Risk assessment for micro companies belonging to selected economic branches of the professional, scientific and technical services sector in Mexico through the Beta coefficient.

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Abstract.

Companies are the economic units that generate economic growth for any country or region by offering the goods and services demanded by society at the same time that they generate a large number and variety of jobs, specifically the micro companies belonging to the sector of the professional, technical and scientific services in Mexico contribute with a significant number of companies and employment generated. Despite this, micro enterprises do not have optimal access to the financing they need to continue growing, mainly due to poor risk management. The valuation of companies is a discipline that offers various methods to determine the risk of an asset, highlighting the Capital Asset Pricing Model which requires the estimation of Beta risk coefficients and which has been applied in a general way to large companies belonging to developed countries. The present work is focused on developing an own index of micro companies in Mexico and determining the respective risk coefficients for nine economic branches of the mentioned subsector. The final results made it possible to identify the nine Beta coefficients for the chosen branches of the professional, scientific and technical services sector, in such a way that said risk indicators can be used to calculate the value and risk associated with the micro-companies of said branches of the economy in Mexico; providing a valuation alternative to improve access to financing.

Resumen.

Las empresas son las unidades económicas que generan el crecimiento económico para cualquier país o región al ofrecer los bienes y servicios demandados por la sociedad al mismo tiempo que generan una gran cantidad y variedad de puestos de trabajo, específicamente las micro empresas pertenecientes al sector de los servicios profesionales, técnicos y científicos en México aportan una importante cantidad de empresas y empleo generado. A pesar de ello, las micro empresas no cuentan con un acceso óptimo al financiamiento que necesitan para continuar creciendo, debido principalmente a una deficiente gestión de su riesgo. La valuación

de empresas es una disciplina que ofrece diversos métodos para determinar el riesgo de un activo, destacando el Modelo de Valuación de Activos de Capital el cual requiere la estimación de los coeficientes de riesgo Beta y se ha aplicado de manera general para grandes empresas pertenecientes a países desarrollados. El presente trabajo se enfocó en desarrollar un Índice propio de micro empresas en México y determinar los coeficientes de riesgo respectivos para nueve ramas económicas del subsector mencionado. Los resultados finales permitieron identificar los nueve coeficientes Beta para las ramas del sector de servicios profesionales, científicos y técnicos elegidos, de tal forma que dichos indicadores de riesgo puedan ser empleados para el cálculo del valor y riesgo asociados a las micro empresas de dichas ramas de la economía en México; aportando una alternativa de valuación para el mejoramiento del acceso a financiamiento.

JEL Classification. G11, G12, L84.

Keywords: valuation, risk betas, micro companies, professional, technical and scientific services.

Palabras clave: valuación, betas de riesgo, micro empresas, servicios profesionales, científicos y técnicos.

Introduction.

In order to satisfy their needs, people are grouped freely in all kinds of organizations focused on various purposes. Those organizations dedicated to the generation of wealth are called companies, which use a great variety of economic, technological and human resources to offer the goods and services that society demands, thus fulfilling its function as an economic agent that generates well-being for all those involved (clients, suppliers, workers and promoters).

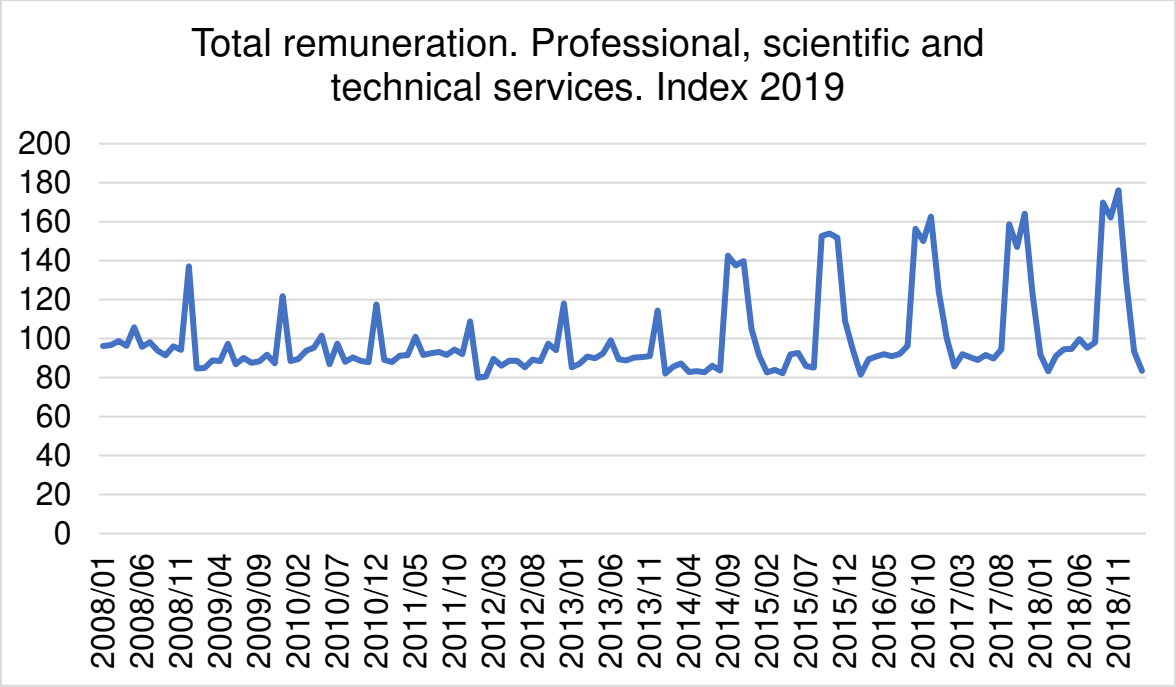
Specifically, in the case of Mexico, micro-enterprises are the economic units that stand out both for the largest number of companies in operation (97.3%) and for the contribution of total employed personnel (37.2%), based on data from INEGI (2018). In addition to this, according to INEGI (2019), the services sector contributes 39.6% and 40.0% of the economic units and of the total employed personnel respectively.

In parallel, according to its contribution to the Gross Domestic Product, which is defined as “The total value of the goods and services produced in the territory of a country in a given period, free of duplication. It can be obtained through the difference between the gross value of production and the goods and services consumed during the production process itself, at buyer prices (intermediate consumption)” (Banxico, 2021); Companies focused on tertiary services or activities contribute 10,746,010 million pesos for the third quarter of 2020 INEGI (2021), which represents 63.48% of the national total.

Specifically, based on information from INEGI (2020), the professional, scientific and technical services subsector stands out for having the highest percentage of variation compared to the previous year for 2020, with 7.7% of total income from the supply of goods and services, 10.0% in total employed personnel and 16.8% in terms of consumption of goods and services, the last two data being the highest within the non-financial private services sector.

Additionally, according to data from INEGI (2021), Graph 1 is presented, which shows the evolution of the index corresponding to total remuneration provided by the professional, scientific and technical services subsector for the 2008-2019 period.

Graph 1 Total remuneration index. Subsector of professional, scientific and technical services for the periods indicated.



