UNIVERSIDAD DE CÓRDOBA

FACULTAD DE DERECHO Y CIENCIAS ECONÓMICAS Y EMPRESARIALES

Departamento de Economía Agraria, Finanzas y Contabilidad

Programa de Doctorado: Ciencias Sociales y Jurídicas

TESIS DOCTORAL:

Estimación del costo de capital a través del Proceso Analítico Jerárquico (*PAJ*). Caso compañías ecuatorianas

Cost of capital estimation through the Analytic Hierarchy Process (*AHP*). Case of ecuadorian companies

Presentada por:

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TITULO: *Estimación del costo de capital a través del Proceso Analítico Jerárquico (PAJ). Caso compañías ecuatorianas*

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Estimación del costo de capital a través del Proceso Analítico Jerárquico (*PAJ*). Caso compañías ecuatorianas

Memoria de tesis doctoral presentada por:

Mgtr. Pablo Ricardo San Andrés Reyes, Ing.

DIRECTOR:

Dr. Juan Antonio Jimber del Río

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TÍTULO DE LA TESIS: Estimación del costo de capital a través del Proceso Analítico Jerárquico (PAJ). Caso compañías ecuatorianas.

DOCTORANDO/A: Mgtr. Pablo Ricardo San Andrés Reyes, Ing.

INFORME RAZONADO DEL/DE LOS DIRECTOR/ES DE LA TESIS

La tesis doctoral titulada "Estimación del costo de capital a través del Proceso Analítico Jerárquico (*PAJ*).", de la que es autor Pablo Ricardo San Andrés Reyes, ha sido realizada bajo nuestra dirección y cumple las condiciones exigidas por la legislación vigente para optar al título de Doctor por la Universidad de Córdoba.

La presente tesis doctoral propone una estimación de costo de capital a través del Proceso Analítico Jerárquico para compañías que no cotizan en el mercado bursátil ecuatoriano, o en su defecto que sus competidores directos tampoco emitan acciones, a través de la Bolsa de Valores de Guayaquil o Quito en Ecuador. Se realizó una revisión bibliografía de costo de capital como de los métodos multicriterios para la evaluación de riesgo. Además, se aplicó la metodología del Proceso Analítico Jerárquico en empresas del Ecuador, insumo de gran utilidad para la toma de decisiones financieras. Los objetivos y conclusiones incentivan a futuros inversionistas a la aplicación del método, ya que para empresarios y financieros es de gran relevancia estimar la tasa que exijen los accionistas, especialmente para compañías que no posean una participación bursátil en el mercado de valores, donde se aborda la investigación.

De la presente tesis se han derivado varias publicaciones científicas, que demuestran la capacidad del doctorando en el ámbito investigador:

- San Andrés, P., Jimber del Río, J., Márquez, F. & Vergara-Romero, A. (2023). Hybrid and avant-garde methods for cost of capital evaluation. Revista Universidad y Sociedad, 15(4), 482-489.

  https://www.researchgate.net/publication/372461326_Hybrid_and_Avant-Garde_Methods_for_Cost_of_Capital_Evaluation

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    - Fuente: Latindex, Directory of Research Journals Indexing (DRJI), Directory of Open Access Journals (DOAJ), la Biblioteca Científico-Electrónica en Línea (en Inglés Scientific Electronic Library Online, Scielo), el Emerging Sources Citation Index (ESCI) de la Web of Science y Scopus
- San Andrés, P., Jimber del Río, J., Márquez, F. & Vergara-Romero, A. (2023). Avant-garde multicriteria decision-making methods for risk assessment. Por enviar a la revista Journal of Business Research

Asimismo, se ha desarrollado investigaciones referentes a la temática, en la cual se evidencia en la participación de congresos internacionales:

- II Congreso Internacional y Multidisciplinar de Investigadores en Formación,organizado por la Universidad de Córdoba entre el 30 de noviembre y el 4 de diciembre de 2020.
- III Congreso Internacional y Multidisciplinar de Investigadores en Formación,organizado por la Universidad de Córdoba entre el 29 de noviembre y el 3 de diciembre de 2021.
- XI Congreso Científico de Investigadores en Formación, organizado por las Escuelas de Doctorado Educo y eidA3 de la Universidad de Córdoba, el día 4 de mayo de 2023

Por todo ello, se autoriza la presentación de la tesis doctoral por compendio de publicaciones.

Córdoba, 6 de marzo de 2024

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Firma del director

Dr. Juan Jimber del Río

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Agradezco a Dios por darme fortaleza para cumplir mis metas profesionales, y a mis padres por ser un pilar fundamental en cada etapa de mi vida; ya que han sido mi motivación para continuar con mis estudios, y desarrollar investigaciones científicas que aporten al Ecuador y América Latina.

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A mis amigos y compañeros, por sus sabios consejos para culminar con éxito este proceso académico.

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Dedicada a mis queridos padres (Martha y Ricardo), quienes, a través de sus consejos y palabras de aliento, me han motivado para fortalecer mi grado académico, y ser un mejor ser humano.

A mi abuela (Teresa), quien me ha enseñado el valor del estudio, desde que era un niño.

A todos mis compañeros y amigos, quienes me apoyaron en la recolección de datos de las investigaciones científicas.

RESUMEN

La valoración del riesgo es fundamental para la evaluación financiera de proyectos empresariales. El costo de capital accionario es uno de los componentes analizados por futuros accionistas antes de la toma de decisiones de inversión, pero es el caso de la Bolsa de Valores de Guayaquil y Quito donde la cotización de acciones en el mercado de valores es escasa, compliando la estimación de la tasa mínima que requieren los inversores al momento de arriesgar su capital en compañías ecuatorianas.

Por tal motivo, el presente estudio tiene como objetivo valorar su riesgo de mercado mediante el Proceso de Análisis Jerárquico (*PAJ*), conocida en inglés, como Analytic Hierarchy Process (*AHP*), con el propósito de determinar del costo del patrimonio para aquellas compañías que actualmente no posean una participación accionaria en el mercado bursátil o que sus competidores directos tampoco mantengan una participación activa en la en las Bolsas antes mencionadas; para tal efecto se realizó una investigación bibliográfica relacionada al tema de investigación. Además, se aplicó un muestreo por conveniencia para seleccionar a las empresas ecuatorianas que son el objeto de estudio, y se estimó el Alpha de Cronbach y el Índice de consistencia para evaluar el grado confiabilidad de los datos.

En la tesis de grado se evidencia una investigación teórica vanguardista, tanto de costo de capital como de métodos multicriterios para la evaluación de riesgo, además de los resultados de costo de capital a través de la metodología *AHP*, misma será de gran utilidad para inversionistas en este tipo de mercados. La investigación cuantiativa también refleja los riesgos y sub-criterios que mayoritariamente influyen en las empresas objeto de estudio.

Palabras clave: Valoración de riesgo, *PAJ*, *AHP*, costo de capital, investigación teoría vanguardista

ABSTRACT

Risk assessment is essential for the financial evaluation of business projects. The cost of capital is one of the components analyzed by future shareholders before making investment decisions, but this is the case of the Guayaquil and Quito Stock Exchange where the price of shares in the stock market is scarce, complying the estimation of the minimum rate that investors require at the time of risking their capital in Ecuadorian companies.

For this reason, the objective of this study is to assess its market risk using the Proceso Analíto Jerárquico (*PAJ*), known in English as Analytic Hierarchy Process (*AHP*), with the purpose of determining the cost of equity for those companies that do not currently have a shareholding in the stock market or that their direct competitors do not maintain an active participation in the stock exchanges mentioned before. For this purpose, bibliographic research related to the research topic was carried out. In addition, convenience sampling was applied to select the ecuadorian companies that are the object of the study, and Cronbach's Alpha and the Consistency Index were estimated to evaluate the degree of reliability of the data.

The thesis shows avant-garde theoretical research, of the cost of capital and multi-criteria methods for risk assessment, in addition to the results of the cost of capital through the *AHP* methodology, which will be very useful for investors in these types of markets. Quantitative research also reflects the risks and sub-criteria that mostly influence the companies under study.

Keywords: Risk assessment, *PAJ*, *AHP*, cost of capital, avant-garde theoretical research

ÍNDICE GENERAL

ÍNDICE DE TABLAS

ÍNDICE DE ILUSTRACIONES

INTRODUCCIÓN

I. ESTADO DEL ARTE: COSTO DE CAPITAL

La tasa de descuento equivale al costo promedio ponderado de capital, en la cual refleja el rendimiento esperado de los activos y el costo de oportunidad de la inversión ajustada a los diferentes riesgos inmersos al financiar un proyecto determinado, siendo este porcentaje mayor para inversiones de alto riesgo y menor en casos de capitales menos riesgosos (Peña Balderrama, Alfstad, Taliotis, Hesamzadeh, & Howells, 2018). Franco Modigliani y Merton H. Miller analizaron en 1958 el efecto del ahorro tributario sobre el valor de las empresas, haciendo hincapié que los intereses pagados al ser deducibles en la contabilidad de las organizaciones, el valor monetario del impuesto disminuye, a pesar que el porcentaje permanezca constante (Modigliani & Miller, 1958). Esta teoría da origen a la metodología del Costo Promedio Ponderado de Capital después de impuestos (Allen, Myers, & Brealey, 2010). El desglose de las fórmulas referentes para la estimación del rendimiento exigido por los inversionistas se muestra en el siguiente cuadro:

Tabla 1. Variables que componen el Costo Promedio Ponderado de Capital (CPPC)

Detalle	Descomposición de la fórmula
Proporción de la deuda	Deuda (D) / [Deuda (D) + Capital propio (E)]
Rendimiento esperado de la deuda o costo de la deuda	RD
Proporción en el capital	Capital propio (E) / [Deuda (D) + Capital propio (E)]
Rendimiento esperado en el capital	RE
Tasa impositiva	T
Rendimiento esperado de los activos o Costo Promedio Ponderado de Capital (CPPC)	{[D / (D + E)] x RD} + {[E / (D+ E)] x RE}
Costo Promedio Ponderado de Capital después de impuestos	{[D / (D + E)] x [(RD (1-T)]} + {[E / (D+ E)] x RE}

Nota: Estimación del Costo Promedio Ponderado de Capital. Adaptado de "Principios de Finanzas Corporativas" por Allen, Myers y Brealey (2010). México: McGraw-Hill

El Costo Promedio Ponderado de Capital es fundamental para determinar el rendimiento esperado por los inversionistas, sin embargo no es suficiente para la toma de decisión de un proyecto, ya que su estudio debe ser complementado con otras técnicas financieras antes de destinar inversiones en activos financieros (Allen et al., 2010). A continuación, se detalla algunas de las que se suelen utilizar en la evaluación de proyectos de inversión:

El valor presente neto estima el valor actual del capital invertido, descontando los flujos de caja a una tasa de descuento, ya que el dinero pierde valor a través del tiempo (Dayananda, Irons, Hanison, Herbohn, & Rowland, 2002). Se espera que la cantidad valorada sea mayor a 0 para que los cobros y pagos generen beneficios económicos a la empresa, caso contrario al ser menor a 0 traerá como consecuencia pérdidas, en la cual emprendedores o empresarios deben rechazar el proyecto. También puede ser el caso que la cantidad sea 0, resultando indiferente su inversión porque es un resultado donde no muestra beneficios o pérdidas para la empresa (Ross et al., 2012).

