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Performance of women-owned businesses that patent



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by *Chahreddine Abbes, Amélie Lafrance-Cooke and Danny Leung*

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Abstract

This study compares the performance of businesses owned by women (majority or equal ownership) that patent with that of majority men-owned businesses and businesses where gender of ownership cannot be assigned. It finds that women-owned firms have higher survival rates, but lower revenue growth rates, after filing for a patent than businesses where gender of ownership cannot be assigned, even after controlling for observable firm characteristics. The differences between women-owned businesses and businesses where gender of ownership cannot be assigned are greater than those between women-owned and majority men-owned businesses. Women-owned businesses have lower revenue growth rates than majority men-owned businesses, but only have higher survival rates in the fifth year after filing for a patent and after controlling for observable firm characteristics. When the possibility of exit through an acquisition is taken into account, differences in survival between women-owned businesses and other businesses disappear. This suggests that women-owned businesses that patent may have different exit strategies than other businesses. The differences in revenue growth suggest that there may be differences in the quality of the invention, or that some previously documented differences in favour of men-owned businesses (i.e., access to financing and knowledge-building opportunities) may affect the type of inventions developed by women-owned businesses and their ability to successfully commercialize them. Overall, the findings support the need for policies that take gender into account.

Keywords: business performance, ownership, patents, intellectual property

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Disclaimer

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Introduction

Intangible investments—investments that do not have a physical form—have been rising in importance in terms of use. From 1976 to 2016, the growth of intangible investments was faster than the growth of tangible investments (Gu and Macdonald, 2020). Intangible capital also contributed significantly to growth. Gu (2018) shows that intangible capital deepening accounted for 20.9% of the labour productivity growth from 1980 to 2000 and 24.7% of the labour productivity growth from 2000 to 2015 in Canada. Patents, copyrights, trademarks and industrial designs are some of the forms of intellectual property (IP) used to protect those investments in intangibles. In 2018, the Government of Canada launched a national Intellectual Property Strategy to raise awareness of the importance of IP, so that creators, entrepreneurs and innovators can take full advantage of Canada's leadership in research and innovation (Government of Canada, 2018). Part of this strategy involved funding a survey to learn how Canadians understand IP, including among groups, such as women. Data from the 2019 Survey of Intellectual Property Awareness and Use show that 15.8% of women majority-owned enterprises held at least one type of formal IP in or outside Canada, compared with 18.2% for all enterprises (Statistics Canada, 2021).

This paper contributes to the understanding of how men- and women-owned businesses differ in their propensity to use IP (with a focus on patents), and how the outcomes from that use differ. A patent gives its owner the right to sue competitors that are making, using or selling their invention for a period of 20 years from the filing date of the patent application. However, this right does not necessarily guarantee better business performance. The requirement to obtain a patent is that the invention is novel, useful and not obvious (Government of Canada, 2021). These characteristics are not necessarily associated with marketability or improved business efficiency. Furthermore, the right needs to be defended, which itself could be costly. This paper uses administrative data on Canadian-resident businesses from 2001 to 2019 to examine the differences in performance among firms after they file a patent application. In particular, it examines the differences between men-owned businesses, women-owned businesses and businesses where gender of ownership cannot be assigned. It also examines factors that may account for these differences.

There is limited evidence on the impact of patenting on business performance in Canada. Using the Survey on Financing and Growth of Small and Medium Enterprises, Collette and Santilli (2019) find that businesses that hold a form of IP are more than 2 times more likely to have a marketing, organizational, process or product innovation; at least 3 times more likely to expand their market; and 1.6 to 1.9 times more likely to have experienced high growth in the past three years. Furthermore, using the same database as this paper, Abbes et al. (2022b) show that filing a patent application is correlated with a higher probability of experiencing a period of high revenue or employment growth after controlling for the employment size of the firm, the age of the firm, whether the firm conducted research and development (R&D), and the industry of the firm. The evidence from both of these studies is cross-sectional in nature. By contrast, this study will look at the performance of businesses after filing a patent application.

While few studies examine performance differences between women- and men-owned businesses that patent, many investigate the patenting differences among all businesses. For Canada, Abbes et al. (2023) show that men-owned businesses accounted for a larger share of patent applications than women-owned businesses in 2001, and that the gap has only widened since. They also find that men-owned businesses are similar to women-owned businesses in many ways, such as the most common fields in which they patent, with the exception that men-owned businesses are more likely to conduct R&D, have their applications granted and have more applications per applicant. Williams-Baron et al. (2018) find similar results for the United States. However, neither study examines the differences in performance of men- and women-owned firms after filing a patent application.

Patenting is a risky activity because it takes significant investment to develop a novel invention. There is uncertainty about whether the patent will be granted and whether it will lead to a successfully commercialized invention. Technology adoption is another risky activity. Differences between men- and women-owned businesses have been documented in that context. Based on their review of the economic literature and interviews, Orser et al. (2019) conclude that there are systemic barriers that lead women-owned businesses to be smaller and to be less likely to have accumulated the knowledge or financing to adopt technology. For Canada, in the population of businesses at large, Grekou et al. (2018b) find that women-owned businesses are smaller than their men-owned counterparts. Huang and Rivard (2021) show that women-owned businesses are more likely to be discouraged borrowers—those that do not apply for financing because they expect their requests to be denied—than men-owned businesses. All these factors may contribute to the gender gap in terms of patenting behaviour and growth after patenting.