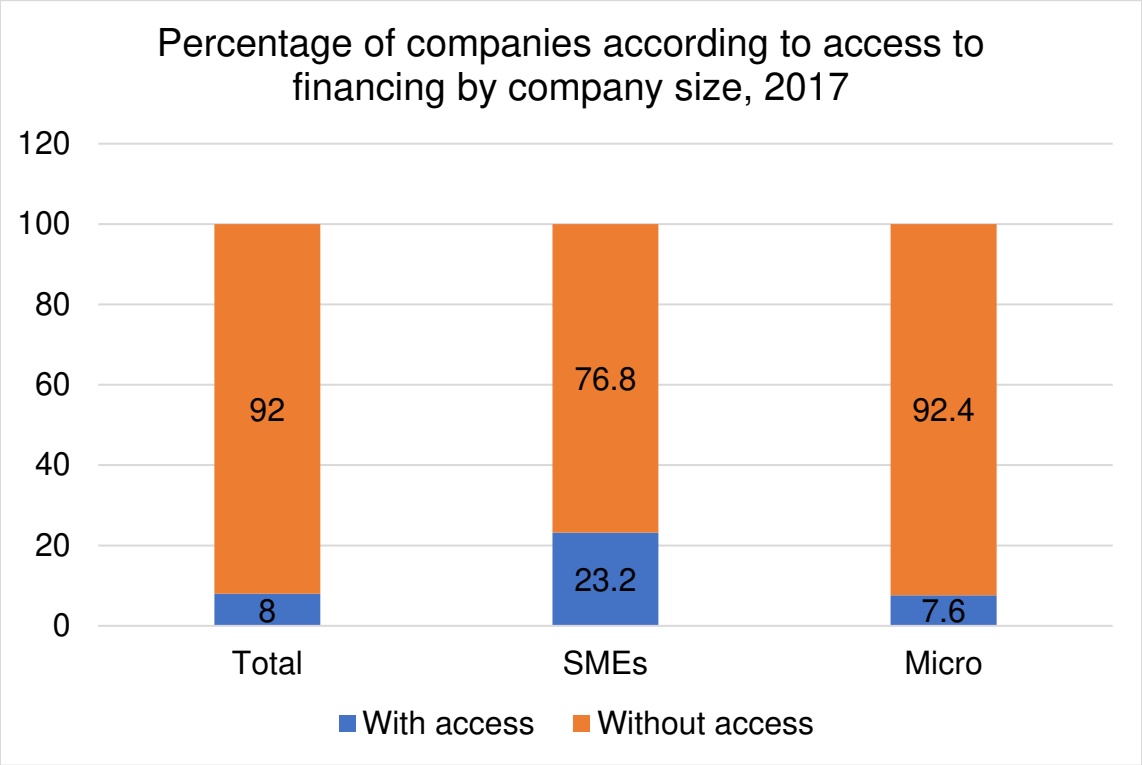
Source: Own elaboration based on INEGI (2021).

Graph 1 shows that, although there is a certain seasonality in the performance of the total remunerations provided by the analyzed subsector, it can be seen that there is a clear upward trend made up of increasing maximums, which reflects the constant and sustained increase in the remuneration of subsector of professional and technical services in Mexico during the last 11 years.

Everything previously presented allows us to conclude the relevance of the services sector for the generation of wealth for a country for Mexico; specifically the weight of the professional, scientific and technical services subsector for the country's economic growth.

On the other hand, it is important to mention that although micro enterprises have a predominant place in the contribution they generate to the economic development of Mexico, when analyzing the economic reality of the country it is evident that these economic units do not have access to the required financing that allows them to grow in a sustained manner, as shown in Graph 2, according to information from INEGI (2018).

Graph 2 Access to financing by company size for 2017, expressed as a percentage.

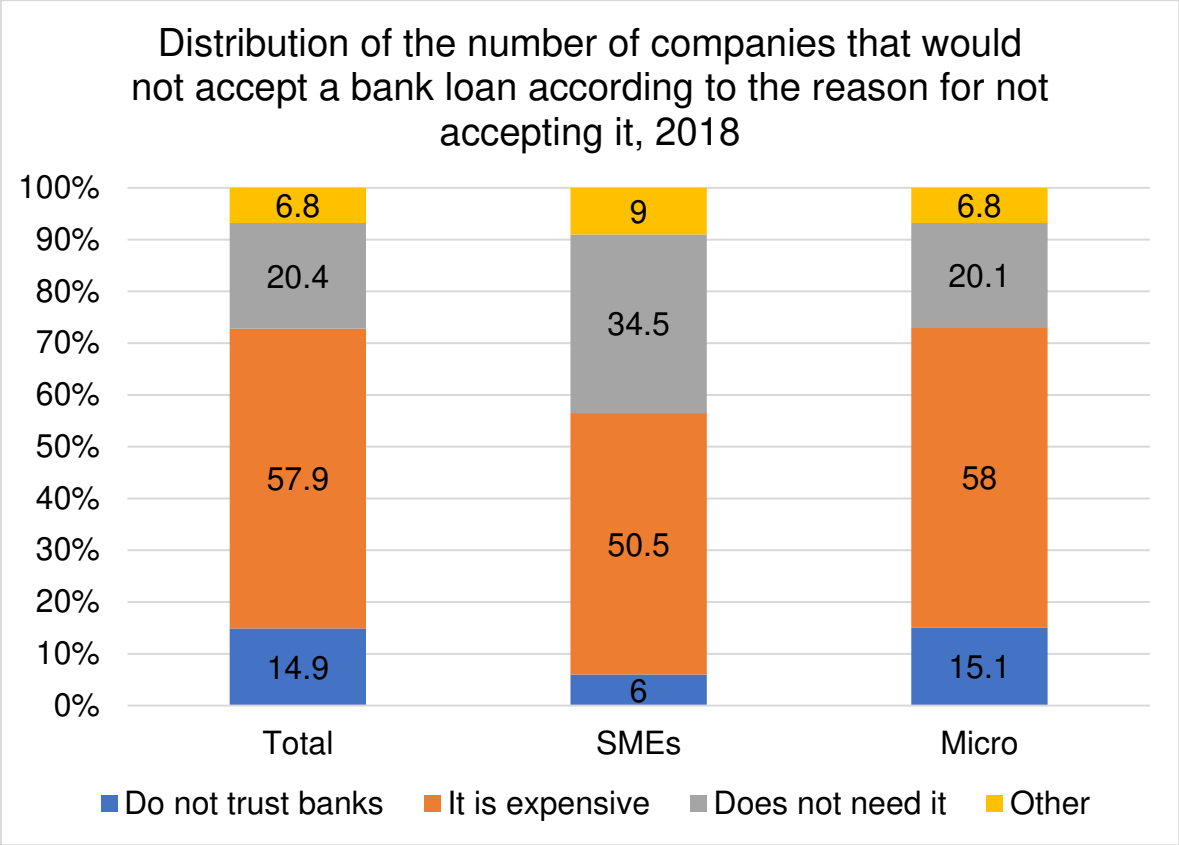


Source: Own elaboration based on INEGI (2018).

