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Innovation in immigrant-owned firms

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Abstract We use data from a nationally representative survey of Canadian firms in 2011, 2014 and 2017 and ask whether immigrant-owned small- and medium-sized firms were more likely than those owned by Canadian-born individuals to implement an innovation. We examined the likelihood of implementing product, process, organizational and marketing innovations, and five types of intellectual property: registered trademarks, patents, registered industrial designs, trade secrets and non-disclosure agreements. The methodology consists of using a coarsened exact matching (CEM) followed by a probit-based analysis to control for both firm and owner characteristics. Both adjusted and unadjusted results indicate that an immigrant-owned firm was more likely to implement a product or process innovation, regardless of whether the immigrant owner was a recent or longer tenured immigrant.

Keywords Immigrants · Firm owners · SME · Innovation · Matching

JEL classification J15 · L26 · M21

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1 Introduction

Innovation has a positive impact on firm performance. This conclusion has been confirmed by numerous studies over the past three decades (see Chen 2017 and Kleinknecht and Mohen 2002, for literature reviews; and Baldwin and Hanel 2003, for a wide-ranging discussion of the innovation process and its effects). The finding is robust and widespread. It has been confirmed for both manufacturing and service sector industries (Salavou 2002; Prajogo 2006), for both large and small firms (Baldwin 1995; Kleinknecht and Mohen 2002), for Fortune 1000 companies (Cho and Pucik 2005) and for firms in numerous countries. Product innovations can positively influence sales growth and market share. Process innovations can lead to increases in productivity. These factors can lead to higher profitability and potentially greater employment growth. In Canada, almost a quarter century ago, Baldwin (1995) found that, among the many factors that could potentially affect the performance of small and medium-sized enterprises (SME), innovation activities played the biggest role in explaining the differences between the more and less successful companies. He concluded that innovation was a key to success in small firms.

The main objective of this study is to determine whether the immigration status of the owner of an SME affects the likelihood of a company implementing an innovation. Our goal is to contribute to the knowledge base in two research areas: the determinants of

innovation and the economic contribution of immigrants. Given the recent high levels of immigration in most Western countries, including Canada, the effect of immigrants on the economy is an important issue for politicians, academics and policy researchers, the business community and the population as a whole. Researchers often address this issue by taking a broad aggregate approach that focuses on the effect of immigration on GDP or GDP per capita. Alternatively, many projects assess the effect of immigration on a particular economic component, such as employment, wages, productivity, trade and, in our case, innovation. As will be discussed in the next section, a number of recent research papers tackled the issue of immigrants and innovation by focusing on patent filing (a proxy for innovation) by individual immigrants. The novelty of this paper, and its contribution to the literature, is the fact that it is one of the very few to address this issue from the perspective of the firm. Innovation occurs within a firm context. We use measures of innovation and intellectual property that provide a much broader perspective of the innovation process than a focus on patents alone.

Regarding the contribution to the literature on the determinants of innovation, the characteristics of the owner or major decision-maker of a firm—such as immigration status—can influence the likelihood of implementing an innovation, particularly in SMEs where a single individual can exert considerable influence. Few papers have had the data necessary to address the effect of owner characteristics on innovation. This paper contributes to filling that research gap.

2 Background and literature review

2.1 Earlier research on innovation in firms

There are numerous reasons to believe that the immigration status of the owner of a firm may affect innovation decisions. However, before the details of this research can be addressed, it is necessary to better understand the context within which this effect may operate.

Much of the research on innovation in firms, particularly European research, uses the OECD Oslo Manual (OECD 2018) definition of innovation, first published in 1992. This manual is an international reference guide that presents guidelines for collecting and using data on innovation in businesses. The richness of the research based on the early innovation surveys is demonstrated in Baldwin and Hanel (2003), which addresses many innovation-related issues. The OECD manual lays out four types of innovation: product, process, organizational and marketing. Some research has suggested that all four types "are more or less positively and significantly associated with some aspects of firm performance" (Gunday et al. 2011). All four types are important, although much of the research tends to focus on the effects of product and perhaps process innovations. The outcome variables used in this paper include all four types of innovation, as well as five types of intellectual property.

Traditional research has focused on firm characteristics as the major determinants of the innovation level of a firm (see Kleinknecht and Mohen 2002 for examples of this research). Generally speaking, firm size is seen as important, with larger firms being more likely to implement an innovation (e.g. De Mel et al. 2009).[1] Past demand growth is also seen as an important determinant as it has a "demand-pull" effect: the greater the past demand and expected future growth, the higher the probability of a firm implementing an innovation. Sources of knowledge and technological collaboration are also seen as important. The level of R&D, the degree of R&D outsourcing and outside collaboration regarding knowledge acquisition are seen to be positively associated with the likelihood of implementing an innovation, particularly a product innovation. The degree of competition—or market structure—is often also seen as a potential determinant, but the research appears to be mixed regarding the importance of this variable. While some studies found a weak positive effect of competition (e.g. Kleinknecht and Mohen 2002), others found a weak negative effect (De Mel et al. 2009). The industry in which the firm operates can also play a role. For example, firms in KBIS tend to have higher innovation rates. However, at a broader level, Prajogo (2006) found no difference between manufacturing and service sector firms in either the product or process innovation rates.

Beyond firm characteristics, the characteristics of the owner/major decision-maker may also influence innovation behaviour. This may be particularly true for smaller firms, where such individuals have significant influence. However, there is little research on this topic. De Mel et al. (2009) examined both firm and owner characteristics as determinants of the four types of

[1] Although, given the large number of small firms, most patents originate in the small firm sector.

innovation. They not only confirmed many of the earlier findings regarding the effect of firm characteristics on innovation but also concluded that the owner characteristics played a role, particularly the educational attainment of the owner, even after controlling for firm size and other firm characteristics. The positive correlation between educational attainment and the likelihood of implementing an innovation was observed for all four types of innovation. This research was conducted using a large sample of SMEs in a developing country (Sri Lanka), but the authors argued that the theoretical model they developed was applicable to both developed and developing countries. However, it is unclear whether the empirical results would be applicable to developed nations.

2.2 Research on immigrants and innovation

There are a number of reasons why the immigration status of the owner or major decision-maker in an SME might be correlated with the likelihood of implementing an innovation. Recent research in labour economics, primarily from the USA, has focused on immigrants and patent filing, which is used as a proxy for innovation. The main question posed is whether high-skilled immigrants contributed disproportionately to the innovative output in the recent past. The research suggests that the answer is yes. Immigrants accounted for 24% of patents in the USA, twice their share in the population (Hunt and Gauthier-Loiselle 2010). Many other studies have come to a similar conclusion, including Kerr (2013) and Kerr and Lincoln (2010). According to the research, the disproportionate patent filing by immigrants (compared with the US-born population) is primarily the result of immigrants being much more likely than their US-born counterparts to be educated in STEM fields that are associated with patent filing, such as engineering and science. These educational choices among immigrants can explain most of the patent filing difference between highly educated immigrants and their US-born counterparts (Hunt and Gauthier-Loiselle 2010; Kerr 2013).

