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Capital Asset Pricing Model (CAPM) applied to the corporate sector of Ecuador

Modelo de Valoración de Activos Financieros (CAPM) aplicado al sector empresarial de Ecuador

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Abstract: the methodologies for calculating market risk have been mainly applied to economies in developed countries. In this research work, it is proposed to use the CAPM to determine the market risk and minimum expected return of companies in the corporate sector of Ecuador in the period 2009-2019. An average of 48,667 companies were analyzed, based on information obtained from the Superintendence of Companies, Securities and Insurance (SCSI). The sectors were analyzed according to the International Standard Industrial Classification (ISIC). An accounting Beta was used in the calculations considering the incipient development of the country's stock market; an estimation was made through ordinary least squares and an adjusted ROE was proposed. In addition, the minimum expected return of the sector was calculated through the CAPM. Among the main findings of this work, it is highlighted that sectors B, C, G, H, J, M and N had a Beta greater than 1, i.e., these sectors are more sensitive to a change in the market. It is also important to mention that sectors P, G, C, E, J and Q perform better than expected. The information provided constitutes a support for organizations or other interest groups, considering the high level of uncertainty existing in the market.

Keywords: CAPM, Beta, performance, uncertainty, return, market risk, corporate sector, ROE.

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Resumen: Las metodologías para el cálculo del riesgo de mercado han sido aplicadas principalmente a economías de países desarrollados. En este trabajo de investigación se propone utilizar el CAPM para determinar el riesgo de mercado y rendimiento mínimo esperado de las empresas del sector corporativo de Ecuador para el periodo 2009-2019. En promedio se analizaron 48 667 empresas, con base en la información obtenida de la Superintendencia de Compañías, Valores y Seguros (SCVS). Los sectores que fueron analizados de acuerdo con la Clasificación Industrial Internacional Uniforme (CIIU). En los cálculos se utilizó un Beta contable, considerando el incipiente desarrollo de la bolsa de valores del país; se realizó una estimación por mínimos cuadrados ordinarios y se propuso un ROE ajustado. Además, se calculó el rendimiento mínimo esperado del sector por medio del CAPM. Entre los principales hallazgos se destaca que los sectores B, C, G, H, J, M, y N tienen un Beta mayor a 1, es decir, estos sectores son más sensibles ante una variación en el mercado. También es importante mencionar que los sectores P, G, C, E, J y Q tienen un desempeño mejor al esperado. La información proporcionada sirve como apoyo para las organizaciones u otros grupos de interés, considerando el alto nivel de incertidumbre en el mercado.

Palabras clave: CAPM, Beta, desempeño, incertidumbre, rendimiento, riesgo de mercado, sector empresarial, ROE.

Introduction

If it is considered that an organization will be exposed to risk due to uncertainty in the market (Rutkowska and Markowski, 2022), a well-diversified portfolio allows for more investment opportunities and better returns. An optimal portfolio is achieved by combining properly diversified shares that maximize expected return and reduce risk. According to Markowitz's theory of diversification (1952), the diversifiable should decrease in relevance. Thus, the Capital Asset Pricing Model (CAPM) would imply that the important component is the non-diversifiable risk (Leyva, 2014). In this model, the expected investment returns on an investment are a function of market returns, the risk-free rate, and a Beta factor or coefficient, measuring the rate of change of the asset's historical returns versus historical returns of the market as a whole (Adekunle *et al.*, 2020; Elsas *et al.*, 2003; St.-Pierre and Bahri, 2006). Historically, the CAPM has been the methodology commonly used among financial institutions and intermediaries to measure the market risk of portfolios made up of shares (Trejo and Gallegos, 2021).

The CAPM was developed based on returns obtained in stock market transactions in countries with developed capital markets. Ruíz *et al.* (2021) stated that the valuation models used can be adapted for developed economies or emerging markets; however, they do not reflect an optimal mechanism for project valuation in countries where there are deficient stock markets. In the Ecuadorian context, as there is no developed stock market, the CAPM can derive from the accounting data of non-listed companies. Thus, the accounting Beta is another way to determine the risk of a closed capital company against its environment. St.-Pierre and Bahri (2006) discussed the feasibility of using accounting in this context to measure intrinsic risk factors. Similarly, Tamara *et al.* (2017) asserts the utility of accounting Betas with referring to companies not having historical data on their share price or else having too much noise. In this context, the accounting measure of total and systematic risk has a significant impact on measures of market risk for companies, and the accounting Beta model presents itself as a powerful alternative to the CAPM (Rutkowska and Markowski, 2022; Faiteh and Aasri, 2022).