As can be seen in Graph 2, micro companies are the economic units that have the least access to financing with 7.6% of the total, compared to small and medium-sized companies that report a figure of 23.2% of the same indicator. Likewise, Graph 3 shows the different reasons that the various economic units distributed by size expressed regarding the refusal to access financing; As can be seen, the main reason why a micro company does not accept financing is because it considers it to be expensive, represented by 58% compared to small and medium-sized companies with 50.5% for the same answer.

In this way, it is possible to conclude that the impossibility of accessing financing by micro enterprises is given by a perception that the cost of said credit is high; The foregoing can be explained due to the fact that micro-enterprises are mainly the economic units that present the greatest lags in terms of the adequate estimation of calculations and economic indicators, specifically the financial analysis factor called risk.

Graph 3 Reasons for not accepting a bank loan for the distribution of the number of companies, for 2018.



Source: Own elaboration based on INEGI (2018).

Regarding the analysis of risks in companies, it is important to note that there have been various authors in the financial literature worldwide who have worked on determining the risk of companies in certain sectors, however, most of them have focused on in the study of large companies, which, as has already been seen, have a relatively small specific weight in terms of job creation and remuneration. The foregoing indicates that risk assessment for micro companies is an area that has not yet been explored in depth, partially due to the scarcity of information that these economic units record and use for their decision making.

When taking into consideration the field of company valuation, the so-called Capital Asset Valuation Model initially presented by Markowitz (1959), has become the most widely used tool to estimate the risk of any type of company. The mentioned model is mainly based on estimating the financial risk of a given asset in reference to the

market in which it exists or operates, by means of an indicator called the Beta risk coefficient, which is used to estimate the value of a company by means of the method of capitalization of income. Said coefficient is one of the data required to calculate the so-called discount rate that converts cash flows belonging to different periods of time into equivalent amounts and allows obtaining their Net Present Value or Net Present Value.

One of the main current exponents of this model to estimate the risk of companies is the renowned author Damodaran (2021), who has used the fundamentals of CAPM to calculate and publish a broad set of beta risk coefficients to determine the risk of a great diversity of large companies operating in industries mainly in the United States. Due to this, the outstanding work carried out by said author allows his results to be applicable to companies with similar characteristics of size and geographical location, which leaves out its usefulness for companies immersed in different contexts.

Because of this, it is considered advisable to apply these methodologies to determine risk, with the particularity of adapting them to contexts of scarce information, which allows their implementation in environments of economic relevance for effective business decision-making by everyone involved.

Regarding the above, the study carried out by Vidaurre (2016), determines in its conclusions that to carry out an optimal application of the CAPM method, it is necessary to consider its implications and limitations; among which it stands out that the data used to estimate the risk coefficient are only accessible in mature stock markets corresponding to developed countries, in contrast to the reality of developing countries in which the companies listed on the Stock Market do not show a Sufficient variety in terms of sectors and number of companies analyzed.

In a similar way, Argueta & Martínez (2016), expose the need to make changes to the Beta coefficient calculations for each particular case study; the authors show the need to put in context the financial data used to estimate the risk indicator. In their conclusions they propose, for example, to consider the beta of the selected industry and then to use some form of adjustment factor to determine the risk more specifically.

Considering all the above, this research work proposes to use the CAPM risk valuation methodology in order to estimate a Beta risk coefficient focused on micro-companies of prominent economic branches belonging to the professional, scientific and technical services sector; due to the information presented that supports its importance for the economy in Mexico. The main objective is to generate a risk indicator that is contextualized to the reality of the analyzed micro companies and that allows it to function as a useful tool for making financial decisions for both micro entrepreneurs and the respective financial institutions; helping to improve the conditions for obtaining and granting financing for said economic units.

Theoretical framework.

Modern portfolio theory is based on the contributions made by Markowitz (1959) and its corresponding simplification Sharpe (1964), where the Capital Asset Pricing Model is proposed. This model uses information such as the market risk-free rate, the asset's Beta risk coefficient, and the market's expected return, as shown in Equation 1.

$$CAPM = RFR + (\beta \, x \, RP) \qquad (1)$$

Source: own elaboration based on the study carried out.

Where:
RFR: Market's Risk Free Rate.
β: Asset's Beta coefficient.
RP: Risk Premium = market's expected average return – RFR.

The application of the CAPM requires information from both the market in general and the sector in which it operates, in addition to the risk-free rate of the selected country. Based on the relationship between the historical performance of the market in which the company is located and the historical performance of the specific sector,

it is possible to calculate the Beta risk coefficient. In the case of the United States, the risk-free rate is represented by the Treasury Bonds issued by the Federal Reserve; in the case of Mexico, it is the Treasury Certificates issued by the Bank of Mexico. In the case of the risk premium, it is considered as the historical performance of the market for a given period; in the case of the United States, the Standard & Poors 500 stock index is used as a reference, which groups the five hundred companies with the greatest weight for the economy of that country. In the case of Mexico, the yield corresponding to the Mexican Stock Exchange is used as a parameter, measured through the price and quotation index (IPC).

Regarding the estimation of the Beta risk coefficient, Troncoso (2008) comments that the variable risk of an asset or company is determined by its covariance with the portfolio in reference to the standard deviation of the portfolio, so the risk can be quantified by a simple regression of a coefficient called Beta. To calculate this Beta coefficient, it is necessary to estimate the covariance[1] between the average performance of the sector and the average performance of the market, plus the variance[2] of the average market return, as shown in Equation 2.

$$Beta\ \beta = \frac{Covariance\ (IR,MR)}{Variance\ (MR)} \qquad (2)$$

Source: own elaboration based on the study carried out.

Where:

IR = Industry's average return.

MR = Market's average return.

Based on Jiménez, Espinoza, & Fonseca (2007), the values that the Beta risk coefficient can adopt are around 1.0, as shown in Table 1.

[1] It is the value that reflects the extent to which two variables vary jointly with respect to their averages, based on (Ross, Westerfield, & Jordan, 2018).

[2] Defined as a dispersion measure that measures the variability of a series of data in relation to its average, according to (Ross, Westerfield, & Jordan, 2018).

Table 1 Interpretation of the Beta coefficient.

Coefficient value	Direction interpretation	Magnitude interpretation
2.0	It moves in the same direction as the market.	Twice more volatile than the market.
1.0	It moves in the same direction as the market.	Same risk as the market.
0.5	It moves in the same direction as the market.	Half the risk of the market.
0	Market movement does not affect it.	Market movement does not affect it.
-0.5	It moves in the opposite direction to the market.	Half the risk of the market.
-1.0	It moves in the opposite direction to the market.	Same risk as the market.
-2.0	It moves in the opposite direction to the market.	Twice more volatile than the market.

Source: Own elaboration based on Jiménez, Espinoza & Fonseca (2007).