The relationship between immigration status and patent filing may differ by country for a number of reasons, including differences in the types of immigrants, in the immigrant selection process and in where the immigrants were educated. There is very little recent Canadian research on the topic of immigrants and patent filing, with only two studies in circulation. A recent study by Blit et al. (2019) found that the impact of Canadian skilled immigration on patent rates has been relatively modest compared with the USA. They show that an increase in the Canadian-born highly skilled population would increase patents more than a comparable increase in highly skilled immigrants.

Another study by the same authors, Blit et al. (2018), used a very different methodology to examine patent filing rates by ethnic minorities in Canada (regardless of whether they were immigrants or Canadian-born). They found that some ethnic groups, notably those with Korean, Japanese or Chinese ancestry, did display higher than average patent filing rates. Most of this advantage could be explained by the higher proportions of people in those groups with high levels of education and STEM occupations, similar to the US findings.

In summary, the international evidence suggests that immigrants contribute disproportionately to patent filing compared with the native-born population although the results for Canada are somewhat mixed. The explanation for this disproportionate contribution by immigrants seems to be related primarily to their educational choice and their level of educational attainment. Since immigrants appear more likely than native-born individuals to contribute to patent filing, one might also expect that immigrants who become business owners are more likely to innovate than Canadian-born business owners.

3 Conceptual framework: immigrant entrepreneurs and firm innovation

The innovation process is seen somewhat differently in the business or industrial organization literature than in the labour economics literature mentioned above, where patent filing is seen as a proxy for innovation. Patents can be seen as reflecting a form of *invention* that focuses on the development of new ideas, whereas *innovation* can be seen as the development of commercially viable products, services or processes derived from creative ideas.[2] The comprehensive 255-page OECD Oslo Manual emphasizes the key difference between an invention and innovation: unlike an invention, an innovation

[2] However, patent filing and innovation activity are positively correlated (Artz et al. 2010). Baldwin et al. (2017) assessed the intensity of innovation and found that the number of firms reporting innovation, R&D and patent intensity were clearly all related at the industry level. Using patents as a proxy for innovation appears to have some validity. However, it does present a very narrow view of innovation.

requires implementation. Although the concept of innovation is necessarily subjective, "its application is rendered fairly objective and comparable by applying common reference points for novelty and utility" (OECD 2018, p. 20). The Manual defines a business innovation as "a new or improved product or business process (or combination thereof) that differs significantly from the firm's previous products or business processes and that has been introduced on the market or brought into use by the firm" (p. 20).[3] This definition leads to a taxonomy of innovation consisting of the four types of innovation listed above: product, process, organizational and marketing. The OECD Oslo Manual taxonomy of innovation is the key building block for most recent innovation surveys, and it is also utilized in the survey data employed in this study and described in the data section.[4]

Importantly, an innovation does not have to be new to the market or the economy, only to the firm. The value of an innovation is in the fact that it is the main force behind the diffusion of ideas. Although the goal of an innovation is to benefit the firm implementing the innovation and to improve its economic performance, innovations implemented by individual firms create knowledge spillovers leading to higher productivity and more rapid economic growth, which is an important policy goal. By making knowledge more widely available, innovation stimulates new ideas and further facilitates new knowledge.

The key input in any innovation activity is the knowledge and human capital accumulated by the firm (Acs et al. 2002). Knowledge is necessary to improve or introduce new production methods and develop new products. However, the value of any knowledge is different for different firms. This fact underscores an important behavioural aspect of innovation activity: risk-taking. By implementing an innovation, a firm takes an economic risk as the costs and benefits of an innovation are often uncertain and can be assessed only after the implementation.

Our conceptual framework emphasizes both the human capital (knowledge) and behavioural (risk-taking) aspects of innovation mentioned above. The human capital of an SME owner is a key contributing factor in the aggregate human capital of an SME. Recent studies found that immigrant SME owners are more highly educated than Canadian-born owners (Ostrovsky et al. 2019). As noted above, previous research has shown that educational attainment had a positive effect on the likelihood of implementing an innovation, an effect that we confirm in this study. Not only are immigrants more highly educated, but among the university educated, they are twice as likely as the highly educated Canadian-born to be educated in a STEM field (Picot and Hou 2019). This may also increase the likelihood of immigrant business owners implementing an innovation. We recognize the importance of adjusting for owner's human capital characteristics in our study by matching treated and control SMEs on a rich set of their observed characteristics including the level of the owner's educational attainment.[5]

In addition, an immigrant effect may reflect immigrant-specific differences in the human capital of immigrant and native firm owners. For instance, unlike native owners, immigrant owners have the experience of immigration.[6] They have the experience of establishing themselves in the new country and adjusting to a different social and economic environment, and these skills may enhance their human capital and contribute to their ability to innovate. In contrast to other aspects of human capital (education, work experience, etc.), immigration experience cannot be acquired by natives and, in the absence of other differences between immigrant and native firm owners, it will manifest itself in the immigrant ownership effect.

Immigrant SME ownership may have an effect on innovation if immigrant owners benefit from immigrants' networks and their involvement in international trade. Immigrant owners tend to have higher levels of international trade than their Canadian-born counterparts, largely because of the networks that they establish

[3] Examples of innovation include a new and more affordable product line made from less expensive materials or a new on-line payment system. In contrast, routine equipment changes, minor aesthetic alterations and regular product or software updates are not innovation.

[4] A recent US study also used this approach and asked a research question similar to the one posed in this paper. Brown et al. (2019) used the *US Annual Survey of Entrepreneurs* to determine whether immigrant entrepreneurs innovate at a higher rate than their US-born counterparts in the US high-tech sector. They employed 16 different measures of innovation and intellectual property ownership and found uniformly higher rates of innovation in immigrant-owned firms for 15 of the 16 different measures. Interestingly, they found a strong correlation between the educational attainment of the owner and the firm's innovation rate.

[5] We think of owner's characteristics as part of the SME characteristics.

[6] We leave aside the possibility that some Canadian-born owners may have repatriated from other countries where they had immigrant experience.

with home-country sources (Fung et al. 2019). Higher levels of trade can also increase the likelihood of innovation.[7]

As mentioned above, a higher propensity to innovate among immigrant SME owners may reflect owners' behavioural traits that, while not uniquely immigrant, are also positively correlated with immigrant experience. For instance, becoming an immigrant may be positively correlated with risk tolerance and risk-taking, and these traits increase the propensity to innovate among immigrants who become firm owners. In this case, immigration serves as a selection mechanism for risk-takers and the immigrant effect may reflect differences in the attitudes towards risk among immigrant and native firm owners.

