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Welcome

Intellectual property rights and enterprise growth: The role of IP rights in the growth of SMEs

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EXECUTIVE SUMMARY

A key challenge for policy makers and investors is to identify small and medium enterprise (SMEs) with high growth potential. The challenge is heightened in the case of new firms, which lack a roster of satisfied customers or track record of successful product launches. This report investigates the relationship between IP activity in SMEs and their potential to achieve high growth in employment and turnover.

The study uses comprehensive administrative, tax and IP data on the full population of Australian firms. It focuses on around 600,000 Australian SMEs from 2002-17. High growth firms are identified as those SMEs that achieve more than 20% annual growth in employment or turnover on average over 3 consecutive years.

The proportion of Australian SMEs that own a patent, trade mark or design right remains relatively small – approximately 4% in 2017 (last available data) – but this share doubled between 2002 and 2017, driven by an upsurge in the use of trade marks in deregulated and service industries. Around 90% of SMEs that own IP rights own trade marks only. IP use is concentrated in Wholesale Trade, Manufacturing, and Information Media and Telecommunications. Wholesale trade includes SMEs that may design and develop IP in Australia that is then produced by other businesses, e.g., through contracting arrangements with domestic or international manufacturers.

On average, SMEs that own IP rights are around 2.5 times larger (in terms of number of employees) than their peers without IP rights, are older and pay a higher median wage. The results are consistent with international studies which show that obtaining IP rights are associated with increased firm performance,

with workers capturing a significant proportion of the surplus in higher earnings.

Controlling for a firm's initial characteristics (e.g., employment, turnover and total assets) and business level factors that vary little over time (e.g., a firm's managerial posture), SMEs that file for at least one IP right in a given year are 10% more likely to experience a subsequent three-year period of high turnover growth than SMEs who file for no IP rights in the same year. The IP filers are 16% more likely to experience high employment growth than their peers that don't file.

SMEs that file for three types of IP rights (patents, trade marks and designs) are the most likely to achieve high growth: they are 235% more likely to achieve high turnover growth and 91% more likely to achieve high employment growth than their peers that have filed for no rights. In commercialising innovations, creating a distinctive product design and an emotionally salient brand can help build market acceptance for new technologies. Results from this study highlight the complimentary advantage of using different types of IP rights to achieve high growth.

The foundation of an effective IP bundle for growth appears to be the use of trade marks, reflecting their role in the commercialisation phase of the innovation process. For a small firm with 2 employees, increasing its number of trade marks from one to 2 will increase its number of employees by 13% (or 0.3 full time equivalent employees). The expected increase in employment from adding a trade mark rises to 19 employees for a medium firm with 150 employees.

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1. INTRODUCTION

A key force that propels the economy forward is the exponential growth achieved by some small and medium enterprise (SMEs).¹ High growth SMEs contribute disproportionately to job creation and economic growth (Schreyer, 2000; Halabisky, et al., 2006; Coad & Hözl, 2012; Moreno & Coad, 2015; Majeed, et al., 2018). Unlocking the growth potential of these firms is crucial for Australia to realise a broad-based economic recovery from the COVID-19 pandemic. SMEs account for 99 per cent of the total number of businesses in Australia, 68 per cent of total Australian employment (around 7 million jobs), and 57 per cent of Australia's gross domestic product (GDP).²

Innovation is a key driver of business growth, economic dynamism and prosperity. By providing inventors with a temporary monopoly on use of their ideas in the marketplace, intellectual property (IP) rights provide incentives for firms to invest in innovation, which can lead to productivity improvements and enable firms to carve out market niches, thereby driving business growth. For new firms, securing registered IP rights can increase investors' estimates of their value (Hsu & Ziedonis, 2013). Strong IP protection opens the option for start-ups to collaborate with industry peers who may have critical resources to share but also a strategic interest

in the start-up's key intellectual assets (Katila, Rosenberg & Eisenhardt, 2008).

In assessing the state of Australia's economy, traditional measurement approaches fail to provide insight into the quality of SMEs including new firms. For example, analysing the total number of SMEs or the number of new businesses born offers no insight into the potential of these businesses to achieve high growth. Similarly, assessing the performance outcomes of SMEs overlooks their as-yet-unrealised growth potential. To design policy that helps SMEs to commercialise and scale, a different approach is needed (e.g., Fazio et al., 2016).

This study uses comprehensive microdata on 600,000 Australian SMEs active from 2002 to 2017 to analyse the relationship between IP activity and business growth.³ High growth firms are classified as firms that achieve 20% average annual growth in employment or turnover over 3 consecutive years. The study finds that for Australian SMEs, IP activity – their use of patents, trade marks and design rights – predicts differences in growth potential. The findings suggest that IP data has a use in targeting support at SMEs with the potential to achieve scale, to ensure they realise their potential.

¹ Following the definition given by the Australian Bureau of Statistics (ABS), small and medium enterprise (SMEs) refers to entities that employ less than 200 employees (full-time equivalent). See: ABS (2018), Counts of Australian Businesses, Including Entries and Exits, Jun 2013 to Jun 2017, Cat. No. 8165.0, Australian Bureau of Statistics, Canberra.

² ABS (2018), Counts of Australian Businesses, Including Entries and Exits, Jun 2013 to Jun 2017, Cat. No. 8165.0, Australian Bureau of Statistics, Canberra. See also: NAB (2017), Moments That Matter: Understanding Australian Small to Medium Business, National Australia Bank. <https://business.nab.com.au/wp-content/uploads/2017/06/J002580_MTM-Whitepaper-IPSOS-FINAL_C1-2.pdf>.

³ The study uses data from the Business Longitudinal Data Environment (BLADE). BLADE is a statistical resource that contains information on the full population of active Australian businesses. The data used for this study focused on the period from fiscal year 2002 to fiscal year 2017.



2. THE USE OF IP RIGHTS BY AUSTRALIAN SMEs

Policy makers have long recognised the positive role of IP rights in economic growth (Maskus, 2000; WIPO, 2009). A recent study by IP Australia's Office of the Chief Economist showed that Australian firms which own IP rights have a higher average profitability than those that don't use IP rights (Zhang, 2020).

International studies suggest that small and new firms which apply for IP rights are more likely to experience exponential growth (EPO and EUIPO, 2019; Fazio et al., 2016).

Firms may use a single type of IP right (e.g., a patent) or a combination of different types of IP rights (e.g., a patent and a trade mark) to protect different facets of their intangible output. Different rights taken on importance at different stages of the innovation and commercialisation process:

- Patents are used to protect the outputs of research and development (R&D) activities, if those results are new, useful and involve an inventive step. Examples of patentable outputs include a new device, substance, method or process. Once a patent is granted, for the life of that patent, it provides a legally enforceable right that the owner can use to prevent other entities from commercially exploiting the patented invention.

- A trade mark is a distinctive sign such as a word, picture, logo, colour, shape or sound (or a combination of these) used to distinguish goods and services in the market. The owner of a registered trade mark can prevent others from exploiting identical or similar signs in the same business area. In markets where consumers cannot easily observe the quality of a product, trade mark protection ensures that consumers can rely on reputation and brand to identify the product's source and quality. Trade mark filings are closely associated with the commercialisation end of the innovation process, as firms will often register trade marks when launching new products in the market (Mendonca et al., 2004).

- A design right protects a product's visual features such as its shape, colour, configuration, pattern, and ornamentation. Design rights may function like trade marks in helping to distinguish a firm's offerings from competing products. Like patents, they provide an incentive for firms to invest in innovation.

Registered IP rights, such as patents, trade marks and design rights, are granted by a competent public authority after a formal application process.⁴ The exclusivity provided by these rights is limited in time and can only be enforced within the jurisdiction/s where it was granted.

⁴ In Australia, patent protection is usually available for a maximum of 20 years from the date of the application, subject to the payment of renewal fees. Registering trade marks provides an initial period of protection extending to 10 years, but can be renewed indefinitely, subject to the payment of renewal fees. In Australia, a design right can be registered without substantial examination but is only enforceable after it is certified through a substantive examination process, with a maximum protection term of 10 years.

2.1 The share of SMEs with IP rights doubled from 2002 to 2017

Only 4% of active Australian SMEs owned at least one valid patent, trade mark or design right in 2017 (last year of available data). The share of Australian SMEs with an active right has, however, doubled over recent decades, from 2% (or 13,846) in 2002 to 4% (or 28,128) in 2017.

Table 2.1. IP right ownership percentage of Australian SMEs by the seven types of IP rights

Type of IP right owners	% of Australian SMEs with an IP right
Patents only	2.3
Trade marks only	89.1
Designs only	1.7
Patents and trade marks	2.9
Patents and designs	0.3
Trade marks and designs	2.4
All three types of IP rights	1.3

Source: ABS BLADE dataset (2016-17 frame)

Table 2.1 reports the share of Australian SMEs that own different types of IP rights. The vast majority of SMEs that own IP rights own trade marks only (89%). Trade mark use is more diffuse throughout the economy than patent use, with sectoral differences in trade mark activity less pronounced than for patents (Greenhalgh & Rogers, 2008). From the mid-1970s, strong trade mark growth has been observed in Australia, the United States, the United Kingdom and Germany (Schauschick & Greenhalgh, 2013). In Australia, the upsurge in trade mark use has been driven by increased adoption in services and deregulated and restructured industries (Jensen & Webster, 2004).