Data

The data source used in this study is the Canadian Patent Research Database (CPRD).¹ This database was created by linking the European Patent Office Worldwide Patent Statistical Database (PATSTAT)² to Statistics Canada's administrative data on firms. PATSTAT provides data on the patent applications of Canadian-resident businesses in Canada and also at IP offices around the world. While the CPRD contains several variables that describe the nature of the patent, the principal patent characteristic used in this study is the year of application.³ There is often more than one applicant on a patent application. In this study, if an application has more than one Canadian-resident business listed, each will be counted as having filed an application.⁴

The data from the CPRD are linked to Statistics Canada's administrative data on firms (corporations with or without employees and unincorporated businesses with employees), including the Canadian Employer–Employee Dynamics Database. Key variables that come from these administrative data are employment size, age of the business, industry, R&D expenditures, export activities, net income and gender of the business owner.⁵ The way in which the gender of a business owner is determined in the administrative data depends on whether the business is incorporated or unincorporated (Grekou et al., 2018a). When the gender of each owner is determined, the business is designated as women-owned, men-owned or equally owned, depending on ownership shares. A business is considered men-owned if the shares owned by one or more men are 51% or more. In many other papers, a women-owned business is defined likewise, and an equally owned business is when men and women own equal shares. However, given how infrequently firms patent,⁶ equally owned businesses are included with women-owned businesses. The overall results in this paper are unchanged when women-owned businesses are not combined with equally owned businesses, or when equally owned businesses are combined with men-owned businesses.

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1. See Abbes et al. (2022a) and Gibson and Leung (2023) for more information about the CPRD.
 2. See [European Patent Office Worldwide Patent Statistical Database](#).
 3. Applications at the World Intellectual Property Organization (WIPO) are not included in this study because WIPO is not a granting authority. After processing at WIPO, the application is transferred to a local patent office for examination. This study takes into account the WIPO applications when they are transferred to a local office to avoid double counting.
 4. In this case, the unit of observation is the business. In other words, the performance of a business after filing for a patent is tracked after each filing over the period examined.
 5. See [Business Research Microdata by the Canadian Research Data Centre Network](#) for examples of the types of administrative data that are available for research purposes.
 6. Abbes et al. (2023) showed that, from 2016 to 2019, an average of 2,416 firms per year filed a patent application. Of those, 54 were women-owned, 45 were equally owned, 519 were men-owned and the remainder were from businesses where gender of ownership could not be assigned.

The largest category of businesses among those that patent is the one in which it is not possible to assign a gender to the majority owner. For instance, in the 2014 cohort, 72.5% of businesses filing for a patent could not be assigned a gender of ownership. For many large businesses, such as government business enterprises, publicly traded firms and foreign-owned firms operating in Canada, ownership cannot be traced back to individuals. Furthermore, only owners with at least a 10% share in a Canadian-controlled private corporation are reported in the administrative source data. Because large firms with 500 or more employees account for a substantial proportion of patents (Abbes et al. [2022b] show that 42% of patents in 2001 were filed by large firms), a considerable share of patents is accounted for by firms where gender of ownership cannot be assigned.

This study examines the firm cohorts active in 2001 through to 2014. A firm is considered active if it had employees, revenues and assets in a given year. Firms that were ever classified in the public administration industry are excluded from the analysis. Each cohort is split between those that filed a patent application in the first year and those that did not. The cohort of firms is then followed for five subsequent years to examine whether there are differences in the survival probabilities, employment growth and revenue growth of firms that file applications and those that do not. For example, active firms in 2001 are followed up to 2006, and active firms in 2014 are followed up to 2019.

Firms that patent are more likely to remain active and have higher growth rates than firms that do not patent

Table 1 compares the survival rates and employment and revenue growth rates of firms that file for a patent in the first year, year t , with those of firms that do not. In this study, survival is defined as being active with employees, revenues and assets. The results show that 93.4% of firms that patent in year t survive until year $t+1$. By comparison, 90.1% of firms that do not patent survive until the following year. In subsequent years, fewer firms remain active. However, those that patent in the first year, year t , are more likely to remain active in subsequent years. Indeed, the difference in survival probabilities grows from 3.3 percentage points in year $t+1$ to 6.1 percentage points in year $t+5$. All differences are statistically significant.

Table 1
Survival rates and compound annual average growth rates of patent applicants and non-applicants

	$t+1$	$t+2$	$t+3$	$t+4$	$t+5$
	percent				
Non-applicants					
Survival rate	90.1	83.1	77.4	72.4	67.9
Employment growth	...	1.1	0.2	-0.1	-0.2
Revenue growth	...	5.8	3.9	3.2	2.7
Patent applicants					
Survival rate	93.4	87.7	82.6	78.3	74.0
Employment growth	...	8.0	4.9	3.7	3.0
Revenue growth	...	25.9	16.5	12.9	10.4

... not applicable

Sources: Statistics Canada, Canadian Patent Research Database and Canadian Employer–Employee Dynamics Database.

Table 1 also shows the employment and revenue growth rates of firms conditional on being active. Given the volatility in growth rates, the first rate shown is for year $t+2$. It is the compound annual growth rate for the period from year t to year $t+2$. The difference in growth rates between firms that patent in year t and those that do not is substantial. Firms that patent have a compound annual employment growth rate of 8.0% over the first two years, compared with 1.1% for firms that do not patent. The difference in revenue growth rates in $t+2$ is even larger, at 25.9% for firms that file a patent application in year t and 5.8% for firms that do not. These differences persist in subsequent years up to $t+5$, but at a declining rate. In year $t+5$, the compound annual employment and revenue growth rates for firms that file a patent application in year t are 3.0% and 10.4%, respectively. These compare with -0.2% and 2.7%, respectively, for firms that do not file a patent application in year t . The differences in employment and revenue growth rates are statistically significant between patent filers and non-filers.

