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The Impact of Input in Scientific Research and Experimental Development on the Survival of Immigrant Firms in Canada

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Abstract
The academic literature validates the beneficial relationship between immigrants, innovation, and economic prosperity. Immigrants are not only the important contributors to the Canadian workforce but also the indispensable source for entrepreneurships and the innovative capabilities of firms in Canada. This study aims to examine the impact of the expenditure qualifying for the Scientific Research and Experimental Development (SR&ED) on survival of firms owned by immigrants. We apply the survival models to the Canadian Employer-Employee Dynamics Database (CEEDD). The results show that the input in SR&ED significantly reduces firms' risk of closure. Firms' and the owners' characteristics, such as total capital, diversity, human capital, and immigration category, are also key factors for the firm survival.

Keywords Immigration · Innovation · Research and development · Firm survival

JEL Classification C42 · D21 · J61 · O32

Introduction

Since the early 2000s, Canada has adopted strategies to improve their competitiveness that include a component of technological and socio-economic innovation. These strategies aim to steer the economy towards a "knowledge economy" with a high degree of social cohesion. The focus lies in allocating resources to Research and development (R&D), facilitating the transition from research to innovation,

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and improving human capital. The concept of innovation has become central to the economy and society.

Immigration holds primary significance within the context of Canada. A considerable segment of immigrants is selected specifically based on their distinct entrepreneurial qualities. Canada Business Immigration Program is designed to attract investors, entrepreneurs, and self-employed individuals, thereby improving the expertise, adaptability, and diversity of the Canadian workforce, while also catering the requirements of the evolving global economy. Both the federal and provincial/territorial governments welcome business immigrants and offer services to help immigrants start a business and settle in Canada.[1] Firms established by immigrants, bring forth multifaceted considerations relating to economic dynamism and immigrants' socio-economic integration in Canada.

The academic literature validates the beneficial relationship between immigrants, innovation, and economic prosperity. This connection can be elucidated through sociocultural diversity, entrepreneurship, knowledge dissemination, and the complementarities of skills between immigrants and native workers. From this perspective, immigrants are not only the valuable contributors to the Canadian workforce but also the indispensable source for entrepreneurships and the innovative capabilities within the country. However, most businesses founded by immigrants are small and medium-sized enterprises (SMEs) that are often plagued with low survival rate. According to the report from Innovation, Science and Economic Development Canada (Archambault & Song, 2018), out of new businesses established from 2002 to 2014, only 63% survived five years and 43% survived ten years. Moreover, immigrant firms frequently confront higher survival risks for a range of reasons such as inadequate social capital, limited knowledge of local market, language obstacles, and more, in comparison to native-owned enterprises.

A range of empirical studies indicate that innovation can enhance a firm's competitiveness and as a result, its sustainability. The objective of this study is to analyze the firm's survival and its association with its allocation of resources to Scientific Research and Experimental Development (SR&ED) (as a proxy for innovation investment or R&D). We seek to answer the following research questions: (i) Does SR&ED expenditure improve firm's survival?; (ii) What factors impact immigrant firms' survival?; (iii) How do the characteristics of immigrant entrepreneurs influence the firms' survival? Through empirical exploration and econometric analyses, this study aims to shed light on the diversity and complexity of this contemporary reality, and to deepen reflection on the contribution of innovation and immigration to socio-economic development.

This study has several original contributions. Firstly, it addresses a gap in the literature where studies on the relationships of immigration and innovation at firm level remains scarce, as noted by certain scholars (Hunt & Gauthier-Loiselle, 2010;

[1] Business immigrants are admitted via pathways such as Federal Start-up Visa program, Quebec Entrepreneur program, and Provincial Entrepreneur within Provincial Nominee programs of other provinces, Quebec Immigrant Investor Program, and Self-employed program at the federal level and Quebec and other provincial levels.

Niebuhr, 2010; Ozgen et al., 2011). Only in recent years have empirical analyses started to emerge. In the context of Canada, only Blit et al. (2017) and Partridge and Furtan (2008) have empirically examined this relationship using macro data. To our knowledge, this study is the first endeavor to analyze R&D activities in immigrant-owned firms using micro-data. Secondly, this study is based on a complex database (Canadian Employer-Employee Dynamics Database, CEEDD) recently available and is still evolving. While the database has been used in research related to productivity, taxation, international trade, or immigrants' labor market integration, this study pilots its application in analyzing innovation activity. Lastly, this article, based on empirical work using econometrics, explicitly analyzes the association of R&D effect with immigrant firm survival while controlling for the characteristics of both the firms and the immigrant owners.

This article is organized as follows. Section "Introduction" is the introduction; "Immigration, Innovation, and Firm Survival" briefly reviews the literature on immigration, innovation, and firm survival. "Methodology" presents the data used and the methodology. "Empirical Results" discusses the results. "Conclusion" concludes the study.

Immigration, Innovation, and Firm Survival

Immigration can influence firm performance through its effect on innovation. In the theoretical literature, human capital accumulation effect, and labor force diversity effect have been posited to explain the influence of immigration on innovation (Ozgen et al., 2011). On one hand, the former effect emphasizes the skill set of immigrants, who are mainly selected from skilled workers (Borjas, 1987). In general, they tend to be better educated, younger, less risk averse, and have a better entrepreneurial spirit (Kloosterman & Rath, 2003; Poot, 2008). In addition, active immigrants often have greater mobility, potentially leading to knowledge and information spillovers for the host countries. On the other hand, the latter effect emphasizes the socio-cultural diversity of the immigrants. According to Jacobs (1969), an economy enriched with a diverse population is likely more productive and more innovative than a more homogeneous counterpart. Immigration fosters diversity in commercial and cultural activities within the host society, stimulating creativity and promoting the exchange of novel ideas, as well as long-term development (Alesina & La Ferrara, 2005; Berliant & Fujita, 2008; Fujita & Weber, 2003; Glaeser et al., 1992). In terms of qualifications and skills, immigrant workers and native workers with the same level of education are two imperfectly substitutable groups due to cultural differences (Niebuhr, 2010). These two groups are often complementary and can thus enrich each other (Partridge & Furtan, 2008). Furthermore, ethnic and cultural diversity in business facilitates access to international markets (Nathan, 2015; Nathan & Lee, 2013). The research by Fan et al. (2022) suggests that hiring immigrant researchers indirectly encourage firms to seek R&D services internationally, while the facilitation of R&D offshoring also encourage firms to recruit immigrants. Given that combining different inputs amplifies the marginal return from R&D

investment, both forces enhance firms' participation in R&D, subsequently boosting firm performance.