Risk indicators are important decision-making tools for various interest groups. Risk management is important for business for the search of competitiveness and sustainability. This situation must be complemented with public policies that guarantee stability and continuity in the long term (Pérez Pravia and Vega de la Cruz, 2021; Urdaneta *et al.*, 2021). The aim of this research is to calculate the market risk and the minimum expected return of the different sectors that make up the economy of Ecuador through the Capital Asset Pricing Model (CAPM) proposed by Sharpe (1964), Lintner (1965) and Mossin (1966). Due to the limited development of the Ecuadorian stock market, the calculation of an accounting Beta is proposed. This research empathizes that CAPM can be adjusted to the Ecuadorian business scenario by means of an adjusted ROE.

Literature review

Diversification is the best way to reduce investment risk. In lay terms, this means "not putting all your eggs in one basket". Markowitz (1952) pioneered a portfolio selection model based on diversification, incorporating mean variance as an essential criterion for the optimal selection of assets. Astaiza (2012) states that the essence of the Markowitz model lies in the rule:

$$E\text{-}V \text{ (Expected return-Variance)} \qquad (1)$$

According to this rule, when the risk involved in two portfolios are the same, the investor should prefer the one with the highest expected return. In market risk analysis, there is diversifiable (non-systematic) risk and non-diversifiable (systematic) risk, which are part of the total risk of an asset (Franchischetti *et al.*, 2014). While the former can be avoided through such strategies as hedging and portfolio diversification, the latter is unavoidable. Systematic risk can be diversified through investments in other assets whose correlation is less than 0 (Gallego and Marhuenda, 1997; Adekunle *et al.*, 2020).

Capital Asset Pricing Model (CAPM)

Markowitz (1952), Sharpe (1964), Lintner (1965) and Mossin (1966) independently developed the Capital Asset Pricing Model, by which one may estimate the profitability of financial assets or portfolios based on their risk, and find an indicator that represents the risk of such asset or portfolio with respect to the market, which is the coefficient β.

Several studies have been proposed to evaluate the effect of the level of systematic risk in companies through the CAPM (Binz, 2020). In the CAPM, there is an assumption that investors select a portfolio of assets that maximize expected returns and minimize associated risks. The relationship between return and risk is deduced to be linear and positive. Accordingly, the systematic risk becomes the only significant variable in the behavior of an asset's return (Galego and Marhuenda, 1997; Bautista, 2013; Adekunle *et al.*, 2020). The higher the Beta coefficient, the higher the required return. Thus, the correction for systematic risk that companies must include in their expected return is fully evaluated by a single parameter: β.

The Beta coefficient does not measure the total risk, but only the aggregate risk of a diversified portfolio; this characteristic, according to Támara *et al.* (2017), is deduced by calculating the Beta coefficient of an asset through a linear regression between the returns of the asset against the returns of the market during a reasonable period. In the same context, Sharpe's theory (1964) relates the profitability of an asset (explained variable), with the profitability of the stock market (explanatory variable), according to the following function:

$$R_t = \alpha + \beta^* R_m + \in \qquad (2)$$

Where:

- R_m = Return of the market index
- $\in$ = Error term or random disturbance
- α=Intercept
- β = Slope of the line

Several authors have developed risk measurement models based on the classic CAPM, among which the following stand out: Zero Beta CAPM (Black, 1972), Intertemporal CAPM (Merton, 1973), APT model (Arbitrage Theory) (Ross, 1976), the Consumption CAPM (Rubinstein, 1976), the Three Factors model (Fama and French, 1992, 1993, 1996) and the D CAPM (Estrada, 2002).

Thus far, the CAPM has been applied primarily in the context of developed countries. Chang and Galindo (2018) asserted that all these models have been evaluated with data from developed economies, such as the United States, leaving open the question of whether such models also overcome the difficulties of the CAPM in emerging economies. Estrada (2002) analyzed market risk in emerging markets, indicating how to estimate the downside Beta, a risk measure proposed in his article, and showing how to integrate it into an alternative price model, the D-CAPM or

Downside CAPM. Other notable applications of the CAPM in emerging markets are Basu and Chawla (2010), who tested the validity of the CAPM for the Indian Stock Market. Martinez *et al.* (2014) calculated the Beta coefficient of a sample of 11 companies listed on the Argentinian Stock Exchange. Santana (2015) calculated the Beta coefficient in the Colombian real estate sector, and planned to explore a dynamic of changing Betas related to cycle theory. Flores *et al.* (2019) supported the importance of the CAMP to determine the financial risk in a company or asset in a manufacturing micro-enterprises in Mexico. Santos *et al.* (2019) applied the CAPM to analyze Brazilian investment funds, compared to alternative models such as the unconditional CAPM and the four-factor model.