There are also reasons why immigrant-owned SMEs may be less likely to innovate than SMEs owned by the Canadian-born. The ability of immigrant SME owners to innovate may be impeded by insufficient proficiency in official languages or inadequate knowledge of markets in the host country. Immigrant networks may strengthen the ability of immigrant SME owners to innovate, but they may also weaken their ability to innovate if they give immigrant SME owners an opportunity to hire low-wage workers. Some argue that immigrant SME owners have less access to financial capital than native-born owners and, as a result, may not be able to finance innovation activities. This appears to be true in some countries, but recent Canadian research suggests that there is little evidence to support that notion in Canada (Ostrovsky et al. 2019).

On balance, given the evidence, we hypothesized that immigrant-owned SMEs were more likely to be involved in innovation activities than their Canadian-born counterparts, after accounting for other factors that can influence innovation. Although our study focuses primarily on identifying and measuring the effect of immigrant ownership on innovation, we return to the discussion of potential sources of the effect in Section 8.

4 Data

The data for this research come from 2011, 2014 and 2017 versions of the *Survey on Financing and Growth of Small and Medium Enterprises*. The survey target population was derived from the Statistics Canada's *Business Register* (BR) and consisted of all SMEs with employment under 500 employees and gross annual revenues of $30,000 or more.[8] The sampling unit of the survey was the enterprise. The main population was stratified by several characteristics such as firm age, firm size, industry and geography, and the sample selection method was random sampling without replacement. The overall survey response rates, computed as the number of respondents divided by the number of estimated in-scope units, were 56% in 2011, 63.5% in 2014 and 59.7% in 2017. The sampling weights were adjusted to account for total non-response, making the final estimates representative of the entire survey population.[9]

The data from all three cross-sectional surveys were pooled together to create a larger sample size. The survey questions central to our analysis, notably questions related to innovation activity, types of intellectual property held, firm characteristics (e.g. firm size, age of firm, firm growth rate, exporting activity and industry employment) and important characteristics of the owners (e.g. the owner's age, years of entrepreneurial experience, educational attainment, language spoken, immigration status and years of residency in Canada), were virtually identical in all three versions of the survey, which made it possible to pool the data. The final sample size for the pooled data from the three surveys was 27,411 firms, of which 5092 were owned by immigrants.[10]

Our analysis primarily focuses on the full sample of SMEs in the economy as a whole. However, there is some analysis of innovation among SMEs in KBI. These include a narrow band of science- and technology-related firms. Lee and Has (1996) used an industry's R&D activity and the educational attainment of its workforce to determine whether it is knowledge

[7] Lileeva and Trefler (2010) show that improved access to US markets stimulated the adoption of advanced technologies by exporting Canadian firms.

[8] Non-profit organizations, joint ventures and government agencies as well as enterprises in several specific industries were excluded. The BR is a list of all Canadian enterprises engaged in the production of goods and services.

[9] More details about the survey are available on Statistics Canada website at https://www.statcan.gc.ca.

[10] The ownership characteristics are collected only for the "primary decision-maker" who is usually the SME owner, but it can also be the general manager or a partner in a partnership. There is no information in the survey about who exactly the primary decision maker is. We use the term "owner" as shorthand for the primary decision-maker since primary decision-makers in most SMEs are their owners.

based. Their list was recently updated by Innovation, Science and Economic Development Canada (ISED) and includes engineering and science-based manufacturers, telecommunications, data processing, computer systems design and consulting services. The list of included industries can be found in Table 2 in Picot and Ostrovsky (2017). Based on the list, 2471 firms in the total sample were in KBIs.

The innovation questions employed in the survey have been used in various business surveys for many years, starting in Canada with the "innovation surveys" of the 1990s. The conceptual framework on which the questions are based is outlined in the OECD Oslo Manual (2018). The specific innovation question is the following:

> "In the last three years has your business developed or introduced any of the following innovations? An innovation must be new to your business, but it does not need to be new to your market.

a) A new or significantly improved good or service
b) A new or significantly improved production process or method
c) A new organizational method in your business practices, workplace organization or external relations
d) A new way of selling your goods or services

The question on intellectual property rights is the following:

> As of (specific date), did your business hold any of the following types of intellectual property…?

a) Registered trademarks[11]
b) Patents[12]
c) Registered industrial designs[13]
d) Trade secrets[14]
e) Non-disclosure agreements[15]
f) Any other type of intellectual property protection, please specify.

5 Descriptive results

5.1 The characteristics of SMEs and their owners

The firms in the sample tended to be small, with an average of 10.2 employees per firm (Table 1). Immigrant-owned firms were smaller, with an average of 8.8 employees per firm.[16] They were also younger. The average age of firms owned by Canadian-born individuals was 20.0 years while the average age of immigrant-owned firms was 15.5 years. Immigrant-owned firms were also more likely to export a larger proportion of their sales and to be in KBIs than were SMEs owned by Canadian-born individuals. These results are consistent with earlier research (Green et al. 2016; Picot and Ostrovsky 2017; Picot and Rollin 2019). Regarding average annual growth over the last 3 years, there was little difference between immigrant-owned firms and those owned by Canadian-born individuals. There was also little difference in the proportion of companies that were started by the present owner—roughly three-quarters for firms with immigrant and Canadian-born owners.

The differences between immigrant-owned firms and those owned by Canadian-born individuals noted above for all firms also tended to apply to firms in KBIs (Table 1). However, KBI firms were younger than other firms, tended to have a higher annual growth rate over the previous 3 years and exported a much larger share of their sales than did SMEs in general.

There were some significant differences in the characteristics of the immigrant and Canadian-born *owners* of these SMEs. Most significantly, the immigrant firm owners were considerably more highly educated than their Canadian-born counterparts: 52.8% had a university degree compared with 33.3% of Canadian-born

[11] The trademark is any name or logo used to distinguish the goods or services of one organization from those of another.
[12] A patent is a set of rights granted to an inventor for a limited period of time in exchange for a public disclosure of that invention.
[13] Industrial designs are any combination of the visual features of a finished article.
[14] A trade secret is secret information that gives its owner an advantage over competitors.
[15] A non-disclosure agreement is a legal contract that outlines confidential material that the parties share with one another but restricts third-party access.
[16] All reported results were produced using sampling weights.