Numerous studies indicate that the combination of immigration policies and the deliberate choices by immigrants themselves contribute to the clustering of highly skilled immigrants within the fields of science and engineering (Hunt & Gauthier-Loiselle, 2010; Kerr, 2010). This trend has a positive impact of R&D activities. Immigrants are more likely to be overrepresented in these professions, resulting from the relatively smoother transfer of science and engineering knowledge and expertise across different countries compared to certain other disciplines. This differentiation is attributed to the fact that it depends less on institutional and/or cultural knowledge (e.g., humanities), professional orders (e.g., medicine), and sophisticated language skills (e.g., law).

However, immigration does not always result in unequivocal benefits for R&D activities. Firstly, an excessive influx of diversity may increase transaction costs, diminish social capital, and ultimately lead to social tensions (Schiff, 1999a, 1999b). Secondly, self-employed individuals often exhibit relatively weak capacity for risk management, resulting into income volatility and undermine the engagement to innovation (Günther & Launov, 2012; Tamvada, 2010). Thirdly, some immigrants who establish businesses may prioritize obtaining permanent resident status over genuinely contributing to the local economy and fostering innovation (Wong & Ng, 1998). Notably, some entrepreneurs may close their businesses once they have secured permanent resident status (Smart 1995). Fourthly, as innovation activities frequently entail risks and initial costs, certain immigrant entrepreneurs may opt for businesses that offer greater stability for themselves and their families, such as retail stores and restaurants (Razin, 1990). Such ventures often have limited prospects for innovation.

It is important to acknowledge that immigrant entrepreneurs face certain challenges in establishing and managing businesses. Firstly, according to assimilation theory (Grant, 1999; Heisler, 2000), newly arrived immigrants often confront hurdles such as language barrier, limited knowledge on markets, cultural disparities, and a lack of social connections, making their situation particularly difficult. Secondly, some entrepreneurs may venture into business not necessarily because they have comparative advantages in commercial operations but rather as a result of facing disadvantages in the labor market (Frenette, 2002; Moore & Mueller, 2002). Finally, immigrant entrepreneurs, particularly those from visible minority groups, may encounter various forms of discrimination that hinder the productivity of their enterprises (Teixeira et al., 2007).

Almost all previous studies have confirmed the positive role of innovation on firm survival (Cefis & Marsili, 2006). Using a hazard rate model, Paul et al. (2008) analyze the impact of different levels of innovation intensity on the survival of Australian firms. Their findings imply that while new firms thrive in risky and innovative sectors compared to established ones, they are also more vulnerable to business cycle fluctuations, such as changes in aggregate demand growth rates, interest rates, and the availability of equity finance. Cefis and Marsili (2006) conducted a similar study in the Netherlands, concluding that innovation positively affects firms' survival, with this effect growing over time, particular for small and young firms,

which are those mostly exposed to the risk of closure. In addition, Cefis and Marsili (2019), Sidorkin and Srholec (2014), and Özşuca (2023) confirm that innovation activities play a critical role in firm survival during crises (e.g., financial crisis and COVID-19 pandemic).

Ugur and Vivarelli (2021) argue and provide evidence there is significant heterogeneity in the relationship between innovation and firm survival, depending on the type of innovation and the firms' operating environment. Buddelmeyer et al. (2010) suggest, based on their study of Australian firms, that the effects of innovation on company survival vary depending on the measures of innovative activity used. Baldwin and Gu (2004) find that, in Canadian manufacturing, while labor productivity growth and survival rates increase after the introduction of process innovation, product innovation has minimal impact on plant performance and even negatively affects plant survival. Maietta and Mazzotta (2018), analyzing data from Italy, conclude that process innovation significantly determines firm survival, followed by product innovation, whereas organizational innovation plays a less significant role.

Manjón-Antolín and Arauzo-Carod (2008) assert that R&D investment generally has usually positive effects on firm survival. Pérez et al. (2004), focusing on Spanish manufacturing firms, confirm that firms that invest in R&D activities experience a lower risk of closure compared to those that do not have such investments, particularly if the firms have a global orientation. Using data from China, Zhang and Mohnen (2022) find that R&D and product innovation, in terms of incidence or intensities, both increase the likelihood of firm survival, while R&D has a greater marginal effect than product innovation. Similarly in China, Sharif and Huang (2010) discover that, amid changing manufacturing environment, Hong Kong-owned businesses that generate a higher share of new product sales or engaging in R&D or collaborative innovation activities are more likely to survive and remain in China. Fontana and Nesta (2009) document a positive non-linear relationship between a firm's R&D effort or its product innovation record and the probability of survival. Ugur et al. (2015) find that the relationship between R&D intensity and survival follows an inverted-U shape, with R&D intensity more likely to increase survival in more concentrated industries.

The impact of immigration on firm survival and performance can be intertwined with various other factors, as indicated in the literature. Elements such as the psychological tendencies and motivations of entrepreneurs, their human capital, and social capital have been recognized as influential factors affecting firm longevity. Studies differentiate between two types of immigrant entrepreneurs: necessity-driven and opportunity-driven (Chrysostome 2010). The former refers to immigrants compelled to engage in business activities due to barriers preventing access to the job market of the host country, while the latter refers to immigrants who voluntarily decide to start a business in order to take advantage of a business opportunity (Chrysostome 2010). Amit and Muller (1995) and Singh and DeNoble (2003) suggest that firms created out of opportunity are more successful than those born out of necessity. Ostrovsky and Picot (2018) also present evidence indicating greater success and survival rates among immigrant firms created by opportunity-driven motivations. Chrysostome and Arcand (2009) suggest that the relatively low level of risk aversion observed in immigrant entrepreneurs contributes firm survival, highlighting the risky nature of

their immigration to Canada and how this risk-taking propensity positively impacts their firms.

Human capital (e.g., education, professional experience) plays an important role in firm survival and performance (Huggins et al., 2017; Singh & DeNoble, 2003). It is also a factor explaining variations in firm performance among immigrant entrepreneurs in Canada (Ley, 2006). Moreover, a higher level of education is correlated with the success of transnational entrepreneurs in Canada (Lin & Tao, 2012).