IP activity by Australian SMEs is concentrated in several industries, namely Wholesale Trade, in Information, Media and Telecommunications, and in Manufacturing (Table 2.2). These rankings are relatively consistent over time. The implication is that certain characteristics of an industry play an important role in determining whether an SME is likely to use IP rights or not. Wholesale trade includes SMEs that may design and develop IP in Australia that is then produced by other businesses, e.g., through contracting arrangements with domestic or international manufacturers.

Table 2.2. Number and share of Australian businesses with at least one IP right by ANZSIC division, annual averages, 2002 to 2017

Industry (ANZSIC division)	Businesses with at least one IP right	
	Number of businesses	Share of businesses (%)
Wholesale Trade (F)	3 853	11.9
Information Media and Telecommunications (J)	535	9.7
Manufacturing (C)	3 765	9.1
Education and Training (P)	364	5.2
Mining (B)	132	5.1
Electricity, Gas, Water and Waste Services (D)	93	4.6
Financial and Insurance Services (K)	1 136	4.6
Professional, Scientific and Technical Services (M)	3 752	4.3
Arts and Recreation Services (R)	234	3.4
Public Administration and Safety (O)	81	3.0
Retail Trade (G)	1 716	2.8
Administrative and Support Services (N)	720	2.7
Rental, Hiring and Real Estate Services (L)	646	2.2
Other Services (S)	646	1.6
Accommodation and Food Services (H)	566	1.4
Health Care and Social Assistance (Q)	496	1.2
Transport, Postal and Warehousing (I)	348	1.1
Construction (E)	1 054	1.0
Agriculture, Forestry and Fishing (A)	465	0.9

Source: ABS BLADE dataset (2016-17 frame)

2.2 SMEs with IP rights are on average older, larger and pay a higher wage than SMEs without IP rights

We compared SMEs that use IP rights to SMEs that do not use IP rights, focusing on characteristics such as employment, age and employee earnings. ‘IP owners’ are defined as SMEs owning at least one registrable IP right (a patent, trade mark or design right) in a given year, while SMEs without IP rights are defined as ‘non owners.’ To derive our sample, we used data on all active SMEs who reported their revenue, income and expenses to the Australian Taxation Office (ATO) in a given year.⁵ More details of the data and method can be found in Appendix A.

Table 2.3 compares IP owners and non owners, with separate analyses for firms with different types of rights (including bundles of different rights). The sample groups are compared for their median number of employees (full time equivalent) and median business age as their distributions are skewed to small values.⁶

By comparison of their median values, IP owners are older than non-owners (11 years as compared to 7 years). The result may indicate that SMEs tend to file their first IP rights late in their lifecycle. Alternatively, the result may reflect survivorship bias: if IP owners survive longer than their peers with no IP rights then they will remain in the dataset longer, influencing the median age of IP owners. SMEs with all three types of IP rights have the longest median business age, at 18 years.⁷

IP owners are also larger, having 7 employees on average, compared to 2 for non-owners. SMEs with multiple types of IP rights tend to be larger than SMEs with only one type of right, and those with all three types of rights – patents, trade marks and designs –

have the greatest median number of employees.

These results are consistent with international research and with prior studies using Australian microdata. For example, using US data, Balasubramanian & Sivadasan (2008) found that patent owning firms are on average 10 times larger than patent non-owning firms for employment. Zhang (2020, looking at the full population of Australian firms, found that IP owners tend to be older and larger than the average Australian firm.

Table 2.3: Group comparisons between IP owning and non-owning SMEs, median firm size and age

	Number of employees	Business age (years)	Number of observations
Non-owners of IP rights	2	7	9 915 096
IP right owners	7	11	330 982
<hr/>			
Type of IP rights			
<hr/>			
Patents only	7	13	7 723
Trade marks only	7	11	294 837
Designs only	7	10	5 680
Patents and trade marks	15	15	9 637
Patents and designs	12	12	957
Trade marks and designs	15	13	7 995
All three types of IP rights	30	18	4 153

Source: ABS BLADE dataset (2016-17 frame)

⁵ In BLADE, there are a large number of businesses that have not reported any financial, production and employment data in specific years, which in many cases likely means that the business is no longer active. This may cause the percentage of firms using IP rights in Australia to be underestimated. To overcome this problem, only ‘active businesses,’ that report sales, income and expenses, and number of employees in a given fiscal year, were kept in that year. There were approximately 0.6 to 0.7 million businesses in each year who reported their sales revenue and number of employees during the period from 2002 and 2017.

⁶ Full time equivalent (FTE) employees are obtained based on the calculation done by Hansell D., Nguyen, T. and Soriano, F. (2015). Can we improve on a headcount? Estimating unobserved labour input with individual wage data, paper presented at the 25th Australian Labour Market Research Conference, Fremantle WA (10 11 November 2014), ABS Canberra. In this report, employees refer to FTE employees.

⁷ Similar results are also obtained focusing on mean values.

Prior research focused on US firms has shown that obtaining an enforceable patent substantially increases both firm productivity and within-firm average earnings (Kline et al., 2019). Consistent with these findings, we find that among Australian SMEs IP owners pay a higher annual median wage (at \$53,755 per employee) than non-owners (at \$43,304 per employee) as shown in Table 2.4. The highest median wage is paid by SMEs with both patents and trade marks, who are likely engaged in commercialising innovations.

Table 2.4: Group comparisons between IP owning and non-owning SMEs, median wage

	Median wage (\$/year)	Number of observations
Non-owners of IP rights	43 304	9 838 444
IP right owner	53 755	330 119
<hr/>		
Type of IP rights		
Patents only	58 593	7 702
Trade marks only	53 342	294 047
Designs only	49 689	5 660
Patents and trade marks	63 215	9 624
Patents and designs	53 649	954
Trade marks and designs	53 904	7 986
All three types of IP rights	60 860	4 146

Source: ABS BLADE dataset (2016-17 frame)



3. IP RIGHTS AND SME GROWTH

In Australia, as in other countries, high growth firms (HGFs) contribute disproportionately to aggregate employment, sales, exports and economic growth (Australian Innovation System Reports, 2016, 2017; Schreyer, 2000; Halabisky, et al., 2006; Coad & Hözl, 2012; Moreno & Coad, 2015; Majeed, et al., 2018). Focusing on Australian firms, Majeed et al. (2018) found that turnover growth is positively correlated with innovation in goods and services or marketing, alongside other business characteristics. In this section, we estimate the relationship between an SME's IP rights filing activity and its subsequent growth, while controlling for both external factors and firm level influences. A particular aim of the analysis is to understand the types and combinations of IP rights that serve as signals of high growth potential for Australian SMEs.

3.1 Data and method

The study focuses on a sample of around 600,000 Australian SMEs tracked over the period of 2002 to 2017. In this report, we define HGFs as those with average annualised growth greater than 20 per cent over 3 consecutive years, consistent with prior studies (Majeed et al., 2018).⁸ This report tests the relationship between IP activity and firm growth, separately, using turnover and employment data.

The dependent variable is a binary variable, equal to 1 if an SME experiences high turnover (or employment) growth or zero otherwise. We separately estimate positive growth, using a binary variable equal to 1 if an SME experiences annual turnover (or employment) growth greater than 0% per annum over 3 consecutive years.

As the dependent variables are binary, we use a logistic probability model. In this we follow the approach of the EPO/EUIPO (2016), but as we have panel data we can improve upon prior research by incorporating fixed and random effects. These control for firm-level factors that don't vary greatly over time (e.g., a firm's managerial posture).

The results reported below are estimated using a fixed effects model. This was found to provide less biased estimates than the alternative random-effect model, using the Hausman test.

It is likely that SME growth is also influenced by unobserved firm attributes or activities that do vary over time, including innovation activity not captured by the IP data. It is possible that certain unobserved variables may be correlated both with a firm's IP filing activity and its subsequent growth. For example, an SME with the capabilities needed to market new products may be both more likely to achieve growth and file for IP rights, since this firm will be able to spread the fixed costs of filing over a larger customer base. Therefore, the results should not be interpreted as suggesting a causal relationship between IP rights and SME growth. Rather than establishing a causal link, the aim of this study is to assess the value of IP data for identifying SMEs with high growth potential, and to understand what happens within SMEs when they file for IP rights.

Full details of the data can be found in Appendix A. Details of the econometric modelling and complete estimation results are available in Appendix B. Inferential results are reported as odds ratios. The odds ratio is the ratio between

⁸ For details, please refer to <https://www.industry.gov.au/data-and-publications/staff-research-papers/what-drives-high-growth-characteristics-of-australian-firms>.

