Received: 16 December 2021 | Revised: 5 March 2023 | Accepted: 10 March 2023

DOI: 10.1111/aehr.12263

ORIGINAL ARTICLE

Asia-Pacific Economic History Review
A JOURNAL OF ECONOMIC, BUSINESS & SOCIAL HISTORY

WILEY

The growth of patenting in New Zealand, 1860–99

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Abstract

Patent applications by male New Zealand inventors sharply increased in the early 1880s after initial official fees were reduced, and the requirement to advertise applications in newspapers abolished. Increasingly, however, applications lapsed, while applications by unskilled workers remained low. Non-fee costs were crucially important, with the 1870 reduction in fees failing to increase patenting, as hoped, because the doubling of mandatory advertising costs negated the fees reduction. Patenting by overseas inventors was less affected by fees, and steadily grew. Only one application was by an indigenous Māori person, while even in 1899 women made just 2.5% of applications.

KEYWORDS

Granger causality, New Zealand patents, patent applications, patent costs

JEL CLASSIFICATION

O31, O33, O34, N17

INTRODUCTION

This article examines the growth in patenting in New Zealand between 1860 and 1899 using new unit record data on all 12,283 patent applications. In addition to collecting data on official applications, sealing and renewal fees for each patent, compulsory newspaper advertising costs

for pre-1884 applications have been imputed. This enables us to consider not just how official fees limited patenting, but also the extent to which the cost of required advertising for patent applications, which at times exceeded official fees, was an obstacle to patenting.

New Zealand patent applications, as in Britain and other British Australasian self-governing colonies, but unlike the United States and some other patent systems (Sarada et al., 2019, p. 3), included the occupation of inventors. We are therefore able to examine the level of patenting by people from different occupational groups, and also make comparisons with census data on the occupations of New Zealand adults. The names of patentees, Patent Office annual reports, and newspaper articles have been used to identify the gender of patentees, whether they were a member of New Zealand's indigenous Māori population, and if they were a migrant from China. This data enables us to consider the extent to which women, Māori, and Chinese migrants used New Zealand's patenting system.

Our research questions are therefore: *What effect did reductions in patenting costs have on the level of patenting? Furthermore, were high* per capita *patenting rates by the 1890s associated with high patenting by a variety of occupational groups, by women, by indigenous* Māori *people, and by Chinese migrants?* In the research presented here we consider the growth in patenting in New Zealand in the mid to late nineteenth century from the perspective of the use of the patent system by inventors from different backgrounds.

These topics are important as patenting and invention in colonial New Zealand was taken seriously, with patenting regularly being reported on by newspapers (Auckland Star Reporter, 1896; Otago Daily Times Wellington correspondent, 1890; Press reporter, 1893). In the 1890s New Zealand considered itself to lead the world in terms of patent applications (Registrar Patents Office, 1890) and living standards (Greasley & Oxley, 2010b), and to be a society where people could advance themselves economically (Fairburn, 1989, p. 25). Admittedly if only complete patent specifications are counted, on a per capita basis New Zealand was behind Belgium, and patented at similar levels to Norway and Switzerland (Federico, 1964). However, despite its low population, New Zealand patent applications in London exceeded those from all except six foreign countries, and were greater than applications from any other British colony and possession except Victoria in Australia, Canada and India (Registrar Patents Office, 1890).

Several of our research questions have been examined using patent data from other countries, enabling us to make cross-country comparisons. Researchers have documented the higher rate of patenting by artisans and manufacturers in the United States than in Britain, where patent fees were higher and regulations more time-consuming (Khan & Sokoloff, 1998, pp. 304–305). Nevertheless, despite the comparative democratisation of patenting in the United States (Khan, 2005), patentees were disproportionately old, white, and male (Sarada et al., 2019).

In Britain, Nicholas found that the 1884 reduction in initial patent fees increased patent applications by more than 250%. Nevertheless, in his sample, the geographic location of patentees; the proportion of patents by corporate entities; the sectors patented; and the proportion of full-term patents were similar. The number of citations to English inventor patents in the United States also showed little response to such changes, implying innovation had not increased (Nicholas, 2011, pp. 326, 334, 337). Using a larger dataset of all patent applications by British inventors between 1879 and 1888, however, Kuegler found high-quality patenting had increased and that a higher percentage of patenting was by inventors from less wealthy backgrounds (Kuegler, 2015, pp. 2, 14, 21).

Data for Australia shows a large jump in patenting in Victoria following the 'massive reduction' in patent fees from 1885, although this effect was much larger for patentees living in Victoria than for those living elsewhere. (Magee, 2000, pp. 18, 35, 96–99). However, changes in

the number of lapsed patents and in expenditure on patents were not considered. Summary data on lapsed patents in Australian patent systems before Federation have been compiled (Easthope, 1992), but has not been systematically analysed and evaluated. Our comprehensive data from New Zealand therefore provides insights into how lower patent application fees, and also other costs, affected patenting activity in an Australasian patenting system. The methods we use could potentially be applied to similar patent systems in other countries in the future.

We first outline New Zealand patent legislation from 1860 to provide and locate a priori dates of interest and calculate the estimated cost of patenting in New Zealand between 1860 and 1899. Then we consider changes in the total number of applications, how this was affected by changes in patenting costs, and the extent to which reductions in initial costs for patent applications during the early 1880s made patenting accessible to a wide range of occupational groups. The effect of variations in the proportion of lapsed and renewed patents on total investment in patents is also discussed. The occupations of patentees are then compared to equivalent data for Victoria, which like New Zealand was a self-governing British colony, and also to 1886 census data on New Zealand males. Then patenting by women is quantified to investigate the extent to which they were using the patent system. Similar analysis for New Zealand's indigenous Māori population and for Chinese immigrants is then made.

PATENT LEGISLATION AND COSTS

The purpose of patents is to ensure innovation and invention are fairly rewarded and protected, and to increase incentives for inventors by increasing their profits. Although counter arguments exist (Boldrin et al., 2008), patents are assumed to stimulate economic growth by ensuring that, in exchange for a temporary monopoly, knowledge and inventions are recorded, and on expiry of the patent become available to others (Auger, 1992, p. 10; Dutton, 1984, pp. 17–22).

New Zealand was a self-governing British colony from 1852. Settlers were overwhelming from the British Isles, or descended from people from Britain who had migrated to its colonial offshoots, and were proud of their close cultural ties to Britain (Belich, 2007, pp. 279, 299, 446). Over 90% of New Zealand's exports went to Britain and Australia (Briggs, 2007). After the first successful shipment of frozen meat to Britain in 1882, growth of first frozen meat, then also dairy products, produced both sustained economic growth and high economic dependence on Britain (Greasley & Oxley, 2009, p. 326). As a result of strong political, legal, cultural and economic links, New Zealand's 1860 *Patents Act* was based upon legislation in Britain and in the British colony of Victoria in Australia (Southern Cross Reporter, 1860, p. 3; Evening Star editor, 1881, p. 1).

As Table 1 shows, under New Zealand's 1860 *Patents Act* applicants paid 10 pounds for a 14-year term. However, the requirement to advertise applications in the Government *Gazette* and newspapers throughout New Zealand, to allow for objections to be filed, considerably increased the cost. Overseas inventors could instead pay 10 pounds for a letter of registration that extended existing overseas patent protection to New Zealand and were not required to advertise (New Zealand Government, 1860). Under the more detailed 1870 *Patents Act*, fees were lower for the initial application to allow inventors to test whether they could get a return on their invention, but higher for 14 years (Gisborne, 1870, p. 31). Advertising costs also doubled because two insertions of applications were now required in newspapers in the main centres (Gibbons, 2016, pp. 20–35).

TABLE 1 Fees for applying for and renewing a patent.

