



# Determinants factors for border and cross-border entrepreneurship in the Cali-Baja Region, Mexico–United States of America border

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## Abstract

This paper presents a cross-sectional exploratory study of determinant factors for border and cross-border entrepreneurship in the Cali-Baja region, i.e., the binational region comprised by the state of Baja California in Mexico and the state of California in the United State of America. Regarding methodology, information from the National Population and Housing Census 2020 applied by the National Institute of Statistics and Geography of Mexico was used. Next, dependent and independent variables were established to set the research hypothesis. Then, using the STATA 14 program, the odds ratios for the dependent and independent variables were calculated using a logistic regression model. As a result, the research findings and the process of accepting or rejecting each research hypothesis are described. Diverse goodness of fit tests was also developed for the variables, obtaining that the logistic regression model better predicts cross-border entrepreneurship. For this undertaking, the goodness of fit test results was an Area Under the Curve of 0.66, a Positive predictive value of 9.91%, and a Hosmer-Lemeshow value of 1, among others. Finally, these results can help to strengthen international entrepreneurship through the creation of public and private sector programs based on the relevant probabilistic relationships presented.

**Keywords** Border entrepreneurship · Determinants factors · Cross-border entrepreneurship · Logistic regression model

## Introduction

In general, entrepreneurship can be understood as the creation of new businesses for self-employment. Thus, entrepreneurship has become one of the main forms of income generation in developing economies, as is the case in Mexico. In the same sense, although there is an increase in the creation of new businesses, the explanation

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**Fig. 1** Cali-Baja region map (Consejo de Desarrollo de Tijuana, 2022)

regarding the determining factors and causality of entrepreneurial activity is still insufficient, although there are relevant research reports regarding entrepreneurship determining factors (González, 2018; Querejazu Vidovic, 2020; Martínez García et al., 2022). However, most of these reports focus on variables such as gender, age, education level, marital status, head of household, and socioeconomic status. The foregoing has generally resulted in a complex relationship between these variables and entrepreneurial intention. Thus, in most of the works, it has been found that the male gender and being older increase the probability of entrepreneurship, while being married, having a greater number of children, having higher education, and having a better socioeconomic position reduce the entrepreneurship intention probability (Naranjo et al., 2020; Ahmadi & Soga, 2022). But, when entrepreneurship determinant factors are addressed in the context of the borders, it has been shown that the variables associated with migration promote the creation of companies (Cruz Vásquez et al., 2019; Abdeljaber et al., 2021; Brandstetter et al., 2021; Afandi & Yacob, 2021).

Regarding the classifications that exist for the entrepreneur, for this work, two classifications will be used, which are 1) border entrepreneurship and 2) cross-border entrepreneurship. The first type of entrepreneurship refers to those entrepreneurs who, at the time of the 2020 National Population and Housing Census, resided in Baja California, and had already started a business in the same state. While the second group of entrepreneurs are those who also live in Baja California but have their businesses in the state of California. It should be noted that both entrepreneurial activities are located in the geographical area called the Cali-Baja region. The Cali-Baja region is shown in Fig. 1. In addition, the impact that both categories of entrepreneurship have on economic development has been previously documented in various studies. For example, Kantis et al. (2004) found that entrepreneurial dynamism is closely connected to the discovery and taking advantage of profitable opportunities, which have a positive and direct impact on the three

productive sectors (i.e., primary, secondary, and tertiary sectors). In the same sense, Galindo and Méndez (2011), Dorán et al. (2018) and Kim et al. (2022) argue that there is a positive and statistically significant relationship between entrepreneurship and Gross Domestic Product (GDP) per capita. An important aspect to highlight as a justification for this analysis is that there is no empirical evidence of previous works that have addressed this pair of entrepreneur categories in this part of the world (i.e., the Cali-Baja region). Hence, given this lack of knowledge about the determinants of entrepreneurship in the mentioned region, this type of work is of interest to be able to define, describe and measure the factors that motivate the population to carry out this practice of high-economic impact in the region.

Thus, the present study aims to determine the factors that motivate border entrepreneurship in Mexico and cross-border in the Cali-Baja region, emphasizing the role of migratory status for the year 2020. Therefore, it is of particular interest to determine the number of undertakings and the profile of the population that carries them out to associate them with the binational economic dynamics of Cali-Baja. The rest of the paper is organized as follows. In the [Literature review](#) section, a critical analysis of various works related to the topic is presented. Then, in the [Description of the Cali-Baja region](#) section, quantitative data and analysis are provided regarding the competitiveness of the Cali-Baja region. Afterward, the [Methodology](#) section presents the variables used and data processing aspects, as well as the hypotheses development. Next, the [Analysis of the results](#) section presents a critical analysis of each dependent variable, as well as a discussion of the various findings and implications. Next, the [Limitations](#) section describes some research project constraints. Finally, the [Conclusions](#) section emphasizes the main findings and implications, as well as proposes future actions to strengthen the research results.

## Literature review

Various empirical studies suggest that a worker's transition from a large company to carrying out their business activities is more common in people employed with low salaries or who have frequently experienced unemployment (Evans & Leighton, 1990). Both situations reduce the opportunity cost of starting a business and increase the probability of starting a business, particularly in times of economic recession. This makes it possible to promote business initiatives to entrepreneurs or unemployed people (Georgellis et al., 2005).

More recent investigations (Ndofirepi, 2020; Orraca et al., 2017) have found that years of schooling and work experience measured in years positively affect the probability of starting a business in Mexico, but not in a cross-border context. These authors also highlight in their findings notorious differences in pecuniary and non-pecuniary determinants controlling for type of enterprise, that is; Variables such as income have different effects on those who start a business in the national territory compared to those who do so in the United States of America. For example, in the same research, the Probit model used by Orraca et al. (2017) is shown, and it was found that, if one decides to become self-employed coming from a household born in the United States of America, the results are statistically significant with 99% of

confidence level. On the other hand, self-employment if one emerges from a home where one was not born, but lives in the United States of America, it is not significant. This finding is particularly interesting and associated with our research topic, as it explores differences in the probability of starting a business in a cross-border context, whether living or being born in a US household. Finally, in the discussion offered by this study and which is closely related to the central topic of this manuscript, it should be noted that, when analyzed by year (2010 and 2015) and the three categories (all entrepreneurs, without employees, and with employees), all the marginal effects shown by the model are positive, except for living and being born in the United States of America.