La tasa interna de retorno mide la rentabilidad de la inversión, y su resultado es comparado contra el costo de capital de un proyecto, junto con otras alternativas atractivas para los inversionistas (Evison, 2018; Hosseni Ali & Vahidreza, 2019). El plazo de recuperación de la inversión mide el tiempo estimado que el capital será recuperado, este puede ser calculado a través de una técnica regular o descontada (Ehrhardt & Brigham, 2009). La primera resta los valores netos del flujo de caja a la inversión, sin embargo, la segunda descuenta el costo de oportunidad a una tasa de descuento porque se calcula bajo es supuesto que el dinero ganado de un proyecto en tiempo presente pierde valor en el futuro.

El análisis de sensibilidad es de gran utilidad para la toma de decisiones financieras de los empresarios, ya que evalúa la viabilidad del proyecto en el caso de una fluctuación en el precio, cantidad vendida, inversión en gastos o costos operativos, porcentaje de crecimiento de los ingresos proyectados o incluso en la tasa de inflación; y puede ser evaluado a través de un escenario optimista, esperado o pesimista (Ross et al., 2012). El primero sobrevalora las variables que inciden positivamente en el flujo de efectivo. El segundo, incluye cantidades más cercanas a la situación real donde desenvuelve el negocio. El tercero subvalora la estimación de las mismas para analizar su rentabilidad en caso de una incidencia económica no esperada o poco predecible durante la ejecución del proyecto.

El análisis de los escenarios antes mencionados fomenta el desarrollo de nuevas alternativas estratégicas para fomentar los ingresos y la participación del mercado de la organización.

Debido a los antecedentes antes expuestos, se puede concluir que la estimación del Costo Promedio Ponderado de Capital es muy importante para el análisis de diversas fórmulas financieras, pero en la literatura se evidencia algunos métodos para estimar el costo de capital. El más común es la Valoración de Activos Financieros, conocida por sus siglas en inglés, como *CAPM*, modelo que fue desarrollado por William Sharpe (1964) y John Lintner (1965), con el propósito de hallar el rendimiento requerido del activo financiero, en la cual su estimación está asociado con el riesgo sistemático o no diversificable, que está en función de las tendencias económicas o de mercado (Galagedera, 2007). Su estudio estima la rentabilidad esperada en función del riesgo de mercado (Rady, Meshreki, Ismail, & Núñez, 2019), asumiendo la existencia de mercados de capitales perfectos donde los inversionistas pretenden financiar sus proyectos.

Sin embargo, se han desarrollado otros métodos, tales como: Teoría de Precios de Arbitraje (*APT*) desarrollado by Stephen A. Ross (1976), Proposición II de Modigliani & Miller`s (1958), modelo del Precio-beneficio de crecimiento (*PEG)* por Easton (2004), Costo de capital basada en la beta e información contable, investigada por Hill & Stone (1980) and Ball & Brown (1968), and applied by Vélez (2002), modelo de crecimiento constante de dividendos, de Gordon and Shapiro (1956), modelo de tres factores de Fama y French (1993), and Proceso Analítico Jerárquico por Cotner y Fletcher (2002), Residual Income Valuation model por Ohlson (1995), el modelo introducido por Easton (2004) y Ohlson y Luettner-Nauroth (2005), que son basados en Ohlson y Ohlson y Juettner-Nauroth`s abnormal earning growth valuation model, el costo de capital construido por Claus y Thomas (2001), pero no todas las metodologías pueden ser aplicadas a organizaciones que no cotizan acciones a través de las Bolsas de Valores (Ardalan, 2017; Ball & Brown, 1968; Barillas et al., 2019; Cotner & Fletcher, 2000; Easton, 2004, 2009; Fama & French, 1993; Gerged et al., 2020; Hill & Stone, 1980; Kling et al., 2021; Lamoreaux et al., 2020; Mali & Lim, 2020; Nhleko & Musingwini, 2016; Pachón, 2013; Ross, 1976; Shen & Zhang, 2020; Vélez, 2002; Wang et al., 2020). Por tal motivo, es de gran importancia estimar un costo de capital que se ajuste a la realidad del mercado, donde laboran este tipo de compañías.

El cálculo del costo de capital se complica, cuando el investigador desea estimar la variable beta, y el mercado carece de información, respecto a las cotizaciones de acciones; como es el caso de Ecuador, en la cual las compañías que poseen un nivel de presencia bursátil mayor al 10%, ascienden a una cantidad de 9 organizaciones cotizadoras, a través de la Bolsa de Valores de Quito, en cambio en la Bolsa de Valores de Guayaquil, solo se evidencia 5 firmas; siendo la Corporación Favorita la que tiene un mayor grado de participación en ambas Bolsas, con un 93,44% y 52,46% respectivamente. Al cierre del 2022, constan 20665 medianas y grandes empresas, 1150627 microempresas y 57123 pequeñas, por ende, es necesario aplicar un método idóneo para la estimación de la tasa que requiere el accionista al momento de invertir su capital.

II. PROCESO DE ANÁLISIS JERÁRQUICO (*PAJ*)

El proceso de análisis jerárquico fue desarrollado por Thomas Saaty (1980) con el propósito de proveer una herramienta para la resolución de problemas complejos, y así diferentes individuos, grupos o agentes económicos puedan tomar una decisión óptima analizando los diferentes riesgos involucrados en el sistema (Wind & Saaty, 1980).

John S. Cotner y Harold D. Fletcher (2000) consideran que es un método adecuado para estimar la prima de riesgo para calcular el costo de recursos propios, en la cual involucra la identificación de los factores que inciden en el riesgo de las compañías (Cotner & Fletcher, 2000). Los pasos para el desarrollo de la metodología son los siguientes: 1) Definir el problema y determinar el tipo de conocimiento solicitado 2) Estructurar la jerarquía desde el nivel más alto hasta el límite inferior, tomando en consideración todos los criterios o factores involucrados para la resolución del problema. Se estiman diferentes alternativas en los niveles inferiores. 3) Se construye matrices de comparaciones apareadas para comparar los elementos de niveles superiores con respecto a los inferiores 4) Ponderar los vectores de las prioridades obtenidas de la matriz de comparaciones apareadas (Saaty, 2016).

III. JUSTIFICACIÓN

La toma de decisiones de inversión implica un análisis de costo en cuanto a la valoración del rendimiento requerido por los inversionistas (Frank & Shen, 2012), y para ello es fundamental tomar en cuenta todos los factores de riesgo que inciden en la organización, sean estos económicos, tecnológicos, de preferencias del consumidor o incluso de competencia (Kengatharan & Nurullah, 2019). Por tal motivo, es importante que la técnica de evaluación determine el nivel de riesgo empresarial para evaluar la incidencia financiera de una empresa (Ross et al., 2012).

En la actualidad existen algunas técnicas de evaluación financiera que son aplicadas por distintas organizaciones, entre ellas se pueden citar a Al-Mutairi, Naser & Saeid (2018); Al Mutairi, Tian, Hasan & Tan (2012); Daunfeldt & Hartwig (2014); Derwall, Guenster, Bauer & Koedijk (2005). Estas se clasifican en tres categorías: sencillas, avanzadas y sofisticadas. La primera, incluye la tasa de rendimiento contable, el tiempo de recuperación de la inversión simple y descontado. La segunda, supone el análisis de sensibilidad vs. punto de equilibrio, escenarios financieros, tasa interna de retorno, valor presente neto y el índice de rentabilidad. Y la última de las técnicas, se relaciona con las opciones reales, decisiones de teorías de juegos, árbol de decisión y el Modelo de Valoración del precio de los Activos Financieros, conocido en inglés como Capital Asset Pricing Model (CAPM) (Kengatharan & Nurullah, 2019). William Sharpe (1964) y Lintner (1965) lo formuló con el propósito de determinar el costo del capital accionario (Cenesizoglu, Papageorgiou, Reeves & Wu, 2018).

El costo de capital forma parte del cálculo del costo promedio ponderado de capital, conocida por sus siglas en inglés como Weighted Average Cost of Capital (WACC) (Al Mutairi et al., 2012; Cenesizoglu et al., 2018; Galagedera, 2007). Este porcentaje es la tasa de descuento que exige el inversionista antes de financiar un proyecto determinando, ya que este incluye todos los riesgos inmersos en la inversión (Ross et al., 2012); y es de suma importancia como indicador comparativo a la rentabilidad de la organización, y para la toma de decisiones de inversión.

En el caso del mercado accionario ecuatoriano, no se evidencia la cultura por parte de la mayoría de los empresarios en cotizar sus activos financieros a través de la Bolsa de Valores (Pérez, Rivera & Solís, 2015; Fernández, 2019; Bolsa de Valores de Quito, 2022), influyendo en la escasez de registro de movimientos y transacciones en el mercado bursátil.

Por tal motivo, no beneficia a los inversores en utilizar un rendimiento esperado del mercado o una beta, con la correlación entre el cambio del precio de la acción y la fluctuación del valor del mercado, complicando la aplicación del modelo *CAPM* como costo del capital accionario.

Debido a los antecedentes antes expuestos, se plantea la valoración del riesgo dirigido a compañías ecuatorianas mediante el proceso de análisis jerárquico (*PAJ*). Este se define como un modelo flexible de gran utilidad para grupos organizacionales, ya que permite resolver problemas cuantitativos. Desde el año 1970, investigadores han desarrollado trabajos sustentados en la toma de decisiones de multicriterio, ya que muchas de ellas son complejas, en la cual los problemas involucran múltiples criterios y propósitos, siendo el proceso analítico jerárquico (*AHP*) uno de los métodos para su evaluación (Daim et al., 2011; Dong & Saaty, 2014; Mardani et al., 2018).

Este método es ideal para abordar problemas políticos y socioeconómicos complejos. Esta técnica está basada en un análisis detallado del problema, y de la información recolectada que depende de la experiencia, conocimiento y opiniones de los individuos que forman parte del proceso de la toma de decisiones (Saaty, 2016).

Las empresas pueden ser influenciadas por factores tanto internos como externos a la organización, motivando a los inversionistas al análisis de cada una de estas incidencias antes de destinar sus fondos en activos financieros. Por tal motivo, la presente investigación valora el riesgo a través de un método alternativo para compañías ecuatorianas que no posean participación bursátil en las Bolsas de Valores de Quito y Guayaquil, o en su defecto que los competidores directos tampoco emitan acciones del mercado bursátil. La aplicación del método ayudará a los empresarios en la toma de decisiones de inversión, ya que el riesgo en este caso iría acorde a la realidad del Ecuador.

El proyecto de investigación pretende responder las siguientes interrogantes:

¿Cuáles son los métodos vanguardistas de costo de capital y toma de decisiones multicriterio que se han aplicado para la evaluación de riesgo?

¿Cuál es la estimación del costo de capital para compañías ecuatorianas que no coticen acciones en el mercado bursátil del país de residencia?

IV. OBJETIVOS DE LA INVESTIGACIÓN

El objetivo principal del presente trabajo de investigación es valorar el costo de capital de compañías ecuatorianas que no cotizan acciones, a través de la metodología del Proceso Analítico Jerárquico (*PAJ*). Los objetivos específicos se muestran a continuación:

1) Examinar la literatura existente, referente a los métodos híbridos y de vanguardia para la evaluación de costo de capital.
2) Sintetizar los métodos vanguardistas de toma de decisiones multicriterio para la evaluación de riesgo.
3) Estimar la prima de riesgo de compañías ecuatorianas a través de la metodología *AHP* y evaluar los factores o criterios que mayoritariamente inciden sobre estas organizaciones.