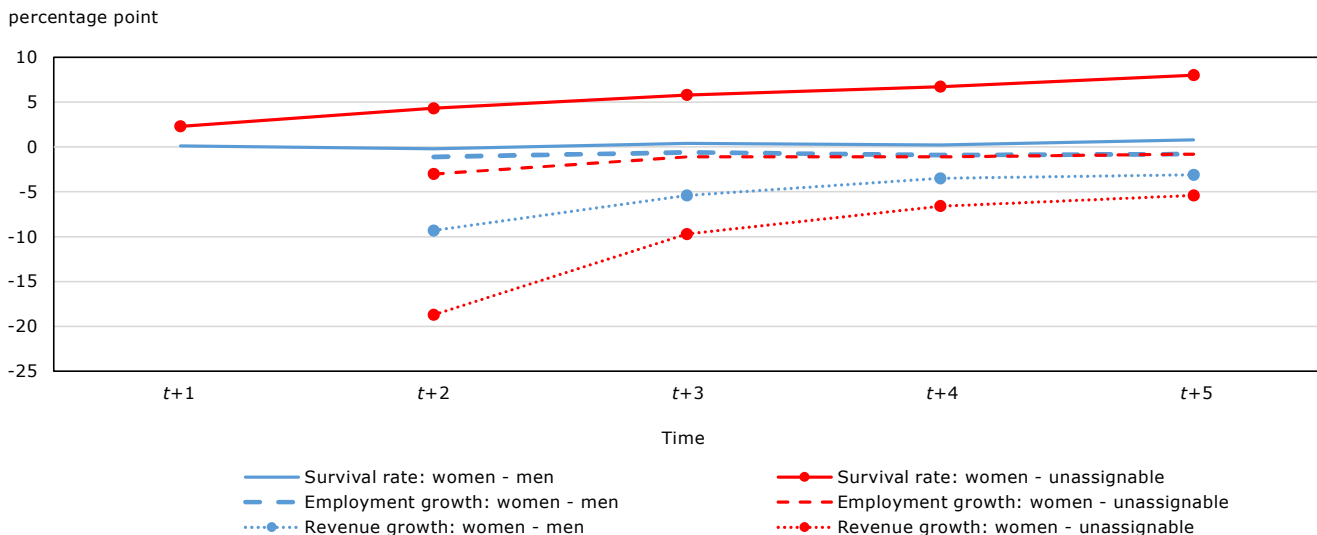
Women-owned businesses that patent have higher survival rates but lower revenue growth rates, compared with other firms that patent

On average, firms that patent have higher survival rates and higher employment and revenue growth rates than those that do not patent. There are, however, differences among businesses that patent. By tracking businesses that patent over time, Chart 1 shows that, compared with businesses where gender of ownership cannot be assigned, women-owned businesses are more likely to be active in the years after they file for a patent (t). In year $t+1$, the survival rate of women-owned businesses that patent is 2.3 percentage points higher than businesses where gender of ownership cannot be assigned. In subsequent years, this difference grows. By year $t+5$, there is an 8.0 percentage point gap in the survival rate of women-owned businesses and businesses that cannot be assigned a gender of ownership that patent in year t . These differences are statistically significant at the 5% level. By contrast, the small differences in survival rates between women-owned businesses that patent and men-owned businesses that patent are not statistically significant.

Although women-owned businesses that patent tend to have higher survival rates compared with businesses where gender of ownership cannot be assigned, they tend to have lower revenue growth rates, compared with men-owned businesses that patent and businesses with unassignable gender of ownership that patent. Two years after filing for a patent ($t+2$), women-owned businesses have a compound annual growth rate that is 18.7 percentage points lower than businesses with unassignable gender of ownership that patent, and 9.3 percentage points lower than men-owned businesses that patent. Over time, the difference in revenue growth rates becomes smaller. Over a five-year time horizon, the compound annual growth of women-owned businesses that patent is 3.1 percentage points less than that of men-owned businesses that patented, and 5.4 percentage points lower than that of businesses where gender of ownership cannot be assigned that patent. By contrast, the differences in employment growth rates between businesses that patent are generally not statistically significant.

Chart 1 focuses on differences between women-owned businesses and the other two groups. Differences between the other groups can be inferred as well. Given that the differences between women-owned businesses and men-owned businesses are smaller than the differences between women-owned businesses and businesses where gender of ownership cannot be assigned, it can be inferred that, among firms that file for a patent, the survival rates of men-owned businesses are slightly lower than those of women-owned businesses, but higher than those of businesses where gender of ownership cannot be assigned. Similarly, among firms that patent, men-owned firms have lower revenue growth than firms where gender of ownership cannot be assigned. Overall, Chart 1 shows that the gaps between men- and women-owned firms that patent are smaller than the gaps between firms where gender of ownership can and cannot be assigned.

Chart 1
Difference in survival and growth rates of businesses that file patent applications, women-owned businesses compared with men-owned businesses and businesses where gender of ownership cannot be assigned



Note: *t* : year when businesses file for a patent. The presence of a marker indicates that the difference is statistically significant at the 5% level.
Sources: Statistics Canada, Canadian Patent Research Database and Canadian Employer–Employee Dynamics Database.