Social capital, mainly acquired through family, ethnic and religious networks, can help immigrants achieve economic security, promoting firm creation, and sustainability (Chai et al., 2018; Le & Needham, 2019). Kariv et al. (2009) highlights the importance of networking in the performance of transnational ethnic firms in Canada. Social capital also influences co-management, which can positively influence firm survival (Paré et al., 2008).

Furthermore, firm survival has also been shown to hinge on specific characteristics of the firm and the market it operates in (Audretsch & Mahmood, 1994; Cefis & Marsili, 2006; Lin & Huang, 2008). These characteristics encompass factors such as firm age and firm size, scale economies, high technology environment, market entry barriers, capital intensity, profit margin, and others.

In summary, while immigration generally promotes innovation activities that could positively affect the survival of immigrant firms, the heterogeneity among immigrant is significant. Some immigrant entrepreneurs may lack motivation to engage in innovation, and the challenges faced by immigrants in socio-economic integration can increase difficulties in managing businesses. Thus, it is important to conduct an in-depth analysis of the interactions between immigration, innovation, and firm survival.

Methodology

Data

This study is based on the Canadian Employer-Employee Dynamics Database (CEEDD) for the period 2001–2017.[2] The data used in this study is composed of three parts. The first part comes from the National Accounts Longitudinal Microdata File (NALMF), which provides annual firm-level financial indicators and other firm characteristics. The second part is from the Corporation Income Tax files (T2), which is data at owner-firm level. This database allows to link the firm and its owners (or individuals). The third part is the Longitudinal Immigration Database (IMDB), which includes administrative data on immigrants. It provides detailed information on the socio-economic status of immigrants at landing, such as admission category, country of origin, education level, and knowledge of official languages.[3]

[2] When we started this study, the dataset CEEDD was only available for the period 2001–2017.

[3] In addition to the three databases used in this study, the CEEDD also includes other data files, such as T1 Family Files, Import files, and Export files. To access the CEEDD, the users must submit an application to Statistics Canada, accompanied by a proposal that explains the objectives of the study, the

The schedule 50 within T2 file provides the share of ownership (in percentage) for each owner, which allows us to calculate the sum of the share of ownership held by all immigrant owners. Following Nathan and Lee (2013), we thus divide the firms into three groups based on ownership share: (i) native firms which are 100 percent owned by native owners, (ii) immigrant firms which are 100 percent owned by immigrant owners, and (iii) mixed firms with a mixture of native and immigrant ownership.

The unique identifier of enterprise and that of individual enable us to integrate data from firm source (NALMF and T2) and the immigrant data (IMDB). We hence create two data files as the foundation for our analyses. The first data file covers all firms, but is limited to firm-specific characteristics. It is used to compare the probabilities of survival among the various types of firms mentioned above. The second data file contains only immigrant and mixed firms, but includes the characteristics of both the firms and the immigrant owners. It allows us to analyze the role of immigrant entrepreneurs in firm survival while controlling for firm characteristics.

Econometric Models

The analyses are performed at the firm level. We first define the firm's closure as the "event." Within each year, we retain exclusively those firms that continue to operate and those that are newly created. When considering an individual firm, the term "duration" refers to the span of time it remains under observation between 2001 and 2017. If a firm is no longer observable beyond a specific year (essentially vanishing from the sample), we categorize it as "closed," thereby concluding its duration.

We apply the survival models to depict the sequence of events of firms' closure. The conditional probability of firm's closure is analyzed with the hazard function, defined by:

$$h(t) = \lim_{dt \to 0} \frac{prob(t \leq T \leq t + dt | T \geq t)}{dt} = \lim_{dt \to 0} \frac{F(t + dt) - F(t)}{dtS(t)} = \frac{f(t)}{S(t)}$$

where T is a random variable indicating the time of the firm closure; t is the realization of T; $f(t)$ is the probability density of T; $F(t)$ and $S(t)$ are, respectively, the probability of closure before time t, and the probability of remaining alive until time t. $h(t)$ is the instantaneous probability of closure at time t, provided that firm remain alive until this time.

To analyze the hazard function, we use two complementary methods: non-parametric analysis and semi-parametric analysis. In the non-parametric analysis, our estimation of the hazard function, denoted as $h(t)$, is contingent solely upon the

Footnote 3 (continued)
research questions, the proposed statistical methodology, the expected products, the software used, the data files needed, the variables used, the population of interest, as well as the planned start and end dates of the project. Statistics Canada reviews the feasibility of the proposal, taking into account data confidentiality, and approves the data files that will be accessible. This process may take several weeks. After obtaining data access rights, users must work on-site in a laboratory designated by Statistics Canada. All statistical results must be subject to disclosure control prior to release to ensure data confidentiality.

duration (t). Conversely, in the semi-parametric analysis, specifically using the Cox model (Lancaster, 1979), the hazard function is bifurcated into two components: (i) one reliant solely on the duration and (ii) another that is a function of the independent variables. Hence, the hazard function associated with firm i at time t is the following:

$$h(t) = h_0(t)e^{\beta X_i}$$

where $h_0(t)$ is the baseline hazard; $X_i = (x_{1,i} \ldots x_{k,i})$ is the vector of explanatory variables. Numerous studies have demonstrated the effectiveness of this model in analyzing firm survival (Buddelmeyer et al., 2010; Maietta & Mazzotta, 2018; Paul et al., 2008; Ugur & Vivarelli, 2021; Zhang & Mohnen, 2022).

Initially, we estimate the hazard function (or the instantaneous rates of firm closure) for the three different types of firms. This analysis allows us to identify the effect of SR&ED participation on firm survival and the differences between the three firm groups. Subsequently, we use the Cox model to examine the influence of exogenous variables on firm survival. Our estimation comprises two regressions. The first regression covers all three types of firms, allowing us to analyze the survival of immigrant firms and mixed firms relative to native firms. However, given the unavailability of native entrepreneurs' characteristics, only firm-specific attributes can be incorporated into this regression. In the second regression, specifically pertaining to immigrant firms and mixed firms, we introduce both firm characteristics and the characteristics of the primary immigrant owner. All the statistical analyses were completed with the software Stata/SE 17.

Explanatory Variables

Innovation efforts can be assessed by utilizing either innovation inputs, such as R&D investment, or innovation output like patent applications. According to Wei et al. (2020), R&D investment measures firms' independent innovation investment and is thus regarded as a more representative indicator. In this study, we opt for the former approach to examine the innovation effect of immigration. R&D investment is estimated by the expenditure qualifying for the Scientific Research and Experimental Development (SR&ED). In the analysis, we define a binary variable indicating whether spending on SR&ED is positive, namely SR&ED participation.