Act	1860	1870	1879	1881	1882	1883	1889
Into force	1861	1871	1880	1882	Sept 1882	1884	1890
On depositing specification	£10.0	£2/10	£2.00	£1.00	£0/10	£0/10	£0/10
On depositing revised specification						£0/10	£0/10[a]
On obtaining letters patent		£2/10	£2.00	£2.00	£2.00	£2.00	£2.00
Extending patent before 3rd year		£15.0	£10.0				
Extending patent before 4th year							£5.00
Extending patent before 5th year				£7.00	£7.00	£7.00	
Extending patent before 7th year							£10.00
Cost of taking to 14 years nominal	£10.0	£20.0	£14.0	£10.0	£9.5	£9.5 or £10.0	£17.5 or £18
Cost of taking to 14 years 1861 values (as decimal)	£10.0	£24.1	£20.25	£14.8	£14.2	£14.9 or £15.6	£29.0 or £29.9
Deposit for challenging	£10.0	£2/10	£2	£2	£2	£2	10s
Cost of revising	£10.0	£2/10	£2/10	£2/10	£2/10	£2/10	£1
Letters of registration	£10.0	£10.0	£10.0	£10.0	£10.0	£10.0	–

[a]Providing lodged provisional specification in first instance. If filed complete specification initially the cost of amending the specification was £1.00.

TABLE 2 Estimated total costs of taking out a patent in 1881 before the elimination of advertising requirements.

Expenses	Cost in pounds, shillings and pence
Local agent	5/0/0
Capital city agent	1/1/0
Telegrams and postage	0/4/2
Advertising application once in 10 newspapers	5/4/0
Cost of application and sealing patent	4/0/0
Miscellaneous expenses	0/3/0
Preparing specification and parchment	0/10/0
Total	16/8/8

Patent fees have been adjusted by the inflation index on the New Zealand Reserve Bank's website. Different inflation series produce similar results (Briggs, 2007, pp. 53–61). The cost of advertising patent applications between 1860 and 1884 has been modelled as staying the same in nominal terms. We collected considerable data on newspaper advertising rates from New Zealand's *Papers Past* website of digitalised newspapers. The high cost of advertising applications in newspapers, which as Table 2 shows was greater in 1881 than the combined fees for applying for and then sealing a patent for 3 years, seems to have slightly increased when papers

closed (Hastings, 2013, pp. 121, 157), decreased when new papers opened (Coleridge, 1995, p. 30), and usually stayed the same despite growing newspaper circulations. All the centres where patentees were required to advertise had competing newspapers. However, patentees generally advertised in relatively prestigious papers, and to promote their invention often included more details than the law required.

During the 1870s falling prices increased the real cost of patenting (Briggs, 2007, pp. 53–61), while there was growing concern in New Zealand that application fees and advertising costs dissuaded 'intelligent artisans' from patenting (Hutchison, 1879, p. 66). This paralleled debate in the United Kingdom and Britain's other Australasian self-governing colonies (Nicholas, 2011, p. 331; Magee, 2000, pp. 5–6). Legislation in 1879, 1881, 1882 and 1883 sharply reduced patent application fees (see Table 1), halved advertising requirements for applications from 1879, and then completely eliminated the need to advertise applications in newspapers from 1881 (New Zealand Government, 1879; New Zealand Government, 1881; Haselden, 1883, p. 7). Britain also reduced initial fees and administrative obstacles from 1884 (Kuegler, 2015, p. 7; MacLeod et al., 2003, pp. 555–557). Similarly, Victoria reduced initial fees from 1885 (Magee, 2000, pp. 17, 96), while also ending the requirement for patent applications to be advertised in newspapers (Age reporter, 1885, p. 7; Waters, 1881, p. 9; Victoria Government, 1865, pp. 61–62; Victoria Government, 1884, p. 8).

From 1884 the cost of a patent application in New Zealand was just the 10-shilling fee plus sixpence for the standard form. Table 1 shows that sealing an application for 5 years patent protection, which occurred after any objections had been turned down, cost another two pounds. Assistance from a patent agent could easily cost another two and a half pounds. However, some patentees filed applications without this help, sometimes for publicity reasons, that would not survive legal scrutiny (Galbraith, 1886, p. 4). To place these costs in context, in 1884 general labourers earned on average about seven shillings a day, and a gallon (3.75 L) of rum cost about 24 shillings. Furthermore, a cow cost three to seven pounds, a saddle horse about 12 pounds, and a draught horse about 20–30 pounds (Registrar General's Office, 1884, pp. 186–187).

The 1889 Act reversed the shift to lower fees, with renewal fees for a 14-year patent more than doubling in 1890 (New Zealand Government, 1889, p. 59). After the sharp increase in fees for a 14-year term in 1890, the inflation adjusted cost increased to about 30 pounds. This was almost 20 pounds higher than for patent fees in the 1860s, and reflected a focus by the government on retrenchment and improving its financial situation (Bassett, 1998, pp. 77–81). Interest in scientific research in New Zealand may have also been decreasing because membership of the main scientific organisation in New Zealand, whose membership included almost 40% of parliamentarians in the 1870s, fell to about half of its 1887 peak by 1900 (Nathan, 2015, pp. 162–163). As with earlier legislation, the 1889 Act was designed to be as similar as possible to legislation in Britain, subject to the 'different conditions of this colony' to facilitate patenting throughout the British Empire (Registrar Patents Office, 1890, p. 1).

PATENT APPLICATIONS, RENEWALS AND EXPENDITURE

Figure 1 shows that the total number of patent applications in New Zealand increased from single figures in the early 1860s, to peak at 1061 in 1897. The increase was fastest for people living in New Zealand. To control for New Zealand's fast-growing population, Figure 2 shows patent applications per capita by New Zealanders increased sharply from the early 1880s as lower patent fees and advertising requirements came into effect between 1880 and 1884.

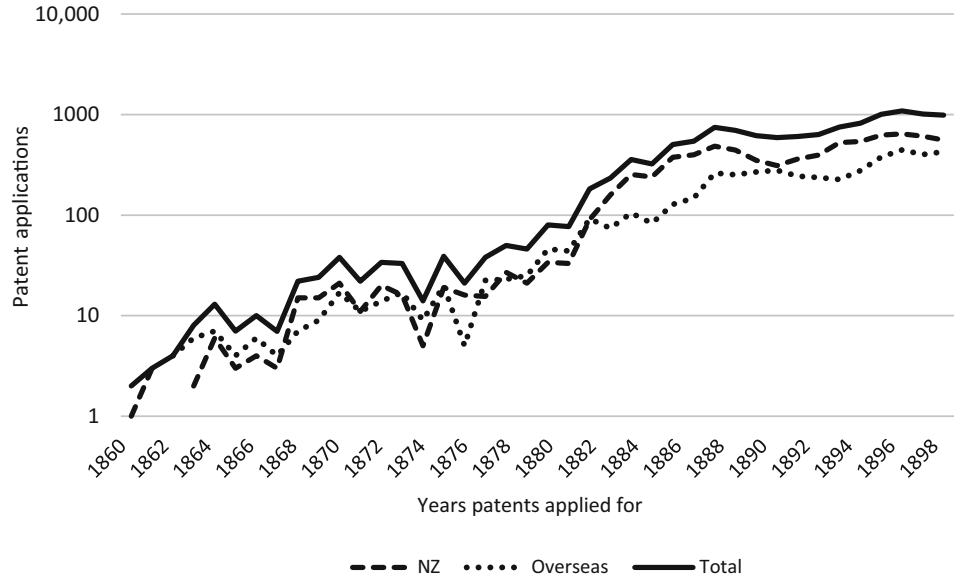

FIGURE 1 Patent applications by people living in New Zealand and overseas, 1860–1899.