Vargas Valle and Coubés (2017), following the line of the aforementioned research, offer a vast theoretical overview of this cross-border dynamic. However, the perspective offered by the authors is biased toward employees, so their results are not completely unrelated to our research. Their findings suggest that analyzing 38 municipalities in Mexico, between 2000 and 2010, the number of cross-border workers in the northern border region decreased from 87,000 to 75,000, respectively. Similarly, the Economically Active Population (EAP), from 3.8% to 2.9%, respectively.

Strengthening the above, Garcia-Macías et al. (2018), mentioned that in the decade of 1990–2000, average population growth rates of 5.4% were registered for the metropolitan area of Tijuana city and 4.3% for Juárez city, when the migration process towards the north still held, with migrants attracted mainly by the high demand for employment in manufacturing industrial sector. However, in the following decade (2000–2010) a drastic reduction is observed concerning the previous decade. In addition, Tovar Cuevas et al. (2018) expose findings from European and South American studies, where the optimal duration of migration and activity options after the return migration of Turkish citizens who returned from Germany in the 1980s are considered. Thus, it was found that a shorter migration period, younger age, and higher education increased the probability of participating in the labor market as self-employed or salaried. In addition, some characteristics before emigration, such as being married and having been self-employed, also increased the probability of becoming self-employed.

Garcia-Macías et al. (2018) raise the main objective of identifying the factors that determine entrepreneurship in Mexico. In this sense, their findings suggest that there are three necessary factors for the context to favor the opening of new businesses. These factors are access to financing, the regulatory framework in which companies operate, and the support and training services to which entrepreneurs can access. This factor set has an important influence on entrepreneurship in Mexico. This same study presents a governmental aspect since it identifies some regions of Mexico, that, despite having a productive structure, present situations that do not favor entrepreneurship. For example, the illegal situation of certain activities that cause a series of unfair competition, as well as high levels of business uncertainty due to the level of violence and intervention of criminal organizations within the commercial activity, particularly for the states of Tamaulipas, Guerrero, and Michoacán.

At the international level, there are some studies outside the context of the Mexico - United States America border. For example, Villaverde and Maza (2012) finds that, in

the case of Spain, it is stated that a huge accumulated growth (145%, approximately) between 1995 and 2005 of GDP per capita could be explained by the demographic effect. This, in other words, means that, if this population dynamic had not been taken into account, the per capita growth could have been negative.

Concerning migration studies, specifically from Mexico to the United States of America, in the last two decades, research on the formation and establishment of small businesses by Mexican immigrants has gained interest. Although it is true, the existence of businesses dates back to the first settlements of this population group, they were small entities with small establishments in neighborhoods, that is, microenterprises that operated with clients in a specific community. In addition to the growth of the population of Mexican origin in the United States of America, in recent years Mexican-owned businesses have also experienced considerable growth (Cota-Cabrera, 2010).

Borjas (1986) presents one of the first works that emphasize the relationship between self-employment and migration. The study considers data from the Census of the United States of America and finds that during the 1970s and 1980s, people who migrated to that country had lower participation rates in practically all sectors of the industry, except for retail trade, i.e., 27.6% versus 17.2% of Americans.

Another author who has made contributions to the analysis of the factors that influence business creation by immigrants in the United States of America is Sassen (1990) who refers to the ethnic and class aspects that served as support in Korean business established in Los Angeles. Ethnic resources are part of the culture of the group and include values, attitudes, customs, leadership, solidarity, and institutions, while class resources refer to the social stratum from which immigrants come, that is middle classes and upper middle classes. mostly and the level of schooling they have (Giambra & McKenzie, 2021; Huang et al., 2022). Besides, Pyong and Bozorgmehr (2000) designed a study comparing business owners from South Korea and Iran and found that business establishment by these two ethnic groups is also strongly related to their ethnic resources and class. For this last pair of authors, these two groups analyzed are distinguished by their high levels of education and extensive work experience. Nonetheless, for the Koreans, having completed their schooling in their country of origin caused them disadvantages to enter the labor market in the United States of America, due to their language complications and the lack of legal documents to be able to work. In contrast to this, even though Iranian migrants had fewer disadvantages to enter the labor market, not only because of their high levels of education but also because most of them had finished their schooling in the United States of America, they also decided to be employed for own account, since they considered that in this way they could obtain better income and greater independence.

In a study carried out with Mexican business owners in Chicago, presented by Rajjman and Tienda (2000), showed that Mexicans who had previously worked in another business of the same ethnic origin were exposed to greater training and acquisition of skills than from the experiences of other immigrant groups who did not work for companies of the same ethnic group. Another study within the same field was carried out by Valenzuela-Varela (1993) with Mexican immigrants residing in Chicago and New York. According to this author, in addition to the structural

and conjunctural conditions that made possible the creation of Mexican businesses, other important factors support the continuity of this process, such as group solidarity, mutual support, and rejection of the process of acculturation, which gives a contextual to the determinants of the decision to undertake. Other research works analyze the determinants of entrepreneurship intentions, innovation performance, and investments in cross-border regions. Still, none will address social variables and formal data collection instruments (Fernandes et al., 2018; Kayaci, 2021; Natário et al., 2018).

In this way, no research was found related to the analysis of the determinants factors for the border and cross-border entrepreneurship in the particular region of the state of Baja California and California, in Mexico, and the United State of America, respectively. This implies that there is a knowledge gap regarding these factors. Therefore, it is important to clarify these determinant factors as part of the analysis before policies and initiatives proposals that promote entrepreneurship in the region intending to increase regional competitiveness.