Among patent filers, women-owned businesses are smaller and less likely to perform research and development, but more likely to be profitable

An examination of firms’ characteristics may shed light on differences in the performance of patent filers and non-filers, and differences in performance among patent filers. Table 2 presents the characteristics of patent applicants and non-applicants by ownership type. Compared with businesses that do not patent, patent applicants tend to be larger, are more likely to perform R&D and are more likely to be exporters. For example, in the business sector, women-owned firms that patent have, on average, 41.6 employees, compared with 5.7 employees in women-owned firms that do not patent. This difference is even larger among firms where gender of ownership cannot be assigned. For those firms, patent applicants have an average employment size of 678.6 employees, while non-applicants have an average size of 25.1. The differences in the propensity to conduct R&D and to export are equally stark between patent applicants and non-applicants. For example, 60.2% of women-owned businesses that patent also conduct R&D, compared with 1.2% for women-owned businesses that do not patent. Similarly, 47.6% of women-owned businesses that patent also export, compared with 5.9% of women-owned businesses that do not patent. Firm size has been linked to firm survival and growth (for example, Macdonald, 2012; Dixon and Rollin, 2012), and conducting R&D and exporting have been linked to growth (for example, Baldwin and Gu, 2003; Baldwin and Yan, 2015), so the differences in these characteristics may help explain the differences in the survival and performance of patent applicants and non-applicants. Interestingly, non-applicants are more likely to have positive profits than patent applicants. This finding could be related to the difference in size, as the average return on assets has been found to peak at 5 to 20 employees and decline thereafter (Lafrance, 2012). It could also be related to patent applicants’ focus on making investments with a view to future growth, at the expense of current profitability.

Table 2
Characteristics of patent applicants and non-applicants by ownership type

	Average age years	Average employment number	R&D performer	Exporter percent	Positive profits
Non-applicants					
Men-owned	12.1	7.3	2.7	3.9	68.5
Women-owned	10.6	5.7	1.2	2.3	65.6
Gender unassignable	11.6	25.1	3.9	5.9	64.0
Patent applicants					
Men-owned	12.3	47.9	76.2	51.9	58.2
Women-owned	12.2	41.6	60.2	47.6	65.3
Gender unassignable	9.6	678.6	76.4	57.0	47.8

Note: R&D stands for research and development.

Sources: Statistics Canada, Canadian Patent Research Database and Canadian Employer–Employee Dynamics Database.

The differences in characteristics among patent filers are less stark than between filers and non-filers. Among patent applicants, businesses for which gender of ownership cannot be assigned are younger and have more employees than women- or men-owned businesses. Larger firms tend to have higher survival rates, but younger firms tend to have lower survival rates, so it is an empirical question whether the combination of the two characteristics can explain the lower survival rates for businesses where gender of ownership cannot be assigned. Businesses where gender of ownership cannot be assigned are more likely to perform R&D and export. For example, among firms that patent, 76.4% of businesses where gender of ownership cannot be assigned perform R&D and 57.0% are exporters, while the percentages for women-owned businesses are 60.2% and 47.6%, respectively. The percentages for men-owned businesses fall between those of women-owned businesses and businesses with unassignable gender of ownership. These patterns are consistent with businesses with unassignable gender of ownership having the highest growth rates, followed by men-owned businesses and then by women-owned businesses. Businesses where gender of ownership cannot be identified are the least likely to have positive profits (47.8% compared with 58.2% for men-owned businesses and 65.3% for women-owned businesses). Again, this could be associated with their employment, but also with their growth focus, as evidenced by their highest propensity to conduct R&D. However, a business that is not profitable is more likely to exit.

Among patent filers, differences in the survival and revenue growth rates between women-owned businesses and other businesses persist, even after controlling for firm size, age, industry, research and development performance, exporter status, and profitability

In this section, the study examines whether the differences seen in Chart 1 can be accounted for by the firm characteristics in Table 2. To do this, a series of multivariate regressions are performed, one for each dependent variable (probability of survival, employment growth and revenue growth) and year after combination. Specifically, the study estimates the following:

$$Active_{i,t+\tau} = \begin{cases} 1 & \text{if } \alpha_0'X_{i,t} + \alpha_1 patent_{i,t} MOB_{i,t} + \alpha_2 patent_{i,t} WOB_{i,t} \\ & + \alpha_3 patent_{i,t} Unassignable_{i,t} + \alpha_4 MOB_{i,t} + \alpha_5 WOB_{i,t} + \varepsilon_{i,t+\tau}^1 > 0 \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

$$\% \Delta Emp_{i,t+\tau} = \beta_0'X_{i,t} + \beta_1 patent_{i,t} MOB_{i,t} + \beta_2 patent_{i,t} WOB_{i,t} + \beta_3 patent_{i,t} Unassignable_{i,t} + \beta_4 MOB_{i,t} + \beta_5 WOB_{i,t} + \varepsilon_{i,t+\tau}^2 \quad (2)$$

$$\% \Delta Rev_{i,t+\tau} = \gamma_0'X_{i,t} + \gamma_1 patent_{i,t} MOB_{i,t} + \gamma_2 patent_{i,t} WOB_{i,t} + \gamma_3 patent_{i,t} Unassignable_{i,t} + \gamma_4 MOB_{i,t} + \gamma_5 WOB_{i,t} + \varepsilon_{i,t+\tau}^3 \quad (3)$$

Equation (1) represents a series of probit regressions where the dependent variable, *Active*, takes the value of 1 if business *i* has employees, revenues and assets in year $t + \tau$, and 0 otherwise. *X* is a vector of firm characteristics, including age; employment size; categorical variables indicating whether a firm is an exporter, an R&D performer and profitable; and a set of industry categorical variables at the two-digit North American Industry Classification System level. The characteristics are measured at time *t* and used to analyze whether they have an impact on whether a firm is active one to five years into the future. Of particular interest are the impacts of filing a patent (*patent*) at time *t*, being a men-owned business (*MOB*) and being a women-owned business (*WOB*); the difference in the impact of patenting between women- and men-owned businesses ($\alpha_2 - \alpha_1$); and the difference in the impact of patenting between women-owned businesses and businesses where gender of ownership cannot be assigned ($\alpha_2 - \alpha_3$).