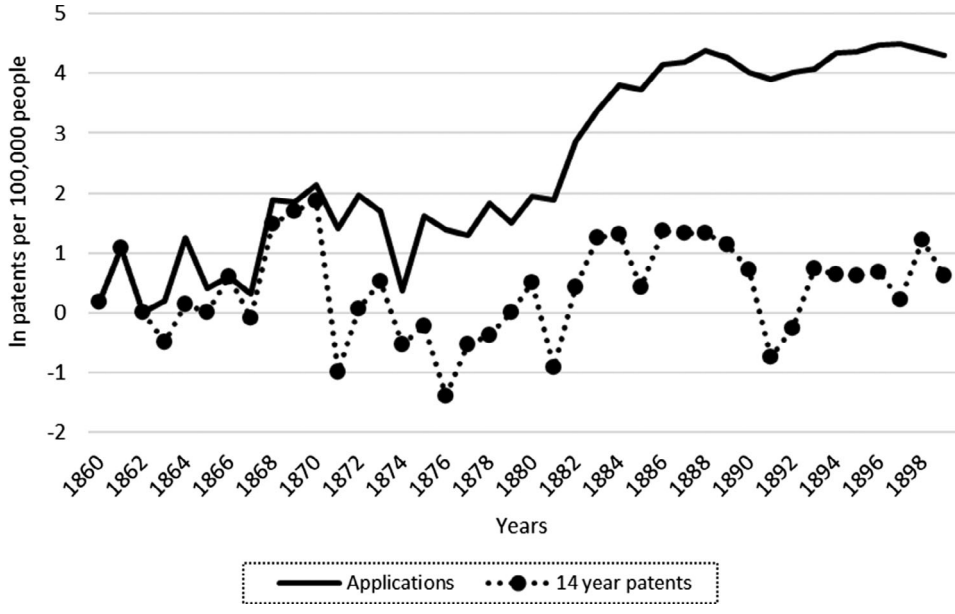

FIGURE 2 Log of patent applications and 14 year Patents By New Zealanders 100,000 people.

Indeed, patent applications by New Zealanders from 1884 were consistently more than seven times higher than in the late 1870s.

However, Figure 2 also shows that growth in patent applications per capita by New Zealanders between 1860 and 1899 was not matched by a similar increase in the number of patents by New Zealanders that were in existence for 14 years. The sharp increase in applications per capita in the early 1880s coincided with an increase in 14-year patents. However, by 1884 the growth in

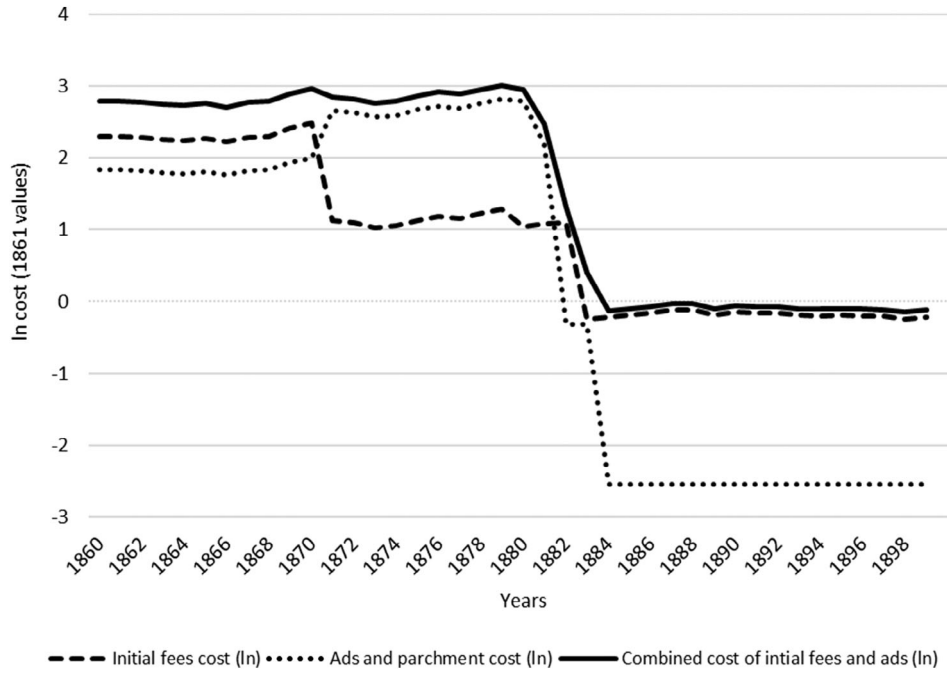

FIGURE 3 Log of initial fees cost and of newspaper ads and parchment or official from in 1861 values.

14-year patents per capita by New Zealanders had ended, whereas applications continued to trend upwards until declining slightly between 1888 and 1891.

The effects of patent fees and other compulsory costs on patenting by people living in New Zealand are now considered. We focus on modelling the effect of changes on patent fees on patenting by New Zealanders because those living overseas paid the same nominal amount until 1890.

Figure 3 shows that in 1870 the initial fees cost and required advertising costs moved in opposite directions, resulting in the combined total cost of patenting (the top line) staying the same. This helps explain why reductions in patent application fees from 1870 did not result in the intended increase in applications. Then in the early 1880s both patent application fees and required advertising costs fell, resulting in a dramatic decline in initial patenting costs. Since the changes in patenting costs in New Zealand took place over several years in the early 1880s our modelling is always a simplification of reality. There were several fluctuations in the cost of a 14-year patent over time, changes in the cost of sealing a patent application, and changes in renewal costs (see online Figure A2).

Figure 2 provides some evidence of a break in applications per capita by New Zealanders in the early 1880s, while a clear break in the total cost of an initial patent application in the early 1880s seems evident from Figure 3. Formal tests for breaks and the effects on the time series properties of the data are presented as Table 3.[1]

When tests for potential structural changes in the data are considered, a break date of 1883 was identified for log applications per capita by New Zealanders. This series was integrated of

[1]Eviews v11 was primarily used for estimation and testing see Eviews, 2021. Eviews computer program, version 11. Irvine, CA: Eviews. Stata 17 was also used for the difference in difference analysis.

TABLE 3 Unit root test results using modified Hannan–Quinn criterion.

	Without a break					With a break				
Variable (in logs)	**Integrated**	**Lags**	**Equation**	**ADF**	***p*-Value**	**Integrated, break**	**Lags**	**Trend specification**	**ADF**	***p*-Value**
Applications by NZers per capita (p.c.)	I(1)	2	T,I	−3.57	0.048	I(0), 1883	0	T,I; break I	−4.88	0.047
Apps by NZ professionals p.c.	I(2)	0	T,I	−13.78	0.000	I(0), 1881	1	T,I; break T,I	−5.91	<0.01
Apps by NZ production workers p.c.	I(2)	0	T,I	−14.72	0.000	I(0), 1883	0	T,I; break T,I	−6.07	<0.01
Apps by NZ farmers p.c.	I(1)	0	T,I	−7.29	0.000	I(1), 1875	0	T,I; break T,I	−9.04	<0.01
Apps by NZ clerical p.c	I(2)	0	T,I	−13.88	0.000	I(1), 1880	0	T,I; break T,I	−9.48	<0.01
14-year patents by NZers per capita	I(1)	0	T,I	−7.87	0.000	I(1), 1871	0	T,I; break T,I	−9.22	<0.01
Initial fees cost	I(1)	0	T, I	−6.51	0.000	I(0), 1882	0	T,I; break T,I	−5.25	0.04
Ads and parchment/form	I(2)	0	T,I	−13.88	0.000	I(0), 1881	0	T,I; break T,I	−7.80	<0.01
Initial fees, ads and form	I(2)	0	T,I	−4.25	0.009	I(0), 1881	0	T,I; break T,I	−14.95	<0.01
Cost of sealing	I(1)	0	T,I	−5.94	0.002	I(1), 1880	0	T,I, break T,I	−9.14	<0.01
Total cost 14 years	I(1)	0	T,I	−9.59	0.000	I(1), 1889	0	TI, break T,I	−9.98	<0.01

Abbreviations: I, intercept; T, trend.

FIGURE 4 Log of patent applications by professionals and by farmers per 100,000 people.

order 0, or I(0).[2] Admittedly, this only held when, as shown in Table 3, only a break in the intercept was allowed for; when a break in the trend was also allowed for (not shown in Table 3) this series was integrated of order 1, or I(1). However, when results for four key occupational groups were analysed, applications per capita by professionals and managers (Figure 4) and by production and elementary workers (Figure 5) were I(0) when allowing for changes in both the trend and intercept for applications. These were the two largest occupational groups for patent applications.