## Description of the Cali-Baja region

The mega-region (called Cali-Baja region) includes populations from Baja California states such as Mexicali, Tijuana, Tecate, Rosarito, and Ensenada, and the American Union such as San Diego and Imperial County. This integrated economic zone is the largest along the border between Mexico and the United States, with a population of approximately 7 million people, a regional GDP of 250 billion dollars, and trade flows of around 70 billion dollars (Canedo et al., 2022). An important part that explains this strong relationship is the economic potential of the state of California, which has a GDP similar to that of the sixth-largest economy in the world, surpassing countries such as India, the United Kingdom, and France. The Bureau of Economic Analysis (2022) indicates that, before the pandemic, California's production was 2.9 trillion dollars. In addition, the state of California has a labor force of 19.5 million people, which when compared to the labor force of India (519 million), leads us to deduce that India required a labor force 26 times larger than that of California (and larger than the entire US population) to produce roughly the same GDP in the year before the pandemic. In the same sense, data from the Observatory of Economic Complexity indicate that, in July of this year, California was the number 2 entity in total exports and the first place in total imports within the United States. In this way, the evidence suggests that the economies of Mexico and the United States are strongly integrated by different variables and that these connections have strengthened since the North American Free Trade Agreement (NAFTA) entered into force (Cedillo Martinez & Martínez Damian, 2018). Therefore, the following graph indicates how the income levels of the economies of California and Baja California, entities that make up the Cali-Baja region, have behaved in recent years; a clear convergence is observed in the GDP of both entities.

Another variable that indicates the economic connection and affects this study's dynamics is the unemployment rate. Regarding this indicator, it can be seen in Fig. 2 that, in the period 2016–2021, the unemployment rate has been

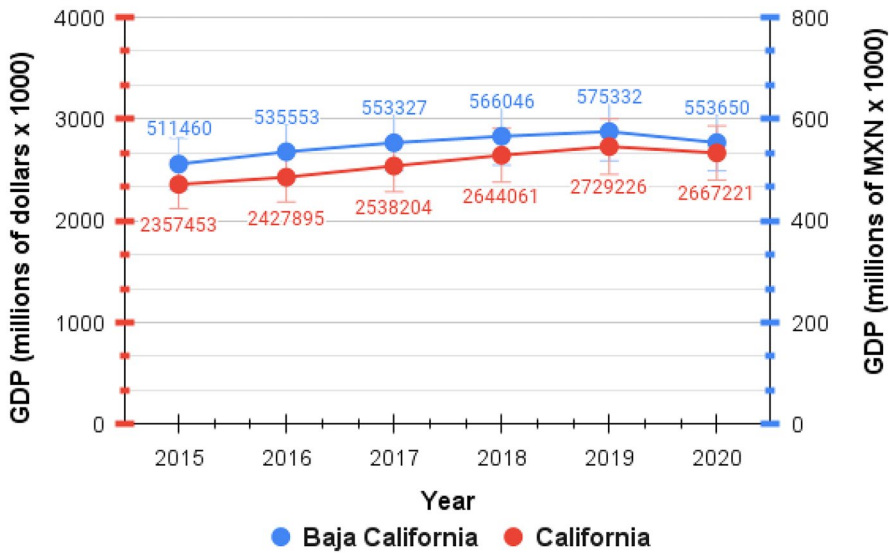


Fig. 2 GDP of California and Baja California for the 2015–2020 period (INEGI, 2020)

higher in California than in Baja California. This can be explained using two arguments. The first argument is that the salaries in the labor market of the US entity are higher than the national average and that somehow discourages certain industries from establishing themselves in said site, opting for other parts of the US nation. The second argument is that this same situation allows entrepreneurship to be generated as an alternative option to generate income for the population.

Something to highlight from the Fig. 3 is also analyzing the variations in unemployment rates in both states. While, in Baja California, it has been around 3% throughout the period shown, in California, it has had a variability between 4 and 10%, and it is precisely this behavior that conditions the context for entrepreneurship out of necessity.

The entrepreneurship dynamic on Mexico's northern border was also explored to learn about its impact on the Cali-Baja region. The information shown in Fig. 4 indicates that Baja California was, in 2020, the entity with the highest rate of entrepreneurship on the northern border of Mexico. This calculation considers the population between 18 and 70 years old and those who participated in the National Population and Housing Census to be entrepreneurs. In particular, minimum values are observed in the rates of cross-border entrepreneurship, but Baja California also leads that value in this category.

This finding is particularly interesting since a possible reason for this dynamic is that the Cali-Baja region generates forward and backward productive chains and, added to this, creates favorable conditions for the creation and permanence of companies in the market.



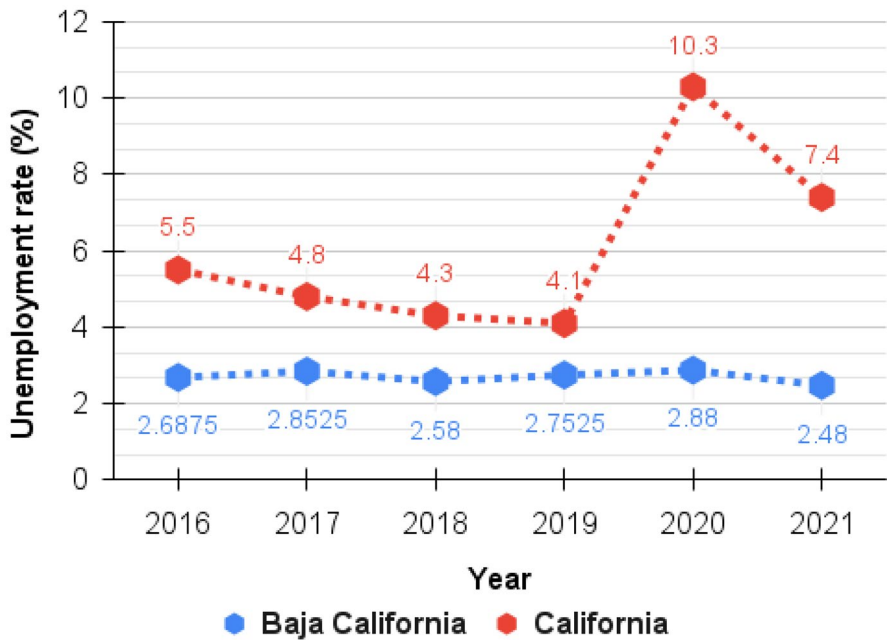


Fig. 3 Unemployment rates of California and Baja California for the 2016–2021 period (INEGI, 2020)

Following up on the above, Fig. 5 includes the entrepreneurship rate of the six Mexican entities that border the United States, where a relevant finding is that the entrepreneurship rate decreased from 2010 to 2015 and increased by 2020. The