In Ecuador, the CAPM has been applied to companies listed on the Guayaquil and Quito Stock Exchange, despite the limited development of this capital exchange. This is observed in Valverde and Caicedo (2019), who mention the limited development of the Ecuadorian Stock Market. Orellana *et al.* (2020) calculate the accounting Beta coefficient and minimum expected return in the manufacturing sector of Ecuador in the period 2009-2018; the authors propose an adjusted ROE (operating profit without taxes / initial equity) in their methodology.

Materials and methods

Data

The total number of companies used in the investigation is presented in Table 1. On average, 48,667 companies were analyzed in the 2009-2019 period. This information was obtained from the Superintendency of Companies, Securities and Insurance (2020). (The description of the economic activities is set out in Annex 1)

Table 1

International Standard Industrial Classification (ISIC)

CIIU	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average
A	2644	2810	3109	3269	3428	3394	3542	3559	3276	3164	3421	3238
B.	416	441	465	517	539	538	552	547	532	542	556	513
C	3639	3855	4008	4119	4269	4251	4487	4489	4141	3965	4148	4125
D	135	134	153	188	238	230	247	249	202	211	237	202
E	127	145	173	194	208	222	221	236	223	222	270	204
F	2610	3002	3485	3899	4300	4184	4270	4181	3822	3223	3730	3701
G	10707	11369	12098	12554	13188	13043	13140	12877	11943	11584	12610	12283
H	3308	3585	3991	4539	5414	5958	6527	6987	7260	7301	7696	5688
I	883	951	960	1000	1028	1059	1147	1165	1098	1094	1134	1047
J	1254	1382	1452	1529	1661	1785	2056	2230	2148	2145	2419	1824
K	572	627	678	552	571	629	1139	1195	1150	1158	1344	874
L	4215	4256	4588	4895	4959	4771	4675	4436	3924	3427	3447	4327
M	3692	4069	4569	4992	5471	5749	6136	6332	6024	5949	6578	5415
N	2781	2879	3005	3110	3304	3338	3495	3553	3414	3446	3824	3286
O	2	3	3	3	5	10	14	12	12	8	6	7
P	451	491	538	552	586	598	627	687	667	709	821	612
Q	457	523	590	792	857	909	984	1004	957	956	1115	831

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CIIU	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average
R	189	196	177	169	179	175	200	223	228	231	259	202
S	251	268	271	284	291	277	304	312	284	295	302	285
T	2	2	2	2	3	4	4	3	2	3	3	3
U	1	1	1		1		1	1	1	1	1	1
Total	38336	40989	44316	47159	50500	51124	53768	54278	51308	49634	53921	48667

Note. Sectors O, T and U are not considered in the analysis due to their low representativeness.
SCSI (2020).

Methodology for calculating market risk and minimum expected return

The CAPM used in this research is formulated as follows:

$$E(R_i) = R_f + \beta_i * (E(R_m) - R_f) \quad (3)$$

Where:

$E(R_i)$ = Minimum expected return on security i.

R_f = Profitability of the risk-free security.

$E(R_m)$ = Expected return on the market portfolio.

$E(R_m) - R_f$ = Expected return premium over the risk-free rate.

β_i = Measure of systematic risk.

The Beta coefficient is estimate using ordinary least squares. The dependent variable is the profitability of the specific asset over time (in this case each of the sectors analyzed), the independent variable is the market profitability (), the Beta of the CAPM is the coefficient associated with the variable . Covariance and correlation are involved in the above. In addition, it must be considered that a stock having high covariance in relation to other stocks must have a high Beta coefficient to those stocks and vice versa.

The Beta coefficient measures the degree of sensitivity of a stock in the market and is represented by the slope of the characteristic line. Kayo *et al.* (2020) and Grant *et al.* (2021) estimate the Beta coefficient based on historical returns. In their study, company's cost of capital depends only on its systematic or non-diversifiable risk, captured by its Beta. For Montenegro *et al.* (2014), evaluating the results of Beta is based on the following assumptions:

- Negative Beta (less than 0): indicates an inverse relationship to the market.
- Beta equal to zero: the asset has no risk.
- Beta between 0 and 1: has a lower volatility than the market.
- Beta equal to 1: reflects the volatility of a representative market index.
- Beta greater than 1: represents higher volatility than the market.