Applications per capita by farmers were I(1) with a breakpoint in 1875, which was when, after 7 years of continuous patenting by them, per capita applications by farmers were at their nadir. The limited number of years clerical and sales workers patented in the 1870s complicates analysis. However, the data implied applications by them were I(1)[3] with a breakpoint in 1880. This followed strong growth in this occupational group between 1878 and 1881 (Statistics Department, 1881) as New Zealand's service sector expanded, and also reductions in advertising costs and patent fees starting to come into effect. The results for farmers and clerical and sales workers highlights limitations of the data resulting from the small number of applications before the 1880s made by these groups, and also of unit root tests that only allow for a single break (Greasley & Oxley, 2010a, pp. 976–978). However, skilled workers, rather than farmers or clerical and sales workers, were the key group that the early 1880s reductions in patent costs targeted (Hutchison, 1879, p. 66). As well as reporting results for changes in applications by all New Zealanders, we therefore report results for production workers; and also for the comparatively large number of patent applications by professionals.

[2]This suggests that applications per capita were not growing rapidly.
[3]Implying a rapid growth in applications.

FIGURE 5 Log of patent applications by production workers and by clerical workers per 100,000 people.

TABLE 4 Pairwise Granger causality probabilities between the log of variables relating to New Zealand applications (5-year lag and using F-statistics).

	Applications per capita by NZers	
	Causality	**F-statistic**
Ads and parchment costs	=>	**0.0459**
	<≠>	0.3117
Total cost application including ads	=>	**0.0003**
	<≠>	0.8131

Note: Bold indicates statistical significance at $p < 0.05$. Initial application costs were not cointegrated with applications per capita, and are therefore omitted. => indicates causality from costs to applications. <≠> indicates no causality from applications to costs.

Table 4 presents results from undertaking Granger causality tests between application cost variables, and applications per capita by New Zealanders.[4] Granger causality tests show how much of the current value of a variable can be explained by its own past values, and then tests whether adding lagged values of another variable improves the explanation (Enders, 2015, p. 306). The key to the 'test' is temporal ordering of the data rather than 'causality' in a philosophical sense (Granger & Newbold, 1977, p. 225). However, over time, the testing procedure

[4]The null hypothesis is that the relevant cost does not Granger cause applications. This hypothesis is rejected when the *p*-value is <5%.

TABLE 5 Pairwise Granger causality probabilities between the log of variables relating to New Zealand applications (5-year lag and using F-statistics).

	Applications per capita by:			
	Production workers		**Professionals**	
Total cost application including ads	Causality	F-stat	Causality	F-stat
	=>	**0.0035**	=>	**0.0005**
	<≠>	0.3402	<≠>	0.8868

Note: Bold indicates statistical significance at $p < 0.05$. => indicates causality from costs (including ads) to applications. <≠>indicates no causality from applications to costs.

has become known as 'Granger causality' and sufficiently famous that it no longer seems to require a specific citation.

Table 4 shows that the total cost of an initial application, defined here as initial fees and required advertising and parchment costs, Granger caused applications by people living in New Zealand. This result also applied with shorter lags. However, this conclusion is not evident when using only initial required fees, which have been omitted from Table 4. The reverse relationship also did not hold; higher applications did not Granger cause application fees and advertising costs.

The results indicate that it is only when private advertising costs for a patent application are added to the application fee that we can identify a causal effect of reductions in application costs on patent applications, even though advertising costs could be avoided by quickly letting an application lapse. These results indicate that policy-makers and researchers need to consider patenting costs more broadly than just official government fees. It is not clear why law makers in 1870 did not anticipate how doubling advertising requirements would negate the reductions in required fees they had thought would increase patenting.

The Granger causality results presented here only hold under the assumption that applications per capita are I(0), which only applies if there is no change in the trend for patent applications.[5] However, for production workers and for professionals and managers, where unit root tests indicate the series are integrated of order zero when allowing for a break in both the trend and intercept for patent applications by these groups, also shows (see Table 5) Granger causality between the total cost of applications and patent applications. The results for production workers suggest that reductions in the cost of an initial application fulfilled their goal of increasing patenting by skilled workers (Hutchison, 1879, p. 66).

However, we would argue that the results are consistent with the main change being increased applications from a broad range of occupational groups, rather than a change in relative proportions by different groups. This is because fluctuations in the relative proportion of patents by production workers and by professionals occurred before and after the reduction in application costs. For clerical workers there are too few applications by them before the 1880s to show a satisfactory statistical relationship between patenting costs and applications. However, the number of applications by New Zealand clerical and services workers steadily grew during the 1880s, after application fees were lowered, even after allowing for population growth. Although for farmers analysis is also complicated by the low number of patent applications by them before 1880, and by the very low number of

[5]See Greasley and Oxley (2010a), for a discussion of how to test for and interpret Granger causality tests.

TABLE 6 Ordinary least squares models of patent applications per 100,000 people by New Zealanders.

Dependent: Ln NZ patents per 100,000 people	Model 1	Model 2
Constant	4.06 (0.12)***	2.29 (0.34)***
Ln fees, advertising and form cost	−0.98 (0.06)***	−0.62 (0.09)***
Trend	–	0.06 (0.01)***
Dummy 1869–1871	–	0.85 (0.19)***
AR(1)	–	−0.26 (0.16)
Adjusted R^2	0.87	0.93
Durbin–Watson	2.10	1.97

*$p < 0.10$, **$p < 0.05$, and ***$p < 0.01$.

applications by them in 1875, Figure 4 shows lower patent application costs were followed by a long period of sustained growth in applications by farmers.

Using regression allows us to also consider models that relax the assumption of no change in the trend for total patent applications after patent fees were reduced. Regressing the log of total applications by New Zealanders per capita on the log of the total cost of fees and advertising costs, explained 87% of the variance in patent applications by New Zealanders. The residuals show that applications before 1868 were lower than expected, suggesting some omitted variable bias. For instance, New Zealand's low population may have meant that patent agent fees were higher in real terms in the 1860s than in later years (Table 6).

Model 2 includes a first order autoregressive term to reduce the reported negative autocorrelation and to allow for the possibility that applications per capita are I(1) rather than I(0). The price elasticity for applications by New Zealanders is now 0.62, implying that a 1% reduction in the cost of an application resulted in a 0.62% increase in patent applications. A dummy variable for the 1869–1871 period, to allow for inventors delaying or bringing forward applications to choose the fee structure that best suited them, was significant. There was some evidence that a dummy variable for the period from 1890, when the cost of a 14-year patent increased, was also significant although this been omitted due to increased autocorrelation.[6] The autoregressive term was not statistically significant.

We also considered other variables. From 1857 the main government science organisation was the New Zealand Institute (Nathan, 2015, pp. 9–10, 73). Apart from a reduction in its director's salary during 1880–1881, when permanent government salaries were temporarily reduced, government funding remained the same in nominal terms during the nineteenth century. Membership of the New Zealand Institute's branches seemed a promising indicator of interest in science by professionals (Reid, 2005), but changes in its membership were not significant in regression analysis. It was not until 1897 that New Zealand's first agricultural research station opened (Strachan, 1983, p. 75). Real wages grew slowly, but relatively steadily (Brooke, 2012, p. 192), while trade openness slowly declined (Briggs, 2007). Neither variable was associated with changes in patenting. The relationship between output and patenting has been tested

[6]A Breusch-Godfrey serial correlation LM test showed that the null hypothesis of serial correlation could be rejected in the regression model. Robust standard errors are reported. A Jarque-Bera test indicated the residuals in the models were normally distributed.

FIGURE 6 Patent applications per 100,000 people in Victoria and New Zealand.

TABLE 7 Difference in difference model of patent applications per 100,000 people in New Zealand and Victoria.