Equations (2) and (3) are similar, except that the dependent variables are the compound annual growth rates for employment growth and revenue growth, respectively. As in the case of Chart 1, the regressions are run starting from $t+2$ to $t+5$, as the average over time helps to deal with the volatility or potentially large fluctuations in the growth rates.

Table 3 presents the estimated regression coefficients, or marginal impacts in the case of equation (1), for each of the dependent variables for the fifth year ($t+5$) after the characteristics of the firm are taken into account, as well as whether the firm files for a patent in year *t*. Compared with businesses where gender of ownership cannot be assigned, a women-owned business has a 4.9 percentage point higher probability of being active after five years than a business where gender of ownership cannot be assigned. By comparison, women-owned businesses have a 1.7 percentage point lower (4.9 minus 6.6) probability of being active after five years than men-owned businesses, after controlling for some observable characteristics of the firm. Interestingly, women-owned businesses are the only ones where patenting has a positive impact on survival after five years. If a women-owned business files a patent application in year *t*, it has a 4.3 percentage point higher probability of being active in year $t+5$, compared with a non-filer. By comparison, the impact of patenting for a men-owned business is not significantly different from zero in year $t+5$. For a business where gender of ownership cannot be assigned, filing for a patent in year *t* is associated with a 1.6 percentage point lower probability of being active in year $t+5$.

Table 3
Marginal impact on survival and growth rates five years after patent application

	Survival		Employment growth		Revenue growth	
	coefficient	p-value	coefficient	p-value	coefficient	p-value
Patent x men-owned	0.08	0.926	2.14	0.000	4.84	0.000
Patent x women-owned	4.33	0.020	2.11	0.012	3.60	0.000
Patent x gender unassignable	-1.62	0.000	1.18	0.000	5.41	0.000
Men-owned	6.55	0.000	-1.07	0.000	-0.97	0.000
Women-owned	4.89	0.000	-1.51	0.000	-1.82	0.000
R&D performer	2.40	0.000	2.82	0.000	3.56	0.000
Exporter	6.47	0.000	0.12	0.000	-0.51	0.000
Profitable	12.65	0.000	1.40	0.000	-1.86	0.000
Age categories (1 to 2 years omitted)						
3 to 4 years	1.07	0.000	-1.96	0.000	-2.49	0.000
5 to 10 years	3.77	0.000	-3.16	0.000	-4.08	0.000
11 to 20 years	6.23	0.000	-4.10	0.000	-5.37	0.000
Over 20 years	4.79	0.000	-4.59	0.000	-5.90	0.000
Firm size categories (5 employees and under omitted)						
6 to 20 employees	11.75	0.000	-2.23	0.000	-0.03	0.000
21 to 100 employees	12.35	0.000	-3.81	0.000	0.00	0.000
101 to 500 employees	8.47	0.000	-5.71	0.000	-0.85	0.000
More than 500 employees	5.55	0.000	-7.15	0.000	-2.52	0.000

Note: R&D stands for research and development.

Sources: Statistics Canada, Canadian Patent Research Database and Canadian Employer–Employee Dynamics Database.

Table 1 showed that firms that patent have a higher chance of survival than firms that do not patent. However, that was before other observable characteristics were considered. The correlation between survival and patenting may have been capturing the impact of other variables on survival, like R&D and firm size, both of which are positively associated with patenting and firm survival. Also, the study looks only at whether a firm patents or not. The quality of the patent is not considered. A patent can be associated with a completely new invention, or it could be part of a family of patents and represent a more incremental innovation. Another patent characteristic that is not considered is riskiness. Not all innovations are successful, and some innovative activities may be associated with more risk than others. For example, Buddelmeyer et al. (2009) show that more radical, risky innovations, like patents, are associated with a lower chance of survival, while less risky innovations, like applications for a trademark, are associated with a higher chance of survival. The businesses where gender of ownership cannot be assigned that are larger and more diversified in ownership may be patenting in riskier areas.

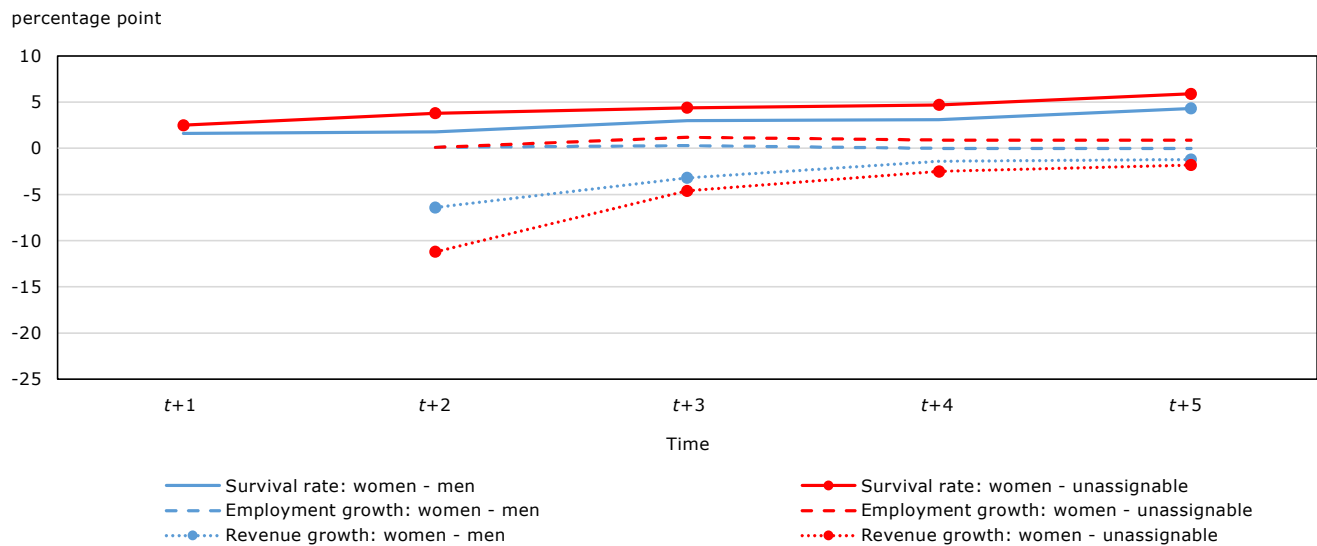
Lastly, measuring the end of operations as no employment, revenue or assets does not capture the heterogeneity in the type of exit.⁷ For example, the business may have truly exited and ceased to exist, or it may have been acquired by another business with a better ability to grow and scale the operations. In the latter case, the exit represents a success rather than a failure. Indeed, Kato et al. (2022) find that Japanese firms with a greater patent stock (measured by citation-weighted number of applications or grants) are more likely to exit by merger. Grazzi et al. (2022) show that patents decrease the probability of involuntary exit and exit through a merger and acquisition among Italian firms, but the impact on involuntary exit is greater.