According to Table 1, it is possible to conclude that a risk Beta with a positive coefficient implies a direct relationship of the company with its market and a negative value shows an inverse relationship to the market in which it operates. Similarly, a risk Beta equal to 1 implies that the company or asset will behave exactly the same as its reference market. A risk coefficient greater than one means that the performance of the company will present a greater sensitivity than the market to which it belongs and, therefore, will expand the movements of said market in any direction. Risk Beta values lower than 1 represent assets with less variability in their profitability with respect to the same indicator for the market in which they are located. Likewise, if the risk Beta is equal to or close to 0, the expected return of the asset or company will be equal to the Risk Free Rate.

Francisco (2010) comments that the range of values that the Beta risk coefficient can adopt is not limited and can be very varied, and also concludes that the Beta is a relative data and that it can also be interpreted as a percentage. This implies that a risk coefficient of, for example 1.55, represents an analyzed company whose performance is 55% more sensitive than the market in which it operates.

For his part, Gitman (2007) states that the risk Betas of a company can be positive or negative, but that the norm is positive values. Additionally, he states that most of the Beta risk coefficients are between 0.5 and 2.0. In the first case, it is considered that the company changes its performance by 0.5% for every 1% change in the market, in the second case, for every 1% of the market movement the company would change its performance by 2%.

Based on the work carried out by Blume (1975), it was possible to demonstrate that the Beta risk coefficients tend to return to the long-term average of all Betas over time. The above means that the risk of existing projects has a tendency to decrease over time, however, it also concludes that the opposite is not applicable for low-risk companies, that is, that over time they see their risk increase. until reaching the average.

Finally, and according to Hamada (1969), some of the main assumptions on which the CAPM is based are: that capital markets are perfect, which implies that the information is freely available, that there are no taxes or costs. transaction and that all assets are indefinitely divisible; it also considers that all investors can borrow or lend at the same interest rate and have the same portfolio opportunities. The fact that not all of these assumptions hold in real life represents important areas of opportunity for the application of the CAPM model in various business contexts.

Literature review.

Based on what is described in the introduction of this work, the determination of the risk of a company through the CAPM is considered as a widely used methodology when calculating the so-called Beta coefficient; Despite this, a large part of the research carried out has been concerned with studying information regarding the profitability of large companies in developed countries. That is why it is considered pertinent to apply said methodology with certain adjustments that allow obtaining representative results to estimate the risk of economic units belonging to certain sectors and subsectors in specific contexts, providing accurate and timely information for all the various related stakeholders.

The main conclusions of some of the most relevant research papers that have recently addressed this approach are presented descriptively below. The respective authors have sought to incorporate various variables and factors into the calculation of financial risk to adjust it to certain specific characteristics of the companies and regions where they operate.

Research focused on demonstrating that risk management models have the possibility of generating value through the reduction of the discount rate applied to the valuation flows of the underlying asset, carried out by Vargas & Cruz (2015); formulated three models of real derivatives in order to estimate the maximum value of the asset through strategies focused on reducing the systematic risk measured by the Beta. The main result reveals that the coverage of Earnings Before Interest and Taxes, eliminates the unexpected variability in demand, which implies that, despite being an EBIT with zero changes in demand, the systematic risk of the asset measured by the coefficient Beta becomes 0, similar to a risk-free rate; which minimizes the discount rate and maximizes the value of the company.

Likewise, the study on sustainable investment in the Mexican Stock Exchange during periods of crisis prepared by De la Torre & Martínez (2015), proposed to study the mean-variance efficiency of sustainable investment in Mexico by comparing the sustainable IPC index with the composite IPC; using daily periodicity values and a standard CAPM model. The main conclusions reflect that not only is there no loss of mean-variance efficiency, but also that sustainable investment in the Stock Market and the conventional one have statistically the same behavior or results. Furthermore, it was shown that volatility is higher for the composite CPI in both high and low volatility periods, but the expected return is significantly higher for the composite CPI in high volatility scenarios. The foregoing shows evidence in favor of sustainable investment both in terms of performance under various volatility scenarios and financial and operating benefits.

For its part, the work carried out by Wong & Chirinos (2016) on the applicability of the CAPM methodology to determine the value of family businesses when estimating cash flows through the corresponding discount rate, including opportunity costs and the total risk; obtained as the main finding that the model has a clear tendency to

dismiss the undertakings considered acceptable by other methods. Additionally, they concluded that, if they took into consideration different modifications such as country risk or liquidity risk, the results obtained would be even more unfavorable for family businesses.

Similarly, the research on the identification of an approximation model of the Beta risk coefficient for the measurement of its risk-return focused on the Bolivian Financial System, carried out by Vidaurre (2016), proposed a practical approach of the alternative models and their correlation with the traditional model; making it possible to calculate the risk-return of a bank in Bolivia. The most outstanding findings indicate that the effectiveness of the accounting Betas is determined by the number of observations, while the qualitative Betas imply a high level of subjectivity on the part of the valuer. Despite this, the generated model validates its methodological applicability and can be used by any type of valuation and finance specialists when calculating the value of companies.

The study carried out by Muñoz & Cuadros (2017), focused on comparing risk management models, as well as their implementation in small and medium-sized companies, was able to prove the impossibility of its application due to: the high cost involved, due to the focus of these methods on large projects and the excessive time involved in applying robust methodologies. Specifically, they point out that small and medium-sized companies do not have the possibility of managing risk adequately due to the lack of resources, knowledge and personnel, which is evident in the lack of: change management, systematization of lessons learned and its application in future decisions and of risk managers related to uncertainty.

Finally, the research on the optimal capital structure for companies in mature markets of emerging economies, carried out by Herrera (2018), used the minimum cost criterion and focused on a Colombian company. The results showed that as indebtedness increases, risk increases and therefore there is a higher return required by investors; Likewise, it is confirmed that the optimal capital structure maximizes the value of the company, as well as the price of each partner's participation, at the same time that it minimizes the weighted average cost of capital.

According to the conclusions pertaining to the works described above, it can be concluded that there is a diversity of studies on the determination and management of risk using traditional methods for its calculation, at the same time that the objective of adjusting said methodologies to varieties is set. from business contexts, such as companies of different sizes, sectors and countries of origin. Due to all this, the relevance and originality of conducting this research on risk valuation is validated through the Beta risk coefficient for micro-companies belonging to the subsector of professional, scientific and technical services in Mexico, through the preparation of an own index corresponding to the national micro-enterprise market.

Methodology.

As described in the previous sections of this paper, the methodology for calculating the Beta risk coefficient uses information corresponding to a sector of the economy and compares it with respect to the performance of the entire market, defined by a Stock Index. Considering that this method yields little applicable results for small companies and more specific subsectors, the proposed methodology consists of creating an Index of micro companies in Mexico of own elaboration, and comparing them with a sample of micro companies of a specific subsector, in this case that of professional, scientific and technical services, due to its importance previously described. The foregoing will allow to obtain valid and applicable results that clearly reflect the true risk of such economic units.

1. Performance of the micro business market.

The first step is to collect relevant information from companies that have comparable characteristics regarding their size measured by national standards, in this way the final results may be useful for decision-making in economic units with similar conditions; in this case, micro companies in Mexico. It is relevant to mention that all the data used in this research work were obtained through primary information sources obtained from a business consulting company located in the City of Puebla,

Mexico; from which your name will be omitted to comply with the established confidentiality contract.