Dependent: Ln patents per 100,000 people	Model 1
Ln fees and advertising cost	−0.71 (0.24)**
Observations	28

*$p < 0.10$, **$p < 0.05$, and ***$p < 0.01$.

elsewhere. Grainger causality usually occurred between output series and real expenditure on patents in related areas, with the direction of causality usually running from output to expenditure (Gibbons & Oxley, 2022, p. 130).

Nominal initial application fees were the same in both the New Zealand and Victoria patent systems during the 1870s. In Victoria, however, applications only had to be advertised in a Melbourne newspaper and one local paper, resulting in advertising costs being less than a fifth of New Zealand levels (Victoria Government, 1865, p. 62; Waters, 1881, p. 9). During the 1880s New Zealand reduced application costs before Victoria, and to a greater extent. After being lower than in Victoria, Figure 6 shows that per capita applications by New Zealanders exceeded applications by Victorians from 1882. Victoria's 1885 reduction in patent application fees, and abolition of the requirement to advertise applications in newspapers, resulted in a large increase in applications (Magee, 2000, pp. 17–18), although not to New Zealand levels. Table 7 shows difference in difference analysis between 1871 and 1884, using Victoria as the control (StataCorp, 2022, p. 10), produces similar results to the ordinary least squares regression. Indeed, applying the methods used for New Zealand to the available data for Victoria produced very similar results.

If unit record data for Victoria, and preferably also other British Australasian colonies such as New South Wales, were available it would be possible to make greater use of difference in difference analysis to examine the effects of changes in patenting costs. Ideally analysis would consider different occupational groups, and include a wide range of control variables. As more data becomes available, there will be potential for further analysis using difference in difference analysis.

While the number of patent applications per capita increased over time, Figure 7 shows that the proportion of patent applications by New Zealanders that went full term declined sharply. In the 1860s most patent applications by New Zealand inventors were successful, and therefore ran for a 14-year term. However, some applications were abandoned or unsuccessful. Changes to patent laws and fees resulted in many 1870s patent applications lapsing after being sealed for an initial 3-year term; with usually less than 10% being renewed, and therefore running for 14 years. The proportion of abandoned patent applications increased after the cost of patenting was reduced in the early 1880s, and from 1883 consistently more than half of patent applications by New Zealanders were abandoned.

Some of the inventors of abandoned applications may have been seeking publicity by applying for a patent (Galbraith, 1886), many may have found the return on their invention did not justify extending protection, and despite reductions in fees some may still have been credit constrained (MacLeod et al., 2003). By the 1890s the New Zealanders who made the most patent applications included inventors whose applications invariably lapsed after 12 months, because they did not pay to have an application sealed as a patent, and who made no apparent contribution to knowledge or New Zealand's economy. In contrast, the 20 New Zealanders who invested most in patient fees were all active, if not always successful, in business and were frequently regarded as having developed useful inventions. Eighteen of the 20 biggest New Zealand investors in patent fees between 1860 and 1899 had 14-year patents. The other two filed a series of applications that were similar to abandoned applications by themselves, and may have considered this a cost-effective way of protecting inventions that were still being refined (Gibbons, 2016, pp. 99–100).

Figure 8 shows that during the 1860s and 1870s most overseas patent applicants opted for letters of registration for patents, which extended patent protection they had secured in their

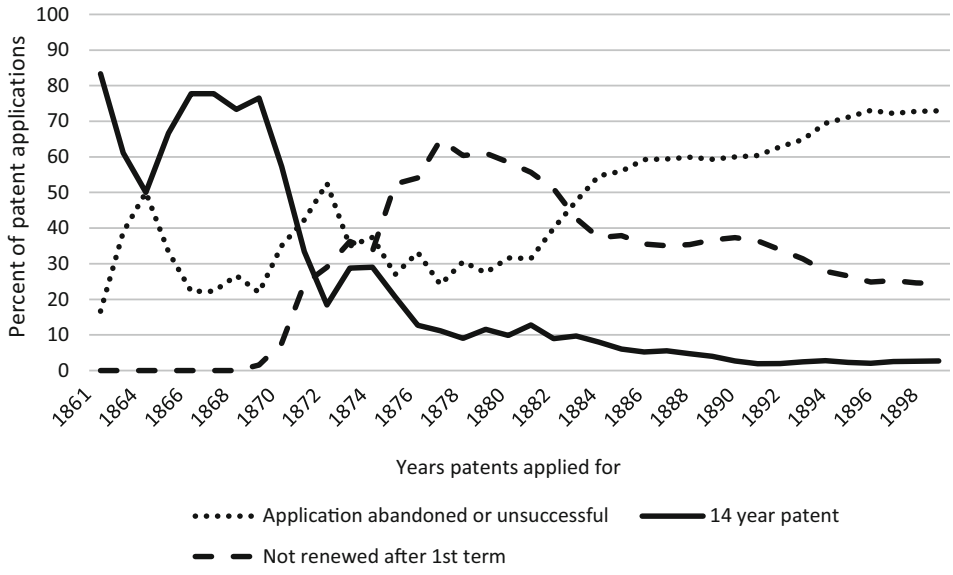

FIGURE 7 Three year moving average of the fate of patents applied for by New Zealanders, 1860–1899.

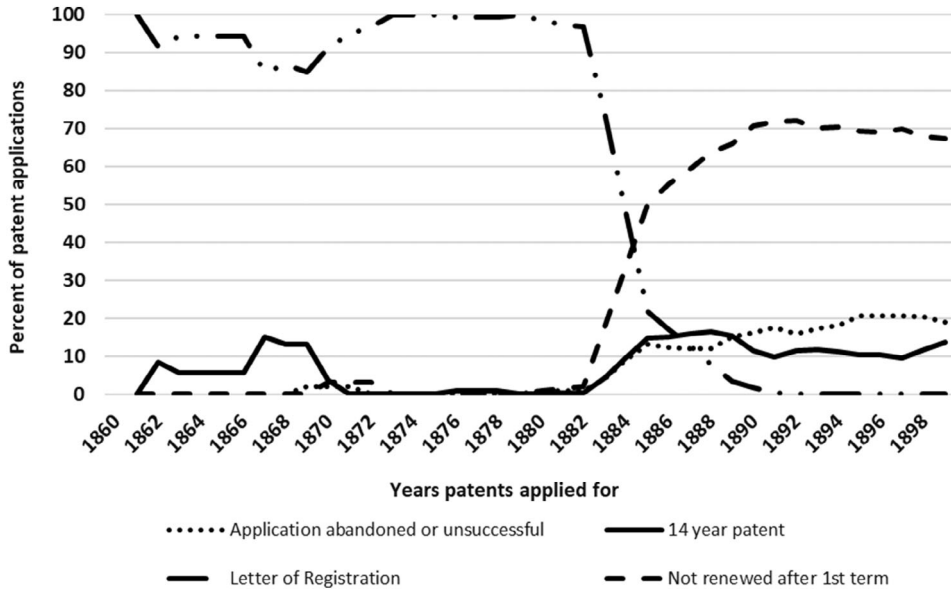

FIGURE 8 Three year moving average of the fate of patents applied for from overseas, 1860–1899.

country of origin to New Zealand. Lower initial patent fees and the elimination of compulsory advertising requirements during the 1880s resulted in increased use of letters patent, with most of these applications not being renewed after the first term. Fewer than 20% of overseas patent applications were abandoned, with overseas inventors who applied for a patent in the small New Zealand market usually also paying to have their application sealed.

There was also an increase in patent applications in Britain that were not sealed, and therefore abandoned, after a reduction in application fees took effect in 1884 (MacLeod et al., 2003, pp. 556–558). Indeed, average unsealed patent applications in Britain in the 1880s and 1890s were similar to the percent abandoned in New Zealand (Boehm, 1967, pp. 33–34). Similarly, after patent application fee reductions in Victoria in 1884, during the early 1890s the abandonment rate for patent applications was about 40% (Victoria Office of the Government Statist, 1894, p. 70).