7. See Cefis et al. (2022) for a recent literature review on the variety of business exit routes and key determinants.

The estimated marginal effects for the other variables are as expected. R&D performers in year t have a 2.4 percentage point higher survival rate than non-performers in year $t+5$, while exporters have a 6.47 percentage point higher survival rate than non-exporters. Firms with positive profits have a 12.65 percentage point higher survival rate than firms that are not profitable, and younger firms tend to have lower survival rates. Lastly, the survival rates by employment size of firm exhibit the same inverted u-shape as found by Lafrance (2012).

The equations can be estimated for each of the periods, $t+1$ through to $t+5$, and the estimated coefficients can be used to reproduce Chart 1, after controlling for firm characteristics. The results are shown in Chart 2. For the survival probabilities, the main conclusion is similar to that in Chart 1. Women-owned businesses have statistically significant higher survival probabilities compared with businesses where gender of ownership cannot be assigned in the five years following the filing of a patent application. The difference grows over time, from 2.5 percentage points in $t+1$ to 5.9 percentage points in $t+5$. These differences are generally smaller than those in Chart 1 that did not control for firm characteristics, suggesting that the older age of women-owned businesses and the fact that they are more likely to be profitable explain some of the raw gap in Chart 1. The point estimates of the differences in survival probabilities between women- and men-owned firms become larger after controlling for firm characteristics. For the most part, they remain statistically insignificant, except in $t+5$, where there is a 4.3 percentage point gap in favour of women-owned businesses. Thus, after considering the fact that men-owned firms that patent are larger, older, more likely to perform R&D and more likely to export than women-owned firms—factors that predict a higher chance of remaining active—there is a greater unexplained difference between women- and men-owned firms in survival five years after filing a patent application.

Chart 2
Difference in marginal impact of filing for a patent on survival and growth rates of businesses, women-owned businesses compared with men-owned businesses and businesses where gender of ownership cannot be assigned



Note: t : year when businesses file for a patent. The presence of a marker indicates that the difference is statistically significant at the 5% level.
Sources: Statistics Canada, Canadian Patent Research Database and Canadian Employer–Employee Dynamics Database.

Regarding the regression coefficients on employment growth from equation (2), patenting is associated with a compound annual employment growth rate that is 1.2 to 2.1 percentage points higher over a five-year period, depending on ownership type. The difference between types, however, is not statistically significant. Thus, controlling for firm characteristics does not alter the results in Chart 1. Moreover,

younger and smaller firms have higher growth rates, as do firms that conduct R&D, export and are profitable. Both women- and men-owned businesses have lower employment growth, compared with firms where gender of ownership cannot be assigned. This may be associated with foreign ownership and with a greater ability to access the resources needed to scale up if successful.

Regarding revenue growth (equation [3]), businesses that patent also have higher compound annual growth for five years after filing. The advantage is 3.6 percentage points for women-owned businesses, 4.8 percentage points for men-owned businesses and 5.4 percentage points for businesses where gender of ownership cannot be assigned. The patents that businesses with unassignable gender of ownership apply for may involve higher risk (as suggested by their lower survival probabilities), but the benefit is that they have a higher reward if the business survives, as shown by the result related to higher revenue for this category. The differences between women-owned businesses and businesses with other types of ownership are statistically significant. Comparing Chart 1 with Chart 2 shows that controlling for firm characteristics reduces the revenue growth gap between women-owned businesses and those with other ownership types. In Chart 1, the difference in the compound annual revenue growth between women- and men-owned businesses ranges from -9.3 percentage points over the first two years after patenting to -3.1 percentage points over five years, while the difference between women-owned businesses and businesses with unassignable gender of ownership is -18.7 percentage points over two years and -5.4 percentage points over five years. By contrast, when firm characteristics are taken into account, the gaps become smaller, at -6.4 to -1.2 percentage points and -11.2 to -1.8 percentage points, respectively.