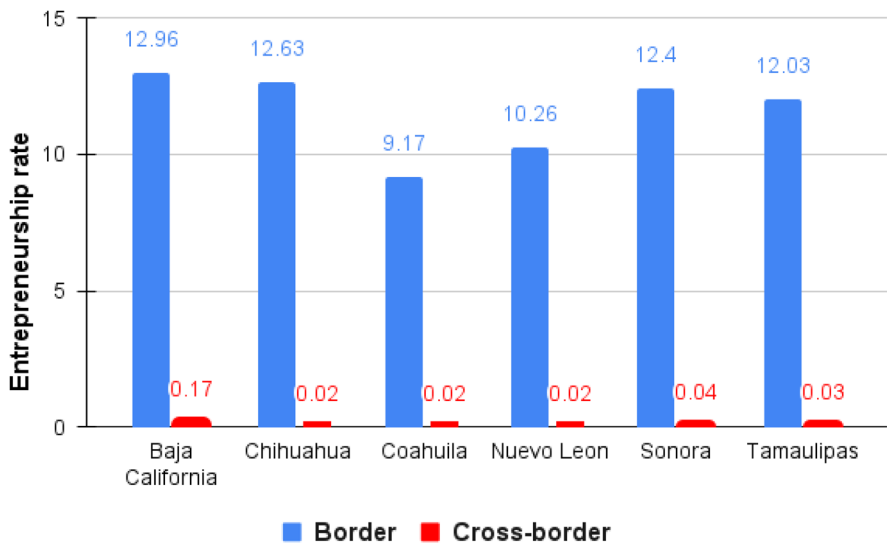
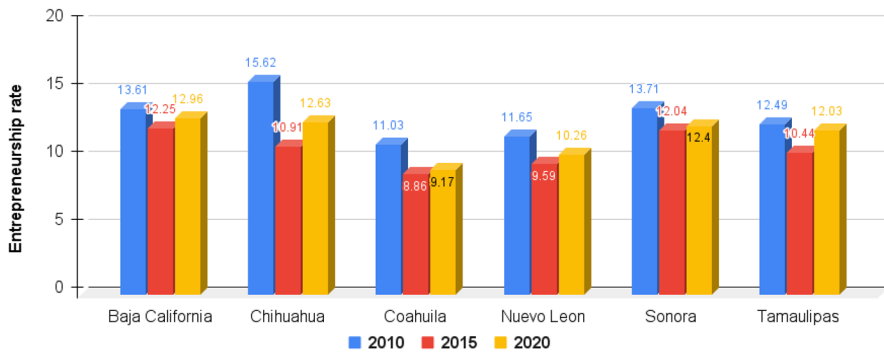


Fig. 4 Entrepreneurship rates of border Mexican states (INEGI, 2020)





**Fig. 5** Entrepreneurship rates of border Mexican states for 2010, 2015, and 2020 (INEGI, 2020)

decrease may be due to the effects that the financial crisis of 2008–2009 had on consumption and unemployment. Meanwhile, the increase in entrepreneurship from 2015 to the last census (2020) is the result of the direction that the national economy had in those five years.

## Methodology

The information source on which this research was based was the National Population and Housing Census 2020 of Mexico, whose main objective is to generate information regarding the volume, structure, and spatial distribution of the Mexican population, as well as its main demographic, socioeconomic, and cultural characteristics. In particular, the information contained in the Expanded Questionnaire was taken as a basis, since it includes data on the international migrant population. The population surveyed was 3,793,797 people. The extracted data was worked with the expansion factor included by the National Institute of Statistics and Geography (INEGI), to make population estimations. The survey period was from March 2 to 27, 2020, which due to pandemic issues had a postponement to complete the capture of all national information. The software used for the econometric analysis was STATA 14.

## Dependent variable

The dependent variable ( $Y$ ) for this study will be entrepreneurship, divided into two categories: border and cross-border entrepreneurship.  $Y_1$  and  $Y_2$ . The first refers to those who have decided to start a business in Baja California state in Mexico. In contrast, cross-border entrepreneurship is understood to mean that the person resides in Mexico and the activity of starting a business is carried out in California state, United States of America. Thus, this practical case study has two dependent variables.

## Independent variables

Next, the construction of the independent variables that will be used to measure the probabilities of an undertaking within and outside Mexico in a border context will be exposed.

### Internal migration ( $X_1$ )

For this research, this independent variable of a non-pecuniary nature is a dummy variable in the sense that it only takes values of 0 and 1. It is zero (0) when it has not migrated within the country in the last 5 years and one (1) when it has migrated internally. For its construction, the following question is required, in which state of the Mexican Republic or in which country were you born? whose answer options are: 1) Here, in the state of Baja California, 2) In another state in Mexico, 3) In the United States of America, and, 4) In another country.

Then, option 2 is used for the construction of the internal migration variable for having been born in another federal entity. The utility of this variable is to identify whether having migrated within the country gives the individual a higher probability of undertaking, compared to the one who has not migrated. The hypothesis is that, if they were the object of migration, there is probably a context of the need for employment, which makes it necessary, given the lack of knowledge of the city, to undertake before engaging in a permanent or permanent job role. In the findings, this variable will be labeled migration.

### Accumulated schooling level ( $X_2$ )

A variable of interest for this study and that is a constant in research of this nature, are the years of schooling, belonging to the group of individual determinants. In this sense, the information sources referred to, consider the question: What was the last year or grade passed in school? With values from 0 to 14, where zero is no academic degree completed and fourteen is a doctorate grade. This variable was chosen and not the academic degree, since the latter presents fewer response options and the survey loses precision.

### Marital status ( $X_3$ )

The intention of using this variable is to segment the population according to their marital status, to create 2 variables: one that contains those who are married and who live with their partner, and another that brings together the 4 categories that do not have one. relationship, i.e. single, widowed, divorced and separated. This allows us to separate our study subjects into two groups: 1) people who are more predisposed to needing employment, such as those who are married or living with a partner, and 2) people who assume the absence of a personal or familiar

commitment. As it is part of the marital status item, this variable will be considered for this study, as a non-pecuniary determinant.

### **Residence town size ( $X_4$ )**

This variable is contextual, in terms of the type of determinant. It refers to the way of grouping the localities according to the number of people who populate them through an ordinal variable that can take the values from 1 to 4. The Mexican national census applied in 2020 considers the following coding: 1) Those localities with less than 2,500 inhabitants, 2) Localities with 2,400 -14,999 inhabitants, 3) Localities with 15,000 – 99,999 inhabitants, and 4) Localities with 100,000 or more inhabitants.