Table 1 Characteristics of the SMEs and SME owners in the study sample

	All private sector SMEs			SMEs in KBI		
	All SMEs	Immigrant owned	Canadian-born owned	All SMEs	Immigrant owned	Canadian-born owned
Firm characteristics						
Started firm (%)	75.0	77.8	74.2	89.3	91.5	88.3
Average firm age	19.0	15.5	20.0	14.2	12.0	15.1
Annual growth in the last 3 years						
Negative	13.4	14.9	12.9	14.2	13.5	14.5
No growth	20.7	20.9	20.6	16.9	16.0	17.3
1 to 10%	46.1	46.1	46.1	45.3	52.2	42.5
11 to 20%	11.4	10.6	11.6	12.2	7.7	14.0
20% or more	8.5	7.4	8.9	11.4	10.6	11.8
Avg. sales outside Canada (%)	4.2	6.2	3.6	10.9	15.0	9.2
Avg. number of employees	10.2	8.8	10.6	9.8	8.6	10.3
In KBI (%)	9.8	12.5	9.0	…	…	…
Owners' characteristics						
Average age	51.7	52.0	51.5	51.2	51.1	51.3
Years of experience owning	20.8	19.4	21.2	18.7	17.0	19.4
Avg. years residing in Canada	…	29.1	…	…	26.8	…
Mother tongue (%)						
English	60.2	29.6	69.4	63.4	36.6	74.6
French	21.4	4.5	26.5	17.5	5.7	22.4
Other	18.4	65.9	4.2	19.1	57.7	3.0
Educational attainment (%)						
Less than HS	8.1	6.0	8.8	1.1	0.3	1.5
HS diploma	23.4	16.8	25.3	8.9	3.0	11.3
Some postsecondary	30.7	24.4	32.6	20.6	12.9	23.8
Bachelor's degree	23.4	30.9	21.1	39.2	42.1	37.9
Graduate degree	14.4	21.9	12.2	30.2	41.7	25.4

Source: Statistics Canada, authors' calculations

owners (Table 1). There was a large difference in the proportion of those with a graduate degree: 21.9% of immigrant owners compared with 12.2% of the Canadian-born owners. Unsurprisingly, immigrant firm owners were more likely to have a mother tongue other than French or English and had marginally fewer years of experience owning a company (19.4 years compared with 21.2 years for the Canadian-born). There was little difference in the age of firm owners: the average age was 51.7 for both groups.

About 9.8% of all firms in the sample were in KBIs, and the share of KBI SMEs was higher among immigrant owners (12.5%) than among Canadian-born owners (9.0%). There were some differences between the owners of the SMEs in KBIs. The educational attainment of the immigrant SME owners in that sector was very high: 83.8% had a university degree compared with 63.3% of their Canadian-born counterparts. About 41.7% of these immigrant SME owners had a graduate degree (compared with 25.4% of Canadian-born owners). Interestingly, the KBI owners were not younger on average than their counterparts in other sectors. Furthermore, the immigrant SME owners in KBIs had been in Canada for roughly the same length of time (26.8 years on average) as immigrant SME owners in general (29.1 years on average). The main difference

between KBI firm owners and those in other industries was educational attainment.

5.2 The tendency to innovate and hold intellectual property rights

We use nine outcome measures, including four types of innovation and five types of intellectual property rights. Included are measures of product, process, organizational and marketing innovations. These are standard measures used in the literature. The intellectual property rights include registered trademarks, patents, registered industrial designs, trade secrets and non-disclosure agreements, which are also common measures used in the literature (OECD 2018). In all cases, the owner is asked whether the firm implemented these innovations or held these intellectual property rights over the 3 years prior to the survey date.

Generally speaking, immigrant-owned SMEs had a higher incidence of innovation than did firms owned by the Canadian-born (Table 2). Of immigrant-owned firms, 25.9% reported a *product* innovation compared with 21.5% of the Canadian-born-owned. Immigrant firm owners also held an edge on *process* innovation (17.0% versus 14.1%) and *marketing* innovations (19.2% versus 15.6%). All of these differences were statistically significant. There was not a statistically significant difference in the rate of *organizational* innovation between immigrant- and Canadian-born-owned firms.

Immigrant SME owners were also more likely to hold intellectual property rights than did Canadian-born SME owners (Table 2). For all five types of intellectual property rights, the incidence was higher among immigrant owners than among their Canadian-born counterparts. However, none of the differences was statistically significant at the 5% significance level.

The trends were similar for KBI SMEs, but the incidence of both innovation and intellectual property rights was higher among KBI SMEs than among SMEs in the economy as a whole. For example, 32.8% of KBI firms reported a product innovation compared with 22.5% of those in the private economy as a whole. The difference was narrower for process innovations, 18.6% versus 14.7%. Similar to the results for SMEs as a whole, in KBIs, immigrant firm owners held the edge in the incidence of three of the four innovation types. Organizational innovation was the outlier once again. However, none of these differences was statistically significant. The relatively small sample of SMEs in the KBI did not allow us to determine whether these differences actually exist, but it is interesting that they reflect the results for the sample as a whole.

In summary, among all SMEs in the private economy as a whole, the incidence of innovation ranged from 14.7 to 22.5%, depending on the type of innovation. Among SMEs in the KBIs, innovation was more prevalent, with an incidence of between 18.6 and 32.8%. The incidence of holding intellectual property rights was much smaller among all private sector SMEs, ranging from 0.9 to 14.3%, depending on the type of intellectual property. In KBIs, this range was higher, from 1.9 to 43.5%. There was some difference between immigrant and Canadian-born owners in the tendency to innovate. In particular, immigrant owners reported a higher incidence of product, process and marketing innovations over the 3 years prior to the survey date than did their Canadian-born owner counterparts. This was true among both all SMEs in the economy as a whole and KBI SMEs (although the results for KBIs were not statistically significant). Overall, although immigrant owners appeared to have a slightly higher rate of intellectual property use than their Canadian-born owner counterparts, the differences were small and not statistically significant at the 5% significance level.

6 Econometric methods

The key objective of our econometric analysis is to estimate the impact of the immigration status of the SME owner on the probability of innovating or holding intellectual property. One of the main problems with using standard linear, probit or logit models in this context is that the estimates are model dependent: the model estimated by the researcher is assumed to be the "true" model generating the data. If this assumption does not hold, the estimates of the effect are likely to be biased (Ho et al. 2007; Imbens and Rubin 2015). To eliminate or greatly reduce model dependency, econometric studies now use matching estimators based on various matching methods such as propensity score matching (Rosenbaum and Rubin 1983), entropy balancing (Hainmueller 2012) and *coarsened exact matching* (CEM) (Iacus et al. 2011, 2012). The main goal of any matching method is to reduce the differences, or *imbalance*, between the empirical distributions of the pre-treatment characteristics of the treatment and control groups and to make the treated group as similar as possible

Table 2 Innovation and intellectual property rates among immigrant and Canadian-born SME owners

	All private sector SMEs				SMEs in KBI			
	All SMEs	Canadian-born owned	Immigrant owned	*p* value	All SMEs	Canadian-born owned	Immigrant owned	*p* value
Innovation								
Good or service	22.5	21.5	25.9	0.000	32.8	32.0	34.7	0.399
Production or method	14.7	14.1	17.0	0.000	18.6	17.5	21.2	0.169
Organizational	15.4	15.6	14.7	0.267	19.2	19.4	18.5	0.735
New way of selling	16.4	15.6	19.2	0.000	17.0	16.3	18.8	0.343
Intellectual property								
Registered trademarks	8.9	8.6	9.7	0.120	13.3	14.0	11.6	0.321
Patents	1.7	1.6	2.0	0.240	3.9	3.8	4.3	0.608
Registered industrial design	0.9	0.9	1.2	0.072	1.9	1.7	2.2	0.618
Trade secrets	4.8	4.8	4.8	0.950	11.7	12.7	9.4	0.072
Non-disclosure agreements	14.3	13.9	15.5	0.068	43.5	41.6	48.2	0.058

Source: Statistics Canada, authors' calculations

to the control group (Stuart 2010; Imbens and Rubin 2015). An important element of this process is to ensure "common support" by eliminating (pruning) observations outside the area where the empirical densities of the treatment and control groups overlap (Heckman et al. 1998; Imbens 2004). Multiple studies have emphasized the advantages of using matching in combination with standard regression methods (Imbens 2004; Abadie and Imbens 2006; Ho et al. 2007; Stuart 2010). A combined strategy usually involves using first-step matching methods to make the treatment and control groups similar and second-step regression models to estimate the treatment effects while removing the remaining imbalance between the two groups.

