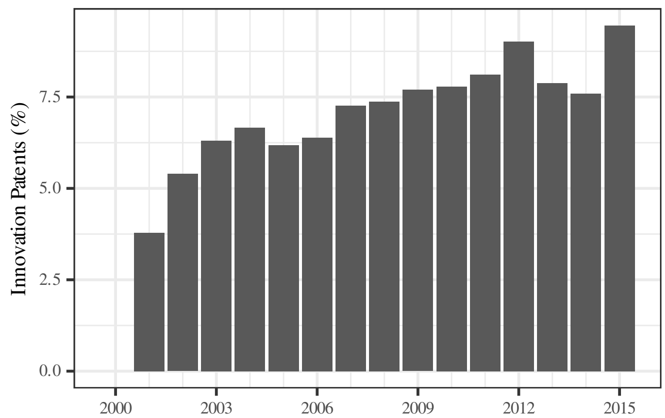


Figure 12: The share of innovation patents from granted patents.

These numbers, however, conceal an important fact that the popularity of innovation patents varied substantially from technology class to technology class. The share of innovation patents by technology class are shown Figure 13.

Innovation patents have been very popular in two fields: IT Methods for Management, and Furniture and Games. About one in four patents granted in IT Methods for Management have been of the innovation type. As mentioned above, these are digital or data innovations specialised to specific applications.

About one in five patents in Furniture and Games are of innovation type. These are innovations related to articles of furnishing (e.g. chairs, tables) or items and apparatus for games and amusement.

The lowest popularity of innovation patents coincides with chemical and medical fields. Biotechnology, Micromolecular Chemistry, Polymers and Organic Fine Chemistry do not have any innovation patents. Other chemistry fields have very few. Arguably, innovation patents were mostly about simpler, lower value, and applied innovations.

8 Conclusion

The digital revolution and continued globalisation have caused a paradigm shift in every aspect of the economy, including the innovation environment. Major economies are experiencing a massive increase in the number of patents, with the increase mostly driven by

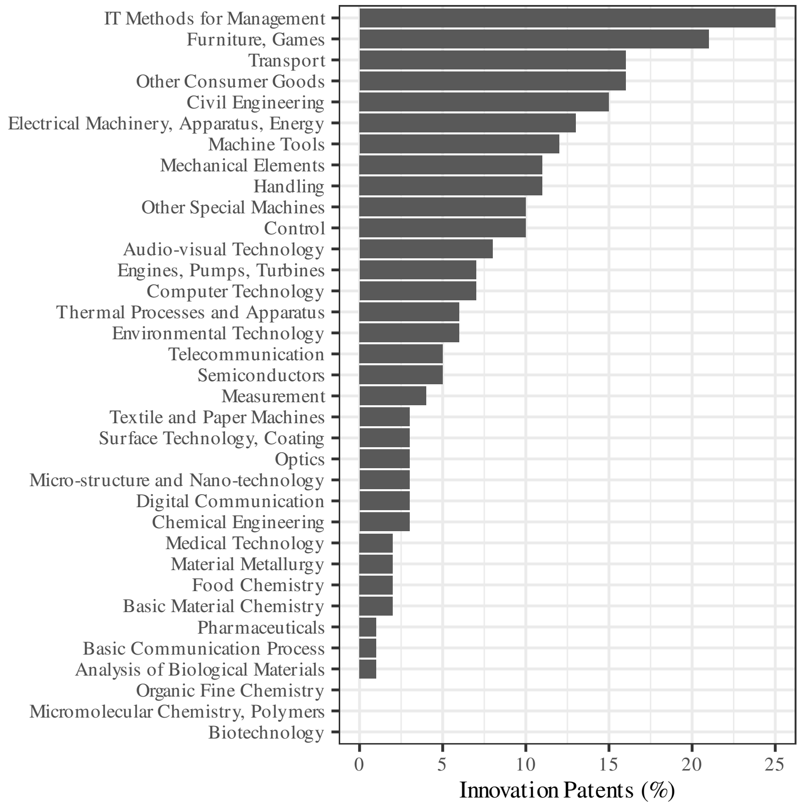


Figure 13: The share of innovation patents from granted patents. The numbers pool all years from 2001 to 2015.

heightened enthusiasm in digital, information and health technologies. Australia, as a small open economy, has had a more mixed experience. There has been a surge in patenting in Australia that looks modest in magnitude compared to what is happening in the US and other large economies. The surge, again, is mostly driven by medical and digital technologies at the expense of lower patenting in other areas of more basic research such as chemical and material sciences. The majority of patents registered in Australia have fully foreign origins, which means innovation trends in other countries do reflect on the direction of patenting in Australia. Patents from Australian innovators have more focus on the applied side of digital and medical technologies and also on technologies related to civil engineering. As such, Australia is moving to find niche spaces in the international innovation system to fill.

At the same time, there has been a drop in the scope of patents, whether the origin of the patent is foreign or Australian. One reason for this drop is exactly the shift from chemical and material sciences, where patents are broader and more basic, to digital and medical technologies, where patents tend to be narrower in their scopes. Another reason has been that industry and private companies are shunning basic research in favour of more applied and faster yield innovations. These shifts could have implications not only for the future of innovation in Australia but also for its long-run productivity and economic growth. Leaning towards lower-value and narrow innovations generates value in the short-run but could be a drag on the longer-term growth and competitiveness as indicated by IMF (2021).

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