Two more binary variables are introduced to indicate immigrant firms and mixed firms, respectively, as well as their interaction with SR&ED participation. This strategy enables us to examine the complex relationship between immigration, innovation, and firm survival. Due to the truncation of CEEDD data on the left side, firms can be divided into two categories: those that existed before 2001 and those that were created after 2001. For the former, the evolution of the characteristics before 2001 are unobservable. Obviously, these two types of firms have different starting points, which could potentially impact their capacity to survive and introduce bias to the results. Consequently, to mitigate this possible bias, we introduce a dummy variable that indicates whether the firm was created before 2001.

In the first regression which covers all three types of firms, we introduce firm characteristics including firm size, industry, controlling country, and diversity. We use the logarithm of total capital to approximate the firm size.[4] According to the literature, industry significantly affects firm survival (Buddelmeyer et al., 2010; Zhang & Mohnen, 2022). For our study, industries are classified into 24 categories according to the first two digits of the industry code. To ensure data confidentiality, we merge some industries that have a small number of firms. We introduce a dummy variable indicating whether Canada is the controlling country of the firm. This variable can, to a certain extent, distinguish firms created in Canada by immigrants from those that were created outside Canada and have relocated, allowing us to capture the impact of firms' internationalization on their survival (Du et al., 2023). Diversities in terms of operating activities and geographic locations are measured by four dummy variables which indicate whether multi-establishment, multi-location, multi-province, and multi-operation activity, respectively. We also control for the year effect and the province effect. These two fixed effects can capture the impact of economic fluctuation and external environment on firm survival, respectively. In addition, we introduce two characteristics concerning all immigrant owners, calculated from T2 and IMDB files: number of owners and average number of owners' years of schooling. The former serves as an indicator of management diversity that can influence firm survival (Paré et al., 2008), while the latter measures the firm level human capital.

In the second regression which includes only immigrant and mixed firms, we add the characteristics of the primary immigrant owner. In the case that a firm has multiple immigrant owners, we prioritize them by ownership shares (descending order), year of arrival in Canada (ascending order), and number of years of schooling (descending order), selecting the first owner as the main owner. We then introduce demographic characteristics of the immigrant owner such as age and gender. In addition, we include human capital (measured by knowledge of official languages, education qualification, and skill level), as it plays an important role in firm performance. The further inclusion of the immigration category in the regression enables us to evaluate the impact of various immigration policies on firm survival. Finally, we introduce the region of birth of the primary immigrant owner, which could capture the effect of ethnic groups on firm performance.

Empirical Results

From 2001 to 2017, the total number of firms in Canada increased from 1.79 million to 2.66 million. Among them, the proportion of immigrant firms and that of mixed firms continued to increase, from 3.7 and 1.8% in 2001 to 12.4 and 4.2% in 2017, respectively. In contrast, for the same period, the proportion of native firms

[4] In the literature, firm size is often measured by the number of employees. However, in CEEDD data, the proportion of missing values in the number of employees is greater than 60%. We therefore use total capital as a proxy of firm size.

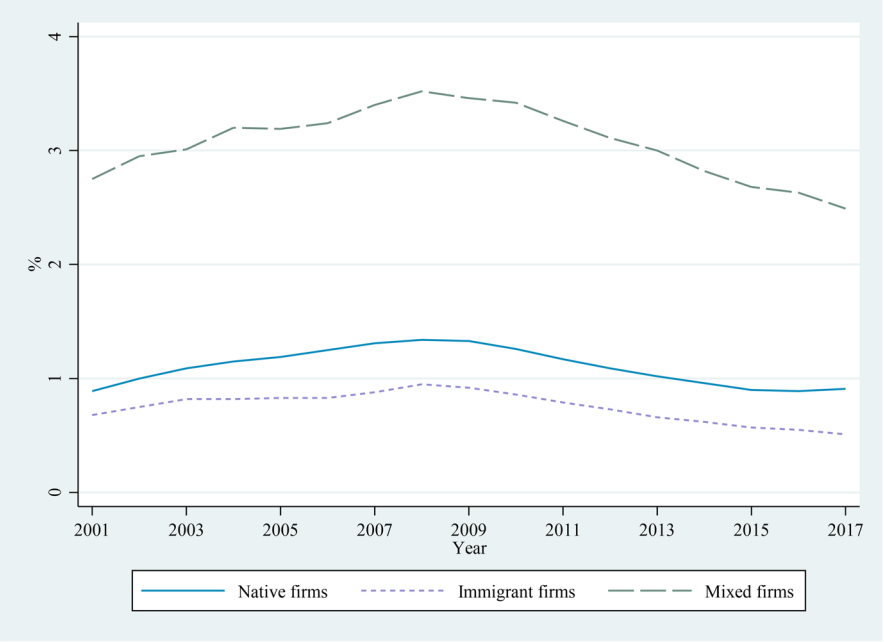

Fig. 1 Evolution of the rate of SR&ED participation (all firms). Source: CEEDD, calculated and presented by the authors. Source: CEEDD, calculated and presented by the authors

decreased from 94.5 to 83.3%. Therefore, immigrant owned firms play an increasingly important role in the economy of Canada.

Figure 1 presents the variation in SR&ED participation rate during the period 2001–2017. For all three groups of firms, this participation rate increased to its maximum in 2008 and then continually declined. A possible explanation for this decline is that the financial crisis of 2007–2008 led to a scarcity of financial resources to boost R&D. Furthermore, mixed firms have higher rate of SR&ED participation, compared to native and immigrant firms. This result aligns with the conclusions drawn by Nathan and Lee (2013). It is plausible that mixed firms benefit from a more diversified management structure, potentially contributing to their heightened likelihood to participate in SR&ED initiatives. In addition, as mentioned above, the complementarity in terms of skills between immigrants and native workers promotes new ideas, creativity, and innovation. However, the observed trend indicates that the rate of participation among immigrant firms consistently remains below that of native firms throughout the studied period.