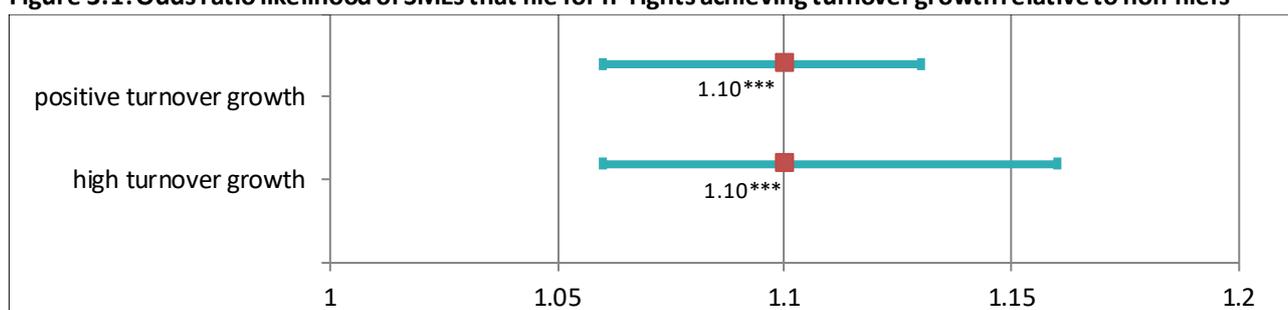
(a) the odds of an SME who files for an IP right achieving positive (or high) growth and (b) the odds of an SME who does not file for an IP right achieving positive (or high) growth. The difference between the estimated odds ratio and 1 indicates the difference in likelihood between filers and non-filers achieving high (or positive) growth.

3.2 The role of IP rights in SME growth

3.2.1 SMEs filing for IP rights are more likely to achieve high growth

Figure 3.1 illustrates, with red marks, the estimated odds ratio of positive growth between filers of any type of right and non-filers (top row) and the estimated odds ratio of high growth between filers of any type of right and non-filers (bottom row). Blue lines denote the 95% confidence interval around the point estimates. Based on the point estimates, SMEs who file for at least one IP right in a given year are 10% more likely to experience a subsequent three-year period of high turnover growth than SMEs who file for no IP rights in the same year, all else being equal. A similar result holds in estimating positive turnover growth (see Appendix Table B.2).

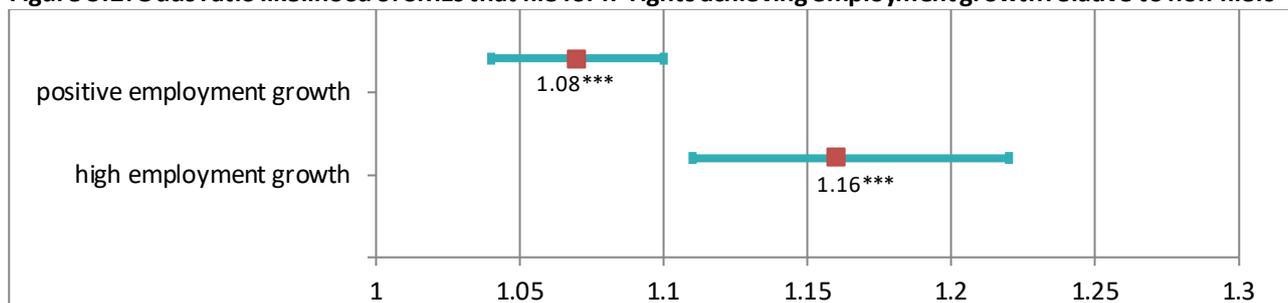
Figure 3.1: Odds ratio likelihood of SMEs that file for IP rights achieving turnover growth relative to non-filers



Note: *p<0.1; **p<0.05; ***p<0.01

Significantly positive results were also found for the association of prior IP right filings to employment growth (see Appendix Table B.4). SMEs that filed for at least one IP right in a given year are 8% more likely to experience positive employment growth (top row) and are 16% more likely to experience high employment growth (bottom row), relative to SMEs that filed for no IP rights the same year (Figure 3.2).

Figure 3.2: Odds ratio likelihood of SMEs that file for IP rights achieving employment growth relative to non-filers



Note: *p<0.1; **p<0.05; ***p<0.01

3.2.2 SMEs filing for all the three types of IP rights are the most likely to achieve high growth.

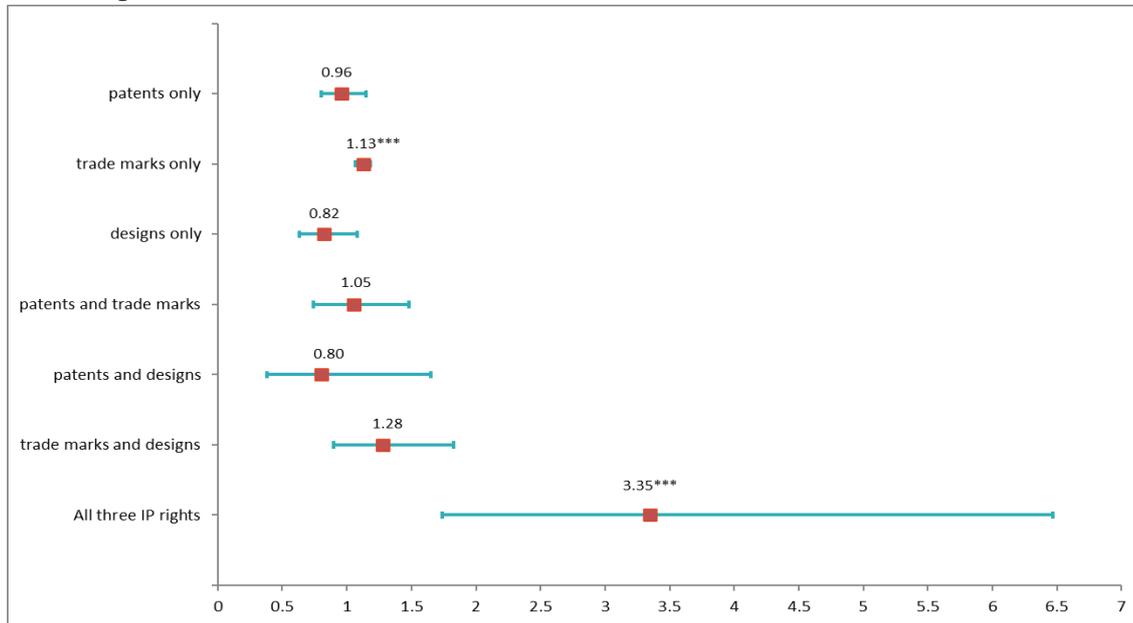
For SMEs who file for single types of IP rights, only those filing for trade marks are statistically more likely to experience positive turnover growth than SMEs who file for no IP rights (Figure 3.3; and also Appendix Table B.3). That is, SMEs who file for patents only or designs only are not statistically more likely to achieve positive growth relative to SMEs who file for IP rights. The results reported in this study focus on near-term growth potential, in the year after filing. A patent or a design alone may signal that an SME's invention or product design is still in the research and development stage and not ready for commercialisation, or that the application for a right is yet to be granted. Supplementary results, focused on the effects of IP activity further in time – 2, 3 or 4 years after filing – are available from the author on request.

Among the SMEs who file for multiple types of IP rights, only those who file for all the three types of IP rights are statistically more likely to experience high growth. Comparing across bundles of different rights, the strongest

predictor of high growth is a firm holding all 3 types of IP rights (patents, trade marks and design rights) – the likelihood of these firms achieving high growth being more than double that of firms who file for no IP rights. This may indicate that the technological inventions (as proxied by patents) are more likely to be financially rewarding when they are also commercialised (as proxied by trade marks) and combined with innovation in aesthetic design and marketing (as proxied by designs).

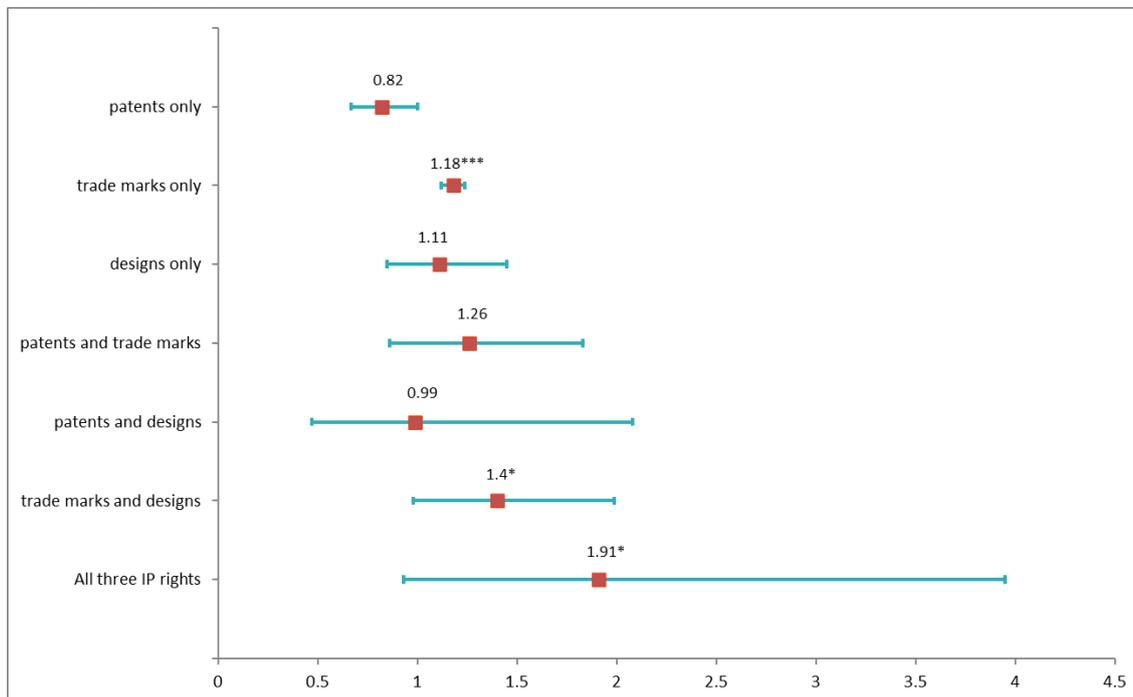
Looking at bundles of any 2 types of IP rights, combining patents and trade marks is positively associated with high growth, as is combining trade marks and designs; however, the coefficients for these bundles are not statistically significant at the 90% confidence level.