Note that in this research in the calculation of the Beta coefficient an adjusted ROE is used to interpret accounting information:

$$ROE_{Ajjusted} = \frac{\textit{Operating profit without taxes } t}{\textit{Equity } t\text{-}1} \quad (4)$$

In the case of market return, businessman must buy and sell through expert market proxies, since the real market portfolio must include all individual investments and is not observable (Kayo *et al.*, 2020)as well as fair tariffs for consumers, we test different options to find the set of parameters that provides the most stable beta for the transmission sector. This paper is prescriptive in nature and attempts to offer alternative options for the cost of equity estimation, without changing the theoretical framework (i.e., CAPM. In this study, the total number of companies in the corporate sector of Ecuador is considered as a "market". Thus, the Beta coefficient initially obtained will be unlevered since interest and taxes will not be considered in calculating the return. In addition, Feria criterion (2004) will be used applying the variance to equation 5, in order to differentiate between market (systematic) risk and specific (diversifiable) risk.

$$\sigma_t^2 = \beta^2 * \sigma_m^2 + \sigma_\in^2 \quad (5)$$

Where:

σ_t^2 = Total security risk t
$\beta^2 * \sigma_m^2$ = Market risk
$\sigma_\in^2$ = Specific risk

As a risk-free rate for the model, 5.044 %, the average passive reference rate (2009-2019) of the Central Bank of Ecuador (2019) was used.

Results

Table 2 shows the adjusted ROE of the analyzed sectors. The market return is 9.19 %; the sectors of Manufacturing industries (C), Distribution of water sewerage-waste management and sanitation activities (E), Wholesale and Retail; repair of motor vehicles and motorcycles (G) and Information and communication (J) have a higher yield than the market. On the other hand, sectors Supply of electricity, Gas, Steam and Air Conditioning (D), Transport and storage (H) and Arts, entertainment and recreation(R) have a negative return.

Table 2

Market performance and by economic activity

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average
Market	**8.00 %**	**18.69 %**	**18.93 %**	**15.94 %**	**14.08 %**	**9.30 %**	**6.12 %**	**2.93 %**	**6.59 %**	**6.68 %**	**6.46 %**	**9.19 %**
A	1.01 %	10.27 %	9.67 %	6.58 %	6.71 %	3.67 %	-0.92 %	1.78 %	5.17 %	2.10 %	3.86 %	3.89 %
B	-3.66 %	16.05 %	16.49 %	23.84 %	22.33 %	10.04 %	-0.58 %	-5.95 %	5.75 %	10.56 %	9.09 %	8.21 %
C	21.41 %	30.83 %	23.37 %	19.58 %	18.43 %	14.83 %	12.84 %	8.35 %	11.63 %	11.29 %	9.96 %	14.99 %
D	-12.41 %	-12.16 %	-2.42 %	0.32 %	-3.39 %	-3.09 %	1.08 %	0.28 %	0.58 %	9.70 %	37.28 %	-2.72 %
E	7.43 %	21.68 %	37.71 %	19.58 %	13.28 %	18.24 %	14.48 %	14.42 %	15.63 %	15.73 %	14.26 %	16.64 %
F	0.59 %		9.00 %	5.20 %	13.36 %	1.80 %	1.54 %	1.59 %	3.80 %	5.34 %	0.38 %	3.79 %
G	15.92 %	27.68 %	25.44 %	20.87 %	19.49 %	13.73 %	10.99 %	5.74 %	10.25 %	9.86 %	9.06 %	13.56 %
H	-10.13 %	1.34 %	29.47 %	8.90 %		-9.48 %	-2.46 %	-5.82 %	-0.27 %	-8.93 %	0.78 %	-0.47 %
I	1.45 %	7.54 %	11.19 %	9.83 %	10.21 %	6.77 %	10.30 %	-1.07 %	3.29 %	5.45 %	8.32 %	6.46 %
J	18.20 %	42.74 %	33.57 %	37.20 %	27.88 %	27.04 %	12.55 %	18.11 %	8.99 %	7.50 %	10.41 %	21.86 %
K	1.24 %	6.43 %	9.77 %	1.85 %	8.09 %	-1.63 %	-2.34 %	-1.17 %	-0.27 %	-3.07 %	-2.01 %	0.30 %
L	-3.28 %	1.10 %	9.37 %	6.79 %	5.07 %	2.40 %	2.39 %	2.39 %	2.52 %	2.69 %	3.59 %	3.18 %
M	0.07 %	24.39 %	24.70 %	11.92 %	25.46 %	2.49 %	2.53 %	-7.15 %	-1.64 %	0.23 %	-0.06 %	4.35 %
N	7.56 %	21.46 %	23.80 %	19.65 %	15.24 %	6.31 %	2.60 %	-4.19 %	-3.04 %	0.88 %	-4.30 %	5.01 %
P	15.74 %	14.40 %	15.28 %	14.93 %	7.42 %	6.41 %	10.69 %	6.71 %	7.86 %	4.50 %	10.21 %	8.90 %
Q	-0.32 %	13.26 %	19.26 %	17.30 %	13.45 %	12.23 %	6.93 %	2.78 %	4.76 %	7.59 %	8.10 %	8.85 %
R			-57.91 %	-8.55 %	-5.30 %	-29.27 %	-5.40 %	-9.48 %	6.32 %	4.43 %	8.57 %	-11.19 %
S	21.39 %	30.28 %	14.08 %	10.95 %	9.28 %	8.76 %	8.79 %	2.66 %	5.36 %	2.57 %	4.82 %	8.53 %