V. HIPÓTESIS DE LA INVESTIGACIÓN

En la investigación se desarrolló una revisión bibliográfica, con el propósito de conocer los métodos vanguardistas para la evaluación de costo de capital y de toma de decisiones multicriterio; luego el estudio aplica el Proceso Analítico Jerárquico para calcular la prima de riesgo, además de evaluar los factores que impactan sobre las compañías que forman parte del objeto de estudio. Las hipótesis son las siguientes:

Hipótesis 1: Los métodos híbridos y vanguardistas influyen en la evaluación de costo de capital.

La hipótesis se valida en el siguiente artículo:

- San Andrés, P., Jimber del Río, J., Márquez, F. & Vergara-Romero, A. (2023). Hybrid and avant-garde methods for cost of capital evaluation. Revista Universidad y Sociedad, 15(4), 482-489.

  https://www.researchgate.net/publication/372461326_Hybrid_and_Avant-Garde_Methods_for_Cost_of_Capital_Evaluation

  Hipótesis 2: Los métodos vanguardistas referentes a la toma de decisiones multicriterio inciden en la evaluación de riesgo

Esta hipótesis se valida en la siguiente investigación científica:

- San Andrés, P., Jimber del Río, J., Márquez, F. & Vergara-Romero, A. (2023). Avant-garde multicriteria decision-making methods for risk assessment. Por enviar a la revista Journal of Business Research

Hipótesis 3: El método del Proceso Analítico Jerárquico estima el costo de capital para compañías ecuatorianas que no cotizan acciones a través de la Bolsa de Valores en Ecuador.

VI. ESTRUCTURA DE LA TESIS

El trabajo de titulación se compone de tres capítulos:

- El primer capítulo presenta una revisión bibliográfica de los métodos híbridos y vanguardistas que autores han desarrollado para la evaluación del costo de capital.
- En el segundo capítulo muestra una revisión bibliográfica de los métodos vanguardistas referentes a la toma de decisiones multicriterio que inciden sobre la evaluación de riesgo.
- En el último capítulo se aplica el Proceso Analítico Jerárquico para la estimación del costo de capital para compañías ecuatorianas que no cotizan acciones a través de la Bolsa de Valores en Ecuador.
- Al final del proyecto, se muestran las conclusiones de cada uno de los objetivos específicos de la investigación. Además, se detallan las implicaciones, limitaciones, y futuras líneas de estudio, con el propósito incentivar al desarrollo de nuevas investigaciones para la estimación de costo de capital en mercados, donde no exista una cultura bursátil en cotizar acciones a través de la Bolsa de Valores.
- Las referencias bibliográficas sustentan la investigación de la tesis doctoral

1. HYBRID AND AVANT-GARDE METHODS FOR COST OF CAPITAL EVALUATION

1.1 Antecedentes

En el presente artículo se desarrolla una investigación bibliográfica sobre los métodos híbridos y de vanguardia para la evaluación de costo de capital. La producción científica se evidencia a continuación:

- San Andrés, P., Jimber del Río, J., Márquez, F. & Vergara-Romero, A. (2023). Hybrid and avant-garde methods for cost of capital evaluation. Revista Universidad y Sociedad, 15(4), 482-489.

Abstract

Nowadays, some capital budgeting techniques have been analyzed by investors in order to make investment decisions because risk takers usually evaluate some techniques, such as the return for projects, net present value for forecasted cash flows, the real-time that an investment can be recuperated, finance variables for sensitivity analysis, and cost of equity. Some methodologies exist; the most common ones are Capital Asset Pricing Model (*CAPM*) and Gordon´s Wealth Growth model. So, evaluating the cost of equity is essential for risk analysis, but in recent years, some have written articles about hybrid and avant-garde methods that complement the analysis of cost-of-equity techniques. The research aims to show the importance of applying those methodologies that benefit international investors and finance scientific researchers who strive to develop advances in theories and models for the cost of equity evaluation. The methodology was bibliographic because it was necessary to investigate recent articles about those methods. Articles information was taken from the Web of Science database from 2017-2022. The number of articles selected was based on convenience sampling. The study shows the recent articles that have applied Hybrid and avant-garde methods in evaluating the cost of equity. Also, the purpose of each investigation and the explanation of the use of those methodologies.

Keywords: Capital budgeting techniques, cost of equity, Weighted Average of Capital, risk analysis, hybrid and avant-garde methods.

Resumen

Hoy en día, los inversionistas han analizado algunas técnicas de presupuesto de capital para tomar decisiones de inversión porque los tomadores de riesgo generalmente evalúan algunas técnicas, como el rendimiento de los proyectos, el valor presente neto para los flujos de efectivo pronosticados, el tiempo real en que se puede recuperar una inversión., variables financieras para análisis de sensibilidad y costo de capital. Existen algunas metodologías; los más comunes son el modelo de fijación de precios de activos de capital (*CAPM*) y el modelo de crecimiento de la riqueza de Gordon. Entonces, evaluar el costo de los recursos propios es esencial para el análisis de riesgo, pero en los últimos años algunos han escrito artículos sobre métodos híbridos y de vanguardia que complementan el análisis de las técnicas del costo de los recursos propios. La investigación pretende mostrar la importancia de aplicar aquellas metodologías que beneficien a los inversionistas internacionales y financien a los investigadores científicos que se esfuerzan por desarrollar avances en teorías y modelos para la evaluación del costo de las acciones. La metodología fue bibliográfica porque fue necesario investigar artículos recientes sobre dichos métodos. La información de los artículos se tomó de la base de datos Web of Science de 2017-2022. El número de artículos seleccionados se basó en un muestreo por conveniencia. El estudio muestra los artículos recientes que han aplicado métodos híbridos y de vanguardia en la evaluación del costo de capital. Asimismo, el propósito de cada investigación y la explicación del uso de dichas metodologías.

Palabras clave: técnicas de presupuesto de capital, costo de capital, promedio ponderado de capital, análisis de riesgo, métodos híbridos y de vanguardia.

1.2 Introduction

Investors analyze different finance tools to make an investment decision. Kirby (2019) indicates that capital budgeting techniques can be divided into three categories. The first one is named naive, and this considers the Accounting Rate of Return (*ARR*), Price–to–Book ratio (*PB*), and Discounted Payback (*DPB).* The second one is advanced, considering sensitivity analysis, Internal Rate of Return (I*RR*), modified IRR, scenario analysis, profitability index, and Net Present Value (*NPV*). Sophisticated techniques are the last one: Real Options, Game Theory Decisions, Decision Trees, and Capital Asset Pricing Model (*CAPM*), which are helpful for opportunity cost estimation.

Investors require a rate of return at the time of investment decision, which refers to the opportunity cost for projects, and it is an essential variable for the Weighted Average of Cost of Equity (WACC) (Shimada, 2020). This is also referred to as the opportunity cost to discount Free Cash Flow (FCF) (Wang et al., 2020), in which the mean of risks is weighted, the average after-tax cost of equity, which interest needs to be adjusted for its calculation. The standard methods for cost of capital estimation are Capital Asset Pricing Model (CAPM) and Gordon´s Wealth Growth model, but others are not frequently used, such as Arbitrage Pricing Theory (AlHares, 2020). Some other methods have been developed that state that CAPM and the three-factor model are inaccurate. Hsieh et al. (2019) consider that companies´ growth rates are related to an expected rate of return, so stock prices, capital of shareholders, and earnings predictions into the residual income are taking accounting in this technique, which shows that opportunity cost gets better outcomes at the time of considering the rise on rates.

Recently, many articles have been written about the cost of equity, which includes the analysis of some new hybrid and avant-garde methods that help investors to make financial decisions on projects. So, this research aims to show the importance of applying those methodologies that benefit international investors and finance scientific researchers who strive to develop advances in theories and models for opportunity cost evaluation. Future opportunity cost investigations might be developed with the input of those researchers since there are different purposes and variables that investigators require to analyze when evaluating the impact of the cost of equity. This study opens a window of opportunities for investors and financers.

1.3 Materials and methods

In this study, bibliographic research was applied since investigators searched for information about the analysis of new hybrid and avant-garde methods that complement the cost of the capital evaluation. Articles information was taken from the Web of Science database from 2017-2022. The selection of articles is based on the search of the last five years and includes all quartiles of the Journal Citation Reports, including the Emerging Sources Citation Index.

The economics, econometrics, finance, and accounting category was selected as an inclusion and exclusion method. A review article, early access, open access, and enriched cited references are included. Likewise, proceeding papers, book reviews, book chapters, editorial material, meeting abstracts, notes, letters, and data papers were excluded.

It was decided to give a consistent triangulation on the definition of high-impact research; each article was checked against the Scopus database, and the articles are in both databases regardless of their research quartile. In this triangulation, there were no inclusion or exclusion criteria, this process being carried out previously.

The search engine is based on “All fields” that includes topic, title, author, publication titles, year published, affiliation, funding agency and publisher. The keywords applied were “Cost of Capital”, “evaluation techniques”, “evaluation”, “evaluation methods”, “Cost of Capital AND evaluation”, “Cost of Capital AND evaluation techniques”, “Cost of Capital AND evaluation methods”, “Costo de capital”, “técnicas de evaluación”, “evaluación”, “métodos de evaluación”, “Costo de Capital AND evaluación”, “Costo de Capital AND técnicas de evaluación”, “Costo de capital AND métodos de evaluación”, “Kapitalkosten”, “Bewertungstechniken”, “Auswertung”, “Bewertungsmethoden”, “Kapitalkosten AND Auswertung”, “Kapitalkosten AND Bewertungstechniken”, “Kapitalkosten AND Bewertungsmethoden”.

Keywords are incorporated in two languages other than English since the number of investigations in Spanish and German is high for the term of the object of study. This incorporation aims to broaden the spectrum of data and conclusions usually excluded because they are in a language other than English.

1.4 Results

In recent years, some investigations about the cost of capital have been evidenced. Valaskova et al. (2019) developed research about how capital structure can influence company valuation. The principal objectives of this research are to analyze the incidence of financial architecture on the opportunity cost of Slovak organizations and the suggestion of an excellent form to develop a finance decision. Slovakia's Stock Market is poorly developed, so investigators selected seventeen stock companies, excluding commercial banks, because they had different capital structures. To evaluate the dependence between variables, it was necessary the use Pearson correlation coefficient, regression analysis, and Man-Whitney U-test. As a result, it shows that the cost of capital, the company´s size, and capital structure have an indirect relationship.

Franek & Kashi (2017) wrote about some new hybrid methods to evaluate the performance of a medium-sized automotive company in the Czech Republic for twelve months in the year 2013. The objective of the investigation was to show a systematic decision-making procedure, which mixes *MADM* methods, such as Simple Additive Weighting (*SAW*) and *COPRAS-G*, with Analytic Hierarchy Process (*AHP*) in order to analyze the business finance management of a manufacturing organization and value the impact of different weighing methods, such as subjective methods of *AHP*, objective methods of entropy, and the combination of both of them. The investigators conclude that those new hybrid methods can assess corporate performance.

As a result, it could be identified four areas or uses those investigators can apply to business and finance decision-making with the help of *MADM* methods. The first is focused on estimating objective, subjective, and relative weights, which can be developed through the method of *AHP*, which *SAW* and *COPRAS-G* complement. The second is to set an order of priorities and established factors, known as strategic alternatives. The third one is useful to calculate the relative priorities chosen alternatives so that managers can make new decisions. The last application of methods is for industry organization analysis.