Figure 3.3 Odds ratio likelihood of SMEs that file for different bundles of rights achieving high turnover growth relative to non-filers



Note: *p<0.1; **p<0.05; ***p<0.01

Figure 3.4 Odds ratio likelihood of SMEs that file for different bundles of rights achieving high employment growth relative to non-filers



Note: *p<0.1; **p<0.05; ***p<0.01

Similar results were obtained considering the relationship between IP filing activity and high employment growth (Appendix Table B.5). SMEs that file for trade marks are more likely to experience positive employment growth than SMEs who do not file for any new IP right, but the same result is not found for patents or design rights (Figure 3.4). Among SMEs who file for multiple types of IP rights, SMEs who file for all the three types of IP rights have the highest likelihood of achieving high employment growth – their likelihood achieving high turnover growth increases by 91% above that of SMEs who file no IP rights. Further, SMEs who file for trade marks and designs are 40% more likely to achieve high employment growth than SMEs who file for no IP rights.

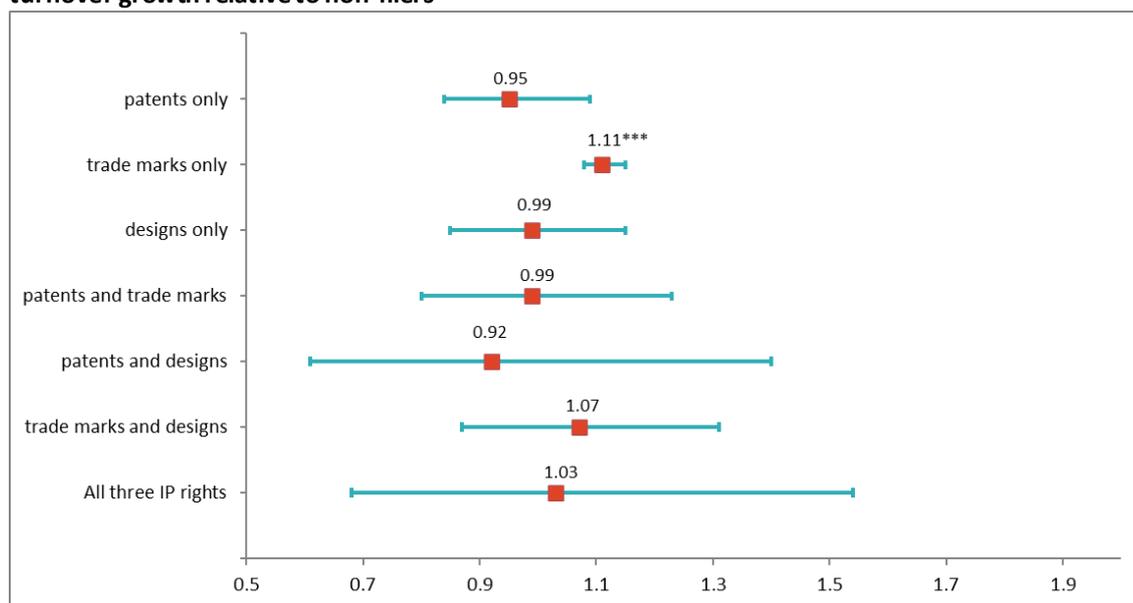
These results increase confidence in our key finding that patents, trade marks, and designs are complimentary pieces of an SME’s IP portfolio, with trade marks playing a particularly significant role in characterising SMEs’ near-term growth potential.

3.2.3 Trade mark filing is a better indicator than patents and designs of an SME’s near-term growth potential.

The previous two sections considered the impact of different IP rights bundles on the likelihood of SMEs realising high growth in turnover or employment. We now consider whether filing for different IP right bundles is associated with positive growth in subsequent years (whether high or not).

When looking at SMEs that file for only one type of right, only those that file for trade marks are statistically more likely to experience positive turnover growth than SMEs who file for no IP rights (Figure 3.5). Further, in contrast to the results for high turnover growth, SMEs who file for multiple types of IP rights are not more likely to achieve positive turnover growth than those who file for no IP rights.

Figure 3.5 Odds ratio likelihood of SMEs that file for different bundles of rights achieving positive turnover growth relative to non-filers



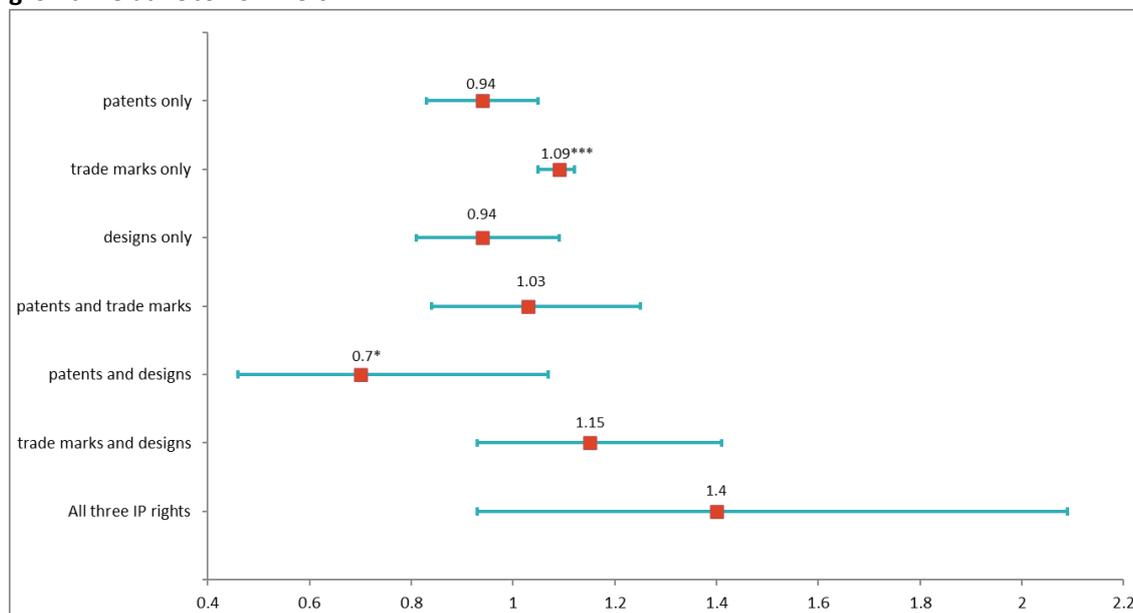
Note: *p<0.1; **p<0.05; ***p<0.01

There are many factors that affect a firm’s ability to achieve positive growth, and IP rights are likely to only have a marginal impact compared to these other factors – consider that while many SMEs achieve positive turnover growth, only a small proportion of those have filed for IP rights. In contrast, achieving sustained high growth is difficult, and will often require something out of the ordinary – such as commercialising an innovation (as proxied and protected by the filing of IP rights).

Similar results are obtained considering the relationship between IP filing activity and subsequent employment growth (Appendix Table B.5). Among SMEs who file for only a single type of IP right, those filing for trade marks are more likely to experience positive employment growth than SMEs who file for no IP rights, but the same is not true for SMEs that file for patents or design rights.

Again, SMEs who file for multiple types of IP rights are not statistically more likely to achieve employment growth over the next three years compared to those who did not file for any IP rights. The point estimates suggest that SMEs who file for patents and designs are 30% less likely to achieve positive employment growth than those who file for no IP rights. However, the result is not significantly different from zero at the 90% confidence level. For SMEs, applying for patents and designs without any trade mark signals that the relevant product technology is in an early stage of research and development and not yet ready for commercialisation.