In this study, CEM was used to match the distributions of the characteristics of immigrant-owned firms (treated group) with the characteristics of the firms owned by Canadian-born individuals (control group). The main element of the CEM algorithm is the *coarsening* or grouping of "substantially indistinguishable" (Iacus et al. 2012) values of each covariate into the same numerical categories and the application of the exact matching algorithm to the coarsened data to match treated and control observations. As a variant of exact matching, CEM has several particularly desirable properties discussed in Iacus et al. (2012). In particular, CEM is a member of the monotonic imbalance bounding methods, meaning that the level of coarsening chosen for each covariate also determines the maximum possible imbalance between the distributions of the treatment and control groups for that variable (Iacus et al. 2011). Furthermore, the level of coarsening chosen for one variable cannot affect the imbalance in other variables.

The CEM algorithm consists of several steps detailed in Iacus et al. (2011, 2012) and Blackwell et al. (2009).[17] Once a matched sample is created, the next step is to compute the main object of interest in this analysis, which is the *average treatment effect on the treated* (ATT)

$$ATT = \frac{1}{\sum_{i=1}^{n} T_i} \sum_{i=1}^{n} T_i E[Y_i(1) - Y_i(0) | X_i] \quad (1)$$

where T_i is the treatment indicator for firm i such that $T_i = 1$ if the firm is immigrant-owned (treated) and $T_i = 0$ if it is owned by a Canadian-born individual (control), $Y_i(1)$ and $Y_i(0)$ are counterfactual outcomes for the same firm i, and the term in the bracket is the random effect for firm i conditional on a set of observed characteristics X_i. The ATT can be interpreted as the average effect of immigrant status on the innovation outcomes of immigrant-owned firms.[18] Following the CEM matching procedure, it can be computed directly by comparing weighted means of the

[17] Blackwell et al. (2009) and Iacus et al. (2012) discuss various considerations for making coarsening choices and the trade-offs involved.

[18] This interpretation is based on the standard "ignorability" assumption which essentially means that any remaining unobserved differences between immigrant and Canadian-born business owners can be ignored after balancing the two groups on the observed variables. The issue is further discussed in Section 8.

treated and control group; or by estimating a CEM-weighted parametric model, such as probit, to remove ("mop up") any remaining imbalance; or by applying propensity score methods (Iacus et al. 2011).[19]

Our set of matching variables is shown in Table 7 in the Appendix. The choice of the matching variables was determined by previous studies on innovation that highlight the importance of owner age and human capital (De Mel et al. 2009), local labour market conditions and region-specific knowledge spillovers (Audretsch and Feldman 2004), and firm characteristics such as industry and firm size (Kleinknecht and Mohen 2002; De Mel et al. 2009). Several categorical variables such as the owner's education, industry and geographic region were coarsened into fewer categories to create matching variables. Continuous variables, such as the firm size and owner's age, were coarsened into matching categorical variables.

Table 7 in the Appendix shows the differences between the distributions of the coarsened and raw variables before (first two columns) and after (last two columns) matching. Much of the imbalance in the raw data is related to the location of immigrant-owned firms and those owned by Canadian-born individuals. Almost 30% of immigrant-owned firms are in Toronto compared with only 10.3% of the firms owned by Canadian-born individuals. In contrast, 67.3% of firms owned by Canadian-born individuals are located outside the five largest Canadian cities compared with only 39.0% of immigrant-owned firms. Given the significance of agglomeration economies related to knowledge production, the city imbalance underscores the importance of including city effects among the matching variables. Other variables with a substantial degree of imbalance include owner's education, geographic region and the indicator of whether the firm is located in a rural area. The last two columns show that CEM resulted in a good balance between the distributions of the characteristics of immigrant and Canadian-born owners even among the variables not used for matching. Of 5092 immigrant owners in the original sample, 4658 could be matched to one or more Canadian-born owners resulting in the 91.5% matching rate. The matched sample consisted of 4658 immigrant owners (treated group) and 15,247 Canadian-born owners (control group).

The CEM algorithm produced matching weights that were used to estimate the second-stage probit. This step allows us to remove the remaining imbalance in the covariates. The variables that were coarsened at the matching stage were disaggregated to their original categories for the second-stage regression analysis. Variables that were continuous in the raw data and coarsened at the first stage entered the second-stage probit specification as continuous variables. The set of controls in the second-stage probit models include a quadratic of age, education, startup status, years of business experience, geographic region, city effects, rural indicator, firm size, firm age, industry (18 two-digit NAICS categories) and the survey year. As some firms can be present in more than one survey year, standard errors are clustered on firms.

7 Results

Using the matched dataset, we estimated the effect of immigrant ownership for each of the nine outcome variables—four innovation types and five intellectual property types. As noted earlier, we used CEM-weighted probit models to remove the remaining minor observable differences between immigrant-owned firms and those owned by Canadian-born individuals in the matched sample. The estimated effect of immigrant ownership was reported as the average marginal effect of the immigrant ownership status.

Differences between the Canadian-born and immigrant owners in innovation adoption may dissipate the longer immigrants spend in Canada. Therefore, two extensions of the main model were considered. A subsample of firms owned by immigrants in Canada for *less than 20 years* was matched to firms with Canadian-born owners to obtain results for more recent immigrants. Similarly, a subsample of firms owned by immigrants in Canada for 20 or more years was matched to firms owned by Canadian-born individuals to obtain results for longer tenured immigrants. For brevity, we show only the estimated effects of the immigrant variables; the full set of estimates is available on request from the authors.

Table 3 shows the results for four innovation outcomes. The innovation results for all firms with immigrant owners reflect those reported earlier in the

[19] Another quantity of interest frequently considered in economics literature is the *average treatment effect* (ATE) representing the treatment effect averaged over treatment effects for all—not just the treated—units (Ho et al. 2007). This study focuses on estimating the ATT because the main object of interest is immigrant-owned firms.