Rajverma et al. (2019) examined the grade of dependence among capital structure, cost of capital, and dividend, considering a sample of 457 organizations that are not financial companies indexed on India's National Stock Exchange (*NSE*). The data was obtained from the Centre for Monitoring Indian Economy (*CMIE*) from 2006 to 2017; the investigation did not include government-owned firms. As a result, it was shown that family firms were dominant because of

the evidence of concentrated ownership, and also, the average cost of opportunity cost, leverage, and the dividend was interlinked. These kinds of firms tend to pay lower dividends and have grand debts with reduced opportunity costs. This research applied the 3SLS system approach (Econometric model), so *DIV*, *LEV*, and *COC* models were used in these segments (Wide, family, FAMCON, and whole firms).

Nourali & Osanloo (2020) developed a model related to the regression tree technique to calculate the mining equity cost. The investigators indicate that underestimating this variable could postpone production and construction projects. If it is overestimated, the company's value can be reduced, and other capital cost estimation models in finance evaluation do not forecast it with a reliable range of error. That is why these investigators propose this methodology for the cost of equity estimation. Opportunity cost data of twenty-eight porphyry copper mines were considered for this research. The model introduced two relevant factors: Yearly Ore Output (*AOP*) and Yearly Rock Output (*ARP*).

For the validation, it was obtained into consideration of a +/- 10% of error in the construction model and also helpful for estimating the Root-Mean-Square error (*RMSE*) and Mean Absolute Error (*MAE*). The first one refers to prediction errors, and the second measures the difference between prediction values and the ones observed, so predicted values taken from the regression tree model, and the estimation of both equations explained before, were necessary for discount rate calculation, showing a reliable model. As a result, it also shows a direct relationship between opportunity cost and *AOP*, and when *ARP* and *AOP* increase, more cost of equity is required for mining activities.

The same authors wrote a similar article in 2019, but the capital cost estimation was obtained with the help of Support Vector Regression (*SVR*). In that case, data from fifty-two pit porphyry copper mines were necessary for the investigation. However, it was orientated under the supposed that the models of the cost of capital do not forecast mining Capital Expenditure (*CAPEX*) with a reliable magnitude of the error. After the testing procedure, it demonstrated that *SVR* was a form to calculate the return required by investors Nourali & Osanloo (2019).

Zhang et al. (2020) also calculated the cost of capital for mining projects, but in this case through a novel artificial intelligence model and deep neural network (DNN)-based Ant Colony Optimization Algorithm (*ACO*).

Seventy-four observations were used for estimation, 22 copper mines from Vietnam, China, Iran, and India, and 52 taken from Copper Mine Project Profiles studied by Zhang et al. (2020). As a result, it is evidenced that through this methodology, the cost of capital can be predicted for open-pit mining projects in a better way than traditional Artificial Neural Networks (*ANN*), so ACO is considered an important function to improve its accuracy in the model. The variables that investigators took into account for the estimation were MineAP (annual mine production), MillAP (annual production of the mill), *SR* (Stripping ratio), *LOM* (life of mine), and *RMG* (reserve mean grade).

Agasha et al. (2022) analyzed the return investors require in the relationship between loan portfolio quality and capital structure. A cross-sectional design was introduced. The research was focused on Uganda`s microfinance institutions (*MFIs*) and considered a sample of eighty-two of the total population. Partial least squares equation modeling (*PLS-SEM*) was used in hypothesis studies. The strength of mediation was assessed through Variance Accounted For (*VAF*).

As a result, it got a percentage of 43,1%, which means that the price of equity partially mediates the relationship between loan portfolio condition and capital structure because the outcome is on the reach of 20% and 80%. It also shows a positive relationship between loan portfolio condition and capital structure, and this tries to explain that if the capital structure has good conditions, it permits the financial institutions to satisfy financial requirements and amend their creditworthiness.

A positive relationship between capital structure and the rate required by investors is evidenced, showing that more financing forces the cost of capital to be higher because of new insurance fees, dividends, and interest payments. Also, the correlation between opportunity cost and loan portfolio quality was positive, indicating that if the first variable increases, it motivates MFIs to give loans, decreasing default rates, which can make that loan portfolio quality can be amended. The investigation suggests rationing credit as a strategy to get repayments faster and also points out the analysis of conditions and terms of funds before making a financial decision.

Hoang et al. (2021) also applied least squares as a methodology that combines the implied cost of capital (*ICC*) to predict stock market returns. This study considered firms from the United States listed on *NYSE, AMEX*, and *NASDAQ*, focusing on the research from 1976 to 2018. It used the most common ICC models: *GLS*, *CT*, *OJ*, *MPEG*, and *GD.*

Ordinary least-squares multiple regression analysis was applied by AlHares (2020) to evaluate the incidence of company management on opportunity cost in Organization for Economic Co-operation and Development (*OECD*) countries. The study was developed for two hundred corporations from Anglo-American and European republics from 2010-2017. As a result, an undesirable correlation between director proprietorship and governance index was evidenced but showed a positive correlation with block ownership.

Shimada (2020) evaluated the economic outcomes of voluntary disclosure for future investments on the cost of capital of manufacturing companies. The sample reached an amount of 1387 firms and 7144 firm-years, taken from Toyo Keizai Kaisha Shiki Ho. Outcomes demonstrate that the opportunity cost of companies that disclose investment forecasts tends to decrease more than those that do not, so that is why finance information influences an investor's decision-making, affecting Opportunity cost. The cost of capital was estimated through earnings forecasts, suggested by Huang et al. (2011). The treatment effect estimates model was applied for multivariate tests, where vectors of determinants, year fixed, industry effects, and firm risks are introduced in the model.

A forecast of the cost of equity through the Bayesian approach for photovoltaic and wind energy was studied by Obane (2019), where compounded value was compared with the actual cost in 2017. This research used the cost of equity calculated in the previous article (after 2011) and the cost of capital data from 2015-2017. As a result, it shows that estimation costs through this methodology are accurate if the real ones are in the estimated cost range. It also forecasted the rate required by investors for the year 2030 with the same technique, and it is expected that the opportunity cost will get more significant than the estimated by Japan. It is essential to remember that one to three years must be the observation period in the practical aspect.

Hsieh et al. (2019) wrote about the grade of dependence on the cost of equity and accounting quality when there is a grade of institutional ownership. Stretchy econometric methodology, established on Panel Smooth Transition Regression (*PSTR*). Hsieh et al. (2019) applied in this investigation, considering sixty-four companies in Taiwan from 2000 to 2017. Usually, to calculate the opportunity cost is necessary to consider risk costs, but the present study proposition, industry effect, investors´ ex-ante evaluation of equity cost, and industry-adjusted EP ratios (dependent variable) were considered.

The grade of institutional ownership is named the transition factor. The model was applied to this research, using market risk premium, SMBt, and HMLt, since those variables tend to influence the opportunity cost. It also included the accounting quality variable (AQi_{t-1}) and a one-year lag to ensure the information can be available to evaluate risk. The outcomes show that both variables tend to have significant variations if the level of institutional ownership changes.

Carp & Constantin (2019) evaluated similar variables since they focused on the grade of dependence on financial information quality and the rate required by investors. The data was taken from Bucharest Stock Exchange, and the period analysis was from 2012 to 2017, in which financial information was analyzed for fifty-eight companies (384 observations). The outcomes showed that financial information quality significantly contributed to the decrease in the cost of equity. This research applied an econometric model by Ohlson (1995), introducing the following variables *WACC* quotation: book value equity per year, net income per share at the end of the year, regression coefficients, and random variables. Also, Jones (1991) model was utilized, considering total accruals, change in current assets, change in cash and current liabilities, fluctuation of short-term debts, amortization, and depreciation to display accurate representation.

Gregory et al. (2021) developed an Environmental Social and Governance (*ESG*) model, considering multi-factors that affect the opportunity cost. The sample corresponds to the period from September 1999-January 2017. Kenneth French´s website helped take financial data for twenty-three developed markets in the United States. In order to test the model, it was necessary to use a two-pass regression analysis to determine if sustainability is priced on the company´s opportunity. As a result, sustainable strategic plans decrease the opportunity cost by 1,6% to 2.9% per year, encouraging the Gross Domestic Product could increase by $1,3 to $2.3 trillion. In other outcomes, it tested that there was a negative grade of dependence between opportunity cost and sustainability.

Bhabra & Rooney (2020) wrote an article about the evaluation of the relationship between corporate governance and the company's value influenced by investment rules, which has Sarbanes-Oxley (*SOX*) Act of 2002 approval and stock exchanges requirements. S&P 1500 index was selected for the analysis because of the consolidation of the S&P MidCap 400 index, S&P 500 index, and S&P SmallCap 600 index. This sample does not include small companies´ stocks. The study focused on 1999-2005, but the data from 2002 was not included since the investigation

evaluated pre and post-*SOX* periods. The subtraction between scope and book-to-market briefcase amount-freighted returns and companies' yearly stock returns were practical to get the excess stock returns. As a result, it was found that a change in governance makes the worth of company-tier capital expenses vary.

The Monte Carlos method has been used by Wan & Li (2021) to analyze high-tech companies' intangible assets, taking into the context of net safety. Sixty companies were chosen for the study, where 30 belonged to information technology and 30 to the manufacturing industry, spanning 2009-2011. The study developed a combination of the Capital Asset Pricing Model (*CAPM*) and Weighted Average Cost of Capital to get the rate investors require but applied the Analytic Hierarchy Process (*AHP*) to estimate its weight. As a result, it was discovered that high-tech firms tend to have higher indicators in terms of net assets and accounting surplus, getting excellent outcomes on earnings per share.

Paton et al. (2019) developed an implicit compound price of capital since *PEG* and *MPEG* standards were adopted to get the outcome through an average of the methods described before. The study was developed with 6261 Australian company-year observations, considering finance information from 1997 to 2016. It recommends using these cross-sectional model-based earnings when estimating the returns investors require. As a result, earning forecasts tend to have less bias than analyst earnings forecasts. The annual earnings response coefficient (*ERC*) was necessary for the revision to get the worth-significance of models.

Fallah (2021) developed scientific research about the incide of institutional ownership on cost of equity and accounting quality. The investigation focused con the organizations that participate on Tehran Stock Exchange, and it spans the period 2011-2017. Regression analysis and test of Zero regression coefficients were introduced to analyze the relationship between variables. As a result, it was shown a significant grade of interrelation.

Some studies have been developed about the implicit price of equity, which has not included changing discount rates over time. In studies where time-varying opportunity cost is introduced, investigators are considering a term structure of implicit price of equity instead of research focusing on unvarying implied opportunity cost. Callen & Lyle (2019) published an article with that approach. Its purpose was to forecast volatilities and future stock returns, being that this model is relevant to get ex-ante earnings announcement premiums. The evaluated years

were 1996-2015, and 4897 companies were considered a sample. Data was taken from Chicago Mercantile Exchange, Option Metrics unpredictability shallow, and the zero-coupon liaison file. Besides the estimate of the price of equity, one of the contributions of this paper is that the methodology can be applied to evaluate variations of implied opportunity cost.

Busato et al. (2019) estimated the cost of capital for the Real Estate Investment Trust (*REIT*) with a sample of fifty-one REITs from January 1997-December 2014. The following methods were compared: the hybrid beta approach, the four-element standard, the REIT-element standard by Chen et al. (2012), and five- element standard developed.

OLS regressions were used to compare risks. For this analysis, it was necessary to compare outcomes of one month, one year, three years, and five years out of sample forecasting accuracy for all methodologies mentioned before. As a result, it was found that absolute forecast errors are reduced than the other ones with the hybrid beta approach, so the study helps investors choose the best estimation of the cost of capital.