The intention for considering this territorial component as an independent variable in our study is because the population settled in small and rural localities is typically more likely to have lower incomes. Another argument is that there is a greater tendency to migrate internally and to the United States of America in those same areas. The last implies that the type of town in terms of size can capture contextual elements that may be important for the motivation to undertake and affect the level of entrepreneurship.

### **Number of living children ( $X_5$ )**

The information sources ask for the number of living children the person had, as well as for the survivors at the time of the census or survey. Considering this pair of options, the second is chosen since the first is subject to the fact that, over time, one or more children have died. So the number that matters is that of the living children because these will somehow be a responsibility in the home, which the father or mother should attend to.

### **Residence in another state within the previous 5 years ( $X_6$ )**

Although it could be confused with the internal migration variable, this variable responds to the concern of knowing if 5 years before the information was collected, the person resided in another Mexican state, even if they were not necessarily born there. In other words, it may be that in 2020 a resident of Coahuila mentions that in 2015 he lived in Mexico City, but it is not a guarantee that he was born in Mexico City. Thus, the construct uses the following question: 5 years ago, in June 2015, in which state of the Republic did he live or in which country did he live?

The previous example applies to the 2020 Population and Housing Census, and the answer that validates that the person has been a resident in another federal entity 5 years ago is the option: In another state. Thus, we did not want to delve into the following question that is addressed to the municipality of residence in 2015, since our research effort is by state.

### **Birth in the United States of America ( $X_7$ )**

Question 6 of section III: Characteristics of people, of the 2020 Census, asks about the state or country of birth, and does so in this way: In what state of Mexico or in what country were you born? being the possible answers: 1) Here, in the state of Baja California, 2) In another state of Mexico, and 3) In the United States of America.

### **In another country ( $X_8$ )**

So, if the person surveyed selected option 3 (i.e., In the United States of America), automatically for our study, the person becomes an American citizen. This variable, both in its design and in its interpretations, must be done with caution for various reasons. The first of these, perhaps the most relevant, is that the person will take the rational action that gives them an advantage, that is, the fact of having been born in the United States of America territory. The second is that the implication per se, of having been born in the United States of America, would make it easier to start a business in said territory. This assumption is based on the facilities offered by the said country, where, although it is indeed a location where immigrants have facilities for opening businesses, this is facilitated with US citizenship, since their said legal status will allow them to access a more favorable context.

### **Entrepreneur gender ( $X_8$ )**

This variable comes from one of the main questions sociodemographic that is carried out in the survey. In particular, it is a dichotomous variable, where the responses are male and female. For this work, a dummy variable was constructed where the value is 1 if the gender person is male and 0 value if the gender person is female.

### **Entrepreneur Age ( $X_9$ )**

This is one of the most used variables in this type of research. In particular, the age data also comes from the sociodemographic category and in the collection of information from the survey, it is an open question where it is answered numerically with the years old. Therefore, this data is used directly in the analysis.

## **Hypothesis development**

Considering the dependent and independent variables declared in the previous section, the following research hypotheses are proposed:

**Hypothesis 1** ( $H_1: X_8 \rightarrow Y_1, Y_2$ ) Entrepreneurs' sexual gender ( $X_8$ ) positively affects both the border ( $Y_1$ ) and cross-border entrepreneurship ( $Y_2$ ) in the Cali-Baja region.

**Hypothesis 2** ( $H_2: X_7 \rightarrow Y_1, Y_2$ ) The fact that the person was born in the United State of America ( $X_7$ ) positively affects both the border ( $Y_1$ ) and cross-border ( $Y_2$ ) entrepreneurship in the Cali-Baja region.

**Hypothesis 3** ( $H_3: X_1, X_2, X_3, X_4, X_5, X_6, X_9 \neq Y_1, Y_2$ ) Internal migration ( $X_1$ ), accumulated schooling level ( $X_2$ ), marital status ( $X_3$ ), residence town size ( $X_4$ ), number of living children ( $X_5$ ), and residence in another state within the previous 5 years' variables ( $X_6$ ) have no effects, both positive and negative, on the border ( $Y_1$ ) and cross-border ( $Y_2$ ) entrepreneurship in the Cali-Baja region.

**Hypothesis 4** ( $H_4: X_9 \rightarrow Y_1, Y_2$ ) The variable, Entrepreneur Age ( $X_9$ ), positively affects both border ( $Y_1$ ) and cross-border ( $Y_2$ ) entrepreneurship in the Cali-Baja region.

**Hypothesis 5** ( $H_5: X_2 \rightarrow Y_1, Y_2$ ) The variable, Accumulated schooling level ( $X_9$ ), positively affects both border ( $Y_1$ ) and cross-border ( $Y_2$ ) entrepreneurship in the Cali-Baja region.

## Analysis of the results

This section presents the results obtained from the data analyzed by applying the logistic regression models for each type of entrepreneur (border and cross-border) in the Cali-Baja region. Table 1 shows the probabilities for the border ( $Y_1$ ) and cross-border ( $Y_2$ ) entrepreneurship concerning the independent variables ( $X$ ).

**Table 1** Results of the logistic regression model for border and cross-border entrepreneurship for 2020

Independent variables	$Y_1$ Odds-ratio	$Y_2$ Odds-ratio
Internal migration ( $X_1$ )	0.725*	1.057
Accumulated schooling level ( $X_2$ )	1.004*	0.992*
Marital status ( $X_3$ )	1.069	1.540
Residence town size ( $X_4$ )	1.052*	1.192
Number of living children ( $X_5$ )	1.000	0.861
Residence in another state within the previous 5 years ( $X_6$ )	1.131*	0.935*
Birth in the United States of America ( $X_7$ )	0.57*	14.577*
Entrepreneur gender ( $X_8$ )	1.723*	1.348*
Entrepreneur Age ( $X_9$ )	0.998	1.004