Specifically, the methodological proposal is to use selected financial information corresponding to 200 companies that present two essential requirements:

1. Incorporated in Mexico, comprising companies from all economic sectors.
2. That, based on the criteria published by the Government authorities, they could be classified within the category of micro companies: from 1 to 10 workers, up to 4 million mexican pesos per year in sales and with a combined maximum ceiling of 4.6[3].

The next step, once the 200 micro-companies that will be used to join the proposed Index have been selected, consists of collecting selected financial information pertaining to a specific period of time. The time horizon that has been selected for this work includes the range of the years 2012, 2013, 2014, 2015 and 2016. Specifically, the estimation of the Beta risk coefficient requires data regarding the profitability of the assets or companies analyzed to each of the years of the selected period; In order to obtain this information, it has been proposed to use the widely known financial indicator Return on Investment[4].

2. Performance of selected professional, scientific and technical services branches.

Once the ROI information pertaining to the 200 micro-companies in Mexico corresponding to each year analyzed is available, the subsequent step consists of estimating the profitability information measured by the ROI for a sample of micro-companies in a given sector or subsector, in this case that of professional, scientific and technical services. It is in this way that it will be possible to estimate the variability of the profitability of these service companies with respect to the profitability of the micro-business market in Mexico; finally resulting in Beta risk coefficients of various branches of the aforementioned subsector.

[3] Classification corresponding to companies in Mexico (Diario Oficial de la Federación, 2009).
[4] Called ROI by its acronym and estimated through the division of net income by the capital of investors (Ross, Westerfield, & Jordan, 2018).

According to the North American Industrial Classification System[5], the companies dedicated to this sector / subsector of the economy include: “economic units whose activity consists of providing professional, scientific and technical services. These services require specialized knowledge and skills, so the main component of the production function of the economic units that make up this sector is, precisely, human capital. " (INEGI, 2018).

Likewise, based on the NAICS INEGI (2018), the branches belonging to the sector / subsector of professional, scientific and technical services are presented in Table 2; showing the total employed personnel contributed by each one, according to information from the INEGI Annual Survey of Non-Financial Private Services (2019).

Table 2 shows the main branches corresponding to the sector / subsector of professional, scientific and technical services, the total employed personnel contributed by each one, as well as their code according to the NAICS. The present investigation will take care of estimating the Beta risk coefficient for each and every one of these branches, with the objective that the final results are applicable for such a variety of economic units in Mexico.

The next step of the proposed methodology consists of using the required financial information belonging to a sample of companies that meet three necessary requirements:

1. Focused on the professional, scientific and technical services sector in Mexico.
2. That, according to the criteria published by the Government authorities, they could be included within the category of micro companies: from 1 to 10 workers, up to 4 million mexican pesos per year in sales and with a combined maximum ceiling of 4.6[6].
3. Belonging to the branches of professional, scientific and technical services in Mexico described in Table 2.

[5] Called NAICS by its acronym.

[6] Classification corresponding to service companies in Mexico (Diario Oficial de la Federación, 2009).

Table 2 Branches corresponding to professional, scientific and technical services by total employed personnel in Mexico.

NAICS Code	Branch	Total employed personnel
5411	Legal services	97, 433
5412	Accounting, auditing and related services	99, 459
5413	Architecture, engineering and related activities services	26,012
5414	Specialized design	27,041
5415	Computer systems design services and related services	22,554
5416	Administrative, scientific and technical consulting services	58,219
5417	Scientific research and development services	4,422
5418	Advertising services and related activities	30, 718
5419	Other professional, scientific and technical services	56,034

Source: Own elaboration based on INEGI (2019).

It is important to mention that this work is presented as a case study of 30 companies for each of the branches, because according to the central limit theorem Johnson & Kuby (2016), such is the minimum number of observations that should be used so that the analyzed variable meets the characteristics of a normal probability distribution. Due to this, the sample will be made up of 270 micro companies divided equally for each of the 9 selected branches and considering obtaining their profitability measured through ROI for the same period of analysis: years 2012, 2013, 2014, 2015 and 2016.

In a similar way to the construction of the Index of micro companies, the information was obtained through an agreement with the business consulting company mentioned above. Based on what was previously described, this research uses a non-probability sampling with the characteristics of an intentional or selective sampling Bonilla-Castro & Rodríguez (2013), taking into consideration that the information required for the study had already been collected from the beginning. of the same.

3. **Estimation of the required statistical variables.**

Once the two databases have been assembled with relevant information on the profitability of micro-companies for the selected period, both from the Index of 200 micro-companies in Mexico and the sample of 270 micro-companies belonging to 9 selected branches of the sector professional, scientific and technical services in Mexico, the last step of the proposed methodology consists of performing the respective calculations of variances and covariances required to apply the CAPM method.

4. **Calculation of beta risk coefficients for selected branches of the professional, scientific and technical services sector.**

The final results will allow obtaining specific risk Betas for each of the analyzed branches and therefore determine the risk with respect to the total market of micro companies in Mexico, these calculations are presented in the following results chapter.

Results.

According to the proposed method based on the creation of an Index of micro companies in Mexico to determine the Beta risk coefficients of micro companies belonging to selected branches of the sector / subsector of professional, scientific and technical services, operations are calculated required by the CAPM model. It is important to mention again that the evaluation horizon of the present study was established based on the information that the model needs and the availability of the data obtained through the previously mentioned consulting company. The data are:

1. Average annual net income of each micro enterprise for the years: 2012, 2013, 2014, 2015 and 2016.
2. Capital invested by the annual average investors of each micro company corresponding to the years: 2012, 2013, 2014, 2015 and 2016.

By having said data belonging to the selected companies, it is possible to calculate the average annual profitability measured by the financial indicator ROI, which was

estimated both for the general index of 200 micro companies in Mexico, and for the sample of 270 Mexican micro companies belonging to various branches of the sector/subsector of professional, scientific and technical services.

1. Performance of the micro business market.

Table 3 shows the results corresponding to the average ROI of the 200 micro companies in Mexico, based on the data obtained in the research.

Table 3 Average annual ROI of the 200 micro-companies in Mexico analyzed for the periods indicated.

Years of observation				
2012	**2013**	**2014**	**2015**	**2016**
41%	44%	49%	38%	54%

Source: own elaboration based on the study carried out.

1.1. Analysis of the performance of the micro business market in Mexico corresponding to each period of analysis.

The CAPM methodology requires that the estimates shown in Equation 3 be made, with respect to the returns of the microenterprise market in Mexico.

$$Analysis\ of\ the\ performance\ of\ the\ micro\ enterprise\ market\ by\ period\ = Micro\ enterprise\ market\ performance\ of\ the\ period\ - Average\ returns\ of\ the\ micro\ business\ market \quad (3)$$

Source: own elaboration based on the study carried out.

The respective results for each year studied appear in Table 4.