Since the cost of applying for a patent dramatically fell over time, and the average duration of a patent decreased, total expenditure on patents is potentially a better measure of the resources being invested in invention than the number of patent applications (Schankerman & Pakes, 1986, p. 1052; Sullivan, 1994, pp. 37–38; Gibbons & Oxley, 2022). Patent quality in other countries has been calculated using citation data (Nuvolari, 2004, pp. 97–98), but information on citations is not available for New Zealand during this period. Our calculation of patent fees expenditure follows a similar trend to the incomplete official data.

Figure 9 shows real expenditure on patents, after including the costs for advertising and for parchment or the standard form used from 1884. In the 1870s these costs sometimes almost doubled expenditure. The reduced application and renewal fees introduced in 1880 and 1882 were associated with expenditure on total patent fees and advertising spiking at 1767 pounds in 1882. Further reductions in fees and advertising requirements initially reduced expenditure, but in 1889 a new peak of 2547 pounds was reached. Higher renewal fees were then associated with lower patent fees expenditure in 1890 and 1891. Thereafter patent fees expenditure grew again, peaking at 4229 pounds in 1897. Nevertheless, patenting fees and required expenditure was only equivalent to 0.08% of private Gross Fixed Capital Formation in 1899 (Dowie, 1966, p. 54).

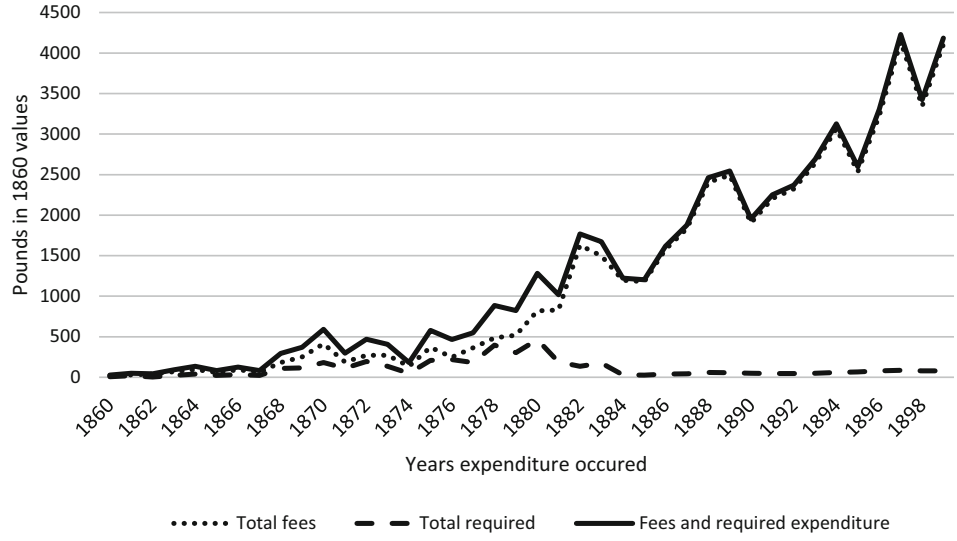

FIGURE 9 Real expenditure on patents between 1860 and 1899, including required expenditure, all countries.

Even after allowing for population growth, total real expenditure on patents increased considerably, but more slowly and smoothly than applications. Inventions by New Zealanders accounted for 62% of applications, but just 45% of fees and other required expenditure on patents. This reflected applications by New Zealanders disproportionately lapsing, as inventors did not proceed with the initial patent application, and indicates that just counting patent applications is potentially a poor way of measuring the sources of knowledge in an economy.

Although data on region is not reported here, no region dominated patenting in New Zealand for long periods, and patenting was sometimes high in sparsely populated frontier regions. Nevertheless, there were some modest agglomeration effects (Williams & Oxley, 2016, pp. 161–162, 169–170). Similarly, there is little evidence of changes in the types of inventions patented being associated with changes in patent fees, although increased investment in patents in particular areas often followed increased output (Gibbons & Oxley, 2022).

PATENTING BY DIFFERENT OCCUPATIONAL GROUPS

This section compares patenting by New Zealand occupational groups between 1860 and 1899 to similar data for Victoria in Australia for 1854 to 1903, and to 1886 census data. Excluding declarations partly about status, such as 'gentleman', almost 90% of patentees in our sample listed their occupation. This is the same percentage as in the self-governing colony of Victoria for a comparable period (Magee, 2000, p. 66), facilitating comparisons. Comparisons are also made with broadly equivalent 1886 Census occupation data for New Zealand males to gain a better idea of how inclusive New Zealand's patenting system was for males. New Zealand data was coded using the OCCHISCO classification (Roberts et al., 2003).[7]

[7]New Zealand patent records recorded the original inventor, even when an application had been assigned.

TABLE 8 Occupations of applicants for patents weighted by their share of patent applications and also for New Zealand by their expenditure on patents.

	All patentees, 1860–99			New Zealand patentees, 1860–99			1886 NZ Census	Victoria (Magee), 1854–1903	
Occupations	**Patents**	**Percent applications**	**Percent expenditure**	**Patents**	**Percent applications**	**Percent expenditure**	**Percent male working popn**	**Patents**	**Percent applications**
Engineers	2594	21.1	24.1	1221	16.0	16.7	1.8	2719	26.8
Farmers, forestry and fishing	1037	8.4	6.4	927	12.1	12.1	29.3	298	2.9
Merchants and sales	957	7.8	7.2	580	7.6	7.3	6.8	490	4.8
Managers and manufacturers	586	4.8	5.7	233	3.0	3.3	0.6	298	2.9
Blacksmiths and metal workers	435	3.5	3.0	368	4.8	5.0	2.6	246	2.4
Gentlemen	415	3.4	4.4	121	1.6	2.5	0.05	98	1
Doctors and other medical	261	2.1	2.0	160	2.1	2.0	0.30	–	–
Chemists and pharmacists	245	2.0	2.3	100	1.3	0.8	0.25	242	2.4
Coach builders	192	1.6	1.2	178	2.3	2.4	0.6	114	1.1
Plumbers and pipe makers	185	1.5	1.0	157	2.1	1.8	1.3	134	1.3
Architects	151	1.2	1.0	116	1.5	1.7	0.1	117	1.2
Carpenters and joiners	148	1.2	0.8	133	1.7	1.5	3.7	113	1.1
Other mining sector	139	1.1	1.3	34	0.4	0.3	0.02	–	–
Electricians and lines	138	1.1	2.4	33	0.4	0.3	0.01	162	1.6

(Continues)

TABLE 8 (Continued)

Occupations	All patentees, 1860–99			New Zealand patentees, 1860–99			1886 NZ Census	Victoria (Magee), 1854–1903	
	Patents	Percent applications	Percent expenditure	Patents	Percent applications	Percent expenditure	Percent male working popn	Patents	Percent applications
Miners	126	1.0	0.8	88	1.1	1.3	7.0	216	2.1
Builders	120	1.0	1.0	98	1.3	1.7	1.4	98	1.0
Machinists	113	0.9	1.1	69	0.9	0.8	0.8	504	5
Labourers	57	0.5	0.3	56	0.7	0.6	10.2	–	–
Other	4385	35.7	34.0	2983	39.0	37.9	33.3	–	42.2
Total	12,283	100	100	7653	62.3%	44.9%	100	10,145	100

As in other patent systems, engineers dominated patenting in New Zealand. Indeed, Table 8 shows that 21.1% of patentees stated they were an engineer, and this group accounted for 24.1% of expenditure on patent fees and required expenditure. In the nineteenth century the occupation of 'engineer' was widely used by skilled trades workers who had received technical training through apprenticeships and practical experience (Magee, 2000, p. 65). The percentage of patent applications by engineers was slightly lower than the 26.8% share of patents by engineers in Victoria. While 16% of applications by patentees living in New Zealand were by engineers, only 1.8% of males in the 1886 New Zealand Census described themselves as an engineer.