Table 3 Post-CEM probit estimates of average marginal effects of immigrant status on innovations (average treatment effects on the treated)

	Innovations			
	Good or service	Production or method	Organizational method	New way of selling
All immigrants				
Immigrant	0.023**	0.035***	0.0014	0.025***
	(0.0086)	(0.0075)	(0.0074)	(0.0077)
Baseline probability	0.267	0.174	0.179	0.181
Observations	19,896	19,897	19,896	19,896
Immigrants in Canada for less than 20 years				
Immigrant	0.036*	0.031*	− 0.0040	0.054***
	(0.015)	(0.013)	(0.013)	(0.014)
Baseline probability	0.284	0.179	0.188	0.185
Observations	10,232	10,230	10,232	10,232
Immigrants in Canada for 20 years or more				
Immigrant	0.019	0.037***	0.0067	0.015
	(0.0097)	(0.0086)	(0.0083)	(0.0087)
Baseline probability	0.258	0.172	0.174	0.178
Observations	16,320	16,316	16,320	16,320

The baseline probability is the estimated probability of a positive outcome assuming that all firms in the matched sample are owned by Canadian-born owners. All probit models control for age, education, startup status, years of business experience, geographic region, city effects, rural indicator, firm size, firm age, industry and the survey year. As some firms can be present in more than one survey year, standard errors are clustered on firms. Source: Statistics Canada, authors' calculations

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

descriptive statistics. Having an immigrant owner had a positive effect on the incidence of three of the four innovation types: product innovations (goods and services), process innovations (production processes or methods) and marketing innovations (new ways of selling).[20] For all firms with immigrant owners, the likelihood of implementing a product innovation was 2.3 percentage points higher than for firms with Canadian-born owners. For process innovations, the likelihood was 3.5 percentage points higher for immigrant-owned firms. Both effects were significant at the 0.1% significance level. Given the baseline probabilities (the probabilities associated with firms owned by Canadian-born individuals) for each of these innovation categories (0.267 for product and 0.174 for process), these effects translated into immigrant-owned firms having an 8.6% higher probability than firms owned by Canadian-born individuals of introducing a new product or service and a 20.1% higher probability of introducing a new production process or method.[21] The effect of the immigrant status variable on the marketing innovation category was also positive and significant at the 1% significance level (0.025). There was no statistically significant difference between immigrant-owned firms and those owned by Canadian-born individuals in the likelihood of implementing an organizational innovation.[22]

Similar to the results for all firms with immigrant owners, those owned by recent immigrants were more likely to implement a product (3.6 percentage points or

[20] The OECD Oslo Manual notes that sometimes "business managers can find it difficult to differentiate between organisational and process innovations" (p. 75), so it is possible that immigrant-native differences in process innovation may partially reflect differences in organizational innovation. Also, there may be less room for organizational innovation in smaller firms than in larger ones, and immigrant-owned SMEs are smaller, on average, than SMEs owned by Canadian-born individuals.

[21] The ATT counterfactual in this case is the rate of innovation that would prevail in immigrant-owned firms if they were owned by Canadian-born individuals.

[22] Since a firm's innovation is self-reported, one possible concern is that immigrant owners may be generally more optimistic about their firms' innovation activities, so the differences between immigrants and natives may be overestimated. This proposition cannot be tested in this study; however, there seems to be no actual evidence to suggest that immigrant owners have higher levels of optimism.

12.7% higher), process (3.1 percentage points or 17.3% higher) or marketing innovation (5.4 percentage points or 29.2% higher) than were firms with Canadian-born owners (Table 3). These differences were significant at the 5% significance level. Firms with immigrant owners who had been in Canada for more than 20 years were also more likely to implement a process innovation (3.7 percentage points or 21.5% higher) than firms with Canadian-born owners.[23]

With regard to the *intellectual property* outcomes, generally speaking, there was no statistically significant difference between firms with immigrant owners and firms with Canadian-born owners in the likelihood of holding registering trademarks or patents (Table 4). Firms with immigrant owners registered a statistically significant higher probability of using such intellectual property (0.0084) for only one of the five intellectual property types (registered industrial designs); the effect of immigrant ownership on the probability of using non-disclosure agreements was negative (− 0.018). For firms with more recent immigrant owners, the probability of using intellectual property was greater for two of the five types of intellectual property at the 1% significance level. However, the results related to holding patents were particularly interesting because they were directly related to the recent studies on patent holding among immigrants mentioned in Section 3. The immigrant effect for all firms with immigrant owners in this category was not statistically significant, but firms with more recent immigrant owners had a 1.8 percentage point higher probability of registering a patent than firms owned by Canadian-born individuals, and the effect was positive and significant at the 1% significance level.[24]

The next set of results focuses on immigrant business owners in KBIs. The firms with immigrant business owners in this category were matched to firms with Canadian-born owners to produce a separate set of CEM weights for this part of the analysis. Of 568 immigrant-owned firms in KBI, 521 were matched to firms with Canadian-born owners as controls, resulting in a 91.7% matching rate. There was a total of 1664 firms in the matched KBI sample (Electronic Appendix Table S1).

The estimation results for the four innovation categories are shown in Table 5.[25] Immigrant-owned firms were more likely to implement a product or process innovation (0.061), but this immigrant effect was only weakly significant at the 5% significance level. This is not surprising given the relatively small sample size. Relative to the baseline probabilities, the effects for immigrant-owned SMEs in KBIs were somewhat larger than those for all immigrant-owned SMEs (as shown in Table 3). In particular, the probability of introducing a process innovation was 28.1% higher among immigrant-owned KBI firms than among firms with Canadian-born owners. There was no statistically significant difference in the likelihood of implementing an organizational or marketing innovation between immigrant-owned firms and those owned by Canadian-born individuals in KBIs.

7.1 Innovation and growth

Earlier research referred to in the introduction found that more innovative firms were more likely to be successful. Data limitations do not allow us to adequately quantify the success of a firm, let alone establish a causal link between the innovation activities of an SME and its success. However, the *Survey on Financing and Growth of Small and Medium Enterprises* asks about the average yearly growth in sales and revenues over the last 3 years. Using this variable as a proxy for success, we examined the strength of the correlation between innovation and growth in SMEs owned by immigrants and Canadian-born individuals.[26] The growth variable is an ordinal categorical variable ranging from 1 (negative growth) to 5 (20% or more per year) (see Table 1 for the list of all categories).

Table 6 shows the strength of the correlation between the growth variable and dummy variables for each type of innovation. The table shows two popular measures. The first column shows the Spearman's rank correlation coefficient (ρ), and the second column shows Kendall's τ, a non-parametric correlation measure particularly suitable for measuring the correlation between two ordinal variables. The third and fourth columns show the

[23] As a robustness check, a set of OLS and probit models was also estimated using the raw (unmatched) sample with the same set of covariates as the second stage post-CEM probit models. The estimated effects of immigrant ownership are shown in Electronic Appendix Table S2 (the full set of estimates is available upon request). The estimates in Table S2 are very similar to the estimates presented in this section.

[24] The baseline probability is 0.044.

[25] The full set of second-stage (post-matching) probit estimates is available from the authors upon request.