The results of the returns shown in Table 4 represent the entire Mexican microenterprise market for the purposes of this study and for the periods shown. Said results are considered as the comparison index through which their covariance will be estimated with respect to the returns of each of the selected professional, scientific and technical services branches; in addition to determining its own variance, according to the methodology for obtaining the Beta risk coefficients.

Table 4 Analysis of the performance of the micro business market in Mexico.

Year	Performance of the micro enterprise market in Mexico	Performance of the micro business market in Mexico - average performance
2012	41.08%	-4.11%
2013	44.16%	-1.04%
2014	48.71%	3.51%
2015	37.72%	-7.47%
2016	54.31%	9.11%
Average	45.20%	

Source: own elaboration based on the study carried out.

2. **Performance of selected branches of the professional, scientific and technical services sector.**

Similarly, Table 5 shows the data of the average annual profitability measured by means of ROI for the branches of the professional, scientific and technical services sector indicated and for the same evaluation period.

Table 5 Average annual ROI of the 270 micro-companies by branches of the professional, scientific and technical services sector in Mexico selected for the periods shown.

Professional, scientific and technical services sector	Average of Return on Investment				
	2012	**2013**	**2014**	**2015**	**2016**
Legal services	44%	97%	95%	59%	75%
Accounting, auditing and related services	44%	108%	96%	47%	68%
Architecture, engineering and related activities services	81%	109%	88%	74%	108%
Specialized design	56%	86%	70%	42%	74%
Computer systems design services and related services	49%	117%	97%	51%	76%
Administrative, scientific and technical consulting services	71%	111%	70%	48%	89%
Scientific research and development services	67%	72%	66%	59%	96%
Advertising services and related activities	65%	104%	66%	48%	89%
Other professional, scientific and technical services	76%	91%	88%	74%	106%

Source: own elaboration based on the study carried out.

Having the results expressed in Tables 3 and 5, the next step is to make the corresponding estimates to obtain the Beta risk coefficient for each of the selected branches with respect to the entire micro-enterprise market in Mexico. It is important to mention that, due to space considerations in this research, the results presented below will correspond to the respective calculations of only one of the selected branches shown as an example, that of legal services. The respective estimates for the other eight selected branches were made in exactly the same way. A broader development of these estimates is shown in Appendix 1.

2.1. Performance analysis of selected branches of the professional, scientific and technical services sector in Mexico by period.

In a similar way to the analysis of the performance of the micro-business market in Mexico and using the data on the returns of the branches obtained, the difference between the performance values for each period and the average of said values analyzed is calculated, as shown in Equation 4.

$$Analysis\ of\ the\ selected\ branch\ by\ period\ = Branch\ performance\ per\ period\ - Average\ yields\ of\ the\ branch \quad (4)$$

Source: own elaboration based on the study carried out.

Once all the respective operations are calculated for each of the five years of evaluation, it is possible to determine the results shown in Table 6. The estimates shown for the legal services branch are made in the same way for the rest of the selected branches of professional, scientific and technical services. The data obtained will be used later to calculate the covariance that exists between the returns of the selected professional, scientific and technical services branches and the performance of the total market for micro-enterprises in the country.

Table 6 Analysis of the performance of companies in the legal services branch.

Year	Average performance of legal services companies	Legal services performance - average performance
2012	43.60%	-30.17%
2013	96.58%	22.80%
2014	94.67%	20.89%
2015	58.62%	-15.15%
2016	75.40%	1.63%
Average	73.77%	

Source: own elaboration based on the study carried out.

3. Estimation of the required statistical variables.

3.1 Variance.

The Beta risk coefficient requires to obtain the estimate of the variance regarding the returns of the microenterprise market for the evaluation period (Table 4). To do this, the data obtained from the total market performance for each year is used and its average is subtracted to later square the corresponding result for each period, as shown in Equation 5.

Finally, the summation of said results is carried out as shown in Table 7.

$$Variance = (Legal\ services\ performance\ -\ average\ performance\ )^2 \quad (5)$$

Source: own elaboration based on the study carried out.

Table 7 Varianza del rendimiento del mercado de micro empresas en México.

Year	Micro enterprise market performance - average performance	Variance
2012	-4.11%	0.0016905036
2013	-1.04%	0.0001083270
2014	3.51%	0.0012339247
2015	-7.47%	0.0055847929
2016	9.11%	0.0083043067
Summatory		0.016922

Source: own elaboration based on the study carried out.

The result of the sum of the variances will be used to calculate the risk coefficients for each of the branches of the professional, scientific and technical services sector/subsector; taking into consideration that said result represents the variability in the returns of the entire micro-enterprise market in Mexico.

3.2 Covariances.

In addition to the calculation of the variance of the microenterprise market and, based on the analysis of the returns of the Microenterprise Market Index (Table 4) and the analysis of the returns of the chosen branches of the professional, scientific and technical services sector (Table 6), it is possible to determine the covariance between the two for each year of analysis. This estimate is shown in Equation 6 and requires multiplying each one of the estimated returns of the chosen branches by the returns calculated from the total market for the same period; the final step is to add the results, thus obtaining their covariance.

The results corresponding to each period analyzed are shown in Table 8.

$$Covariance = Branch\ performance\ analysis\ X\ Analysis\ of\ total\ market\ returns \quad (6)$$

Source: own elaboration based on the study carried out.

Table 8 Covariance between the analysis of the returns of the micro legal services companies and the analysis of the returns of the micro business market in Mexico.

Year	Legal services performance - average performance	Market performance - average performance	Covariance
2012	-30.17%	-4.11%	0.012406
2013	22.80%	-1.04%	-0.002373
2014	20.89%	3.51%	0.007339
2015	-15.15%	-7.47%	0.011322
2016	1.63%	9.11%	0.001483
		Summatory	**0.030177**

Source: own elaboration based on the study carried out.

The results shown in Table 8 are calculated similarly for the rest of the branches corresponding to the sector/subsector of professional, technical and scientific services; these covariances will be used to estimate the Beta risk coefficients.

Once the necessary data of the covariances corresponding to the returns of the selected branches of professional, scientific and technical services are available for the period studied and of the respective variance of the returns of the micro-business market in Mexico for the same period, we proceed to calculate the Beta risk coefficients for each of the branches.

4. Calculation of beta risk coefficients for selected branches of the professional, scientific and technical services sector.

According to the results calculated from the covariances and variances previously presented, Equation 7 is used to estimate the Beta risk coefficient for the legal services branch.

$$Beta\ \beta = \frac{Covariance\ (Legal\ services\ return,\ \ Micro\ business\ market\ return\ )}{Variance\ (\ Micro\ business\ market\ return)} \qquad (7)$$

Source: own elaboration based on the study carried out.

Substituting the variables for the corresponding values, Equation 8 is obtained.

$$Beta\ \beta = \frac{0.030177}{0.016922} = \ 1.7833 \qquad (8)$$

Source: own elaboration based on the study carried out.

It is possible to conclude, from the result obtained, that the Beta risk coefficient corresponding to the micro companies in Mexico dedicated to the legal services branch is 1.7833, with respect to the total of micro companies in Mexico. Likewise, estimates of the risk coefficients are carried out for the other selected branches of the professional, scientific and technical services sector, concluding with the results shown in Table 9.