Women-owned firms that apply for patents are less likely to experience high revenue growth rates than men-owned firms

Chart 1 showed that women-owned businesses that apply for a patent have lower revenue growth rates, compared with their men-owned counterparts and businesses for which gender of ownership cannot be assigned. The estimated marginal effects in Table 3 suggest that these differences persist after controlling for observable firm characteristics. One possible explanation was the quality or riskiness of the invention being patented. While this paper does not take these characteristics into account, some suggestive evidence could be obtained by examining the distribution of revenue growth rates. Table 4 shows that the mean compound average revenue growth rate for women-owned businesses that patent is lower, as is the median. However, the differences in the medians are not as large as the differences in the means. This suggests that the distribution of growth rates for women-owned businesses that patent is less skewed to the left. Indeed, the skewness and kurtosis characteristics suggest that women-owned businesses that patent have a lower probability of experiencing higher growth rates, compared with other firms that patent, but a higher probability compared with non-applicants.

Table 4
Characteristics of the revenue growth distribution

	Mean	Median	Skewness	Kurtosis
	percent		number	
Patent applicants	10.4	5.2	4.2	46.2
Men-owned	8.9	5.1	3.6	31.2
Women-owned	5.8	3.5	2.2	18.4
Gender unassignable	11.2	5.3	4.2	46.3
Non-applicants	2.7	2.1	1.6	26.7

Note: Revenue growth is the compound annual growth rate over a period of five years.

Sources: Statistics Canada, Canadian Patent Research Database and Canadian Employer–Employee Dynamics Database.

Women-owned firms that apply for patents are less likely to experience an exit through an acquisition

This section examines one of the possible explanations for the higher survival rates of women-owned businesses that patent: whether the exit is associated with an event that results in the continuation of the firm in another form (e.g., merger and acquisition). Up to now, firms have been tracked over time, based on the identifiers assigned to them in the administrative data by the Canada Revenue Agency (i.e., Business Number) and Statistics Canada (i.e., Statistical Enterprise Number). At times, a business may experience a change in its identifier, which could be triggered by a change in ownership—such as a merger and acquisition—or other administrative changes. By following workers from firms whose identifiers stopped being used to new (start-up) or existing firms, it is possible to develop an indicator to track firms through these life changes and remove “false” exits (Baldwin et al., 2018). This activity occurs for under 5,000 firms on an annual basis.

Once the possibility of a firm continuing⁸ in this manner is considered, the differences between the survival rates of firms that apply for patents and those that do not apply for patents grow (tables 1 and 5). For example, the difference in survival rates adjusted for false exits (i.e., firms that experienced a change in their identifier but remained active) between patent applicants and non-applicants five years after filing is 11.6 percentage points (80.7% versus 69.1%). By comparison, the difference in the non-adjusted survival rates in Table 1 is 6.1 percentage points (74.0% versus 67.9%). Accounting for false exits raises the survival rates for both types of firms, but more so for patent applicants.

In addition, Table 5 now shows that the survival rates of businesses of different ownership types are similar. Accounting for false exits raises the survival rates of businesses where gender of ownership cannot be assigned more than for the other business types. In other words, businesses with unassignable gender of ownership are likely to have experienced a merger or acquisition. Accounting for differences in other business characteristics does not change this finding.

8. For this analysis, if there is a change in a firm’s gender of ownership after an acquisition, it is not explored in this study.

Table 5
Survival rates adjusted for mergers and acquisitions

	t+1	t+2	t+3	t+4	t+5
	percent				
Patent applicants	0.952	0.910	0.872	0.839	0.807
Men-owned	0.955	0.918	0.883	0.853	0.823
Women-owned	0.952	0.912	0.873	0.839	0.810
Gender unassignable	0.951	0.908	0.869	0.835	0.803
Non-applicants	0.905	0.838	0.783	0.735	0.691

Sources: Statistics Canada, Canadian Patent Research Database and Canadian Employer–Employee Dynamics Database.

Conclusion

This study compares the performance of women-owned firms that patent with that of men-owned firms and firms for which gender of ownership cannot be assigned. There is evidence to suggest that women-owned firms that patent have higher survival rates but lower revenue growth rates, compared with businesses where gender of ownership cannot be assigned. Businesses where gender of ownership cannot be assigned are those where ownership is more diverse, such as publicly traded enterprises, foreign-owned firms and private corporations, where there are many owners with less than a 10% ownership share who are therefore not recorded in the administrative data. The differences are statistically significant and exist before and after controlling for firm characteristics but are smaller in magnitude when the characteristics are taken into account.

By comparison, the differences between women-owned businesses and men-owned businesses are smaller. The evidence suggests that women-owned businesses have a similar survival rate as men-owned businesses after filing for a patent and that women-owned businesses that patent have lower revenue growth rates than men-owned businesses.

There is evidence to suggest that the different survival probabilities of men-owned businesses and businesses with unassignable gender of ownership may be related to their different exit strategies. They are more likely to experience administrative changes in their business structure that could be interpreted as an acquisition.

The differences in revenue growth suggest that there may be differences in the quality of inventions or that some previously documented differences between men- and women-owned businesses (i.e., access to financing and knowledge-building opportunities) affect the type of inventions that women-owned businesses make and their ability to successfully commercialize their inventions. Overall, the findings support the need for policies that take gender into account.