Figure 3.6 Odds ratio likelihood of SMEs that file for different bundles of rights achieving positive employment growth relative to non-filers



Note: *p<0.1; **p<0.05; ***p<0.01

3.2.5 For SMEs, initial turnover or employment are weak predictors of subsequent growth

Across the estimation models in this study, we control for a firm’s age and initial conditions such as its initial turnover or employment level. Consistent across the various models, with a 10% increase in an SME’s initial turnover level it is 0.2% more likely to achieve growth (positive or high), holding other factors constant. With a 10% increase in initial employment, an SMEs likelihood of achieving growth (positive or high) increases by around 0.3%. SMEs by definition have a small employment base and low turnover, relative to large firms, so percentage increases in resources may not lead to large changes in their absolute level of that resource. That said, the average age for firms in our sample is 6 years. As an SME’s age increases by 10%, its likelihood of achieving positive or high growth increases by 21–22%. With age, firms acquire experience and specific human capital which may increase the firm’s growth potential.⁹

3.2.6 The association between IP right filing activity and high growth for SMEs is sustained for growth spells of up to 4 years

As a sensitivity test of the relationship between firm growth to IP filing activity, we carried out several tests examining the period over which that relationship is sustained. To do this, we re-estimated our baseline models extending the period over which growth is measured from 3 years to 4 years, to 5 years, and to more than 5 years. For the details of the methodology, please refer to Appendix B.6.1.

⁹ As we use the natural logarithm of turnover, employment and age in the logistic model, we use an exponential transformation of the estimated coefficients to interpret the impact of the variables in terms of odds ratio likelihood. For example, to interpret the relationship between business growth likelihood, expressed in terms of odds ratios between filers and non-filers of IP rights, we perform the following calculation drawing on the estimate in Table B.2: the estimated impact for positive growth is $\exp(0.77) = 2.16$, while that for high growth is $\exp(0.75) = 2.12$.

The estimated results reported in Appendix Table B.6 indicate that SMEs who file for IP rights are 12% (in the case of turnover growth) or 14% (in the case of employment growth) more likely to experience subsequent high growth over 4 years compared to their peers that don't file. However, the IP filers are not more likely to experience high growth sustained over periods of 5 years or longer. In identifying potential high growth SMEs it is thus important to consider their capacity for sustained innovation, as indicated by repeat filing activity.

3.2.7 IP filing by start-ups indicates differences in their growth potential

A key force that propels the economy forward is the exponential growth achieved by some new firms. In pursuing growth, start-ups face significant challenges. In the early stages of a new venture, what sets a start-up apart from its peers may be mostly intangible – a great business plan, an early-stage idea or invention. At this stage, firms may lack a roster of satisfied customers or track record of successful product launches to point to as evidence of their quality or potential for growth. As a result, investors and policy makers typically lack readily available and reliable information by which to assess a start-up's quality. Previous research shows that obtaining patents and trade marks can increase a start-up's likelihood of obtaining venture capital, especially during early investment rounds (Hsu & Ziedonis, 2013). Both patents and trade marks can increase investors' estimates of a start-up's value (Block et al., 2014; Hsu & Ziedonis, 2013).

We re-estimated our baseline models, focusing only on newly established firms and assessing their growth over the 3 years following their establishment. Full details of the methodology and results are available in Appendix B.6.2. Newly established SMEs who file for at least one IP right in their first year are approximately twice as likely as those who file for no IP rights in their first year to experience high turnover and employment growth. The finding reinforces the value of IP data for targeting support at small and new firms with high growth potential.

3.3 The relationship between IP rights and firm size

To provide an understanding of the potential economic significance of the results reported so far, we estimated the effect of a firm having active patents, trade marks and design rights on its employment, measured as its number of full time equivalent employees, after accounting for factors such as the firm's size and total assets.

Table 3.1. Determinants of employment

Variables	Fixed effects
Prior IP right filer	.62***
Log of size (employment) at t-3	.32***
Total assets	.01***
Patents in force	0.03***
Trade marks in force	0.13***
Active (registered) designs	0.05***
Sector dummies	Omitted °
Year dummies	Yes °
<hr/>	
Number of observations	7 656 571
Number of groups	1 496 719
R ² (overall)	0.4946

Notes:

* = significant at the 10 per cent level; ** = significant at the 5 per cent level; *** = significant at the 1 per cent level.

° Industry and year dummy variables were included in the analysis as control variables. In order to maintain readability, these are not included in the table. The estimated coefficients for industry dummy variables in fixed effects models are omitted because of no within-group variance.

The key explanatory variables are a binary variable indicating whether an SME filed any type of right in a given year, the firm's number of active (registered) design rights, its patents in force and its trade marks in force in a given year. In addition to these variables, we include a set of year and business dummy variables and a random term to capture the sum of all other factors that affect employment. Firm performance is likely to be a function not only of observable characteristics but also of time-invariant firm-specific differences such as differences in capability. We account for these unobserved firm-specific effects using a fixed effects estimator.

Table 3.1 presents the results estimated via a fixed effects (within) estimator on the full sample of SMEs. Based on the results we found that the coefficients on patents in force, trade marks in force and active designs rights to be positive and significant, with the coefficient on trade marks in force substantially greater in magnitude than for patents and design rights.

If we mechanically apply the estimates in Table 3.1 to our data, we can estimate the effect of having one more of a given right on employment, all else being equal. These estimates, presented in Table 3.2, suggest that for a small firm with 2 employees, increasing its number of trade marks from one to 2 will increase its number of employees by 13% (or 0.3 full time equivalent employees). The expected increase in employment rises to an increase by 19 employees for a medium firm with 150 employees. Patents and design rights are estimated to have significant positive near-term effects on employment that are lower in magnitude than in the case of trade marks.

Table 3.2: Simulation of the employment effect of an additional right, for given values of employment and stocks of patents in force, trade marks in force and active (registered) design rights

Firm size (FTE employees)	Stock of the focal right	Marginal effect of a patent in force (FTE employees)	Marginal effect of a trade mark in force (FTE employees)	Marginal effect of an active design right (FTE employees)
2	1	0.1	0.3	0.1
20	1	0.7	2.5	0.9
50	1	1.7	6.3	2.3
100	1	3.3	12.7	4.6
150	1	5.0	19.0	6.9
2	2	0.0	0.1	0.0
20	2	0.3	1.3	0.5
50	2	0.8	3.2	1.1
100	2	1.7	6.3	2.3
150	2	2.5	9.5	3.4
2	10	0.0	0.0	0.0
20	10	0.1	0.3	0.1
50	10	0.2	0.6	0.2
100	10	0.3	1.3	0.5
150	10	0.5	1.9	0.7

The larger a firm is, the greater the marginal benefit it is likely to derive from having an additional right. Conversely, the greater a firm's stock of a given right is, the smaller the marginal benefit that it is likely to derive from having an additional right. The annual increase to employment from an additional trade mark ranges from 2.5 for a firm with 20 employees with one existing trade mark to 0.3 for the same firm with 10 trade marks.

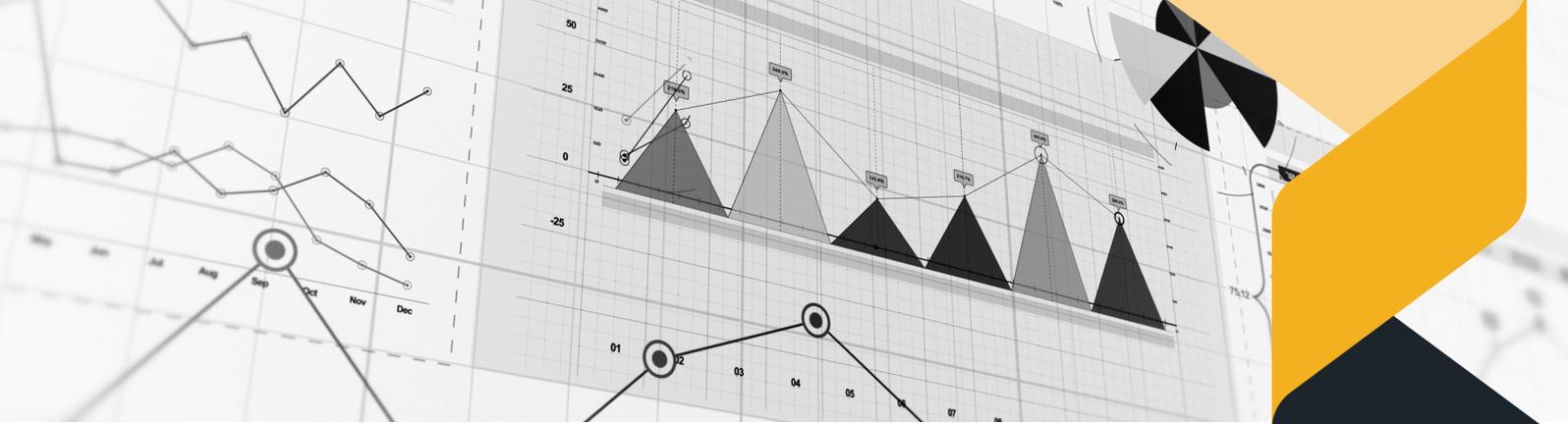


4. CONCLUSION

This study examines the characteristics of SMEs with and without IP rights, and the association between SME growth and prior IP right filing activities in Australia. Both the number and proportion of Australian SMEs owning IP rights doubled from 2001-02 to 2016-17. On average, SMEs with IP rights tend to be larger, older and more remunerative to employees than SMEs without IP rights, though the within-firm distribution of wages is a subject for further research.