Note. SCSI (2020).

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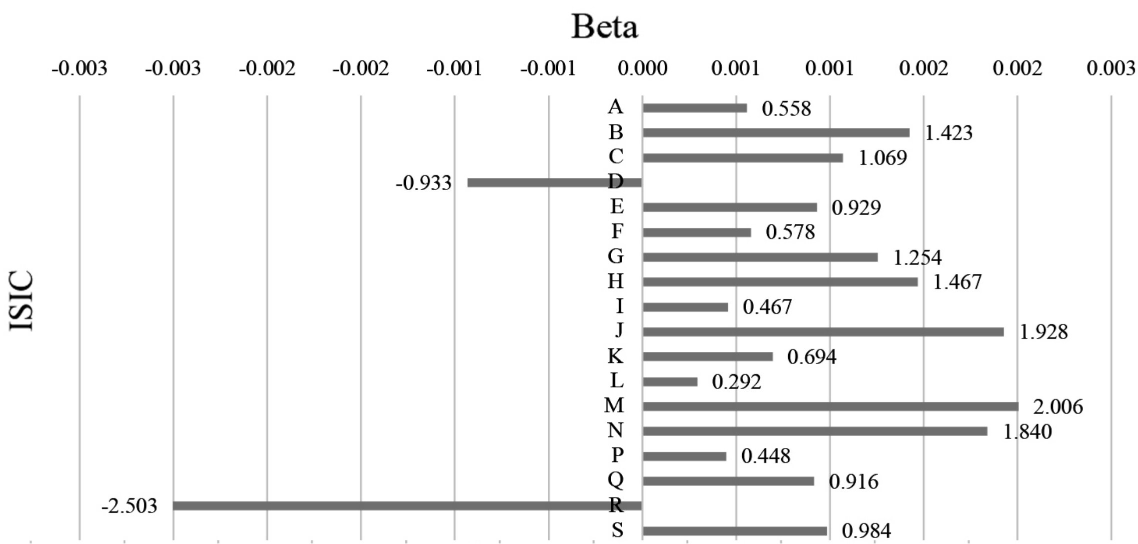
The Beta obtained for the different economic activities is summarized in Figure 1. The sectors of Exploitation of mines and quarries (B), Manufacturing industries (C), Wholesale and Retail; Repair of motor vehicles and motorcycles (G), Transport and storage (H), Information and communication (J), Professional, scientific and technical activities (M) and Administrative and support services activities (N), which have a Beta greater than 1, are considered risky.

Figure 1

Beta coefficient by economic activity



Note. SCSI (2020).

It is important to note that not all calculated Betas are statistically significant using a 5 % level of significance. In all cases, we reject the hypotheses of heteroscedasticity and autocorrelation. (Table 3).