Silvia et al. (2019) used Monte Carlo simulations to develop probability distributions to forecast different scenarios of the value of the Company AMBEV since the investigation aimed to estimate the organization's worth through the reduced currency flow method but incorporating the uncertainty variable of cost of equity. The range data for the investigation was from the year 2013-2017. The stochastic valuation model was developed through Monte Carlo simulations. As a result, it was concluded that it is a good tool for financers because although it is not possible to forecast the actual value of the firm, it is helpful to analyze risks.

Wang et al. (2020) analyzed the change in the proportion necessary by financiers among U.S. domestic companies and U.S.-based multinational companies. The investigation considered a sampling of 1228 company-year remarks from 1994 to 2013. The results revealed that this last one had a higher equity price and showed that the industry affects outcomes. The price of equity, capital structure, and cost of equity was calculated through Bayesian Markov, using Monte Carlo simulation.

Art. 1 Table 1: Summary information about recent investigations of cost of capital

Target/Range period	Sampling	Method	Investigator
Slovakia Stock Market	17 Stock companies, including commercial banks	Pearson correlation coefficient, regression analysis, and Man-Whitney U-Test for the evaluation of the interrelationship between variables.	Valaskova et al., 2019.
Business performance of a medium-sized automotive company in the Czech Republic for twelve months in 2013.	A medium-sized automotive company	*MADM* methods: Simple Additive Weighting and *COPRAS-G* with Analytic Hierarchy Process (*AHP*)	Franek & Kashi, 2017.
Non-financial firms are indexed on India's National Stock Exchange (*NSE*). The data was taken from the Centre for Monitoring Indian Economy (CMIE) from the years 2006 and 2017.	457 non-financial firms	3 SLS system approach (Econometric model). *DIV*, *LEV*, and *COC* models were used.	Rajverma et al., 2019.
Porphyry copper mines with Annual Rock were studied. Capital Cost data was escalated to 2016 American Dollars	Twenty-eight porphyry copper mines	A regression tree-based model. Two relevant factors were introduced in the model: Yearly Ore Output (*AOP*) and Yearly Rock Output (*ARP*)	Nourali & Osanloo, 2020

Open-pit Porphyry copper mines with Annual Rock were studied. Capital cost data was escalated to 2016 American dollars.	Fifty-two porphyry copper mines	The estimation of capital cost was based on Support Vector Regression (SVR)	Nourali & Osanloo, 2019[a].
The model was developed to estimate the price of capital of 22 copper mines in Vietnam, China, Iran, and India, and 52 taken from Copper Mine Project Profiles studied by [14].	74 Copper mines were studied	Novel Artificial Intelligence model and Deep Neutral Network-based Ant Colony Optimization algorithm (*ACO*) to forecast the cost of capital.	Zhang et al., 2020
Uganda´s microfinance institutions	82 Uganda´s microfinance institutions	Partial least squares equation (*PLS-SEM*) and Variance Accounted For (*VAF*)	Agasha et al., 2022.
Firms from the United States, listed on NYSE, AMEX, and NASDAQ, focus the research from 1976 to 2018.	Firms from the United States	Least squares and Implied Cost of Capital (*ICC*). *GLS*, *CT*, *OJ*, *MPEG*, and *GD* models were applied in the investigation.	Hoang et al., 2021.
Anglo-American and European countries from the year 2010-2017	Two hundred corporations from Anglo-American and European countries	Least squares multiple regression analysis.	AlHares, 2020.
Manufacturing companies in Japanese markets from the year 2004 to 2011	One thousand three hundred eighty-seven	The cost of capital was estimated through the earnings forecasts model.	Shimada, 2020.

	firms and 7144 firm-years.	The treatment effect estimates model was applied for multivariate tests.	
The cost of equity calculated in the previous article was used (after 2011), and the cost of capital data from 2015-2017.	Photovoltaic and wind energy capital costs in Japan	Bayesian Approach	Obane, 2019.
Companies in Taiwan from the year 2000-2017	Sixty-four companies in Taiwan	A stretchy econometric methodology based on Panel Smooth Transition Regression (*PSTR*). Fama & French model was applied in this research	Hsieh et al., 2019.
The company data was taken from Bucharest Stock Exchange, and period analysis was from the year 2012-2017	58 companies (384 observations)	Econometric model by Ohlson (1995) and Jones (1991)	Carp & Constantin (2019)
All organizations that participate on Tehran Stock Exchange. It spans the period 2011-2017	All companies that negociate assets on Tehran Stock Exchange.	Regression analysis and test of Zero regression coefficients.	Fallah, 2021.
The sample of developed markets (*USA*) corresponds to the period September 1999-January 2017	23 developed markets	Environmental Social and Governance (*ESG*) model, considering multi-factors of (Fama & MacBeth, 1973).	Gregory et al., 2021.

The analysis period 1994-2013 of multinational and domestic corporations in the United States.	The investigation considered a sample of 1228 firm-year observations	Bayesian Markov chain Monte Carlo Approach	Wang et al., 2020.
The study of the incidence of SOX on the grade of investment in capital expenditures was focused to the period 1999-2005 (Combination of S&P MidCap 400 index, S&P Small Cap 600 index, S&P 500 index)	S&P 1500 Index (Excluding micro and nano capitalism stocks)	Fama and French (1993) to estimate the excess stock of return	Bhabra & Rooney (2020)
Tecnology and Manufacturing companies. The investigation spans the period 2009-2011, and data was taken from Shanghai Stock Exchange	60 companies (30 belonged to technology industry, and the difference to manufacturing)	Monte Carlo method, Capital Asset Pricing Model (*CAPM*), Weighted Average Cost of Capital (*WACC*), and Analytic Hierarchy Process (*AHP*)	Paton et al. (2019)
The evaluated years belonged to the period 1996-2015. Data was taken from Chicago Mercantile Exchange, OptionMetrics volatility surface database and the zero-coupon bond file	4897 firms where considered as a sample	Term structure of implied cost of equity	Callen & Lyle (2019)

The range data for the investigation of Company AMBEV was from the year 2013-2017	Company AMBEV	Stochastic valuation model was developed through Monte Carlo simulations	Silvia et al. (2019)

1.5 Conclusions

In recent years, some investigations about hybrid and avant-garde methods for cost of equity evaluation have been developed in the finance scientific world, beneficing international investors of different sectors and new researchers who wish to provide an advance of theories and models. The published articles have had different purposes, besides the estimate of the prospect cost, such as: Analyzing the correlation among price of capital and capital structure, dividends, corporate governance, voluntary disclosure for future investments, and accounting and finance quality, evaluating interrelationship among poor portfolio quality and capital structure, showing a systematic decision-making procedure, comparing the impact of different hybrid methodologies, forecast a cost of capital with reliable error, predicting stock market returns, estimating the implied cost of equity where investigators can include the criteria of dynamic discount rates, forecasting different scenarios to value a firm, and contrasting cost of equity outcomes from different sectors.

Some of the hybrid and avant-garde methods that have been applied in the last years are: Simple Addictive Weighing and *COPRAS-G*, Analytic Hierarchy Process (*AHP*), 3SLS system approach (*DIV, LEV*, and *COC* models), regression tree, cost of capital-based con Support Vector Regression (*SVR*), Novel Artificial Intelligence model, Deep Neutral Network-based Ant Colony Optimization algorithm, Partial Least Squares equation (PLS-SEM), Least Squares multiple regression analysis, Accounted FOR (*VAF*), Implied cost of capital (*GLS, CT, OJ, MPEG* and *GD* models), Bayesian Markov chain Monte Carlo approach, stochastic valuation through Monte Carlo simulations, Stretchy econometric methodology, based on Panel Smooth Transition Regression (*PSTR*), Environmental Social and Governance (*ESG*), Hybrid beta approach, regression analysis, test of zero regression coefficient and REIT factor model, and Econometric model by Ohlson (1995) and Jones (1991).

It has been evidenced in some investigations where they have used the theory of the Fama & French model to include variables that incise the outcomes of cost of equity for industries and organizations. So, taking into account the point that some specific variables also can influence stock returns, it would be interesting that countries of Latin America, where the stock market is not well developed, can consider this model at the time estimating the cost capital since the existence of external causes that investors evaluate for future investments.

2. AVANT-GARDE MULTI-CRITERIA DECISION-MAKING METHODS FOR RISK ASSESMENT

2.1 Antecedentes

El presente artículo se enfoca en la revisión bibliográfica referente a métodos vanguardistas sobre toma de decisiones multicriterio para la evaluación de riesgo. La producción científica se muestra a continuación:

- San Andrés, P., Jimber del Río, J., Márquez, F. & Vergara-Romero, A. (2023). Avant-garde multicriteria decision-making methods for risk assessment. Por enviar a la revista Journal of Business Research

Abstract

Investors, company owners, and even entrepreneurs tend to evaluate the risk for different projects since they wish to get more profits and introduce their capital to the best alternatives. Nowadays, there are some financial tools to assess the profitability and viability of a business. However, some scientific articles have evidenced the application of Multi-Criteria Decision Making (*MCDM*) to solve complex problems that imply analyzing different options to select the most reasonable ways to get better outcomes for an organization or business proposal. Authors have developed some systematic procedures for criteria evaluation. In recent years, some papers with different methods have been published that identify the most and least relevant factors that impact the results of different studies. Executives have seen the necessity to use those avant-garde techniques to score weights of selected variables, compare benefits, be conscious of the worst choices, and privilege the best form to obtain satisfactory consequences in the short or long term. This investigation aims to highlight the usefulness of those methods for business or investment decision-makers who intend to develop efficient strategies to improve productivity and finance resources. Convenience sampling was considered, and research spans the period 2018-2022. A bibliographic methodology was applied since investigators collected recent publications about that kind of evaluation process, based on the examination of criteria and cost/benefit comparisons, in order that it can be served as a guide for future complex decisions.

Keywords: Risk, Multi-criteria decision-making (*MCDM*), decision-makers, criteria, productivity, and financial resources

Resumen

This Inversionistas, dueños de empresas e incluso empresarios tienden a evaluar el riesgo de diferentes proyectos ya que desean obtener mayores ganancias e introducir su capital en las mejores alternativas. Hoy en día, existen algunas herramientas financieras para evaluar la rentabilidad y viabilidad de un negocio. Sin embargo, algunos artículos científicos han evidenciado la aplicación de la Toma de Decisiones Multicriterio (MCDM) para resolver problemas complejos que implican analizar diferentes opciones para seleccionar las formas más razonables de obtener mejores resultados para una organización o propuesta de negocio. Los autores han desarrollado algunos procedimientos sistemáticos para la evaluación de criterios. En los últimos años se han publicado algunos trabajos con diferentes métodos que identifican los factores más y menos relevantes que impactan en los resultados de diferentes estudios. Los ejecutivos se han visto en la necesidad de utilizar esas técnicas de vanguardia para ponderar las variables seleccionadas, comparar beneficios, ser conscientes de las peores elecciones y privilegiar la mejor forma de obtener resultados satisfactorios a corto o largo plazo. Esta investigación tiene como objetivo resaltar la utilidad de estos métodos para los tomadores de decisiones empresariales o de inversión que pretenden desarrollar estrategias eficientes para mejorar la productividad y financiar los recursos. Se consideró un muestreo por conveniencia y la investigación abarca el período 2018-2022. Se aplicó una metodología bibliográfica ya que los investigadores recolectaron publicaciones recientes sobre ese tipo de proceso de evaluación, con base en el examen de criterios y comparaciones costo/beneficio, con el fin de que sirva de guía para futuras decisiones complejas.