Figure 2 presents the fluctuations in the proportion of closed firms over the analyzed time frame. Our initial observation reveals that SR&ED participation mitigates the risk of firm closure across all three firm groups. Moreover, immigrant and mixed firms exhibit a lower closure rate than native firms, irrespective of their engagement in SR&ED. Notably, the closure rate reached its peak around 2008, which may be due to the financial crisis of 2007–2008, resulting in the closure of a substantial number of firms (especially SMEs). Interestingly, the

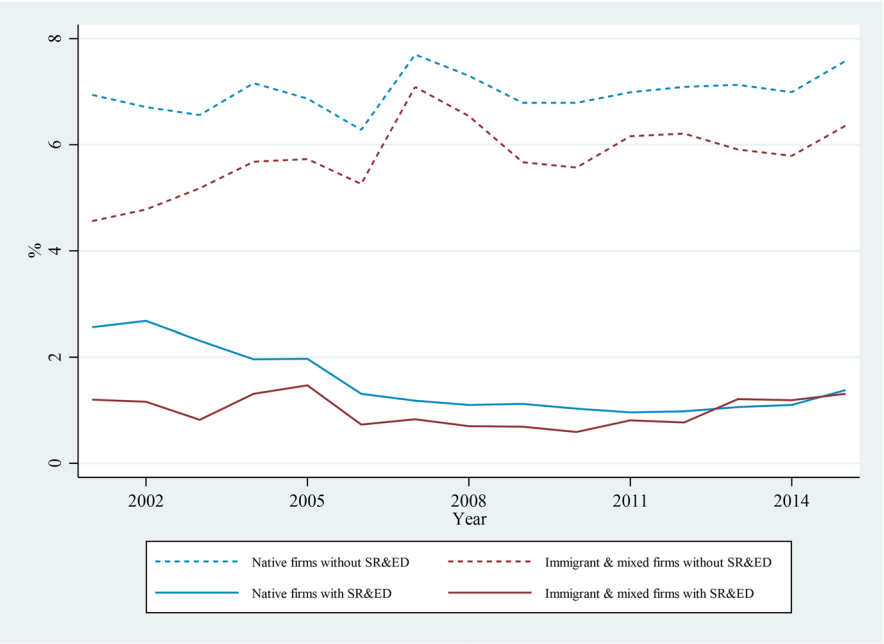

Fig. 2 Percentage of closed firms (all firms). Source: CEEDD, calculated and presented by the authors

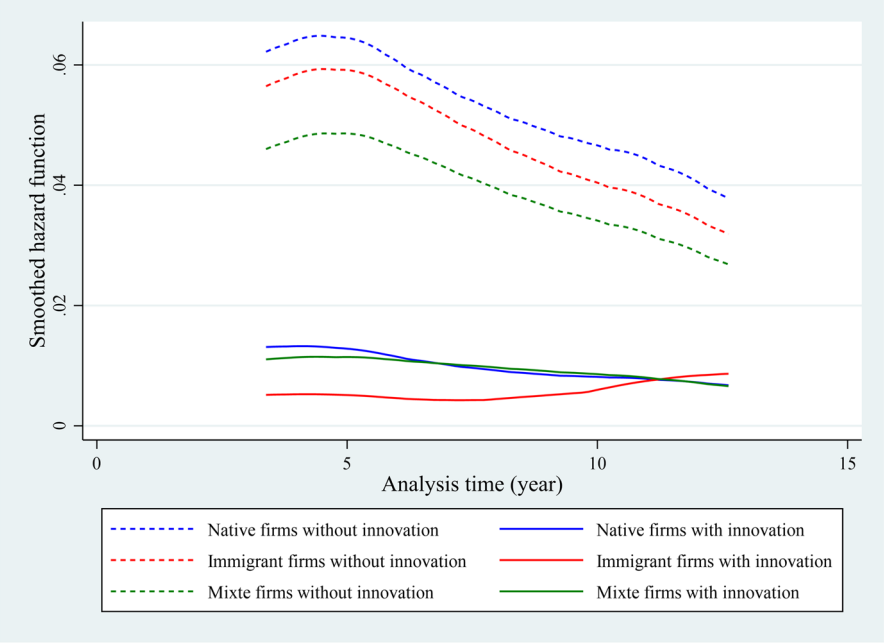

Fig. 3 Smoothed hazard function (all firms). Source: CEEDD, calculated and presented by the authors

financial crisis appears to have had minimal impact on the closure rate of firms that had invested in SR&ED.

Subsequently, we use a non-parametric method to examine the instantaneous rates of firm closure for different types of firms. Figure 3 portrays the smoothed curve of hazard function for the three firm groups. Firstly, firms lacking engagement in SR&ED experience an escalation in the instantaneous closure rate from their initial entry into the observed timeframe, peaking after 4–5 years and gradually declining thereafter. This pattern may arise due to newly created firms undergoing a phase of operational and commercial instability, leading to an elevated closure risk. As these firms stabilize their operations, the threat of closure diminishes. Secondly, among firms without SR&ED, the risk of closure decreases in a sequential manner: native firms, followed by immigrant firms, and then mixed firms, which seems to corroborate previous predictions from studies suggesting that immigrant-owned firms have greater vitality (Chrysostome & Arcand, 2009; Paré et al., 2008). Thirdly, involvement in SR&ED significantly reduces the risk of closure across all three firm categories. The instantaneous closure rate for firms with SR&ED appears relatively consistent across firms' survival times. While the differences between native firms and mixed firms are not significant, the risk of closure is notably lower in immigrant firms compared to the other two groups. Consequently, in terms of minimizing the risk of closure, participation in SR&ED appears to render more substantial benefits to immigrant firms than to their counterparts.

As shown in Fig. 1 above, the rate of SR&ED participation among immigrant firms is comparatively lower. Nonetheless, once they become participants, they retrieve greater benefits from SR&ED compared to their counterparts. One possible explanation for this phenomenon is rooted in the motivation for immigration. Certain studies (Jones, 2004; Ley, 2006) propose that some immigrant entrepreneurs prioritize the improved quality of life in Canada and the education of their children over purely economic opportunities. Their entrepreneurial ventures are geared more toward securing immigration status than maximizing monetary gains. They often concentrate on sectors such as retail stores and restaurants, which offer limited prospect for innovation (Smart, 1995; Wong & Ng, 1998). These individuals can be characterized as necessity entrepreneurs. In contrast, those who invested in R&D can be categorized as opportunity entrepreneurs, driven by a desire to exploit business prospects and generate profits. Consequently, their enterprises have a stronger vitality.