Econometric analysis reveals that SMEs including start-ups that have filed for IP rights are more likely to achieve high growth over the near-term, especially if they have filed for trade marks. The results further indicate that SMEs who file for all the three types of IP rights (patents, trade marks and design rights) are the most likely to achieve high growth, relative to their peers that don't file or that file for narrower sets of rights. These results highlight the existing complementarity between different categories of IP rights and the relevance for SMEs of combining patents, trade marks and designs to more effectively support the high growth of their business.

The results are of particular relevance to policy makers, potential investors and business partners who wish to identify firms at an early stage in their development but which have high growth potential. IP data is openly available and provides a rich source of information to identify such firms.



APPENDIX A: DATA

This study uses data in the Business Longitudinal Analysis Data Environment (BLADE) – a collection of business level datasets managed by the Australian Bureau of Statistics (ABS). The data are sourced from the Australian Taxation Office (ATO) and other Australian Government departments and agencies. At the core of BLADE are the ATO’s Business Activity Statement (BAS), Pay As You Go (PAYG), and Business Income Tax data. The version of BLADE used for this study contains information from fiscal year 2002 to 2017.

Business Activity Statements are submitted to the ATO by businesses to report their Goods and Services Tax (GST) obligations. The BLADE data items include total sales, other GST free sales, non capital purchases, capital purchases, export sales, wages and salaries. Employing businesses are responsible for collecting the personal income tax obligations of their employees and providing employees with an annual payment summary at the end of each fiscal year. They report this information to the ATO through a PAYG statement or Single Touch Payroll system.

Business Income Taxation (BIT) forms are submitted to the ATO by businesses to report taxable income or loss. There are four main types of businesses that report annual income tax; companies, trusts and beneficiaries, partnerships and partners, and sole traders. The majority of items reported across the four different types of BIT forms are similar, such as income, expenses, profit or loss, sales, total and current assets, and total and current liabilities. However, the level of detail required can be quite different.

The current study uses the core ATO data integrated at the firm-level with longitudinal data on the IP filing activity of Australian firms. The IP data is provided by the Intellectual Property Longitudinal Research Dataset (IPLORD), which provides an annual snapshot of the stocks and flows of registrable IP rights for Australian and international applicants since 1998 onwards. IPLORD was built from the Intellectual Property Government Open Data (IPGOD), which contains over 100 years of application-level data on patents, trade marks, designs and plant breeder's rights administered by IP Australia.¹⁰ IPLORD systematically transforms all the application information in IPGOD into derived variables to track each applicant’s IP activity over time. There are two versions of IPLORD. The public version is available on data.gov.au, the Australian Government’s open data platform. The BLADE version of IPLORD is a subset of this that excludes private and international applicants that do not have an Australian business number (ABN). By linking financial and IP information about businesses, the BLADE IPLORD dataset provides an evidence base of high granularity for IP related economic analysis with the potential to yield valuable insights into the impact of IP on Australian businesses.

In BLADE, the basic unit of observation is the Type of Activity Unit (TAU). The majority of TAUs have a one to one relationship with businesses who have a unique ABN. However, for large and diverse businesses with complex structures, the TAU is structured to represent a grouping of one or more businesses within an Enterprise Group (EG), that with that grouping covering the operations of the corporation within a given industry sub division and for which a basic set of financial, production and employment data can be reported.

¹⁰ Visit <<https://www.ipaustralia.gov.au/about-us/data-and-research/ip-government-open-data>>.

In the BLADE version of IPLORD, an average of 3.9 per cent of the total annual observations are duplicates, which may be caused by two sources. The first comes from the input of dataset duplicates caused by the same ABNs having multiple observations in the IPLORD dataset for a given year; these will appear in the final BLADE version of IPLORD as multiple observations. The second type of duplicate is caused by a matching process. Some businesses in IPLORD match to more than one TAU identifier during data integration and these will remain as duplicates in the BLADE version of IPLORD. Duplicates in IPLORD were treated and dropped prior to integration with the core business datasets in BLADE. The detailed integration methodology can be obtained upon request.



APPENDIX B: ECONOMETRIC MODELLING

The chapter describes the econometric modelling, including the construction of measures, and presents descriptive statistics for the main variables and the key estimation results.

B.1 Dependent variable

A central aim of this study is to analyse the relationship between the filing of IP rights and SME growth. Therefore, the dependent variable of the models needs to be an indicator of business growth. Following prior literature (Eurostat 2007; Majeed et al 2018; EPO and EUIPO 2019), this study uses annual data on turnover (revenue) and employment (number of full time equivalent employees) to measure an SME's growth rate.

The dependent variables used in modelling positive growth are binary variables which take a value of one if an SME achieved a growth rate for employment or turnover (depending on the model) greater than 0% over 3 consecutive years, and which equals zero otherwise. High growth is defined as annual average growth in employment or turnover (depending on the model) greater than 20% over 3 consecutive years.

The models are estimated to predict the probability of a positive outcome – i.e., observing high growth or positive growth – for SMEs who filed for a given set of IP rights in a year, relative to the probability of an SME that filed for no IP rights that year achieving the same outcome. As the dependent variables are binary, a logistic regression model is appropriate to estimate the relationship between prior IP right applications and the likelihood of a growth outcome. For a binary dependent variable, the probability that it takes a value of one is defined as P . Logistic regression focuses on modelling $\text{logit}(P)$, which equals the natural logarithm of $P/(1-P)$. Logistic regression describes the logarithm of odds that the dependent variable takes a value of one (positive/high growth) as a function of the values of the predictors as illustrated in equation (1) (Jaccard, 2001):

$$\text{logit}(P) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k \quad (1)$$

The essence of odds is the comparison of probability of a positive event with the probability of the alternative outcome as in equation (2):

$$\text{Odds} = P/(1 - P) \quad (2)$$

where P is a probability of an event.

If the probability of the event equals 0.5, associated odds of positive outcome will be exactly the same as the probability of a negative outcome, hence the odds for positive outcome equal one. Table B.1 illustrates the relationship between probability and odds.

Table B.1: Relationship between probability and odds

Probability	Odds
0.1	0.11
0.25	0.33
0.5	1
0.67	2

In this study, the results of logistic regression estimation are presented focusing on the focal IP right variables, which are also dichotomous; taking a value of one if an SME applied for any IP right in a year and zero if a firm did not apply for IP right protection in that year. The exponent of the coefficient of the dichotomous IP right variable is equivalent to the estimated odds ratio (OR), as shown in equation (3):

$$OR = \frac{\text{(odds of achieving high growth for IPR applicants)}}{\text{(odds for achieving high growth for SMEs not applying for IPR)}} \quad (3)$$

where OR is the odds ratio estimated by the logistic regression.

The logistic regressions allow for the estimation of odds ratios of achieving positive or high growth of IP right applicants compared with other SMEs, controlling for other important aspects that may play a role in the propensity to achieve positive or high growth such as a firm's initial level of turnover or employment, industry affiliation and year. Additionally, this regression approach allows an estimate to be made of the statistical significance of the results.

B.2 Explanatory variables

We seek to relate differences between SMEs in their turnover and employment growth to a set of explanatory variables, which fall into two main categories:

1) A set of variables that measure a firm's IP rights filing activity

We measure a firm's IP filing activity using binary indicators that take the value one if an SME files for a given registrable IP right (patent, trade mark or design right) in a given year, and zero otherwise. To estimate the effects of various IP right bundles, we include a set of seven dummy variables which indicate whether or not an SME files for a specific combination of IP rights in a given year:

- **Patents only:** takes the value 1 if an SME files for patents but no other type of IP right, and 0 otherwise.
- **Trade marks only:** takes the value 1 if an SME files for trade marks but no other type of IP right, and 0 otherwise.
- **Designs only:** takes the value 1 if an SME files for design rights but no other type of IP right, and 0 otherwise.
- **Patents and trade marks:** takes the value 1 if an SME files for at least one patent and one trade mark but not design, and 0 otherwise.
- **Patents and designs:** takes the value 1 if an SME files for at least one patent and one design but not trade mark, and 0 otherwise.
- **Trade marks and designs:** takes the value 1 if an SME files for at least one trade mark and one design but not patent, and 0 otherwise.
- **Patents, trade marks and designs:** takes the value 1 if an SME files for all three types of IP rights, and 0 otherwise.

2) In addition, a set of control variables that measure or control for non IP right factors affecting business growth need to be included when analysing the relationship between SME growth and IP right filing. These include:

- **Initial level of turnover or employment:** controls different initial levels of an SME's turnover or employment in a given year.
- **Age:** indicates the age of an SME in a given year, which is equal to the survey year minus the starting year.
- **Year dummies:** a set of dummy variables which equals 1 for a given fiscal year and 0 for all other years. It allows control for year specific fixed effects, i.e. shocks whose impact is restricted to a given year period and which are not controlled by other explanatory variables. As there are a total of 16 fiscal years, only 15 such year dummies are included in the model.
- **Industry dummies:** there are 18 industry dummies out of the total 19 ANZSIC industry divisions with Agriculture, Forestry and Fishing set as the base industry for comparison.