Palabras clave: Riesgo, toma de decisions multicriterio (MCDM), tomadores de decisiones, criterios, productividad y recursos financieros

2.2 Introduction

Unexpected events can befall projects, showing positive or negative results. It means that they can be opportunities or losses. Risk assessment is essential because its outcomes help make strategic decisions to avoid harmful consequences (Xidonas et al., 2021). The risk is defined as the probability of loss/gain, and it is quantifiable since evaluation and analysis can be developed with computational methods. The magnitude of risk depends on the difference between the expected value and the original results (Khalilzadeh et al., 2020). The Australian Standard for Risk Management has presented a risk management process to find weaknesses in applied methods through a structured approach to avoid or decrease the level of risk of a product or service developed. The procedure is as follows: To establish the context of risk, risk identification, risk analysis, risk evaluation, risk treatment, monitoring and controlling risk, and communication and consultation with stakeholders.

Context establishment focuses on the design of project units and also how they are interrelated between processes or data. The techniques are Project Network Diagram, Precedence Diagramming Method (*PDM*), Design Structure Matrices (*DSM*), Generalized Activity Networks (*GANS*), IDEF3 process modeling, and IDEF0 functional modeling. Risk identification tries to recognize the adverse effects of a project during a specific period. So, it is necessary to identify those future consequences to mitigate risk. Checklists, Influence Diagrams, Cause-and-Effect Diagrams, Failure Mode and Effect Analysis, Hazard and Operability Study, Fault trees, and Event Trees are techniques for recognizing risk.

Risk analysis examines the incidence of internal or external factors on specific variables, but it is crucial to consider that high-quality data is necessary. Some techniques are Probability and Impact Grids, Estimation of System Reliability, Fault tree analysis, Event Tree Analysis, Sensitivity Analysis, and Simulation. Risk evaluation helps develop risk migration plans. Some evaluation techniques are Decision Tree Analysis, Portfolio Management, and Multiple Criteria Decision-Making Method (*MCDM*).

MCDM includes methodologies that assess different criteria and alternatives to make an efficient decision in complex problems that could be pertained to different area studies. Investigations can be developed using qualitative and qualitative approaches (Broniewicz & Ogrodnik, 2021). The ones that researchers more frequently apply are classified by the following

categories: Value Measurement Models, Distance functions or ideal-solution-based models, Outranking models, and Fuzzy Evaluation Sets. The first one aims to estimate a rate, represented as a weight for available options, to evaluate a branch of alternatives (Koulinas et al., 2019).

In this group, articles have been published using the Analytical Hierarchy Process (*AHP*), where alternatives and relevant factors are identified to develop a pairwise comparison to examine the level of importance of each criterion and check out the consistency grade in the model. The help of experts is necessary for the assessment of different choices.

An advanced AHP method is called Analytic Network Process (*ANP*), which considers dependencies between different factors that affect a specific problem (Jurevicience et al., 2020). This technique has also been mixed with Decision-Making Trial and Evaluation Laboratory (DEMATEL) since it analyzes the cause and consequences between case study factors and identifies the most influential variables with an effect affinity chart. The second group is associated with the raking of distinct options about specific goals, ambitious grades, and optimal results. In this class of *MCDM*, publications about the application of Technique for Order Performance by Similarity to Ideal Solution (*TOPSIS*) have been evidenced. This technique focuses on ranking the results of different options, according to the level of importance, to find the most suitable ways to fix a problem, and they are compared with the ones not considered appropriate forms to solve complex troubles. VIKOR method also forms part of this classification. It evaluates, analyzes, and identifies the options that critically bring better outcomes to avoid adverse effects in a case (Xidonas et al., 2021)

Grey Relational Analysis (*GRA*) technique also helps investigators to discover those factors that influence a significant way of study. It also analyses the relationship among various criteria. One of the benefits of this methodology is that a large amount of data is not necessary for assessment (Zhou et al., 2020). To evaluate issues related to various and unfavorable objectives, GP is a proper technique; so for applying this method, it is necessary to settle the goals of each factor. The best option is reducing deviations, considering all research purposes. The third group applies pairwise comparisons to observe how different options beat among them when considering all variables as factors. Options are joined for categorization ranking.

The techniques used the most in this category are The Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) and Elimination Et Choice Translating

Reality (*ELECTRE*). It also has been evidenced investigations with the following methodologies: *PROMETHEE II* and *ELECTRE* III. The last group tries to develop a closure outcome related to imperfect, ambiguous, and risky data reports. Some of the methods are Fuzzy *AHP* or Fuzzy *TOPSIS.*

Risk treatment focuses on developing suitable measures to mitigate risk (Tavana et al., 2019). Audit and compliance programs, technical control, structured training, disaster recovery plans, and fraud control planning are some options to manage and monitor risk. However, it is also necessary to control the positive influence of risk treatment plans or strategies to ensure that any change in the project would not significantly affect the costs or expenses. Besides the techniques mentioned before, it is essential to develop a communication plan for stakeholders to guarantee the implementation of risk management. Also, they can understand the organization`s interests since decisions also depend on the perception of risk, and sometimes they can be different because of stakeholders` needs or concerns.

There are some factors and objectives that encourage investors to select specific variables. Extrinsic factors are the ones that affect organizations that do not have a direct influence because they are considered as outside criteria that can impact a firm`s returns, such as economic, political, social, and technical issues. In contrast, intrinsic factors or operational characteristics evaluate companies` decision-making. In other words, they measure quality management and competitiveness. Profitability, size, technology, and philosophy are some examples. In the business world, a variety of objectives can influence managers or investors at the time of making a decision. Profitability, control, and security could be important reasons why they need to choose another path (Pramanik et al., 2020).

Investors also analyze a country's risk before providing capital to national or international financial institutions or organizations. It indicates the possibility that any nation could not cover its external debts because of the lack of foreign exchange. It not only evaluates the willingness and ability to pay its obligations, but it also analyzes political, social, economic, and financial factors because they can affect investment returns. That is why country risk analysis and assessment tries to identify and justify the principal risk criteria that impact countries` economy and has become a relevant analytical tool for banks, companies, and foreign organizations to discover debt troubles in a sovereign state and also to make sound financial decisions (Tey et al., 2019).

Some academic techniques help investors choose the best finance (Nguyen et al., 2020). Capital Asset Pricing Model (*CAPM*) is one of the variables that financers estimate to calculate the Weighted Average Cost of Capital (*WACC*). However, when firms or competitors do not trade shares in the Stock Exchange, they need to apply alternative methodologies, such as Analytic Hierarchy Process (*AHP*) method, that is developed by Thomas Saaty (Kaulinas et al., 2019) to resolve complex problems at the time the taking a suitable decision. It has been applied in different areas, but it is necessary for the intervention of experts for criteria evaluation.

The method is formed by object, index, and sub-index layers. It is helpful to develop effective decisions that include complex problems (Tey et al., 2019), considering some relevant criteria, and enabling shareholders or investors to choose the best option according to the organization´s objectives (Carpitella et al., 2021). This method is also valuable for calculating equity risk premiums and identifying risk factors that could affect the firm's cost (Atta et al., 2020).

Nowadays, some articles about Multi-Criteria Decision-Making (*MCDA*) methods have been published in the last years, which investigators can take advantage of to choose different types of decisions. Risk has been evaluated in some research, which is helpful for investors or administrators who must select the best alternative for a specific situation. The objective of this investigation is to present the recent investigations of MCDA that have been applied recently so that future scientific researchers and financial and administrative evaluators can apply the methodology for risk evaluation.

2.3 Materials and methods

In this study, bibliographic research was applied since investigators searched for information about the analysis of new hybrid and avant-garde methods that complement the cost of the capital evaluation. Articles information was taken from the Web of Science database from 2018-2022. The selection of articles is based on the search of the last five years and includes all quartiles of the Journal Citation Reports, including the Emerging Sources Citation Index.

The economics, econometrics, finance, and accounting category was selected as an inclusion and exclusion method. A review article, early access, open access, and enriched cited references are included. Likewise, proceeding papers, book reviews, book chapters, editorial material, meeting abstracts, notes, letters, and data papers were excluded.

It was decided to give a consistent triangulation on the definition of high-impact research; each article was checked against the Scopus database, and the articles are in both databases regardless of their research quartile. In this triangulation, there were no inclusion or exclusion criteria, this process being carried out previously.

The search engine is based on “All fields, " including the topic, title, author, publication titles, year published, affiliation, funding agency, and publisher. The keywords applied were “multi-criteria”, “multi-criteria AND decision-making”, “risk assessment”, “multi-criteria AND decision-making AND risk assessment”, “multicriterio AND toma de decisión”, “evaluación de riesgo”, “multicriterio AND toma de decision AND evaluación de riesgo”, “multikriterien”, “multikriterien AND entscheidungsfindung”, “risikoabschätzung”, “multikriterien AND entscheidungsfindung AND entscheidungsfindung”.

Keywords are incorporated in two languages other than English since the number of investigations in Spanish and German is high for the term of the object of study. This incorporation aims to broaden the spectrum of data and conclusions usually excluded because they are in a language other than English.

2.4 Results

In recent years, some research has been developed about Analytic Network Process (*ANP*) since it has been considered an effective technique when making complex decisions. It developed a bibliometric investigation to benefit future scientific researchers. The Web of Science database was helpful for data collection. Investigators evidenced 1485 articles about the analytic network process. The outcomes showed that Expert Systems with Applications was the journal that produced more articles about that topic, reaching a total of 118 productions, and in second place corresponds the Journal of Cleaner Production, which got 47 published units. China and the United States are the countries that have developed more of those types of publications, and the percentage of share raised to 48,26% and 68,31%, respectively. The most frequent topics are supply chain management, environmental management, and sustainability.

Zhao et al. (2020) evaluated the network risk with the help of a differential manifold (DM), a mathematical method for this type of assessment. The study was necessary to apply traditional techniques, such as the Analytic Hierarchy Process (*AHP*) and Common Vulnerability Scoring System (*SVSS*). This research developed two experiments.

The first one was helpful in estimating network structure and behavior risk, reproducing a small network environment. The second was focused on demonstrating the veracity of the methodology, so for its evaluation, it was necessary the collection of data from the 2017 Canadian Institute for Cybersecurity Intrusion Detection System (*CICIDS2017*) since it considers updated attacks and has outcomes of network traffic analysis. As a result, it was evidenced that DM is appropriate when researchers assess network risk.

Zhou et al. (2020) recommended a sentiment index developed using the Intuitionistic Fuzzy Analytic Network Process (*IFANP*) and regression model. The outcomes were contrasted with the one created with Principal Component Analysis's (*PCA*) help. Chinese A-share information was obtained from Wind and Reith databases. It spanned May 1st, 2015 - December 31st, 2017. As a result, it was evidenced that the first investor sentiment index described before had a better grade of adjustment than the other one. Also, it was evaluated the relationship between those indexes and the Shanghai Composite Index (*SHCI*) showed a one-way causality between returns of SHCI and the index developed by PCA, and this reflected incongruent results. Autoregressive Moving Average (*ARMA*) was useful for predicting investor sentiment index, and the cointegration model was necessary to forecast SHCI returns, which data was focused on from January 1st to 31st, 2018 since it was considered for the short-term forecast. However, for medium-term prediction, the analyzed period started from January 1st to March 31st, 2018.

Khalilzadeh et al. (2020) calculated and evaluated risks for payment service provider (PSP) organizations in banking deals. The research identified the ones that significantly affect those kinds of projects. Thirty experts among managers and seniors were considered for the investigation, who belonged to Iranian PSP companies with more than ten years of labor, and those firms got the higher rate at central offices (Tehran). Fuzzy decision-making and evaluation laboratory method was used to examine affected risks and identify the impact grade between them. The weight of each cost was estimated through Fuzzy Analytic Network Process. Also, this research introduced the Fuzzy Analytical Hierarchy Process since second-level risks did not have a strong interrelationship. The Delphi method was applied to determine and categorize risks with the help of the interviews with the sample described before. DEMATEL and ANP methods were introduced to minimize risks. BWM methodology was also incorporated in the study since weights of the riskier aspects were calculated.