The risk of firm's closure is influenced not only by its survival duration, but also by a multitude of other factors, including firm's internal organizational attributes and external economic conditions. To account for these complexities, we expand our study to a semi-parametric analysis that incorporates both firm and owner characteristics. This entails the estimation of two regressions: one targeting all firms and the other focusing on immigrant and mixed firms. In the first regression, we only introduce firm-specific characteristics, while for the subsequent regression we add the characteristics of immigrant owners. The regression outcomes are presented in Table 1. In cases where a variable has a significant negative (positive) coefficient, it indicates a reduction (increase) in the probability of firm closure.

Table 1 Determinants of firm survival (Cox model)

Dependent variable: firm closure = 1; otherwise = 0	Regression 1 (all firms)		Regression 2 (immigrant and mixed firms)	
Firm characteristics				
Having invested in SR & ED	−0.427***	(−27.01)	−0.756***	(−13.03)
Immigrant firms	0.220***	(74.98)		
Immigrant firms × having invested in SR&ED	−1.129***	(−12.62)		
Mixed firms	0.194***	(38.11)	0.236***	(46.57)
Mixed firms × having invested in SR&ED	−0.432***	(−7.72)	1.077***	(16.97)
Firm born before 2001	−0.100***	(−38.43)	−0.048***	(−5.66)
Log of total capital	−0.180***	(−1225.41)	−0.193***	(−424.91)
Industry	Yes		Yes	
Country of control is not Canada	−0.028***	(−3.34)	0.404***	(7.87)
Non-profit organization	−0.665***	(−117.60)	−0.119***	(−3.14)
Enterprise has more than one establishment operating under it	−0.221***	(−9.15)	0.313***	(3.48)
Enterprise has more than one location operating under it	−0.362***	(−18.23)	−0.235***	(−3.21)
Enterprise operates in more than one province or territory	0.415***	(60.01)	0.661***	(17.88)
Enterprise has more than one activity operating	0.233***	(14.35)	0.540***	(6.65)
Year effect	Yes		Yes	
Firm location (Reference: Ontario)				
Prince Edward Island; Nova Scotia; New Brunswick	−0.064***	(−16.73)	0.128***	(6.28)
Quebec	0.055***	(25.88)	0.186***	(23.46)
Manitoba	−0.093***	(−19.10)	0.181***	(8.89)
Saskatchewan	0.011**	(2.29)	0.285***	(13.49)
Alberta	0.272***	(115.56)	0.227***	(33.93)
British Columbia	0.103***	(45.28)	0.162***	(27.19)
Other regions	−0.145***	(−24.46)	0.205***	(4.81)

Table 1 (continued)

Dependent variable: firm closure = 1; otherwise = 0	Regression 1 (all firms)	Regression 2 (immigrant and mixed firms)	
Number of owners		−0.081***	(−19.62)
Average owners' years of schooling		−0.008***	(−11.18)
Characteristics of the main immigrant owner			
Man		0.014***	(2.74)
Age		0.003***	(10.01)
Knowledge of official languages (Ref.: French)			
English		−0.048***	(−3.79)
English and French		−0.028**	(−2.03)
Allophone		−0.068***	(−5.21)
Number of years since landing in Canada		−0.005***	(−13.09)
Education qualifications (reference: non-university certificate and below)			
Some university — no degree		−0.009	(−1.02)
Bachelor's degree		−0.043***	(−6.32)
Some post-graduate education — no degree		−0.055***	(−2.91)
Master's degree		−0.038***	(−3.69)
Doctorate		−0.073***	(−3.66)
Skill level (reference: elemental and laborers; not stated)			

Table 1 (continued)

Dependent variable: firm closure = 1; otherwise = 0	Regression 1 (all firms)	Regression 2 (immigrant and mixed firms)	
Managerial		0.013	(0.67)
Professionals		−0.048**	(−2.57)
Skilled and technical		−0.044**	(−2.40)
Intermediate and clerical		−0.032	(−1.64)
New workers		−0.031*	(−1.75)
Other non-workers and retired		−0.017	(−0.91)
Students		0.017	(0.91)
Immigration category (reference: other categories)			
Federal skilled workers		−0.028***	(−4.93)
Quebec skilled workers		−0.020	(−1.42)
Skilled trades		−0.170	(−0.48)
Canadian experience		−0.010	(−0.34)
Live-in caregivers and other caregivers		0.057**	(1.98)
Federal entrepreneurs and start-up business		0.020*	(1.93)
Quebec entrepreneurs		0.069**	(2.22)
Federal investors		0.046**	(2.51)
Quebec investors		0.058***	(2.83)
Federal self-employed		−0.090***	(−5.76)
Quebec self-employed		0.041	(0.59)
Provincial Nominees		−0.010	(−0.64)
World area of birth (Reference: Southern Asia)			

Table 1 (continued)

Dependent variable: firm closure = 1; otherwise = 0	Regression 1 (all firms)	Regression 2 (immigrant and mixed firms)	
Europe		−0.184***	(−18.69)
Africa and the Middle East		−0.104***	(−10.42)
Eastern Asia		−0.087***	(−8.70)
Oceania and other Asia		−0.021**	(−2.01)
South and Central America		−0.045***	(−3.83)
USA or other miscellaneous		−0.005	(−0.30)
Log likelihood	−25,310,826.0	−2,787,206.6	
Number of observations	28,749,290	3,010,670	

Dependent variable: firm closure = 1; otherwise = 0. *t*-statistics in parentheses. Source: CEEDD, calculated and presented by the authors