\* $p$ -valor < 0.05

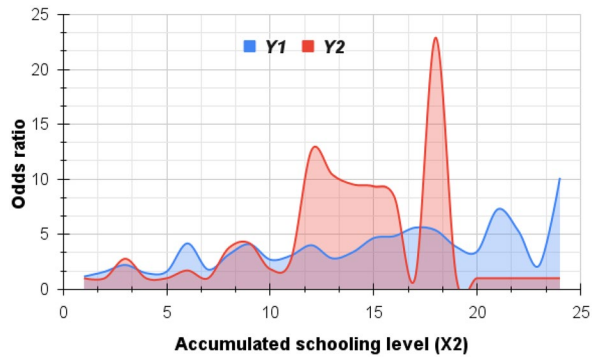
## Analysis for the variable $Y_1$

In this way, for the  $Y_1$  event, all the variables are statistically significant ( $p$ -value  $< 0.05$ ), except for Marital status ( $X_3$ ), Number of living children ( $X_5$ ), and Entrepreneur Age ( $X_9$ ), because they present a  $p$ -value  $> 0.05$ . While the variables Accumulated schooling level ( $X_2$ ), Marital status ( $X_3$ ), Residence town size ( $X_4$ ), Residence in another state within the previous 5 years ( $X_6$ ), and Entrepreneur gender ( $X_8$ ), increase the probability of entrepreneurship (i.e., because the Odds-ratio  $> 1$ ), but the three remaining variables reduce the likelihood of occurrence, i.e., Internal migration ( $X_1$ ), Birth in the United States of America ( $X_7$ ) and Entrepreneur Age ( $X_9$ ), due to that Odds-ratio  $\leq 1$ . Particularly, the variable Number of living children ( $X_5$ ) does not generate changes in the probability of occurrence. The variable that most exposes the person to carrying out border entrepreneurship ( $Y_1$ ) is Entrepreneur gender ( $X_8$ ) (male), since the reported odds - ratio (1,723) implies that being a man increases the probability of undertaking a business in Baja California by 72.3%. The variable Residence in another state within the previous 5 years ( $X_6$ ) increases the likelihood of border entrepreneurship by 13.1% since the odds-ratio value is 1.131. Meanwhile, the variable that most reduces the probability of  $Y_1$  is the Birth in the United States of America ( $X_7$ ), since it presents an odds-ratio value of 0.57. The last implies a probability reduction of 43%. On the other hand, the variables Accumulated schooling level ( $X_2$ ) and Residence town size ( $X_4$ ) present statistically significant increases in the probability of starting a business (1,004 and 1,052 odds-ratio, respectively), but with marginal strength. In other words, having more academic degrees or years of study, as well as living in localities with more residents, does not have a significant impact on border entrepreneurship.

## Analysis for the variable $Y_2$

Once the results of the entrepreneurship by the population living in Baja California in that same entity were explored (event  $Y_1$ ), the logistic regression was also calculated for those who undertake in the region of California that is part of Cali-Baja (event  $Y_2$ ). Table 1 shows that the variable, Birth in the United States of America ( $X_7$ ), presents an Odds-ratio of 14,557, which implies that being born in the United States of America increases the probability of entrepreneurship by 13.5 times compared to people who do not have this condition. Meanwhile, the variable that most reduces this probability is the Number of living children ( $X_5$ ) (Odds-ratio of 0.861), which decreases the probability of occurrence of event  $Y_2$  by almost 14%. Also, the results of cross-border entrepreneurship indicate that six variables, which are: Internal migration ( $X_1$ ), Marital status ( $X_3$ ), Residence town size ( $X_4$ ), and Birth in the United States of America ( $X_7$ ), Entrepreneur gender ( $X_8$ ), and Entrepreneur Age ( $X_9$ ) increase the probability of event  $Y_2$ . The value of the odds-ratio of the variable Entrepreneur gender ( $X_8$ ) implies that being a man increases the possibility of being an entrepreneur in California by 34.8%. While the result of the variable Marital status ( $X_3$ ) implies an increase in the probability of occurrence of event  $Y_2$  by 54%. Finally, as already mentioned, Birth in the United States of America is the variable that most exposes the individual to being a cross-border entrepreneur ( $X_7$ ). While

**Fig. 6** Odds ratio results for accumulated schooling level variable



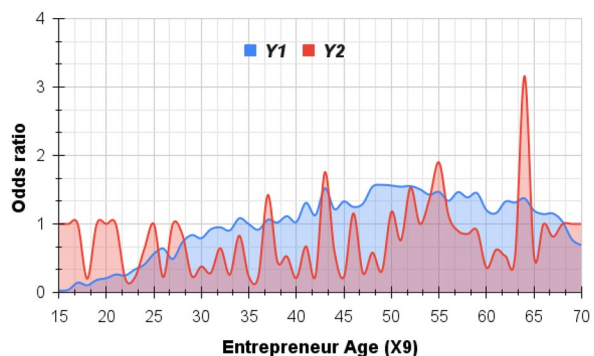
the variables that negatively affect the occurrence of event  $Y_2$  are Accumulated schooling level ( $X_2$ ), Number of living children ( $X_5$ ), and Residence in another state within the previous 5 years ( $X_6$ ), with odds-ratio values of 0.992, 0.861, and 0.935, respectively. This can also be interpreted as a reduction in the probability of  $Y_2$  by 0.08%, 13.9%, and 6.5%, respectively.

### Analysis of the variables $X_2$ and $X_9$

Figure 6 shows that  $Y_1$  and  $Y_2$  events are positively affected by the people's schooling years,  $X_2$ . However, in the case of the  $Y_2$  event, it can be seen that the probability of occurrence increases for the range from 11 to 17 years of schooling, as well as for 18 years of schooling (i.e., people who finished university or some graduate study). While for event  $Y_1$ , there is no specific range of  $X_2$  values that positively affect the occurrence of the event. Although it can be seen that the higher years of schooling, the probability of occurrence of  $Y_1$  increases, but not in a similar way to the behavior of  $Y_2$  mentioned. In particular, the fact that finishing a university degree increases the occurrence of  $Y_2$  by 21.89 times.

Figure 7 shows the relationship of Entrepreneur Age ( $X_9$ ) with the probability of occurrence of events  $Y_1$  and  $Y_2$ . It can be seen that, for the event  $Y_2$ , there is no

**Fig. 7** Odds ratio results for entrepreneur age variable





obvious pattern for this relationship,  $X_0$ , and  $Y_2$ . However, for event  $Y_1$ , there is an obvious behavior pattern. In particular, the figure shows that starting at 37 years of age, the probability of occurrence of event  $Y_1$  increases. This relationship is detailed in the findings section.