B.3 Econometric modelling

Logistic regression is used to predict the relationship between explanatory variables and a predicted variable (the dependent variable). Our estimation model, in the basic linear logistic form, is expressed as follows:

$$\text{Logit}(B)_{i,t} = \alpha + \beta IP_{i,t-3} + \gamma TE_{i,t-3} + \theta A_{i,t-3} + \delta X_{i,t} + \epsilon_{i,t} \quad (\text{Equation 4})$$

where the dependent variable is a binary variable which equals 1 if an SME achieves a given growth outcome and which equals zero otherwise. Our key explanatory variable, IP, takes two forms: in the first form, this is a binary indicator equal to one if an SME filed for any IP right (patent, trade mark or design) in a given year, and zero otherwise; in the second form, IP is a binary indicator denoting whether an SME filed for a particular IP bundle in a given year.

The term TE refers to two firm-level measures, the logarithm of a firm's turnover and the logarithm of a firm's employment, which are used interchangeably depending on what is used to capture initial conditions. The term A is the firm's business age at the start of the three-period when the growth outcome was measured, while the term $X_{i,t}$ contains a set of control variables such as industry and year dummies. Subscript i refers to an individual SME, while t refers to a given year and $t-3$ refers to 3 years ago before a given year in the dataset.

The coefficient α is a constant term and ϵ is an error term, while β , γ , θ , and δ are sets of estimated coefficients for explanatory variables. The basic model assumes that an SME's growth potential is a function of, or mainly determined by, its initial business turnover or employment level, business age, IP right filing activity, and other business, industry and time effects.

Firm fixed effects are included in the models. These help to control for unobserved time-invariant factors that may influence a firm's likelihood of achieving growth (e.g., its managerial posture). Even after including the fixed effects, we only control for unobserved sources of heterogeneity that are time-invariant. The models may still suffer the omitted variable problem due to the influence of time-variant unobserved factors, such as new innovation not captured by registrable IP rights.

In certain cases, unobserved time-invariant variables will have no impact on the dependent variable, while in other cases they will have an impact. In the former case a random effects model is preferable and offers more accurate estimates than the fixed effects model. We use the Hausman test to determine whether a fixed or random effects is better suited to estimating the data.¹¹ Our results from the Hausman tests have consistently favoured fixed effects. However, a fixed effects model still suffers from sample attrition issues as it requires within-subject variability in the dependent variable. Therefore, some groups of observations will be dropped due to all positive or all negative outcomes.

¹¹ For details of choosing fixed or random effects models, please refer to <https://www3.nd.edu/~rwilliam/stats3/Panel04-FixedVsRandom.pdf>.

B.4 Descriptive statistics

The dataset used for the regression analysis consists of approximately ten million observations.¹² The basic descriptive statistics for the main variables are shown in Table A.1. The mean value of the logarithm of turnover is 13.0947, while the mean value of the logarithm of employment is 0.6342.

Figure B.1 presents a simple statistical comparison between the share of filers and non-filers of IP rights who achieved positive turnover growth (left panel) or high turnover growth (right panel). Based on the sample data, 51% of SMEs who file for (any type of) IP rights achieve positive turnover growth, compared to 25% of SMEs who file for no rights. Similarly, a higher share (16%) of SMEs who file for IP rights achieve high turnover growth, more than double the share of SMEs who file for no rights (7%).

A similar result is found looking at employment growth, as illustrated in Figure B.2. Based on our data, 53% of SMEs that file for any IP rights achieve positive employment growth, compared to 25% of SMEs that file for no rights. Similarly, 16% of SMEs who file for IP rights achieve high employment growth, compared to 16% of SMEs that file for no rights.

Table B.2 Descriptive statistics of main variables

Variable	Observations	Mean	Std. dev.	Min	Max
Dummy variable for filers of:					
any IP rights	N = 10 246 078	0.0051	0.0712	0.00	1.00
patents only	N = 10 246 078	0.0002	0.0164	0.00	1.00
trade marks only	N = 10 246 078	0.0045	0.0667	0.00	1.00
designs only	N = 10 246 078	0.0002	0.0123	0.00	1.00
patents and trade marks	N = 10 246 078	0.0001	0.0095	0.00	1.00
patents and designs	N = 10 246 078	0.00002	0.0042	0.00	1.00
designs and trade marks	N = 10 246 078	0.0001	0.0091	0.00	1.00
patents, trade marks and designs	N = 10 246 078	0.00002	0.0046	0.00	1.00
Dummy variable for being a:					
positive turnover growth SME	N = 10 246 078	0.2533	0.4349	0.00	1.00
high turnover growth SME	N = 10 246 078	0.0691	0.2539	0.00	1.00
positive employment growth SME	N = 10 246 078	0.2547	0.4357	0.00	1.00
high employment growth SME	N = 10 246 078	0.0772	0.2669	0.00	1.00
Variable	Observations	Mean	Std. dev.	Value at 10% percentile	Value at 90% percentile
Log of turnover (t-3)	N = 10 246 078	13.0947	1.4893	11.4234	14.9566
Log of employment (t-3)	N = 10 246 078	0.6342	1.3937	-1.0018	2.3948
Log of business age (t-3)	N = 10 111 021	1.8155	0.8159	0.6931	2.7726

Source: ABS BLADE (2016-17 frame). For continuous variables, we are not allowed to report the maximum and the minimum due to data regulations, instead we reported the values at 10% and 90% percentiles.

Given the ratios shown in Figures B.1 and B.2, we can calculate the odds ratio of a high growth period for SME rights filers as compared with other SMEs. For example, the odds ratio of SMEs that have filed for IP rights achieving high turnover growth is 2.3. The odds ratio for SMEs who file for IP rights to achieve positive turnover growth is 2.¹³ Ratios above 1 indicate a higher probability of observing a high growth potential.

¹² Only SMEs who reported turnover and employment during the period from 2001 02 to 2016 17 were kept in the dataset.

¹³ Please refer to Appendix B for more detailed explanation.

These odds ratios implicitly assume that the presence of IP rights is the only independent variable. However, clearly there are other factors such as initial turnover level, business age, and industry characteristics are likely to play a role in determining a firm's growth. Therefore, we estimate fixed and random effects logistic regressions to allow for the estimation of odds ratios of achieving high or positive growth of IP right applicants compared with other SMEs, controlling for other important factors that may also play a role in the propensity to achieve (high) growth.

Figure B.1. Share of SMEs that achieve positive turnover growth (left panel) or high turnover growth (right panel), by IP rights filing status

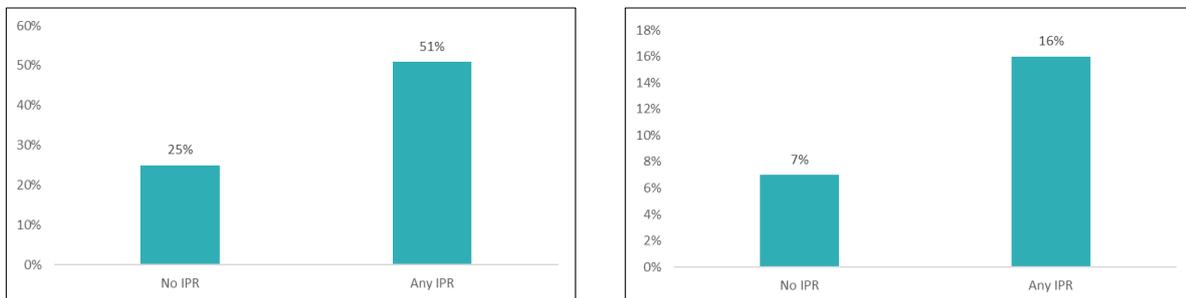
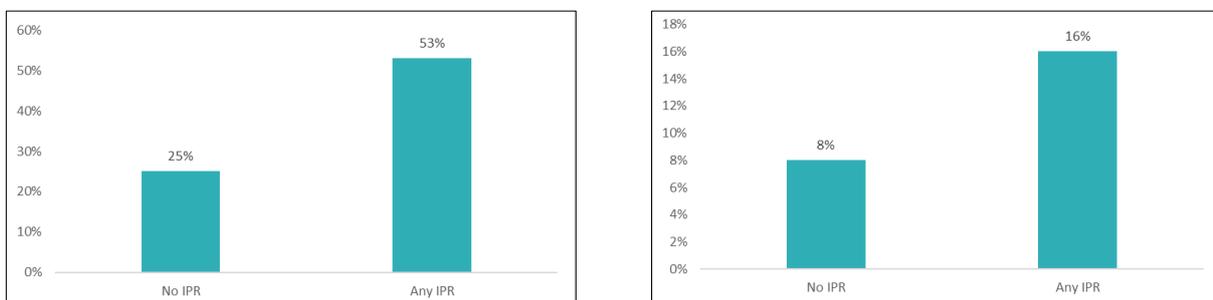


Figure B.2: Share of SMEs that achieve positive employment growth (left panel) or high employment growth (right panel), by IP rights filing status



B.5 Results of econometric models

B.5.1 Regression results on turnover growth

The regression results are reported in following tables. Table B.3 presents results relating to whether an SME that files an IP right has a statistically higher probability to achieve positive or high growth in terms of turnover, relative to its peers that don't file, estimated using fixed and random effects models.