*** significant at 1%; ** significant at 5%; * significant at 10%

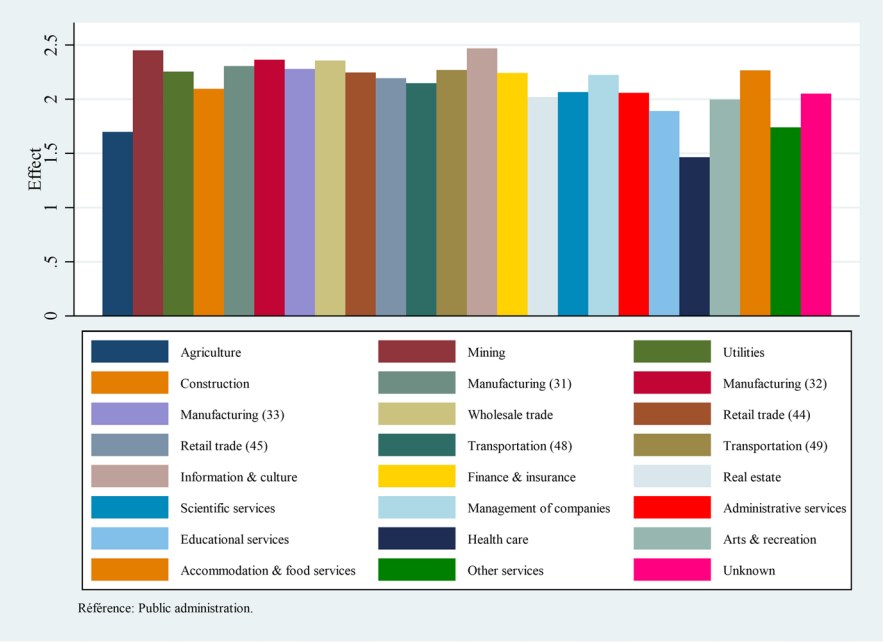

Fig. 4 Effect of industry on the probability of firm closure (all firms). Source: CEEDD, calculated and presented by the authors

In the first regression that covers all firms, SR&ED participation is markedly linked to the reduction in the likelihood of firm closure, which confirms the result observed in the non-parametric analysis (Fig. 3). When controlling for firm's characteristics, immigrant and mixed firms face a higher risk of closure. However, upon their investments in SR&ED, the risk of closure is significantly mitigated. This result sheds light on the relationship between immigration, innovation, and firm survival. Shifting focus to the second regression, which is limited to immigrant and mixed firms, SR&ED participation again emerges as a potent factor in significant association with the reduction of the risk of closure. Nevertheless, it is worth noting that the coefficient of the interaction between mixed firms and SR&ED participation turns out to be significantly positive. This result is consistent with our observation from the non-parametric analysis (Fig. 3), indicating that the effect of reducing closure risk is more pronounced in immigrant firms than in mixed firms.

The firms established prior to 2001 have a more resilient longevity. It could be attributed to these firms having already navigated their initial vulnerable phase characterized by higher closure risk. Firm size, proxy by total capital, yields a negative impact on the probability of closure. Compared with small and medium-sized firms, large firms have advantages in technical product integrity, R&D resources, financial support, information, and management capacity. They thus have a stronger capacity to withstand risks and achieve a higher survival rate.

The influence of industry on firm survival is illustrated in Fig. 4, estimated for all firms (Regression 1). Compared to firms categorized under "Public

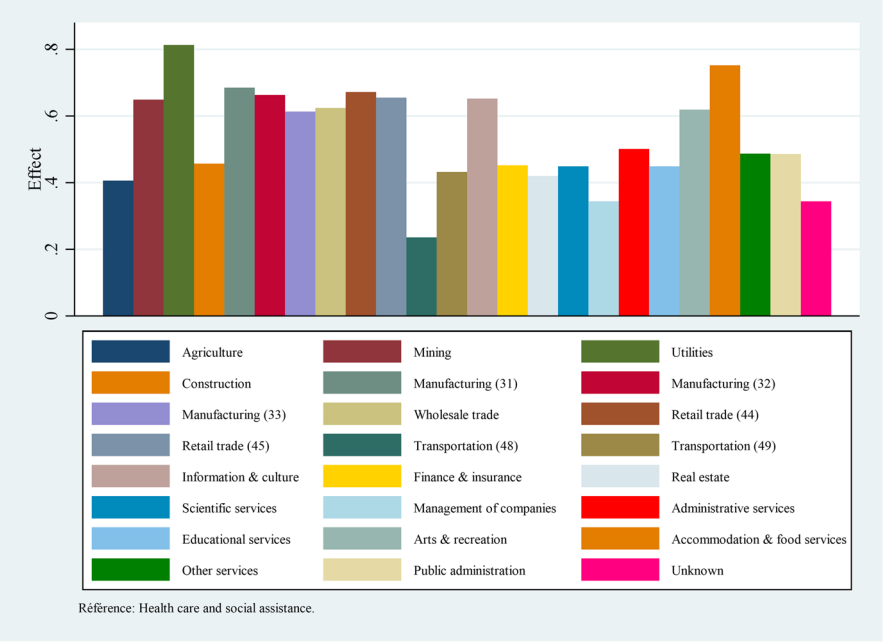

Fig. 5 Effect of industry on the probability of firm closure (immigrant and mixed firms). Source: CEEDD, calculated and presented by the authors

administration" (used as the reference category), firms in all other industries show significantly positive coefficients. Industries such as "Mining," "Information and cultural industries," "Manufacturing," and "Wholesale trade" are associated with elevated closure risks, while industries like "Agriculture," "Educational services," "Health care," and "Other services" are linked to relatively lower closure risks.

Displayed in Fig. 5 is the impact of industry on the survival prospects of immigrant and mixed firms (Regression 2). In this regression, we take the industry "Health care and social assistance" as the reference category, differing from the choice in Regression 1. Our findings unveil that firms in the industries "Utilities"; "Manufacturing (31): food, beverage and tobacco, textile, clothing, leather, etc."; "Retail trade (44): food and beverage; health and personal care stores; gasoline stations; clothing, etc."; and "Accommodation and food services" present a higher risk of closure. It is noteworthy that the last three are industries which are precisely the sectors in which immigrant businesses have remarkably concentrated their operations.

As illustrated in Regression 1, concerning all firms, compared to those located in Ontario, firms situated in the Atlantic provinces, Manitoba, and other regions exhibit a reduced risk of closure. Conversely, firms positioned in Quebec, Saskatchewan, Alberta, and British Columbia face higher risk of closure. In Regression 2 that exclusively relates to immigrant and mixed firms, all provinces except Ontario have a significantly positive influence. This suggests that that being located in Ontario,

where the "immigrant economy" is most developed, promotes the survival prospects of immigrant and mixed firms.

Results in Regression 2 also show strong associations between immigrant owners' characteristics and the firm survival. The number of owners has been found in connection with lower risk of closure. A larger number of owners signifies a co-management of the firm and, to some extent, may reflect management diversification. The coefficients related to "Average years of schooling among owners" and "Education qualifications" of the main immigrant owner display a significant negative trend. Moreover, the presence of two high skill categories of the main immigrant owner, "Professionals," and "Skilled and Technical" also contributes to promote the firm's survival. These results confirm the constructive role of human capital in sustaining businesses. As previously mentioned, both diversity and human capital emerge as pivotal elements fostering the firms' innovation. Our results further underscore the favorable influence of these two factors on firm's survival.