People in farming occupations applied for 8.4% of patent applications in New Zealand, which was more than twice the 2.9% of patents farmers applied for in Victoria. Farmers made 12.1% of patent applications and expenditure by New Zealand inventors. Just over 29% of New Zealand's male working population stated that they worked on a farm in the 1886 Census, although some of them were farm labourers (7% of the male population), or forestry workers (1.6%), or shepherds (1.0%), and these occupations were rarely listed on patent applications.

Merchants and salespeople accounted for 7.8% of patent applications in New Zealand. This was substantially higher than their 4.8% share of patent applications in Victoria. The 7.6% of patent applications by New Zealand merchants and salespeople was only slightly higher than the 6.8% of the male workforce in the 1886 Census who stated these occupations.

Managers and manufacturers accounted for almost 4.8% of patent applications in New Zealand, which was higher than the 2.9% in Victoria, but just 3.0% of patent applications and 3.3% of expenditure were by New Zealanders in these occupational groups. The 1886 Census data indicated only 0.6% of the male population were managers or manufacturers. However, this probably partly reflects managers specifying other occupations, while since manufacturing rapidly expanded in the 1880s (Greasley & Oxley, 2010b) analysing later census data would probably reveal more manufacturers.

Blacksmiths made 3.5% of total patent applications in New Zealand, compared to 2.4% in Victoria. Blacksmiths made 4.8% of patent applications and 5.0% of expenditure by New Zealanders, while just 2.6% of men in the workforce stated they were a blacksmith in the 1886 Census.

Miners made 1% of total patent applications, although metallurgists and mining engineers and proprietors more than doubled the proportion of patentees working in mining related occupations. New Zealand miners accounted for 1.1% of patent applications, but other mining occupations were less important than when applications by those living overseas were also included. Expenditure results reveal similar patterns. However, 1886 Census data indicated 7.0% of the male population were miners and data from other censuses (Bloomfield, 1984, pp. 126–133) also indicates New Zealand miners were under-represented in patenting.

Representation of trades workers in patenting occurred through occupations such as plumbing (1.5% of all patent applications; 2.1% by New Zealanders), coach building (1.6% and 2.3% of applications), carpentry (1.2% and 1.7% of applications) and building (1.0% and 1.3% of applications). There was over-representation in patenting of some trades occupations, such as coach and other builders, by New Zealanders relative to the 1886 Census data.

However, the occupations usually thought of as least skilled accounted for few patents, even after patent application costs were reduced in the early 1880s. Collectively all occupations that included the word labourer (except agricultural occupations) made 0.5% of all patent applications and 0.7% of applications by New Zealanders. In contrast, over 10% of New Zealand working men at the 1886 Census simply stated they were a 'labourer', and adding railway and waterfront labourers increases this group to 14% of the male population. Data from other censuses produces similar results. There were only 2 years in which New Zealand labourers

patented before 1886, but from 1886, by which time the reductions in patent application costs had taken place, they consistently patented. Nevertheless, during the 1890s New Zealand labourers made just 48.5 patent applications and accounted for only 0.75% of expenditure on patents by New Zealanders.

Just over 3.4% of patentees stated they were a 'gentleman', which often meant they were of independent means, while 0.6% gave their occupation as 'inventor'. Among patentees living in New Zealand the proportion of gentlemen more than halved to 1.6%, and this percentage fell sharply from the early 1880s. Just 0.05% of the male workforce gave their occupation as being a gentleman at the 1886 Census. However, the comparable statistic for the 1896 Census was 0.65%, suggesting that the 1886 Census count for gentlemen is not representative of the entire time-period. Comparing the results for engineers, manufacturers, chemists, and electricians suggests that New Zealand patentees on average tended to be less skilled than foreign patentees.

The results for the main HISCO groups (see Table A2) shows that the professionals group, which included most engineers, accounted for 40.2% of total patent expenditure and 29.8% of patent expenditure by New Zealand patent applicants. In contrast, at the 1886 Census just 6.7% of New Zealand's male working age population were professionals.

Elementary occupations and labourers, who were in HISCO group nine, made 6.4% of patent applications by New Zealanders and paid 5.6% of patent expenditure, but were 21% of New Zealand's male working age population. Applications and expenditure by this group were predominantly by carpenters, joiners, printers, and painters. However, production trades workers, who are the second lowest group in HISCO, paid 18.2% of patent fees and associated costs by New Zealanders, but were only 10.0% of the 1886 male working age population. This group includes blacksmiths, coach makers, saddlers, bootmakers and electrical workers. The HISCO groups who patented at the lowest levels were clerical workers (such as office workers) and service workers (such as restaurant and household workers, police and prison guards). New Zealand sales workers' 6.9% of patent expenditure was similar to their 6.8% share of the male workforce in 1886.

PATENTING BY WOMEN

The level of patenting by women is an important indicator of their level of participation in the economy. Between 1860 and 1899 just 1.5% of patent applications were by women, although this is slightly higher than the 1.1% of patent applications that were made by women in Victoria between 1854 and 1903 (Magee, 2000, p. 64). There was only one patent application by a woman before patent application costs were reduced in the early 1880s. However, thereafter applications by women grew (see Figure A5), and the proportion of applications by women was 2.5% in 1899.

Statistics based on official data shows that by the late 1890s women accounted for just under a per cent of patents granted in the United States, although the trend there was also upwards (Khan, 2005, pp. 133–135). Similarly, an official report states the percentage of patent applications by United States women was just 1.1% in 1905 (United States Department of Labour, 1923, p. 13). Women made a higher proportion of patent applications in Britain than in the United States. In France, however, where middle-class women were strongly involved in family firms, women patented at a higher rate than in Britain, the United States (Khan, 2020, pp. 259–262) and also New Zealand.

The United States official statistics missed some patents by women, however, even when names were 'evidently female' (Khan, 2005, p. 133). Recent research linking patent data to census data in the United States indicates patenting by women there was several times higher than previously thought (Sarada et al., 2019), and therefore exceeded New Zealand levels in the 1890s. Although New Zealand considered itself a world leader in social progress for women during the late nineteenth century (Brookes, 2016, pp. 113–133), in terms of patenting by women New Zealand's record was probably unexceptional.

The first woman to make a New Zealand patent application was Matilda Lang, who lived in Melbourne, Victoria, and who in 1871 patented an improvement for washing and scouring clothes, wool and flax. She made one of only 38 patent applications in 1871. The second patent application solely by a woman was by Elisabeth Barton of Dunedin, New Zealand, for a new bedspread in 1884. Barton's invention was widely reported as pleasing advocates of women's rights (Timaru Herald reporter, 1885, p. 2; New Zealand Herald reporter, 1885, p. 4), and occurred in the year the *Married Women's Property Act* increased property rights for women. One article commented that an advisor on patent applications had been dismissive of another women's plan for a patent for improvements in dresses (Auckland Star reporter, 1885, p. 4). However, by the late 1890s patents applications by women were sometimes outlined in newspapers without reference to the gender of the inventor (Timaru Herald reporter, 1897, p. 2). There were 30 applications by women inventors during 1898, five of which concerned clothing (Registrar Patents Office, 1899, p. 1).

Table 9 shows that 37.3% of female patent applicants stated they were married or widowed. For New Zealand female applicants, the proportion was slightly higher at 41.0%, but this was considerably less than the 72.6% of New Zealand women who were classified as married or widowed in the 1886 census. Collectively, 14.2% of all female applicants described themselves as a gentlewoman or lady. The 9.8% of New Zealand female applicants who gave these occupations was much greater than the 0.03% of such New Zealand women in the 1886 census. Another 6.6% of all female applicants and 6.0% of New Zealand female applicants described themselves as a spinster.