Table 3

Summary of statistical significance

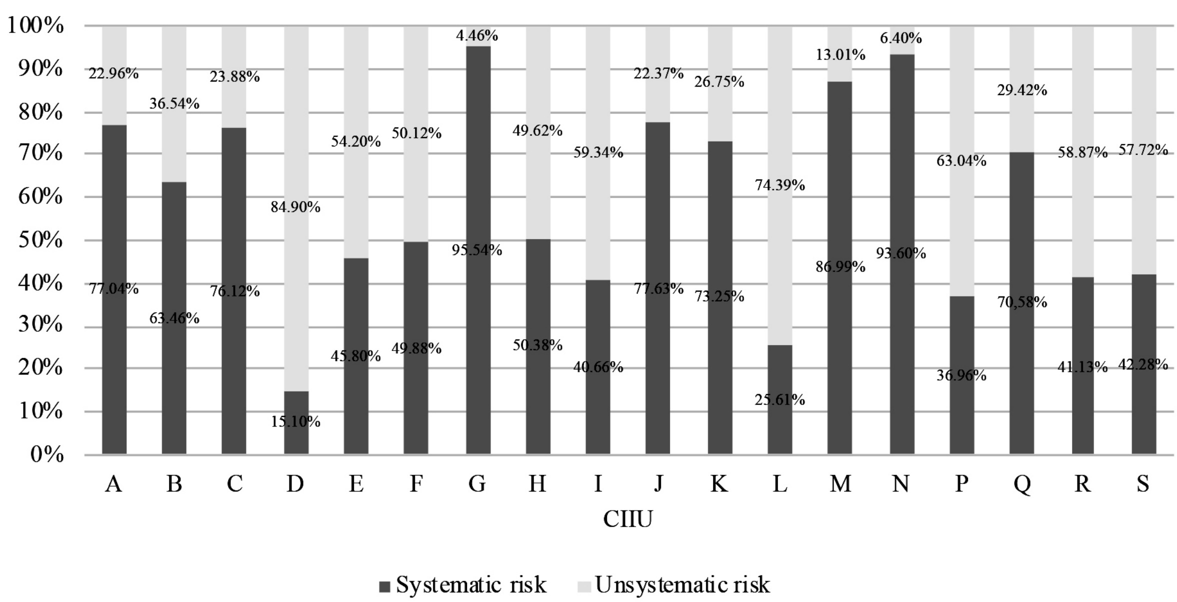
Sector	Individual significance at 5 %	Heteroscedasticity	Autocorrelation
A	Yes	No	No
B.	Yes	No	No
C	Yes	No	No
D	No	No	No
E	Yes	No	No
F	Yes	No	No
G	Yes	No	No
H	Yes	Yes	No
I	Yes	No	No

Sector	Individual significance at 5 %	Heteroscedasticity	Autocorrelation
J	Yes	No	No
K	Yes	No	No
L	No	No	No
M	Yes	No	No
N	Yes	No	No
O	No	No	No
P	Yes	No	No
Q	Yes	No	No
R	No	No	No
S	Yes	No	No
T	No	No	No

The specific risk is obtained by substituting the values of equation 5; the total risk of each of the activities analyzed is presented in Figure 2.

Figure 2

Systematic and non-systematic risk by economic activity



Note. SCSI (2020).

Figure 3 shows the expected minimum return calculated by means of the CAPM. The sectors of Professional, scientific and technical activities (M), Information and communication (J) and Administrative and support services activities (N) have the highest performance with percentages of 13.36 %, 13.04 % and 12.67 % respectively. On the other hand, the sector of Arts, Entertainment and Recreation (R) has a negative minimum expected return (-5.33 %).

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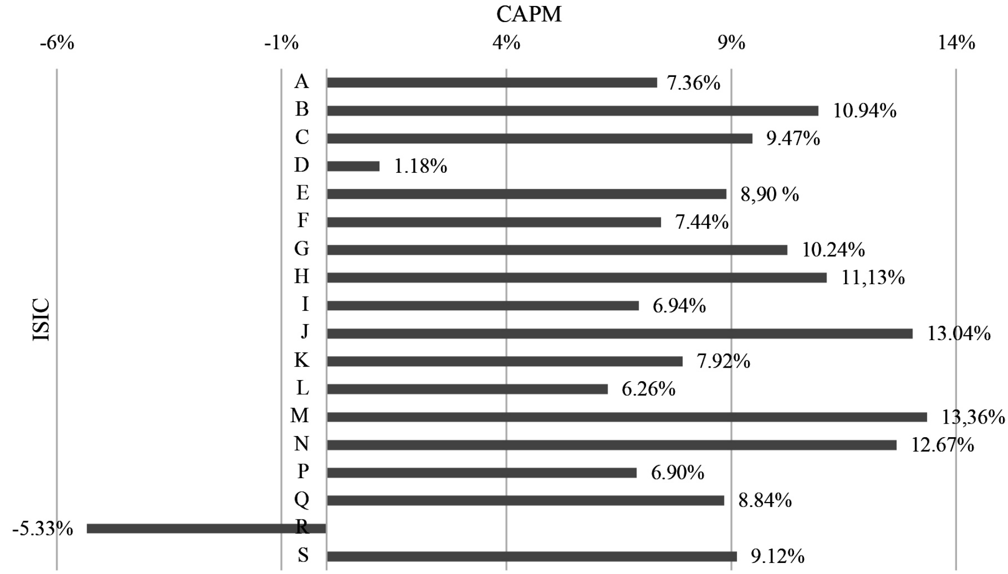
Figure 3

Minimum expected return by economic activity



Note. SCSI (2020).