Table 4 Post-CEM probit estimates of average marginal effects of immigrant status on intellectual property (average treatment effects on the treated)

	Intellectual property					
	Trademark	Patent	Industrial design	Trade secrets	Non-disclosure	Other
All immigrants						
Immigrant	− 0.0039	0.0035	0.0084**	− 0.0034	− 0.018**	0.00093
	(0.0066)	(0.0037)	(0.0027)	(0.0050)	(0.0068)	(0.0035)
Baseline probability	0.140	0.037	0.016	0.078	0.205	0.031
Observations	19,892	19,892	19,701	19,892	19,901	19,897
Immigrants in Canada for less than 20 years						
Immigrant	− 0.0022	0.018**	0.019***	0.0091	− 0.020	0.000022
	(0.012)	(0.0068)	(0.0052)	(0.0088)	(0.012)	(0.0061)
Baseline probability	0.161	0.044	0.018	0.084	0.225	0.037
Observations	10,228	10,228	10,122	10,228	10,232	10,228
Immigrants in Canada for 20 years or more						
Immigrant	− 0.0047	− 0.0031	0.0040	− 0.0076	− 0.016*	0.0028
	(0.0072)	(0.0038)	(0.0029)	(0.0055)	(0.0077)	(0.0038)
Baseline probability	0.130	0.034	0.014	0.075	0.195	0.028
Observations	16,316	16,186	15,889	16,316	16,324	16,320

The baseline probability is the estimated probability of a positive outcome assuming that all firms in the matched sample are owned by Canadian-born owners. All probit models control for age, education, startup status, years of business experience, geographic region, city effects, rural indicator, firm size, firm age, industry and the survey year. As some firms can be present in more than one survey year, standard errors are clustered on firms. Source: Statistics Canada, authors' calculations

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

lower and upper limits of the confidence interval for Kendall's τ. Both coefficients measure the strength of the correlation on the − 1 to 1 scale with 0 corresponding to the absence of correlation and 1 corresponding to the perfect positive correlation.

The results suggest that there is a positive correlation between innovation and growth for all four innovation types and for both immigrant-owned SMEs and SMEs owned by Canadian-born individuals. The strength of the correlation is fairly modest, but it is statistically significant in all cases. The results in panel A also seem to indicate that the correlation between innovation and growth may be stronger for immigrant-owned SMEs than for SMEs owned by Canadian-born individuals as both coefficients are somewhat higher for immigrant-owned SMEs for all innovation types. However, when we looked at SMEs reporting implementing an innovation, we found no evidence of a positive correlation between the owner's immigrant status and growth (panel B). Hence, we found no evidence that innovation is associated with faster growth in immigrant-owned SMEs compared with SMEs owned by Canadian-born individuals although, as we noted above, implementing an innovation was positively associated with growth in sales and revenue during the 3 years prior to the survey for both groups of SMEs.

8 Discussion

Controlling for various important observed differences in the characteristics of firms owned by immigrants and firms owned by Canadian-born individuals, we found that immigrant-owned SMEs were somewhat more likely to innovate. Although we controlled for a very rich set of observed covariates, we cannot be certain that the effect is causal since there may be unobserved factors correlated with both the SME owner's immigrant status and the outcomes that could bias our estimates. In this section, we ask, what it is about the characteristics of immigrant owners and immigrant-owned firms—beyond those controlled for in this study—that might contribute to the findings mentioned above. Several possibilities warrant particular attention.

Table 5 Post-CEM probit estimates of average marginal effects of immigrant status on innovation in KBI (average treatment effects on the treated)

	Innovations			
	Good or service	Production or method	Organizational method	New way of selling
Immigrant	0.043	0.061*	0.014	0.016
	(0.028)	(0.025)	(0.023)	(0.023)
Baseline probability	0.366	0.217	0.218	0.196
Observations	1664	1664	1664	1664

The baseline probability is the estimated probability of a positive outcome assuming that all firms in the matched sample are owned by Canadian-born owners. All probit models control for age, education, startup status, years of business experience, geographic region, city effects, rural indicator, firm size, firm age, industry and the survey year. As some firms can be present in more than one survey year, standard errors are clustered on firms. Source: Statistics Canada, authors' calculations

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

First, it is possible that one need not turn to an inherent difference between immigrants and the native born to explain the differences in outcomes. For example, although the analysis adjusts for differences in the levels of educational attainment between immigrant and Canadian-born owners, it does not adjust for possible differences in their fields of study. University-educated immigrants are twice as likely to be educated in a STEM field and three times as likely to be educated in engineering or computer science as the university-educated Canadian-born individuals (Picot and Hou 2019). Immigrant owners may be more likely to implement product and process innovations not because they are immigrants but because a larger share of them are educated in STEM fields, and there is earlier research to support this notion. For example, Hunt and Gauthier-Loiselle (2010) found that the difference in patent

Table 6 Correlation between (A) innovation and growth and (B) immigrant status and growth in SMEs reporting innovation activities

	Spearman's	Kendall's tau		
	ρ	τ	Lower limit	Upper limit
Panel A: correlation between innovation and growth				
SMEs owned by immigrants				
Good or service	0.111*	0.055	0.040	0.070
Process or method	0.129*	0.057	0.044	0.071
Organizational method	0.119*	0.050	0.037	0.063
New way of selling	0.064*	0.028	0.014	0.042
SMEs owned by Canadian-born individuals				
Good or service	0.081*	0.039	0.025	0.053
Process or method	0.090*	0.037	0.026	0.048
Organizational method	0.094*	0.039	0.028	0.051
New way of selling	0.048*	0.020	0.008	0.031
Panel B: correlation between immigrant status and growth in SMEs reporting innovation				
Good or service	0.001	0.000	− 0.015	0.016
Process or method	0.007	0.004	− 0.015	0.022
Organizational method	0.006	0.003	− 0.016	0.021
New way of selling	− 0.004	− 0.002	− 0.020	0.017

"Lower limit" and "upper limit" refer to the limits of the confidence interval for Kendall's tau. Calculations are performed on the matched sample using CEM weights. Source: Statistics Canada, authors' calculations

* Significance at the 5% level

filing rates between college-educated immigrants and the native-born can be completely explained by the fact that college-educated immigrants in the USA are more likely than their US-born counterparts to be engineers and scientists. However, we could not control for the difference in the share of STEM-educated owners because the field of study information was not available.[26]

It is also possible that the immigrant effect found in this study stems from characteristics uniquely or primarily affiliated with immigrants. As we mentioned in Section 3, the immigrant effect may reflect the immigration experience of immigrant SME owners or higher risk tolerance that can be expected from those who take on the challenges of immigration. Immigrant-owned SMEs may be more likely to innovate because their owners are more familiar with foreign markets, have greater access to information in languages other than English or French or benefit from the experience of doing business abroad and from being exposed to technological innovations introduced in other countries. For instance, some of the innovations introduced by immigrant SME owners may reflect practices that are well known in their countries of origin but less known in Canada. It would be possible to shed some light on the importance of this issue if the information on the country of origin or mother tongue were available.[27]

Lastly, there is also a possibility that the results are related to some important features of the Canadian immigration system. About 40% of immigrant business owners are economic class immigrants (Green et al. 2016). The Canadian government selects economic immigrants based in part on their human capital characteristics to improve their chances of success in the Canadian labour market. Compared with an average business owner, economic-class immigrants may have the advantage of having had greater work experience in companies that value innovation and have contributed to the development of new products or processes before starting their own business. The large share of economic-class immigrants among immigrant firm owners could indirectly increase the likelihood of immigrant owners undertaking activities that may lead to more successful companies, including innovation activities.