Almost 5.6% of female patentee applicants and 6.2% of female New Zealand applicants were involved in making clothes, usually as a dressmaker. In the 1886 Census, 6.6% of New Zealand women gave these occupations. Just over 4.7% of female patentees and 4.9% of New Zealand female applicants described their occupation as a farmer. This was considerably higher than the 0.7% of such women in the 1886 census. Teaching, nursing and being an artist were also relatively important occupations for female patentees, and these groups were over-represented in patenting in relation to their share of New Zealand's female population. Similarly, the small proportion of New Zealand women who were merchants or machinists were over-represented in patenting. Although in the 1886 census 14.3% of New Zealand women were hotel or domestic workers, this low paid group made just 3.6% of applications by New Zealand women. Female patentees disproportionately tended to be of independent means or working in relatively high-income occupations.

No female patentees described themselves as an engineer, but there was one mining proprietor. There was positive newspaper coverage of technological innovation in mining by former Dunedin resident Alice Cornwall, who had recovered from a disastrous marriage to rebuild her family's economic fortunes (Otago Daily Times reporter, 1889, p. 3). Inventions by Ada Frances Cole, who was a New Zealand machinist, for well-sinking equipment during the 1880s were also positively commented upon by newspapers (Evening Star reporter, 1889, p. 1). Inventions by women, as in the United States (Khan, 2005, p. 145), often focused on household production and consumption, and medicinal products and clothing, but women also patented engineering, mining, and manufacturing inventions.

TABLE 9 Occupations of all female applicants and New Zealand female applications for patents, 1860–1899, weighted by their share of patent applications and their expenditure on patents.

	All female patentees, 1860–99			All New Zealand female patentees, 1860–99			1886 census
	Patents	Percent applications	Percent expenditure	Patents	Percent applications	Percent expenditure	Percent female working age population
Wife, widowed or married	68	37.3	35.7	54.5	41.0	41.1	72.6
Gentlewoman or lady	36	14.2	10.3	13	9.8	4.3	0.03
Spinster	12	6.6	5.8	8	6.0	5.5	NA
Dressmaker and clothes	10.3	5.6	7.3	8.3	6.2	7.0	6.6
Farmers	8.5	4.7	5.5	6.5	4.9	7.1	0.7
Hotel and domestic workers	4.8	2.7	3.0	4.8	3.6	4.9	14.3
Teachers and governesses	4	2.2	1.3	3	2.3	0.8	0.9
Doctors and other medical	3.5	1.9	1.5	3	2.3	1.8	0.39
Merchants and sales	3.5	1.8	0.2	2.5	1.9	0.7	0.76
Machinists	3	1.6	1.2	3	2.3	2.0	1.48
Other including none given	38.9	21.4	28.2	27.8	20.9	24.8	2.2
Total	182.5	100	100	132.9	72.8	100	100

PATENTING BY MĀORI AND BY CHINESE

New Zealand's indigenous Māori population constituted at least 6% of New Zealand's population at every census during the nineteenth century (Pool, 1991). However, the only Māori to make a patent application was Tare Ruka of Westport, who in 1884 applied to protect a toothache treatment (New Zealand Herald reporter, 1885). However, the application was not sealed, and therefore lapsed after 12 months. Ruka was actively involved in the Māori community, and in promoting the political and cultural needs of Māori (Ruka et al., 1886, p. 2; Westport Times reporter, 1884, p. 2).

The low level of patenting by Māori reflected their relatively weak economic situation. Māori land ownership fell dramatically during the period studied because of land confiscations and sales. Language and cultural differences also limited Māori participation in the economy. By the 1870s Māori were largely engaged in subsistence farming and wage labour in isolated rural areas, although some Māori were becoming successful sheep farmers (Monin, 2009, pp. 141, 145). Māori expertise was acknowledged in areas such as flax growing and processing (Flax Commissioners, 1870, pp. 24, 39; Firth, 1959, pp. 61–67, 87), and Māori expertise was used by four inventors to differentiate their patents. However, this expertise did not result in patent applications by Māori, even after the reduction in initial patenting costs.

During the nineteenth century New Zealand migrants overwhelmingly came from the British Isles. However, New Zealand also had a small Chinese population, which between 1874 and 1881 was over 1% of New Zealand's population. Three Chinese patentees lived in New Zealand, with the most prolific making three patent applications. All the parent applications by Chinese were during the 1890s, when New Zealand's Chinese population was falling (Office of the Registrar General, 1902, p. 9).

CONCLUSIONS

The work presented here has considered the effects that changes in patenting costs had on the level of patenting in New Zealand between 1860 and 1899, and whether high per capita patenting rates were associated with high patenting by a wide range of economic and social groups. We have shown there was a rapid increase in per capita patent applications in New Zealand from the early 1880s, when initial application fees and mandatory advertising costs were sharply reduced to encourage applications by skilled workers. The total cost of an initial application, which included both fees and required private advertising costs, explains most of the variation in patent applications per capita by New Zealanders. However, official fees alone do not explain the level of applications by New Zealanders. These results indicate policy makers and researchers need to consider both fees and other required expenses, such as compulsory advertising requirements, to understand the effects of costs on patenting.

Lower total initial patenting costs in the early 1880s, which were also occurring in Britain and other self-governing British colonies, were associated with patent applications increasing across a wide range of New Zealand occupational groups. A clear step change is apparent in applications by both professionals, such as engineers, and production workers. The number of applications by New Zealand clerical and sales workers and by farmers also steadily grew after initial patenting costs were reduced in the early 1880s. However, real expenditure per capita on patents by New Zealanders showed only a gradual upward trend. This was because although applications increased, the cost of sealing and renewing a patent resulted in the majority of patent applications by New Zealanders from 1883 being allowed to lapse. Overseas patent applications showed less

growth than applications by New Zealanders. Nevertheless, overseas patentees also sometimes responded to changes in patent fees, with greater use being made by them of provisional applications, rather than letters of registration, after the cost of the former was reduced.

Occupation data showed that patents by engineers accounted for almost a quarter of total expenditure on patents. Comparisons with census data confirmed that New Zealand engineers patented at a much higher rate than the male population as a whole. Farmers were a more important group for patent applications than in equivalent data for the Australian colony of Victoria. Skilled trade workers, such as blacksmiths, electricians and builders, were over-represented in patent applications and expenditure. In contrast, unskilled workers, such as labourers and miners, made relatively few patent applications, even after application costs were sharply reduced in the early 1880s.

Women accounted for a growing share of patent applications from the early 1880s, and made 2.5% of patent applications in 1899. Female patentees tended to be disproportionately of independent means, or working in potentially relatively well paid occupations. Despite consistently being over 6% of New Zealand's population, only one patent application by a New Zealand Māori was identified. Only three Chinese living in New Zealand made patent applications.

It would be desirable in the future to extend the unit record data for New Zealand into the twentieth century. This would cover the period when New Zealand's dairying sector grew to lead the world in innovation (Greasley & Oxley, 2010b, p. 444), and cover a period when official statistics for more potential explanatory variables for patenting exist. Further information on patenting may become available as more New Zealand newspapers are digitalised. In addition, careful comparisons with other patent systems may enable more precise calculations of the effects of fees, and of differences in patenting by groups such as women.

The new data considered here shows that by 1899 the New Zealand patenting system had become more accessible to New Zealand men of European origin than during the 1870s. This reflected reductions in fees and required newspaper advertising during the early 1880s that had facilitated high per capita patent application rates. An increase in patent applications had occurred across all the main male occupational groups. Admittedly patenting by unskilled workers, by women, and by non-European population groups remained very low. However, there was considerable public and official interest in the growing level and proportion of patent applications by New Zealand women.

ACKNOWLEDGEMENTS

We would like to thank the University of Waikato Postgraduate Committee for financial support provided to the first author. We also wish to acknowledge the two referees and Editor of this *Journal* for the extensive and detailed comments and suggestions they made on the article. We believe that in addressing them the paper has improved significantly. Open access publishing facilitated by Victoria University of Wellington, as part of the Wiley - Victoria University of Wellington agreement via the Council of Australian University Librarians.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Gibbons, M. & Oxley, L. (2023) The growth of patenting in New Zealand, 1860–99. *Asia-Pacific Economic History Review*, 1–27. Available from: https://doi.org/10.1111/aehr.12263