Table 4 shows the yield of the analyzed sectors, compared with the minimum expected return of the CAPM. When the performance obtained from the CAPM is lower, the sector has a better performance since it has given a higher yield than required, i.e., value created. In this context, the sectors that create value are Information and communication (J), Distribution of water sewerage-waste management and sanitation activities (E), Manufacturing industries (C), Wholesale and Retail; repair of motor vehicles and motorcycles (G), Teaching (P) and Human health care and social assistance activities (Q).

Table 4

Minimum expected return vs average return of the sectors

ISIC	Average performance	Minimum expected return	Value creation	Value destruction
J	21.86 %	13.04 %	8.83 %	
E	16.64 %	8.90 %	7.75 %	
C	14.99 %	9.47 %	5.52 %	
G	13.56 %	10.24 %	3.32 %	
P	8.90 %	6.90 %	2.00 %	
Q	8.85 %	8.84 %	0.01 %	
S	8.53 %	9.12 %		-0.59 %
B	8.21 %	10.94 %		-2.73 %
I	6.46 %	6.94 %		-0.48 %
N	5.01 %	12.67 %		-7.66 %
M	4.35 %	13.36 %		-9.01 %
A	3.89 %	7.36 %		-3.47 %

ISIC	Average performance	Minimum expected return	Value creation	Value destruction
F	3.79 %	7.44 %		-3.65 %
L	3.18 %	6.26 %		-3.08 %
K	0.30 %	7.92 %		-7.62 %
H	-0.47 %	11.13 %		-11.60 %
D	-2.72 %	1.18 %		-3.89 %
R	-11.19 %	-5.33 %		-5.85 %

Note. *SCSI (2020).*

Conclusions y discusion

Discussion

Two questions are pivoted to the discussion of the validity of analysis based on the capital asset pricing model. 1) Does the expected return increase as the risk increases? 2) Is the relationship between risk and return linear?

Clearly, the expected return does increase as the risk increases (Banerjee *et al.*, 2007; Breeden *et al.*, 1989). On the other hand, in a study conducted by Breeden *et al.* (1989), the linear relationship between risk and return implicit in the CCAPM (Consumption CAPM) is rejected with a significance level of 0.05. In the same scenario, Fama and French (1992) disagreed about the assumption of the positive relationship between average returns indicated by the CAPM.

There are various comments and criticisms about the CAMP, mainly about the feasibility of using the Beta coefficient as an adequate measure of risk. The CAPM assumes that the Beta coefficient is static and that the returns of the weighted portfolio (stock value) are an indicator of the return of aggregate wealth; its static specification is limited by its failure to consider the effects of time-varying investment opportunities in calculating an asset's risk (Jagannathan and Wang, 1996; Lettau and Ludvigson, 2001; Estrada, 2002; Miralles *et al.*, 2009).

The use of accounting information for calculating the Beta coefficient is justified by underdeveloped stock market in Ecuador. According to Valverde and Caicedo (2019), the limited development of that stock market makes its operational functions inefficient. Moreover, the individual interests of the Stock Exchanges of Guayaquil and Quito, each with its own self-regulations, prices and commissions, makes statistical analysis difficult. Likewise, Riofrío (2019), asserts that:

> The Ecuadorian stock market in recent years has not had a development in relation to countries such as Colombia and Peru since the market capitalization vs GDP is lower than in said countries in the period of analysis 2016-2018. (p.3)

To the inherent analytical difficulties of the incipient Ecuadorian securities market, it must be added the poor availability and quality of information. Pereiro (2010) refers to such statistical barriers in CAPM logic regarding investment assets in emerging markets, in that relevant local data may be nonexistent, unreliable or atypical. According to Poquechoque (2020), accounting Betas are generally used in emerging countries, where there are such limitations as: "few transactions in the stock market, changes in the composition of stock indices, absence of data statistics, high volatility, high informality and absence of historical data" (p.66).

It must be also considered the difficulties that may arise when applying accounting information for calculating the Beta coefficient. Tamara *et al.* (2017) indicates that there are three problems in the accounting Beta approach: profits in companies tend to be smoothed with respect to the underlying value of the company (Beta biased downwards for risky and upwards for less risky companies). Also, the majority of companies have non-operational factors that influence profits from an accounting view or results in changes in depreciation methods among others. Furthermore, quarterly or annual

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consolidation periods for accounting imply regressions with few observations.