Table 9 Beta risk coefficients for selected micro-companies belonging to the professional, scientific and technical services sectors in Mexico.

Professional, scientific and technical services sector	Number of companies	Beta coefficient
Legal services	30	1.7833
Accounting, auditing and related services	30	1.8389
Architecture, engineering and related activities services	30	1.7257
Specialized design	30	1.6874
Computer systems design services and related services	30	1.9217
Administrative, scientific and technical consulting services	30	1.6832
Scientific research and development services	30	1.8913
Advertising services and related activities	30	1.7914
Other professional, scientific and technical services	30	1.8626

Source: own elaboration based on the study carried out.

The final results displayed in Table 9 show the estimated Beta risk coefficients for the selected branches of the professional, scientific and technical services sector, ranging from 1.6832 for administrative, scientific and technical consulting services, to 1.9217 for services of design of systems of computing and related services. In this way, it is possible to conclude that for every 1.00% that the profitability of the micro-business market in Mexico varies, the profitability of the selected branches will change in the same direction and in the following proportions: legal services by 1.78%, accounting services , audit and related services by 1.83%, architecture, engineering and related activities services 1.72%, specialized design by 1.68%, computer systems design services and related services by 1.92%, administrative, scientific and technical by 1.68%, scientific research and development services by 1.89%, advertising services and related activities by 1.79% and other professional, scientific and technical services by 1.86%.

As final results, it is important to mention that all the Beta risk coefficients obtained present positive values and greater than 1, so it is considered that all the selected branches of the sector / subsector professional, scientific and technical services

have greater variability or volatility than the total micro-business market and moving in the same direction. The average of these risk Betas is 1.7984, so in general they are considered branches with a yield and associated risk much higher than those of the total company market in Mexico; which indicates that it is advisable to invest in such companies in times of economic prosperity and divest from them in times of turbulence.

Conclusions.

Companies are the economic units that promote the development of any country or region by producing the goods and services that society demands while generating a diverse amount of direct and indirect jobs throughout the distribution chain in which they operate. This is particularly true for micro-enterprises, which represent the majority of economic units in Mexico.

Despite the above, it is precisely the micro-enterprises that, due to various circumstances, have the worst access to the required financing that allows them to continue growing and generate greater benefits for all those involved in their operations: suppliers, workers, clients, investors and the society in general. Some of these circumstances include the fact that they consider the costs of such financing to be high due to poor risk management and also the scant financial information they record.

Additionally, in Mexico it is specifically the services sector that accounts for the largest number of units and employed personnel; specifically, the subsector of professional, scientific and technical services presents the highest percentage of variation in the total income of all services for 2020; in addition to presenting a growing trend in terms of total remuneration.

On the other hand, asset valuation provides important tools for determining the risk of all kinds of assets, including companies, and measuring their risk. Among these tools, the Capital Assets Valuation Model stands out, which since its original construction has represented an important instrument to determine the risk of an asset in reference to the entire market in which it exists, using a relatively low amount

of financial information. The literature reviewed shows, however, that this methodology is still applied mainly in large companies belonging to developed countries and that, although there have been efforts to adjust the Beta risk coefficient to different realities and contexts, there are still areas of opportunity to use CAPM to different types of companies that allow to contribute to the improvement in the respective business decision making.

Due to all of the above, the main objective of this research work was to propose an alternative of application of the Beta risk coefficients by assembling an own Index made up of micro companies in Mexico and determining the respective variability of nine selected branches of the service sector. professionals, scientists and technicians. The Index was formed with data on profitability, measured through the financial indicator ROI, of 200 micro companies in Mexico and the risk Betas were calculated according to 30 companies belonging to each of the nine branches selected for the evaluation horizon of the years: 2012, 2013, 2014, 2015 and 2016; according to the availability of the information.

By analyzing the respective returns and estimating the variance and covariances required by the risk model for each branch, it was possible to obtain the resulting coefficients, which presented a positive sign in their entirety and whose values were from 1.6832 to 1.9217, with a mean of 1.7984 for all the branches of professional, scientific and technical services analyzed.

It is in this way that it is possible to conclude that the selected branches belonging to the sector / subsector of professional, scientific and technical services move in the same direction as the total market of micro-enterprises and that they report greater sensitivity or variability than the market, being the branch of administrative, scientific and technical consulting services the least risky and that of services for the design of computer systems and related services the one that presents the greatest risk.

Based on all of the above, the selected branches can be considered volatile as they present higher levels of risk and return than the market in which they operate, which is reflected in both bullish and bearish changes that are deeper than those that occurred in the general market. The foregoing is due to the systemic or non-diversifiable risk that it is impossible for them to control the decision makers in the

companies, therefore it is advisable to take into consideration the present conclusions in reference to the investment and divestment of capital in these branches and depending on the specific moment of the economic cycle in which you are.

The main contribution of this research lies in the contribution of a contextualized tool for calculating the risks of micro-enterprises in the selected branches of professional, scientific and technical services, contributing to the generation of valid conclusions that allow said economic units improve their conditions for access to the required financing and be able to continue contributing more and more to the development and economic growth of the country.

Future research that seeks to continue on the respective line of risk identification through the Beta coefficient, could use information corresponding to different sectors, subsectors and economic branches, as well as consider economic units of different sizes and geographical location for the study; adding to the construction of a contextualized, complete and updated database. It is in this way that relevant and valid information can continue to be generated for effective decision-making in companies that benefits all stakeholders involved.

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Appendixes.

Appendix 1. Development of the analysis to obtain the Beta risk coefficient for the selected branches of the sector / subsector of professional, scientific and technical services.

Estimate of the beta risk coefficient for the branch of accounting, auditing and related services.

Covariance between the analysis of the returns of the accounting, auditing and related services micro companies and the analysis of the returns of the Mexican micro business market.

Year	Average performance of accounting companies.	Performance accounting services - average performance	Market performance - average performance	Covariance
2012	43.60%	-30.17%	-4.11%	0.012406
2013	107.53%	33.75%	-1.04%	-0.003513
2014	95.61%	21.83%	3.51%	0.007668
2015	46.66%	-27.11%	-7.47%	0.020263
2016	67.51%	-6.26%	9.11%	-0.005708
Average	**72.18%**		**Summatory**	**0.031117**

Equation to estimate the Beta risk coefficient for the branch of accounting, auditing and related services.

$$Beta\ \beta = \frac{Covariance\ (Accouting\ serv.return,\ \ Micro\ business\ market\ return)}{Variance\ (\ Micro\ business\ market\ return)}$$

$$Beta\ \beta = \frac{0.031117}{0.016922} = \ 1.8388$$

Estimation of the beta risk coefficient for the branch of architectural, engineering and related activities services.

Covariance between the analysis of the returns of the micro-companies of services of architecture, engineering and related activities and the analysis of the returns of the market of micro-companies in Mexico.