References

- Abbes, C., Baldwin, J., Gibson, R., & Leung, D. (2022a). *Canadian Patent Research Database*. (Analytical Studies: Methods and References, No. 42) Statistics Canada.
- Abbes, C., Baldwin, J., & Leung, D. (2022b). Patenting activity of Canadian resident businesses. *Economic and Social Reports*, 2(3). <https://doi.org/10.25318/36280001202200300005-eng>
- Abbes, C., Lafrance-Cooke, A., & Leung, D. (2023). Patenting activity of women-owned businesses in Canada. *Economic and Social Reports*, 3(2). <https://doi.org/10.25318/36280001202300200003-eng>
- Baldwin, J., & Gu, W. (2003). Export-Market Participation and Productivity Performance in Canadian Manufacturing. *The Canadian Journal of Economics*, 36(3), 634-657.
- Baldwin, J., Leung, D., & Rollin, A. (2018). "Developing and Using Longitudinal Business Data in Canada." in Guidelines on the use of statistical business registers for business demography and entrepreneurship statistics. United Nations Economic Commission for Europe. New York and Geneva, 129-138. <https://www.unece.org/fileadmin/DAM/stats/publications/2018/ECECESSTAT20185.pdf>
- Baldwin, J., & Yan, B. (2015). *Empirical Evidence from Canadian Firm-level Data on the Relationship Between Trade and Productivity Performance*. (Economic Analysis Research Paper Series, No. 97). <https://www150.statcan.gc.ca/n1/pub/11f0027m/11f0027m2015097-eng.htm>
- Buddelmeyer, H., Jensen, P., & Webster, E. (2009). Innovation and the Determinants of Company Survival. *Oxford Economic Papers*, 62(2), 261-285.
- Cefis, E., Bettinelli, C., Coad, A., & Marsilli, O. (2022). Understanding Firm Exit: A Systematic Literature Review. *Small Business Economics*, 59: 423-446.
- Collette, E., & Santilli, D. (2019). *IP Canada Report 2019*. Innovation, Science and Economic Development Canada – Canadian Intellectual Property Office. <https://ised-isde.canada.ca/site/canadian-intellectual-property-office/en/ip-canada-report-2019>
- Dixon, J., & Rollin, A.-M. (2012). *Firm Dynamics: Employment Growth Rates of Small Versus Large Firms in Canada*. (The Canadian Economy in Transition Series, No. 025) Statistics Canada. <https://www150.statcan.gc.ca/n1/pub/11-622-m/11-622-m2012025-eng.htm>
- Gibson, R., & Leung, D. (2023). *Canadian Patent Research Database 2001 to 2019*. (Analytical Studies: Methods and References, No. 47) Statistics Canada.
- Government of Canada. (2021). *What is a Patent?* <https://ised-isde.canada.ca/site/canadian-intellectual-property-office/en/patents/what-patent>
- Government of Canada. (2018). *Budget 2018*. <https://www.budget.canada.ca/2018/docs/plan/budget-2018-en.pdf>
- Grazzi, M., Piccardo, C., & Vergari, C. (2022). *Turmoil Over the Crisis: Innovation Capabilities and Firm Exit*. *Small Business Economics*, 59: 537-564.
- Grekou, D., Li, J., & Liu, H. (2018a). *The Measurement of Business Ownership by Gender in the Canadian Employer–Employee Dynamics Database*. (Analytical Studies: Methods and References, No. 17) Statistics Canada. <https://www150.statcan.gc.ca/n1/pub/11-633-x/11-633-x2018017-eng.htm>

- Grekou, D., Li, J., & Liu, H. (2018b). *Women-owned Enterprises in Canada*. (Economic Insights, No. 083) Statistics Canada. <https://www150.statcan.gc.ca/n1/pub/11-626-x/11-626-x2018083-eng.htm>
- Gu, W. (2018). *Accounting for Slower Productivity Growth in the Canadian Business Sector After 2000: Do Measurement Issues Matter?* (Analytical Studies Branch Research Paper Series, No. 409) Statistics Canada. <https://www150.statcan.gc.ca/n1/pub/11f0019m/11f0019m2018409-eng.htm>
- Gu, W., & Macdonald, R. (2020). *Business Sector Intangible Capital and Sources of Labour Productivity Growth in Canada*. (Analytical Studies Branch Research Paper Series, No. 442) Statistics Canada. <https://www150.statcan.gc.ca/n1/pub/11f0019m/11f0019m2020005-eng.htm>
- Huang, L., & Rivard, P. (2021). *Financing of Women-owned Small and Medium-sized Enterprises in Canada*. Innovation, Science and Economic Development Canada.
- Kato, M., Onishi, K., & Honjo, Y. (2022). Does Patenting Always Help New Firm Survival? Understanding Heterogeneity Among Exit Routes. *Small Business Economics*, 59: 449-475.
- Lafrance, A. (2012). *Firm Dynamics: Variation in Profitability Across Canadian Firms of Different Sizes, 2000 to 2009*. (The Canadian Economy in Transition Series, No. 026) Statistics Canada. <https://www150.statcan.gc.ca/n1/pub/11-622-m/11-622-m2012026-eng.htm>
- Macdonald, R. (2012). *Firm Dynamics: The Death of New Canadian Firms: A Survival Analysis of the 2002 Cohort of Entrants to the Business Sector*. (The Canadian Economy in Transition Series, No. 028) Statistics Canada. <https://www150.statcan.gc.ca/n1/pub/11-622-m/11-622-m2012028-eng.htm>
- Orser, B., Riding, A., & Li, Y. (2019). Technology adoption and gender-inclusive entrepreneurship education and training. *International Journal of Gender and Entrepreneurship*. 11(3): 273-298.
- Statistics Canada. (2021). Table 33-10-0271-01 Intellectual property awareness and use, by business characteristics (Data table). <https://doi.org/10.25318/3310027101-eng>
- Williams-Baron, E., Milli, J., & Gault, B. (2018). *Innovation and Intellectual Property Among Women Entrepreneurs*. Institute for Women's Policy Research. https://iwpr.org/wp-content/uploads/2020/10/C472_Report-Innovation-and-Entrepreneurship-9.6.18-clean.pdf