As indicated by Orellana *et al*. (2020), the CAPM is notable for its simplicity and the hypotheses implicit in it. These characteristics, however, have given rise to a series of criticisms from researchers. Among these were: Fama and French (1992), who refers to contradictions in the model, and one of the main ones is related to the size effect proposed by Banz (1981), who concludes that "in the period 1936-1975, the common shares of small companies had, on average, higher risk-adjusted returns than the common shares of large companies" (pp.3-4). He also asserts a strong negative relationship between average performance and firm size. In the same context. St.-Pierre and Bahri (2006) indicated that the accounting Beta is not a sufficient measure to determine the risk in SMEs and also suggested the development of a new model that links more risk components. Fama and French (1992) criticize the weakness of the Beta coefficient as an explanatory variable of the variations in returns, and affirm the existence of other variables that influence variation. They further asserted that a multifactorial model should be worked on, where there is a conditional relationship with a positive slope between the average return and Beta.

Despite such criticisms of the classic CAPM, and especially of the Beta coefficient as a factor to assess systemic risk, various authors have highlighted its importance and usefulness: The CAPM is a benchmark for calculating the cost of capital, and it is under this model that Beta is useful as a parameter to estimate risk (Támara *et al*., 2017). Pereiro (2010) affirmed that the cost of capital of a company can be determined through the CAPM, and that it is a tool to determine the risk in companies that list on the Stock Market. Breeden *et al.* (1989) examined the performance of the consumption-oriented Capital Asset Pricing Model (Consumption CAPM or CCAPM) with a market portfolio-based model. The authors conclude that the performance of the traditional CAPM and the CCAPM are approximately the same. On the other hand, Ruiz *et al.* (2021) analyzed the feasibility of using the CAPM in emerging markets, concluding that there are several formulas with different proposed variables, however, there is no universal formula.

Conclusions

Determining the level of risk is a fundamental aspect of decision making. In the field of investment, an investment portfolio with poorly or negatively correlated assets will be less volatile than one with positively correlated assets, since when one portion falls the other portion rises or at least maintains its value. Therefore. diversification is the best way to reduce investment risk. Since unsystematic risk can be minimized with diversification, it becomes irrelevant in market risk analysis. This is one of the implications of the CAPM: the only important component the non-diversifiable risk.

In this research, the objective is met by determining the market risk and the minimum expected return of 18 sectors of Ecuador's economy through the Capital Assets Price Model proposed by Sharpe (1964), this time using accounting information. The analysis involved all of the different economic activities of the Ecuadorian market, classified according to the International Standard Industrial Classification (ISIC), i.e., 48,667 companies on average per year and a total of 535,333 observations in the period 2009-2019. It should be noted that the financial information has an annual periodicity, which is a limitation of the research since the classic methodology looks at daily returns.

The applied methodology offers a return-risk ratio, which was a central inspiration in the introduction of the CAPM. The Beta coefficient was obtained from accounting information for reasons explained above. There were highlighted sectors of Exploitation of mines and quarries (B), Manufacturing industries (C), Wholesale and Retail; Repair of motor vehicles and motorcycles (G), Transport and storage (H), Information and communication (J), Professional, scientific and technical activities (M), and Administrative and support services activities (N) as having a Beta greater than 1. Thus, they are considered risky in that a variation in the market causes a greater variation in each of these sectors. On the other hand, sectors as Supply electricity, gas, steam and air conditioning (D) and Arts, entertainment and recreation (R) have a negative Beta coefficient, therefore, an inverse relationship to the market (the sector appreciates when the market as a whole falls). Finally, the sectors of Manufacturing industries (C), Distribution of water sewerage, waste management and sanitation activities (E), Wholesale and Retail; repair of motor vehicles and motorcycles (G), Information and communication (J), Teaching (P) and Human health care and assistance activities(Q) add value, since they have a higher performance than expected.

It should be noted that these results reflect the Beta coefficient in the 2009-2019 period, and must be updated as more recent financial information becomes available. The results obtained will serve as a reference and support for business decision-making and indicator of the demand level of projects in the analyzed sectors.

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Annexes

Annex 1

Information on economic activities

ISIC	Description
A	Agriculture. forestry and fishing.
B	Exploitation of mines and quarries.
C	Manufacturing industries
D	Supply of electricity. gas. steam and air conditioning.
E	Distribution of water sewerage. waste management and sanitation activities.
F	Building
G	Wholesale and Retail; repair of motor vehicles and motorcycles.
H	Transport and storage
I	Accommodation and meal service activities.
J	Information and communication
K	Financial and insurance activities
L	Real estate activities
M	Professional. scientific and technical activities.
N	Administrative and support services activities.
O	Public administration and defense; compulsory social security plans.
P	Teaching
Q	Human health care and social assistance activities.
R	Arts. entertainment and recreation.
S	Other service activities
T	Activities of households as employers; Undifferentiated activities of households as producers of goods and services for their own use.

Note. SCSI (2020).