All such possibilities should be considered when interpreting the "immigration effect". However, data limitations do not allow us to unpack the immigration effect any further.

9 Conclusion

Using data from a survey of Canadian SMEs in 2011, 2014 and 2017, we ask whether immigrant-owned SMEs were more likely to innovate during the 3 years prior to the survey than those owned by Canadian-born individuals. We discuss a number of reasons why one might expect to see such an outcome and hypothesize that immigrant owners would innovate at a higher rate. Our outcome variables include product, process, organizational and marketing innovations, as well as five types of intellectual property: registered trademarks, patents, registered industrial designs, trade secrets and non-disclosure agreements.

Both the unadjusted results based on raw data and the results based on a sample in which firms owned by immigrant owners were matched to firms owned by Canadian-born individuals to adjust for the differences in firm and owner characteristics between the two groups indicate that immigrant-owned SMEs had a higher probability of implementing a product, process or marketing innovation than firms owned by Canadian-born individuals. Immigrant-owned SMEs had an 8.6% higher likelihood of implementing a product innovation (relative to the 0.27 baseline rate computed for SMEs with Canadian-born owners) and a 20.1% higher probability of implementing a process innovation (relative to the 0.17 baseline rate). A separate analysis was conducted for firms whose owners were either more recent immigrants (in Canada for less than 20 years) or longer tenured immigrants (in Canada for greater than 20 years). The results were similar to those reported above. Both firms owned by more recent and longer tenured immigrants were more likely to implement a process innovation than firms with Canadian-born owners, while firms owned by more recent immigrants were also more likely to implement a product innovation.

Regarding the use of the five types of *intellectual property*, the results adjusted for firm and owner characteristics indicated that the effect of immigrant ownership was positive and statistically significant for only one of the five intellectual property types (registered industrial designs); for the probability of using non-

[26] Similarly, although Picot and Rollin (2019) observed a higher job creation rate among immigrant-owned firms, they also found that this could be explained by the fact that immigrant-owned firms tended to be younger than firms owned by Canadian-born individuals, and younger firms create jobs at a higher rate.

[27] Information about immigrants' countries of origin was written in during the survey but could not be coded.

disclosure agreements, the effect was negative. Overall, the evidence suggests that immigrant-owned SMEs and those owned by Canadian-born individuals were largely similar in their use of intellectual property. One interesting result is that SMEs with recent immigrant owners were more likely to use patents than SMEs with Canadian-born owners. This result may also be explained in part by the greater tendency of more recent highly educated immigrants to be educated in a more technical (STEM) field than the Canadian-born individuals.

Finally, we conducted a separate analysis for SMEs in the knowledge-based industries. The unadjusted results and the results based on the matched sample were similar to those reported for SMEs in the economy as a whole; immigrant-owned firms were more likely to implement a product or process innovation. However, this immigrant effect was only weakly significant at the 5% significance level.

Taken together, this evidence indicates that an immigrant-owned firm appears somewhat more likely to implement a product or process innovation, regardless of whether the immigrant owner is a recent or longer tenured immigrant and whether the firm is in a KBI or in the economy as a whole. These results may be related to the unobserved differences between immigrant and Canadian-born SME owners or may reflect characteristics primarily found among immigrants such as the experience of doing business abroad and exposure to technological innovations introduced in other countries. Future research will look at the sources of immigrant innovation activities in more detail.

Appendix

Table 7 Balancing the sample by using coarsened exact matching

Variable	Raw data[1]		CEM weighted	
	Canadian-born	Immigrants	Canadian-born	Immigrants
Matching (coarsened) variables				
Owner's age				
18–34	6.3	5.0	3.7	3.7
35–54	51.7	53.3	50.8	50.8
55+	41.9	41.7	45.5	45.5
Owner's education				
No university	66.7	47.2	51.0	51.0
Bachelor's degree	21.1	30.9	30.1	30.1

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Table 7 (continued)

Variable	Raw data[1]		CEM weighted	
	Canadian-born	Immigrants	Canadian-born	Immigrants
Graduate degree	12.2	21.9	18.9	18.9
Industry				
Primary	8.1	2.3	5.0	5.0
Construction	19.1	9.6	7.3	7.3
Manufacturing	6.4	7.0	13.0	13.0
Wholesale	5.7	6.1	11.3	11.3
Retail	10.9	12.0	9.9	9.9
Transportation	5.4	6.5	7.9	7.9
Professional	12.5	15.7	14.1	14.1
Accommodations	5.9	11.7	9.6	9.6
Other services	7.4	6.7	7.4	7.4
All other industries	18.6	22.5	14.5	14.5
Firm size (employees)				
Less than 5	54.2	60.9	48.5	48.5
5–9	21.1	20.0	17.4	17.4
10–49	20.5	16.5	22.4	22.4
50 or more	4.1	2.6	11.7	11.7
Geographic region				
Atlantic	7.9	2.6	4.8	4.8
Quebec	24.9	11.6	9.9	9.9
Ontario	31.2	48.3	51.0	51.0
Prairies	20.7	15.9	17.8	17.8
BC and the territories	15.2	21.4	16.5	16.5
City				
Other cities	67.3	39.0	52.7	52.7
Montreal	9.5	9.1	7.0	7.0
Toronto	10.3	29.6	21.3	21.3
Calgary	3.7	5.4	5.0	5.0
Edmonton	3.4	4.0	3.6	3.6
Vancouver	5.8	13.0	10.4	10.4
Rural	23.3	8.8	11.4	11.4
Sample variables				
Owner's age (mean)	51.5	52.0	52.6	53.1
CEM owner's experience (mean)	21.2	19.4	21.9	21.2
Firm size (mean)	10.6	8.8	23.4	24.5
Start-up (percentage)	74.2	77.8	71.5	74.3
Education (percentage)				
Less than HS	8.8	6.0	5.6	6.5
HS	25.3	16.8	20.7	18.3
Some postsecondary	32.6	24.4	24.7	26.2
Bachelor's degree	21.1	30.9	30.1	30.1
Graduate degree	12.2	21.9	18.9	18.9
Observations (unweighted)				
All	22,320	5092		
Matched	15,247	4658		
Unmatched	7,73	434		

Source: Statistics Canada, authors' calculations

[1] Raw data are weighted using survey weights

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