To implement this technique, it was necessary to discover the most and least relevant risk through a questionnaire developed for ten more experience people that were investigated in the previous research. As a result, the grade of incidence of each risk on banking projects shows that the factors that have more influence are: executive interaction with the bank, the credibility and power of the company, and the efficiency of the agencies.

Analytic Network Process (ANP) was applied by Ngan et al. (2019) to identify and evaluate risks related to the oil palm biomass industry in Malaysia since, despite the economic development that this country has had in the last decades, the green industry keeps having difficulties in sustainable development. Some factors affect the industry, so investors tend to analyze their impact before financing. That is why investigators consider the elaboration of this study significant since it is necessary to create strategies to reduce risk. Fifteen investigators of biomass were researched, and which results were helpful in methodology application. The outcomes showed that the significant risk was the financing, technology in second place, and the supply chain.

Fuzzy Bayesian Network (*FBN*) method was applied by Li et al. (2019) to evaluate the risk for Babao Coal Mine ignition sources in China since they can affect the production process. First, investigators developed a risk topological structural model for risk evaluation. Second, validating data through the methodology, where experts' weights were estimated, was necessary. A questionnaire was responded to by four experienced advisors. Sensitivity analysis was also developed to estimate potential risk events. The study examined 215 kinds of ignition sources that have caused more than ten deaths in the country from 2000 to 2017. As a result, it was shown that this methodology was adequate to diagnose why gas explosion ignition can affect this kind of business.

Analytic Hierarchy Process (*AHP*) and Network analysis were combined by Yang et al. (2019) to develop a consensus model in order to evaluate product design alternatives and produce the best prototype with a high-quality standard in a way that the risk of a wrong decision can be decreased since the reliability of the stock may enhance to benefit the profits of a company. The purpose of the consensus model is to gauge the diagnostic of analyzers' opinions and desires, assessing the consistency grade. A portable temperature tester design was assessed as a case for this research, where eight evaluators with experience were selected for the application of the model. This method is beneficial because of the improvement of unanimity in the investigation

results, to amend the quality of the final product, diminishing the impact of subjectivity, so the results affirm the validation of the model.

Bayesian network (BN) was used by Shang & Xingyu (2020) in order to assess the risk that tends to have more influence on Chinese hydropower corporations. GeNIe 2.0 software was needed to run the data. The triangular fuzzy numbers methodology was introduced to reduce the possibility of getting risky fortuitous events. The Delphi technique was implemented since collecting information from experts through a survey was necessary. In this investigation, three seniors were researched to evaluate risks, and those results were beneficial in finding out the hazardous variables. Then eight evaluators were questioned in a second round to analyze the grade of influence of challenging aspects. Hence, those results helped construct the model, where a third round of investigation was applied. The outcomes of the combination of qualitative and quantitative research show the validation of BN, and the factors that impact the most to those types of companies, which are: social, intercompany, and ecological aspects, reflecting a high grade of sensibility, so this study helps this kind of sector to develop strategic planning.

The fuzzy Analytic Network Process (*FANP*) was utilized by Galankashi et al. (2020) to evaluate and identify the best portfolios in the Tehran Stock Exchange. This market includes 339 organizations and is considered the largest one in Iran. A bibliographic study was essential to classify the principal criteria to choose the optimum alternatives. Then, a questionnaire with twenty-three questions was developed to get the final list of aspects that must be assessed so investigators can consider other relevant factors influencing the investigation results. Inconsistency evaluations were applied for the pairwise comparison matrix. The research evaluated ten portfolios, and the outcomes demonstrated that the A6 option was the most appropriate for investors, and other results showed that risk, growth, market, and profitability were the most relevant factors in selecting portfolios.

Choosing the best alternative is a complex task for investors, bosses, experts, and scientific investigators. Nguyen et al. (2020) developed an article that helps agriculture investors to select a good choice among thirteen firms, which stocks are the most frequently traded on Vietnam Stock Exchange. The period analysis spans from December 2016 to December 2019. In order to avoid economic troubles after investing funds, they applied Analytical Hierarchy Process (*AHP*) to value weights of investment indicators. Grey Relational Analysis (*GRA*), Technique for Order of Preference by Similarity to Ideal Solution (*TOPSIS*).

Multiobjective Optimization Ratio Analysis (*MOORA*) methods were also adapted to get the final interesting outcome to investing outstanding options. The Spearman correlation coefficient was calculated to evaluate the grade of significant amount ranks, showing that estimates were not dispersed, which validated the investigation result. Investigators recommend that HSL organization invest, but HKT firm not, since its results do not show a suitable rank. Researchers advise applying the same methodology in other industries, including more incidence factors and using techniques such as Fuzzy Entropy and Fuzzy AHP.

Tavana et al. (2019) formulated a hybrid mathematical programming model with the help of the Fuzzy Inference System (*FIS*) and Fuzzy Analytic Hierarchy Process (FAHP). They developed two phases to choose the most advantageous project portfolio to minimize risks and maximize earnings for a cyber-security organization in Pennsylvania, in which ten projects were assessed. The first phase consisted in identifying the criteria involved in the research with the guidance of previous fact-finding, then experts cooperated in the final selection of the aspects. A pairwise comparison matrix was useful to weight sub-criteria, and six project directors were investigated to rate all projects. The closing rate was gauged with the aid of FIS methodology.

The second phase was related to the development of a multi-objective zero-one mathematical method to identify the best portfolio choice, being necessary for the use of CPLEX solver in the GAMS operating system v.24.1.2, which income, rate, expenditure, and risk were introduced as relevant information. The results showed the six best projects. The research also estimated three different scenario measurements as the study aims: maximizing profit, minimizing risk, and maximizing project value, and the outcomes evidenced that if each proposal is evaluated lonely, good results for that specific objective emerge, but the other ones aggravate.

The risk of nonlisted real estate funds in India was evaluated with Analytical Hierarchy Process (*AHP*) by Gupta & Newell (2020). For the model development, investigators formulated a survey of thirty-five experienced and competent professionals involved in estate fund management. The hazard of three relevant phases of funds was gauged: Investment, monitoring, and exit. As a result, I found that the factors that affected the most in the first stage were entry and business risk. The project and business risk is evidenced in the second and the last business and FDI risks. The investigation suggested the implementation of hedging strategies in order to decrease the impacts of currency variations on financing contributions.

The validation of the answers was assessed by consistency ratio (*CR*), in which the outcomes of each stage got a rate less than 20%, and that means that the responses by experts were accurate since precedent investigations of this sector limit this percentage value.

Atta Mills et al. (2020) applied hybrid multi-criteria decision-making (*MCDM*), where Grey-DEMATEL and Analytic Network Process (*ANP*) were also introduced in order to help investors to choose the best portfolio. Five organizations from the ten premium traded stocks in 2019 were picked from Shanghai Stock Exchange (*SSE*) for evaluation. Seven experts working in that Stock Exchange were necessary to analyze the most relevant criteria to get the best portfolio option, and recent research helped select factors. Twenty other advisors were needed to answer the questionnaires and develop the pairwise comparison matrices. The outcomes showed that dividends, financial ratios, and return are the principal factors that cause significant profits, and shares offered for public trading (secondary market) were considered the last aspect that impacts earnings. The stocks issued by Industrial and Commercial Bank were the most reasonable choice.

Neutrosophic Data Analytic Hierarchy Process (*NDAHP*) was developed by Tey et al. (2019). The principal difference between this method and others, such as *AHP* and Fuzzy *AHP*, is that this introduces an objective criterion when weighing variables, which outcomes are necessary for matrix examination. In this case, information is not varied according to the different points of view of the selected sample. That is why the methodology is considered a step further than the other multi-criteria decision-making techniques. Five public petrochemical organizations from Kuala Lumpur Stock Exchange (*KLSE*) were evaluated in this research, analyzing the results of fifteen finance indicators in the year 2017 in order to rate each firm. The outcome was compared with the following techniques: Neutrosophic Evaluation based on Distance from Average Solution (*NEDAS*), Order Preference by Similarity to an Ideal Solution (*NTOPSIS*), Improved Single Valued Neutrosophic Weighted Averaging Geometric Aggregation Operator (*ISVN-WAGAO*), Neutrosophic Correlation Coefficient (*NCC*), and Neutrosophic Cross-Entropy (*NCE*). The results showed that NDAHP was more effective since Spearman and Pearson Correlation final values presented a higher correlation among all methodologies and current rating, becoming the model in a consistent way to evaluate problems about decision making.

A has published an article about developing a current NS-entropy methodology to create a modern Multi-Attribute Group Decision Making (*MAGDM*) approach supporting the single-valued neutrosophic criteria. This technique offers the advantage of dealing with troubles about the unidentified weight of criteria and influencers. In this investigation, a risk-taker company examined five types of well-established organizations intending to choose the best alternative for venture capital. Three experts in this kind of decision were taking account. As a result, Food enterprises was the most suitable option, and Military manufacturing company was considered the worst decision for investors. The research shows the validation of the model and an opposite relationship between the grade of acceptance and cross-entropy rates (Pramanik et al., 2018).

Broniewicz & Ogrodnik (2021) applied multicriteria Decision Making (*MCDA*) methods to choose the best zone to build an expressway and a road in Poland. The project's development benefits the region's economy because applying those methodologies is relevant to making a suitable and less risky decision. Decision Making Trial and Evaluation Laboratory (*DEMATEL*), *REMBRANDT*, and *VIKOR* are the ones considered for the research. The first one was useful for examining the grade of impact among different factors (Si et al., 2018), showing that the ones about NATURA 2000 areas got a more extraordinary significance. The second was needed to calculate weights for factors (Olson et al., 1995), and the third one to rank options.

The research considered six locations and thirteen criteria influencing venture capitalists' decisions. To analyze the results of the ranking, the Technique for Order of Preference by Similarity to Ideal Solution (*TOPSIS*), Preference Ranking Organization Method for Enrichment Evaluation (*PROMETHEE*), and *VIKOR* techniques were calculated, which each method was estimated with the inclusion of *AHP*, *FAHP* and *REMBRANDT* weights. It was revealed that there was a grade of the difference amount the estimated weights, using the AHP and Fuzzy *AHP* techniques, which there are lower than the comparison among AHP and *REMBRANDT* rates, so that meant that *REMBRANDT* method tends to impact exceptionally on the vector of rates. The outcomes were contrasted with Environmental Impact estimation.

Jurevicience et al. (2020) evaluated the impact of the choice of financial strategies on crisis development in the United States. The study was assessed by seven experts with substantial experience in capital investment who worked on jobs related to financial organizations. Kendall's coefficient of concordance was applied to evaluate the grade of accordance. The coefficient of

expertise was estimated with the quotation developed by Augustinaitis in 2009, and the results indicated the evidence of competent advisors. Eight criteria were evaluated, considering they tend to influence unreasonable economic policies. The outcomes showed that the aspect affecting incoherent decisions in a higher grade is confidence about future finance. TOPSIS method was introduced to analyze the effect of economic tactics on crisis phases. The study spans the following periods: 2001-2006 and 2010-2017. The results showed that the most distraught decision was implemented in 2004, and in 2001 were taken the least fallacious resolution. Other outcomes revealed that individuals tend to be more careful in their financial decisions after the crisis than when the economy is getting better because, in that situation, they make riskier financial choices.