Table B.3 presents results relating to whether an SME that files for a different category or combination of IP rights has a statistically higher probability to achieve positive or high growth in terms of turnover, relative to its peers that don't file, estimated using fixed and random effects models.

Table B.3: Results of fixed and random-effect models focusing on differences with or without an IP right prior application on turnover growth

Turnover growth	Fixed effects		Random effects	
	Positive growth	High growth	Positive growth	High growth
Prior IP right filer	1.10***	1.10***	1.57***	2.02***
Log of size (turnover or employment) at t-3	.02***	.03***	.62***	.25***
Log of age at t-3	.77***	.75***	.56***	.30***
Sector dummies	Omitted °	Omitted °	Yes °	Yes °
Year dummies	Yes °	Yes °	Yes °	Yes °
Number of observations	4 197 312	2 354 024	5 156 025	5 156 025
Number of groups	597 835	353 717	1 025 981	1 025 981
Hausman test	408462.52***	165724.33***		

Notes:

* = significant at the 10 per cent level; ** = significant at the 5 per cent level; *** = significant at the 1 per cent level.

° Industry and year dummy variables were included in the analysis as control variables. In order to maintain readability, these are not included in the table. The estimated coefficients for industry dummy variables in fixed effects models are omitted because of no within-group variance.

Table B.4: Results on differences filing for a different bundle or combination of IP rights

Turnover growth	Fixed effects		Random effects	
	Positive growth	High growth	Positive growth	High growth
Patents only	.95	.96	1.38***	1.84***
Trade marks only	1.11***	1.13***	1.58***	2.03***
Designs only	.99	.82	1.40***	1.59***
Patents and trade marks	.99	1.05	1.59***	2.30***
Patents and designs	.92	.80	1.95***	1.77*
Trade marks and designs	1.07	1.28	1.72***	2.52***
Patents, trade marks and designs	1.03	3.35***	2.08***	7.06***
Log of size (turnover or employment) at t-3	.02***	.03***	.62***	.25***
Log of age at t-3	.77***	.75***	.56***	.30***
Sector dummies	Omitted °	Omitted °	Yes °	Yes °
Year dummies	Yes °	Yes °	Yes °	Yes °
Number of observations	4 197 312	2 354 024	5 156 025	5 156 025
Number of groups	597 835	353 717	1 025 981	1 025 981
Hausman test	408469.11***	165769.98***		

Notes:

* = significant at the 10 per cent level; ** = significant at the 5 per cent level; *** = significant at the 1 per cent level.

° Industry and year dummy variables were included in the analysis as control variables. In order to maintain readability, these are not included in the table. The estimated coefficients for industry dummy variables in fixed effects models are omitted because of no within-group variance.

Table B.5: Results of random-effect models focusing on differences with or without an IP right prior application on employment growth

Employment growth	Fixed effects		Random effects	
	Positive growth	High growth	Positive growth	High growth
Prior IP right filer	1.07***	1.16***	1.57***	2.08***
Log of size (turnover or employment) at t-3	.03***	.02***	.54***	.12***
Log of age at t-3	.79***	1.03***	.62***	.39***
Sector dummies	Omitted °	Omitted °	Yes °	Yes °
Year dummies	Yes °	Yes °	Yes °	Yes °
Number of observations	4 236 936	2 602 657	5 156 025	5 156 025
Number of groups	606 788	388 465	1 025 981	1 025 981
Hausman test	378302.47***	154430.02***		

Notes:

* = significant at the 10 per cent level; ** = significant at the 5 per cent level; *** = significant at the 1 per cent level.

° Industry and year dummy variables were included in the analysis as control variables. In order to maintain readability, these are not included in the table. The estimated coefficients for industry dummy variables in fixed effects models are omitted because of no within-group variance.

Table B.6: Results on differences filing for a different bundle or combination of IP rights

Employment	Fixed effects		Random effects	
	Positive growth	High growth	Positive growth	High growth
Patents only	.94	.82*	1.43***	1.88***
Trade marks only	1.09***	1.18***	1.58***	2.07***
Designs only	.94	1.11	1.38***	1.77***
Patents and trade marks	1.03	1.26	1.75***	3.08***
Patents and designs	.70*	0.99	1.32	2.57***
Trade marks and designs	1.15	1.40*	2.10***	3.32***
Patents, trade marks and designs	1.40	1.91*	2.74***	5.37***
Log of size (turnover or employment) at t-3	.03***	.02***	.54***	.12***
Log of age at t-3	.79***	1.03***	.62***	.39***
Sector dummies	Omitted °	Omitted °	Yes °	Yes °
Year dummies	Yes °	Yes °	Yes °	Yes °
Number of observations	4 236 936	2 602 657	5 156 025	5 156 025
Number of groups	606 788	388 465	1 025 981	1 025 981
Hausman test	378285.71***	154464.85***		

Notes:

* = significant at the 10 per cent level; ** = significant at the 5 per cent level; *** = significant at the 1 per cent level.

° Industry and year dummy variables were included in the analysis as control variables. In order to maintain readability, these are not included in the table. The estimated coefficients for industry dummy variables in fixed effects models are omitted because of no within-group variance.

B.5.2 Regression results on employment growth

The estimation results for employment growth are reported in the next set of tables. Table B.5 presents results relating to whether an SME that files an IP right has a statistically higher probability to achieve positive or high growth in terms of employment, relative to its peers that don't file, estimated using fixed and random effects models.

B.6 Sensitivity tests

B.6.1 Length of spell over which high growth is sustained following IP rights filing activity

In Table B.6 we report estimation results from varying our baseline model (Equation 4) by extending the period over which high growth is measured, from 3 years to 4 years (2nd and 3rd column), and to 5 years (4th and 5th columns). The positive statistical significance of IP right filing activity on the likelihood of predicting SME high growth disappears for growth spells of over 4 years.

Table B.6: Estimation results of fixed-effect models testing the effects of IP right filing activity on high growth spells extending to 4 and 5 years

Fixed effects	High growth episode of 4 years		High growth episode of 5 years	
	Turnover	Employment	Turnover	Employment
Prior IP right filer	1.12***	1.14***	1.05	1.05
Log of initial size (turnover or employment)	.02***	.01***	.01***	.01***
Log of initial age	.87***	1.08***	.87***	1.03
Sector dummies	Omitted °	Omitted °	Omitted °	Omitted °
Year dummies	Yes °	Yes °	Yes °	Yes °
Number of observations	1 522 602	1 736 244	984 662	1 165 437
Number of groups	238 119	268 770	162 275	189 931

Notes:

* = significant at the 10 per cent level; ** = significant at the 5 per cent level; *** = significant at the 1 per cent level.

° Industry and year dummy variables were included in the analysis as control variables. In order to maintain readability, these are not included in the table. The estimated coefficients for industry dummy variables in fixed effects models are omitted because of no within-group variance.

B.6.2 Regression results for SME start-ups

To test the impact of IP filing activity on newly established SMEs, the dataset is reduced to SMEs that were newly established in the dataset after 2001. A logit model similar to Equation (4) is estimated as follows:

$$\text{Logit}(B)_{i,t} = \alpha + \beta \text{IP}_{i,t-3} + \gamma \text{TE}_{i,t-3} + \delta \text{D}_{i,t} + \epsilon_{i,t} \quad (\text{Equation 5})$$

where the dependent variable B is the same binary variable as in Equation (4) which equals to 1 if a firm achieves high growth and which equals zero otherwise. The explanatory variables, IP and TE have the same definition as in Equation (4), while the term D contains only a set of industry dummies. A firm's initial age is excluded from the estimation equation as the age of each firm in this sample will be zero.

The basic model assumes that a start-up's growth potential is a function of its initial turnover or employment level and its IP right filing activity, controlling for other business and industry effects. As we do not have a panel data for new start-ups, we adopted logit regressions without fixed effects. Table B.7 reports results relating to whether a start-up that files for at least one IP right in its first year has a statistically higher probability to achieve positive or high growth in terms of turnover or employment, relative to its peers that don't file in their first year.

Table B.7: Results of logit models focusing on start-ups

	Turnover		Employment	
	Positive growth	High growth	Positive growth	High growth
Prior IP right filer	1.51***	2.02***	1.46***	1.92***
Log of size (turnover or employment) at t-3	.65***	.52***	.69***	.50***
Sector dummies	Yes°	Yes°	Yes°	Yes°
Number of observations	268 664	268 664	268 664	268 664

Notes:

* = significant at the 10 per cent level; ** = significant at the 5 per cent level; *** = significant at the 1 per cent level.

° Industry dummy variables were included in the analysis as control variables. In order to maintain readability, these are not included in the table.

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