### Goodness of fit tests

Next, Table 2 shows the results of goodness-of-fit tests. In particular, the Area Under the Curve (AUC) of the Receiver Operating Characteristic (ROC) curve was calculated. Thus, the AUC value for events  $Y_1$  and  $Y_2$  is 0.56 and 0.66, respectively. To clarify, the AUC value is between 0.5 and 1, where 1 represents an excellent diagnostic and 0.5 is a test without discriminatory diagnostic capacity. Thus, both events ( $Y_1$  and  $Y_2$ ) present AUC values far from a perfect diagnostic value (i.e., 1). In the case of event  $Y_1$ , according to its AUC value of 0.56, it is considered that, with the raw data analyzed, the diagnostic test is bad. While for event  $Y_2$ , according to its value of AUC=0.66, the diagnostic test is considered to be regular (regular test). Considering the above, rawer data, variables, and diverse methods are needed to improve the diagnostic test for  $Y_1$  and  $Y_2$  events. For example, it could be that the test is good if AUC=[0.75–0.9), very good for AUC values=[0.9–0.97), and an excellent test for AUC values=[0.97–1).

The Hosmer-Lemeshow test is a method to study the goodness of fit of the logistic regression model that consists of comparing the expected values with the actual observed values. Both distribution functions, expected and observed, are compared using the Chi-square test. This test has as a null hypothesis ( $H_0$ ) the fact that there are no differences between the observed and predicted values. The last means that the model fits the data well. In contrast, the alternative hypothesis ( $H_a$ ) implies that the model has a bad fit. This way, the  $H_0$  is accepted if the statistical value obtained is greater than 0.5. Thus, as shown in Table 2, the  $H_0$  is accepted for both the  $Y_1$  and  $Y_2$  event models, with statistical values of 0.555 and 1, respectively. On the other hand, the confusion matrix shows that the positive predicted values are better estimated for the cross-border model (event  $Y_2$ ) than event  $Y_1$  since this logistic regression model achieves 99.91% of the predicted values correctly in comparison with 89.02% related to the event  $Y_1$ . Similarly, according to the sensitivity and

**Table 2** Goodness of fit tests results

Goodness of Fit Parameters	$Y_1$ Odds-ratio	$Y_2$ Odds-ratio
ROC curve	AUC=0.56	AUC=0.66
Positive predictive value	80.92%	99.91%
Sensitivity	0%	0%
Specificity	100%	100%
Negative predictive value	89.02%	99.91%
False negatives for true values	100%	100%
Classified false negatives	10.92%	0.09%
Hosmer-Lemeshow	0.555	1

specificity values (0% and 100% respectively), it can be stated that both models are more specific than sensitive. These maximum levels of specificity indicate that the two regressions have a perfect rate of true negatives, that is; it is the proportion between the negative cases well classified by the model, concerning the total number of negatives. It also implies that there are no false positive values in the model. However, there is a difference in the false negative values classified for events  $Y_1$  and  $Y_2$ , 10.92% and 0.09% respectively, a situation that shows a better estimate of event  $Y_2$ . Considering the above, these goodness-of-fit tests indicate that the cross-border entrepreneurship ( $Y_2$ ) prediction model is more reliable than the border entrepreneurship ( $Y_1$ ) protection model.

## Findings and implications

**Finding 1** Only three variables increase the probability of both border ( $Y_1$ ) and cross-border ( $Y_2$ ) entrepreneurship. These variables are Marital status ( $X_3$ ), Residence town size ( $X_4$ ), and Entrepreneur gender ( $X_8$ ).

The fact that these three variables increase the probability of occurrence of the venture allows exploring and designing actions that facilitate and encourage the population that does not have this profile. For example, if residing in larger towns favors entrepreneurship, then actions and strategies should be designed in municipalities and areas with few populations to bring government programs and higher education institutions closer to them that encourage business creation. In the same sense, if the variables of being married and man positively condition entrepreneurship in the region, strengthening women's participation in support programs for entrepreneurs should be a short-term goal. In this way, the gender gap is reduced for the business ecosystem.

**Finding 2** The variable, Birth in the United States of America ( $X_7$ ), negatively affects border entrepreneurship ( $Y_1$ ), but positively affects cross-border entrepreneurship ( $Y_2$ ).

As a consequence of being born in the United States of America, starting a company in California has its advantages and disadvantages to starting a business in Baja California, Mexico. The aforementioned indicates that there is still no favorable and straightforward context in the Cali-Baja region for, for example, a San Diego (California state, USA) resident starting a business in Tijuana (Baja California state, Mexico) or vice versa. As this finding is an important area of opportunity, binational efforts should be generated between Mexico and the United State of America, as well as between the state of California and Baja California so that immigration status is not a barrier in the necessary procedures or permits to undertake. In the same way, the educational system can contribute to entrepreneurship, so that language is not a determinant that disadvantages entrepreneurship.

Considering the results shown, and the analysis of hypothesis 2, it is concluded that Hypothesis 2 ( $H_2: X_7 \rightarrow Y_1, Y_2$ ) is not supported, that is, it is rejected.

**Finding 3** The variable, Entrepreneur gender ( $X_8$ ), positively affects border entrepreneurship ( $Y_1$ ) more than cross-border entrepreneurship ( $Y_2$ ).

As empirical evidence from other investigations has found, in this study the male category suggests that belonging to the male gender increases the probability of entrepreneurship in the region, which is why women are less active in business creation. At the regional level, this can generate actions by agencies such as the Women's Institutes in coordination with other government secretaries and academia to bring women closer to a more favorable context to turn them into entrepreneurs. Some countermeasures could be to encourage more female entrepreneurship by giving more accessible credits with reduced rates. A more accessible scheme for Doing Business issues can also be generated for the citizens of Baja California who try to start a business in California since if this is deployed and has a significant impact on society, the competitiveness of the Cali-Baja region will be increased by strengthening the value and supply chain, creating employees on both sides of the Mexico - USA border.

Considering the results shown, and the analysis of hypothesis 1, it is concluded that Hypothesis 1 ( $H_1: X_8 \rightarrow Y_1, Y_2$ ) is not supported, that is, it is rejected.