Regarding other characteristics of the main immigrant owner, the impact of knowledge in official languages is notably connected to the risk of firm closure. The negative effect of being an allophone on the risk of firm closure can be explained by the contribution of the "enclave economy" to the performance of immigrant businesses. Some businesses of allophone immigrants serve the internal market of minority communities and have strong vitality. Among various immigration categories, only "Federal Skilled Workers" and "Federal Self-Employed" show a significantly negative effect on the risk of firm closure, which implies that firms established by immigrants in these two categories display stronger resilience. This may stem from the fact that these groups predominantly consist mainly of opportunity entrepreneurs striving for financial gains. In contrast, certain other categories like "Entrepreneurs" and "Investors" substantially elevate the risk of closure. A plausible explanation is that immigrants in these categories tend to be necessity entrepreneurs. They usually arrive in Canada with substantial capital and launch businesses primarily to secure immigration status, attaching less significance to business survival.

Regarding region of birth (a proxy for ethnic background), except for the "US or other miscellaneous" category, all other birth regions of the main immigrant owner are associated with lower probability of firm closure when compared to the reference group of South Asia. In particular, firms created by European immigrants exhibit stronger performance.

Conclusion

Immigration is increasingly recognized not only as a solution to the shortage of workers and skills but also essential to improving economic competitiveness and innovation. This study examines the relationships between immigration, SR&ED input and firm survival. The findings reveal that participation in SR&ED significantly reduces the likelihood of firm closure across all types of firms. Although immigrant firms have lower rate of SR&ED participation, the impact on the firms' survival is more pronounced once they participate. Moreover, firms that abstained from SR&ED participation proved to be more vulnerable during the financial crisis

of 2007–2008, whereas those that participated in SR&ED were relatively resilient to the crisis. According to the semi-parametric analysis, considering firm characteristics, both immigrant firms and mixed firms indeed face a higher risk of closure than native firms. However, the implementation of SR&ED activities significantly enhances their resilience.

The findings of this study also show that firms with a combination of immigrant and native owners are more likely to invest in SR&ED. This relationship can be attributable to the complementarities of skills between immigrants and natives. Diverse cultural backgrounds contribute significantly to knowledge advancement, as research and development activities benefit from collaboration among individuals with varying ideas and proficiencies (Fujita & Weber, 2003). Additionally, management diversity positively impacts firm survival. According to Nathan and Lee (2013), firms with diverse management are more likely to introduce new product innovations than are those with homogeneous management teams. Diversity is particularly important for accessing international markets and serving a cosmopolitan population in host society, functioning as both an economic asset and social capital that encourages innovations and enhances firm survival. Thus, the promotion of mixture of ownership in Canadian businesses may be contributing directly or indirectly to the Canada's R&D ecosystem, help create more positive work environment for all levels of employees, and improve Canada's productivity performance.

The study underscores the positive impact of human capital of immigrant entrepreneurs on firm survival. Due to selection criteria based on qualifications, immigrants are often highly skilled, educated, younger, more mobile, more entrepreneurial, and less risk averse. Their arrival improves the host country's human capital, introducing new ideas and knowledge that generate positive spillover effects for innovation and economic development.

The survival of firms depends not only on their intrinsic endowment but also on the external environment of local economy. While the CEEDD data confidentiality limits detailed geographic identification, the results indicate that immigrant and mixed firms located in Ontario appear to benefit from a more favorable external environment. Ontario, particularly its largest city Toronto, is a key "immigration gateways" in Canada, with over 40% of immigrants residing in Ontario, as shown in the Census data. This concentration of immigrants boosts the diversification of local demand, leading to greater capacity and variety of local production, ultimately fostering new investments and new technologies. The expansion of "immigrant economy" stimulates new firm creation, further encouraging innovation and enhance firm vitality. Furthermore, according to Audretsch and Feldman (1996), knowledge externalities are greater when the actors are geographically close to each other. Immigrant agglomeration can create a more conductive environment for innovation activities. Thus, policymakers should consider the macro-socio-economic contexts in which immigrant businesses thrive, in particular, focusing on immigration traditions and ethnic diversity in regional markets.

The study shows that certain "immigrant industries" such as "Retail trade" and "Accommodation and food services" have higher closure risk. Policies aimed at enhancing the performance of immigrant-led businesses should guide immigrant entrepreneurs towards industries with higher productivity.

Factors such as educational attainment, diversity, skill levels, language ability, and immigration category can exert both direct effects on firm performance and indirect effects through their impact on SR&ED participation. To maximize the contribution of immigration to economic development, it is beneficial to assess the "innovation capacity" when selecting immigrant entrepreneurs. This capacity includes human capital as well as the possession of patented inventions, intangible capital, engagement in international collaborations (such as production and trade), and more.

The caveat of this study is that the data coverage period is up to 2017, due to the delay in data availability from Statistics Canada. However, it does not compromise the validity of our findings for several reasons.

Firstly, the data used spans from 2001 to 2017, a sufficiently long period to reveal the structural factors between innovation and survival in immigrant enterprises. The COVID pandemic in 2020 was merely a transitory, incidental factor that did not create structural changes to the immigration policies or the business environment for immigrant enterprises. Moreover, the economy quickly recovered after the pandemic, and the macroeconomic condition for immigrant enterprises did not differ much from the pre-pandemic period. Therefore, the absence of data extending to 2020 does not affect the study's relevance and significance.

Secondly, the study itself is grounded in robust theoretical frameworks and employs rigorous econometric techniques. The key findings align with previous related research, hence its applicability is not changed by the absence of post-2017 data.

Finally, immigration policy is a long-term national strategy for Canada, with its economic goals promoting population growth and employment as well as innovation, unaltered since the enactment of Immigration and Refugee Protection Act 2002. Based on this understanding, the study strives to identify the close relationship between the survival of immigrant enterprises and the innovation investment, and their contribution to achieving the economic objectives of immigration policy. The main findings present general practical implications for immigrant selection, settlement, and integration under current framework of the immigration policy. As for the immigrant enterprise survival during the pandemic, it will be treated as a special case in future research.

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Declarations

Conflict of Interest The authors declare no competing interests.

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