Year	Average performance of architecture companies.	Performance architecture services - average performance	Market performance - average performance	Covariance
2012	80.97%	7.20%	-4.11%	-0.002960
2013	108.53%	34.75%	-1.04%	-0.003617
2014	88.11%	14.33%	3.51%	0.005034
2015	74.18%	0.40%	-7.47%	-0.000301
2016	107.84%	34.07%	9.11%	0.031046
Average	**91.93%**		**Summatory**	**0.029202**

Equation to estimate the Beta risk coefficient for the branch of architecture, engineering and related activities services.

$$Beta\ \beta = \frac{Covariance\ (Arch.services\ return,\ \ Micro\ business\ market\ return)}{Variance\ (\ Micro\ business\ market\ return}$$

$$Beta\ \beta = \frac{0.029202}{0.016922} = \ 1.7257$$

Estimation of the beta risk coefficient for the branch of specialized design services.

Covariance between the analysis of the returns of specialized design services micro-companies and the analysis of the returns of the Mexican micro-business market.

Year	Average performance of spec. design services.	Performance spec. design services - average performance	Market performance - average performance	Covariance
2012	56.06%	-17.72%	-4.11%	0.007284
2013	85.63%	11.85%	-1.04%	-0.001233
2014	70.30%	-3.48%	3.51%	-0.001221
2015	41.87%	-31.90%	-7.47%	0.023840
2016	73.65%	-0.13%	9.11%	-0.000115
Average	**65.50%**		**Summatory**	**0.028554**

Equation to estimate the Beta risk coefficient for the specialized design services branch.

$$Beta\ \beta = \frac{Covariance\ (Spec.\ design\ serv\ return,\ \ Micro\ business\ market\ return)}{Variance\ (\ Micro\ business\ market\ return)}$$

$$Beta\ \beta = \frac{0.028554}{0.016922} = \ 1.6874$$

Estimation of the beta risk coefficient for the branch of computer systems design services and related services.

Covariance between the analysis of the performance of the micro-enterprises of computer systems design services and related services and the analysis of the performance of the market of micro-enterprises in Mexico.

Year	Average performance of comp. systems services.	Performance compt. systems serv. - average performance	Market performance - average performance	Covariance
2012	49.21%	-24.57%	-4.11%	0.010101
2013	117.49%	43.71%	-1.04%	-0.004549
2014	96.54%	22.77%	3.51%	0.007998
2015	51.45%	-22.33%	-7.47%	0.016687
2016	76.28%	2.50%	9.11%	0.002282
Average	**78.19%**		**Summatory**	**0.032518**

Equation to estimate the Beta risk coefficient for the branch of computer systems design services and related services.

$$Beta\ \beta = \frac{Covariance\ (Comp.systems\ serv.return,\ Micro\ business\ market\ return)}{Variance\ (\ Micro\ business\ market\ return)}$$

$$Beta\ \beta = \frac{0.032518}{0.016922} = 1.9216$$

Estimation of the beta risk coefficient for the branch of administrative, scientific and technical consulting services.

Covariance between the analysis of the returns of the micro-enterprises of administrative, scientific and technical consulting services and the analysis of the returns of the micro-enterprise market in Mexico.

Year	Average performance of consulting services.	Performance consulting services - average performance	Market performance - average performance	Covariance
2012	71.01%	-2.77%	-4.11%	0.001138
2013	110.52%	36.74%	-1.04%	-0.003824
2014	70.30%	-3.48%	3.51%	-0.001221
2015	48.45%	-25.32%	-7.47%	0.018922
2016	88.55%	14.78%	9.11%	0.013468
Average	**77.77%**		**Summatory**	**0.028482**

Equation to estimate the Beta risk coefficient for the branch of administrative, scientific and technical consulting services.

$$Beta\ \beta = \frac{Covariance\ (Consulting\ services\ return,\ \ Micro\ business\ market\ return)}{Variance\ (Micro\ business\ market\ return)}$$

$$Beta\ \beta = \frac{0.028482}{0.016922} = 1.6831$$

Estimation of the beta risk coefficient for the branch of scientific research and development services.

Covariance between the analysis of the returns of the micro companies of scientific research and development services and the analysis of the returns of the market of micro companies in Mexico.

Year	Average performance of scientific services.	Performance scientific serv. - average performance	Market performance - average performance	Covariance
2012	67.27%	-6.50%	-4.11%	0.002674
2013	71.69%	-2.09%	-1.04%	0.000217
2014	65.61%	-8.16%	3.51%	-0.002868
2015	58.62%	-15.15%	-7.47%	0.011322
2016	96.45%	22.67%	9.11%	0.020659
Average	**71.93%**		**Summatory**	**0.032005**

Equation to estimate the Beta risk coefficient for the branch of scientific research and development services.

$$Beta\ \beta = \frac{Covariance\ (Scientific\ serv.return,\ \ Micro\ business\ market\ return)}{Variance\ (\ Micro\ business\ market\ return)}$$

$$Beta\ \beta = \frac{0.032005}{0.016922} = \ 1.8913$$

Estimation of the beta risk coefficient for the branch of advertising services and related activities.

Covariance between the analysis of the returns of the micro companies of advertising services and related activities and the analysis of the returns of the market of micro companies in Mexico.

Year	Average performance of advertising companies	Performance advertising serv. - average performance	Market performance - average performance	Covariance
2012	65.40%	-8.37%	-4.11%	0.003442
2013	103.55%	29.77%	-1.04%	-0.003099
2014	65.61%	-8.16%	3.51%	-0.002868
2015	47.86%	-25.92%	-7.47%	0.019369
2016	88.55%	14.78%	9.11%	0.013468
Average	**74.19%**		**Summatory**	**0.030313**

Equation to estimate the Beta risk coefficient for the advertising services branch and related activities.

$$Beta\ \beta = \frac{Covariance\ (Advertising\ serv.return,\ \ Micro\ business\ market\ return)}{Variance\ (\ Micro\ business\ market\ return)}$$

$$Beta\ \beta = \frac{0.030313}{0.016922} = \ 1.7913$$

Estimation of the beta risk coefficient for the branch of other professional, scientific and technical services.

Covariance between the analysis of the returns of the micro-companies of other professional, scientific and technical services and the analysis of the returns of the micro-business market in Mexico.

Year	Average performance of other prof. services	Performance of other prof serv. - average performance	Market performance - average performance	Covariance
2012	75.99%	2.22%	-4.11%	-0.000911
2013	90.60%	16.83%	-1.04%	-0.001752
2014	88.11%	14.33%	3.51%	0.005034
2015	74.18%	0.40%	-7.47%	-0.000301
2016	106.09%	32.31%	9.11%	0.029448
Average	**86.99%**		**Summatory**	**0.031518**

Equation to estimate the Beta risk coefficient for the branch of other professional, scientific and technical services.

$$Beta\ \beta = \frac{Covariance\ (Other\ prof.services\ return,\ \ Micro\ business\ market\ return)}{Variance\ (\ Micro\ business\ market\ return)}$$

$$Beta\ \beta = \frac{0.031518}{0.016922} = \ 1.8625$$