**Finding 4** The variable, Accumulated schooling level ( $X_2$ ), does not significantly affect both border ( $Y_1$ ) and cross-border ( $Y_2$ ) entrepreneurship.

This result alerts us about the need to generate restructuring in the educational system so that from the classroom the student can be provided with better hard and soft skills, knowledge, and aptitudes necessary to early start a business, e.g., from the university stage or after graduating from any academic degree. Although efforts have indeed been made as entrepreneurship fairs, usually they are only seen as a necessary step to accredit subjects, but they are not perceived as business hotbeds. Therefore, it is necessary to modify the curricula and establish collaborations with the banking and government sectors to facilitate access to financing for projects starting in the academic context, so entrepreneurship is not perceived exclusively as an option for the unemployed person.

Considering Findings 1 and 4, and concerning the analysis of hypothesis 3, it is concluded that Hypothesis 3 ( $H_3: X_1, X_2, X_3, X_4, X_5, X_6, X_9 \neq Y_1, Y_2$ ) is not partially supported, that is, it is not possible to be rejected since more detailed analysis is required.

**Finding 5** The variable, Entrepreneur Age ( $X_9$ ), affects both events  $Y_1$  and  $Y_2$  significantly differently. In particular, based on Fig. 7, it is determined that event  $Y_2$  presents more variations regarding the positive and negative impact concerning  $X_9$ , that is, there is no specific pattern or relationship between  $X_9$  and  $Y_2$ . This means that there are no specific age ranges in which the  $Y_2$  event is positively or negatively affected. However, if a particular pattern is found in the case of the  $Y_1$  event. Thus, in the age range from 37 to 68 years, the probability of occurrence of the  $Y_1$  event increases. While, for values less than 37 years, the probability of occurrence

is directly proportional to age, that is, it is less probably that younger people begin a business. Therefore, considering this finding, Hypothesis 4 ( $H_4: X_9 \rightarrow Y_1, Y_2$ ) is not partially supported, that is, it is not possible to be rejected since a more detailed analysis is required.

**Finding 6** The variable, Accumulated schooling level ( $X_2$ ), affects both events  $Y_1$  and  $Y_2$  significantly differently. In particular, based on Fig. 2, it can be seen that there are no clear and specific patterns regarding this relationship. But, there is a trend regarding the relationship of  $X_2$  and  $Y_2$  for the range from 11 to 18 accumulated years of schooling. Otherwise, event  $Y_1$  does not present any specific pattern. Thus, considering this finding, Hypothesis 5 ( $H_5: X_2 \rightarrow Y_1, Y_2$ ), is not partially supported, that is, it is not possible to be rejected since a more detailed analysis is required.

## Limitations

Regarding the limitations of this research, the fact of using an instrument (National Population and Housing Census) that, although it is true is the maximum resource that Mexico has to know, describe and count its population, stands out, it was affected in its operation due to the pandemic concerning the way to collect all the information by the National Institute of Statistics and Geography. It should also be mentioned that, even though the survey was applied in 2020, the disclosure of the census data was published until the following year (2021). This somehow conditioned the delay of the results of this study. Considering the aforementioned, the results in this paper can serve as a starting point for the establishment of activities that promote border and cross-border entrepreneurship, without forgetting that, in the year 2025, the National Population and Housing Census will be applied again, which can modify the findings mentioned.

Another aspect that directly affects the results was the selection of explanatory variables for events  $Y_1$  and  $Y_2$ . So, including other types of variables such as personal income, occupation of the couple, household receiving remittances or institutional variables could give more robustness and significance to the study proposed here. In addition, something that could contribute to future studies would undoubtedly be the comparison of entrepreneurship in the Cali-Baja region, with two different but compatible instruments, one for California state in the United States of America and the other for the state of Baja California in Mexico. This would help generate updated empirical evidence with a comparable design for a more rigorous study that can contribute more evidence to research on entrepreneurship.

Likewise, this study may be subject to changes that give more validity to the findings, one of them would be to add more information questions about the economic unit as such, highlighting elements such as years of operation, sector to which it belongs, size of the company, number of employees, if they had financing for their opening and other information that could be translated into more complete empirical evidence.

## Conclusions

The topic of entrepreneurship is not a process of recent appearance, nor is it a phenomenon of little study. In fact, over the last few years, significant efforts have been to conceptualize, understand, categorize, measure, and, above all, find the determinants factor associated with its appearance, which has been the subject of study worldwide. In Mexico, notorious discrepancies persist in the thirty-two states that comprise it, because each locality, municipality, federal entity, and region respond to its processes (not only of an economic nature but also of social aspects). For these reasons, this entrepreneurship study is necessary, which is a dynamic and evolutionary phenomenon. In addition, the qualitative and quantitative description of the determinants factors of entrepreneurship is relevant, not only associated with a particular country but also considering various regions which present different social and economic dynamics. In the particular case of this article, the binational Cali-Baja region. A general finding of this research is that the conditions of the chosen study location interact with the selected several independent variables, giving rise to a segmented analysis into interest groups with particular findings (from Findings 1 to 6). In fact, considering the proposed hypotheses and the particular findings previously described, it was concluded that all hypotheses were not accepted. Thus, considering the values of odds ratios, it is concluded that in order to identify the individual profile in which event  $Y_1$  (border entrepreneurship) occurs, the following conditions are required: male gender, being married, having been born in another entity. While for the  $Y_2$  event (cross-border entrepreneurship) the conditions are being born in the United States. The latter supports the fact that the probabilities of the border and cross-border entrepreneurship are determined in a differentiated way by the different factors, with immigration status being the main differentiator. Thus, considering the exploratory sense of this research project, and the findings and implications discussed, this research highlights the need for an economic, social, and educational policy developed considering the real determining factors for entrepreneurship. In particular, the policy development mentioned is not the aim of this research but can be addressed in future work. Furthermore, the findings and implications of this research can help the academic, business, and government sectors of the Cali-Baja region to create and strengthen binational programs for entrepreneurs.

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**Data availability** The datasets generated during and/or analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request.

## Declarations

**Ethics approval** This research work does not require an ethical approval form.

**Conflict of interest** All authors certify that they have no affiliations with or involvement in any organization or entity with any financial or nonfinancial interest in the subject matter or materials discussed in this manuscript.

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