Carpitella et al. (2021) chose a salt manufacturing company in Italy to select the most suitable plan for maintaining the production line since it could give positive outcomes in the final output and profits. The organization is in charge of the manufacturing process, which includes the supervision and regulation of the operation. That is why the investigators considered it necessary to apply a methodology to choose a convenient action to decrease the hazard grade. This research applied ANP and ELECTRE III. The first one was introduced to estimate the weights of different criteria to select the best strategy. Factors were taken from the literature review. Maintenance executives helped to select subcriteria since they had experience in that field, and the evidence of Mean Time Between Failure also supported the choice. As a result, preventive maintenance is a reasonable option as a tactic to manage complex difficulties in this kind of evaluation process.

The second one was developed to rank options and examine their level of risk. The information was provided by the following positions: Prevention and Protection Service, Maintenance, and Consultant. The outcomes showed that automatic, crumbling, postural, and comfortable risks tend to have an unfavorable impact during maintenance, except for the biological aspect. According to the authors, this is the first investigation where both techniques were applied in this type of research, related to developing a maintenance strategy and assessing possible troubles during the production system.

Analytical Hierarchy Process and Goal Programming (*GP*) methods have been implemented by Cyril et al. (2019), in order to save capital and improve the productivity of Kerala State Road Transport Corporation (*KSRTC*). Twelve factors were evaluated, reflecting the thought of clients and engineers. The first method helped assess criteria and estimate weights as cost data

for the other technique since it reduces the total weighted deviations. The second technique manages adverse factors which are related to specific objectives. This method helps decision-makers since it reduces risk through the optimization approach. Experts' consultations were necessary to score variables and analyze their level of relevance.

They knew the area and were involved in the scientific world. The outcomes showed that the factors considered more relevant by operators are costs and staff per schedule. However, clients had another point of view since they stated that travel safety is variable with a high grade of importance. The weight of the criteria corresponds to 67% and 33%, respectively. The investigation considers that if accessibility, safety, and regularity are improved, the company could get more clients, and if the personnel per bus decreases, expenses would be reduced. Information was obtained from the organization`s audit reports and Economic Review of Kerala, spanning the following period: 2014-2015 and 2015-2016.

It has been evidenced by an article by Shen et al. (2022), in which authors have mixed the use of the following methodologies: ELECTRE II and Probabilistic Linguistic Term Sets (PLTS), to evaluate eight different choices of the investment project for an organization who wish to finance business opportunities. The first technique has developed to rank alternatives and discover the grade of preference between them. That is why this method analyzes the similarity and dissidence among options. The research also applied the other technique because in this investigation, not only quantitative indicators (financial ratios) were assessed, since investigators also considered qualitative information, which experts evaluated. PLTS is a reasonable method for venture capitalists examining non-numeric variables. The outcomes showed that the third alternative (A3) was the most suitable option. It was suggested to apply PLTS-ELECTRE II in other scientific papers in which both variables needed to be included.

Portfolio optimization is a critical topic analyzed by financers since they wish to decrease the level of risk through efficient diversification. Xidonas et al. (2021) published an article that showed a non-traditional procedure to get the best portfolio expansion. The first step concerns choosing the securities that are suitable for conventional financing. The assessment of this process was developed with the analysis of financial indexes. Different options were ranked with the following methodologies: *ELECTRE III, PROMETHEE II, MAUT, and TOPSIS*. The results of all of them were transformed into a closing ranking by estimating the cumulative ranking index. The

study demonstrated the application of the method, using the data of thirty hundred and fifty-eight securities in the NYSE Stock Exchange from 2016 to 2018, focusing on the Technology, Financial, and Energy sectors. The research chose the best twenty alternatives for each sector. The second step was focused on portfolio optimization, where Mean-Variance MIQP, Goal Programming, MOIP P*ROMETHEE*, and Genetic algorithm were applied to get the outcomes. In this investigation, Python programming language was helpful in the development of both phases.

The fuzzy *TOPSIS* technique has been used by Koulinas et al. (2019) in order to benefit people who work on a construction project in Halkidiki, Greece, since the investigation focused on safeguarding the salubriousness of employees, so risk assessment is relevant to develop efficient decisions about the finance that the business must consider to avoid security problems during the hours of labor. A supervising project executive was needed to evaluate each criterion since the method suggests the intervention of experts to give feedback in this process. The proportional Risk Assessment Technique (*PRAT*) was complemented in the study because the analysis is examined through accurate information on the accidents taken from ELSTAT, covering the period 2014-2016. The research objective was centered on ranking different types of risk through both methodologies, minimizing costs involved in this kind of organization. The results showed the factors that got a significant impact on accidents, which are: shocked with something stable in a place, being hit by a thing that is moving around, electrical troubles, dangerous materials, or being captured or smashed at work, so they tend to be the consequences of the 74,8% of hazards that occur in the job.

Art. 2 Table 1: Summary information about recent investigations of Multi-criteria decision-making methods for risk assessment

Target	Sampling	Method	Investigator
Canadian Institute for Cybersecurity Intrusion Detection System (CICIDS2017) dataset	2017 Canadian Institute for Cybersecurity Intrusion Detection System (CICIDS2017) from July 3rd to July 7th, 2017	Analytic Hierarchy Process (*AHP*) Vulnerability Scoring System (*CVSS*) Differential Manifold (*DM*)	Zhao et al. (2020)
Chinese A-share market.	Chinese A-share data from May 1st, 2015, to December 31st, 2017. To forecast short-term yields of SHCI, it was considered 22 trading days, and the period focused from January 1st to 31st, 2018; but for medium-term predictions, 58 trading days, and the term spanned 1st to March 31st, 2018.	Fuzzy Analytic Network Process *(IFANP)* Principal Component Analysis (*PCA*) Cointegration model Arma model	Zhou et al. (2020)
Managers and seniors who belonged to Iranian PSP companies with more than ten years of labor, those firms got a higher rate at central offices (Tehran).	Thirty experts among managers and seniors. The previous research investigated ten more experienced people to apply the *BWM* technique.	Fuzzy ANP and AHP techniques. *DEMATEL* technique. Delphi method Best-worst method (*BWM*)	Khalilzadeh et al. (2020)
Investigators of biomass in Malaysia	Fifteen investigators of biomass were research	Analytic Network Process (*ANP*)	Ngan et al. (2019)
Babao Coal Mine ignition sources in China	A questionnaire was responded by four experienced advisors.	Fuzzy Bayesian Network (*FBN*) method	Li et al. (2019)

	The study examined 215 kinds of ignition sources that that have caused more than ten deaths in the country from the year 2000 to 2017		
Portable temperature tester design was assessed as a case for this research to develop a consensus model	Eight evaluators with experience were selected	Analytic Hierarchy Process (AHP) Network analysis consensus model	Yang et al. (2019)
Chinese hydropower corporations	Three seniors were researched to evaluate risks, and those results were beneficial in finding out the hazardous variables; then, eight evaluators were questioned in a second round to analyze the grade of influence of challenging aspects.	Bayesian network (*BN*) Triangular fuzzy numbers methodology Delphi technique	Shang & Xingyu (2020)
Data information from Tehran Stock Exchange were selected.	Tehran Stock Exchange includes 339 organizations. Ten portfolios were evaluated	Fuzzy Analytic Network Process (*FANP*)	Galankashi et al. (2020)
Firms, which stocks are the most frequently traded on Vietnam Stock Exchange	Thirteen companies from Vietnam Stock Exchange. The period analysis spanned from December 2016 to December 2019.	Analytical Hierarchy Process (*AHP*). Grey Relational Analysis (*GRA*) Technique for Order of Preference by Similarity to Ideal Solution (*TOPSIS*).	Nguyen et al. (2020)

		Multiobjective Optimization Ratio Analysis (MOORA)	
Cyber-security organization in Pennsylvania	Ten projects were assessed. Six project directors were investigated to rate all projects.	A hybrid mathematical programming model. Fuzzy Inference System (*FIS*). Fuzzy Analytic Hierarchy Process (*FAHP*).	Tavana et al. (2019)
The risk of nonlisted real estate funds in India was evaluated	Investigators formulated a survey of thirty-five experienced and competent professionals involved in estate fund management.	Analytical Hierarchy Process Consistency ratio (*CR*)	Gupta & Newell (2020)
Organizations from the ten premium traded stocks	Five organizations from the ten premium traded stocks 2019 from Shanghai Stock Exchange (*SSE*). Seven experts that worked in that Stock Exchange were needed for the investigation	Hybrid multi-criteria decision making (*MCDM*), where Grey-DEMATEL and Analytic Network Process (*ANP*) were introduced.	Atta Mills et al. (2020)
Public petrochemical organizations from Kuala Lumpur Stock Exchange (*KLSE*) were evaluated in this research, analyzing the results of fifteen finance indicators in the year 2017	Five public petrochemical organizations from Kuala Lumpur Stock Exchange (*KLSE*).	Neutrosophic Data Analytic Hierarchy Process (NDAHP) Neutrosophic Evaluation based on Distance from Average Solution (NEDAS) Order Preference by Similarity to an Ideal Solution (NTOPSIS)	(Tey et al., 2019)

		Improved Single Valued Neutrosophic Weighted Averaging Geometric Aggregation Operator (ISVN-WAGAO) Neutrosophic Correlation Coefficient (NCC) Neutrosophic Cross-Entropy (NCE).	
A risk-taker company	Five different types of well-established organizations.	NS-Cross Entropy-based MAGDM, supporting the Single Neutrosophic criteria	Pramanik et al. (2018)
Information was taken from General Directorate for National Roads and Motorways to choose the best zone to build an expressway and a road in Poland	Six locations and thirteen criteria influence on decisions of venture capitalists.	*TOPIS*, *POMETHEE VIKOR*, *DEMATEL*, *REMBRANDT*. *AHP*, *FAHP* and *REMBRANDT* weights	Broniewicz & Ogrodnik (2021)
Impact evaluation of the choice of financial strategies on crisis development in the United States.	Seven experts assessed the study. The study spans the following periods: 2001-2006 and 2010-2017.	Kendall coefficient of concordance. Coefficient of expertise by Augustinaitis in 2009 TOPSIS method	Jurevicience et al. (2020)

A salt manufacturing company in Italy	Maintenance executives and the evidence of Mean Time Between Failure also supported the subcriteria (ANP) choice. The risk information was provided by the following positions: Prevention and Protection service, Maintenance and Consultant of the organization (ELECTRE III).	*ANP* *ELECTRE* III	Carpitella et al. (2021)
The research was developed to save capital and improve the productivity of Kerala Stata Road Transport Corporation (*KSRTC*)	Information was gotten from the organization´s audit reports and Economic Review of Kerala, spanning the following period: 2014-2015 and 2015-2016. The weight of criteria corresponds to 67% (Operators) and 33% (Clients)	Analytical Hierarchy Process (*AHP*) Goal Programming (*GP*)	Cyril et al. (2019)
The investigation was developed to evaluate choices of investment project for an organization who wish to finance business opportunities	Eight projects' options were assessed in the research. The criteria were classified in 6 finantial ratios and 4 qualitive indicators	*PLTS-ELECTRE II*	Shen et al. (2022)
Securities in the NYSE Stock Exchange were assessed to choose the best alternatives and determine the	Thirty hundred and fifty-eight securities in the NYSE Stock Exchange, from 2016 to 2018, focusing on the Technology, Financial, and	*ELECTRE III* *PROMETHEE II* *MAUT*	Xidonas et al. (2021)

most efficient way for portfolio optimization.	Energy sector, were evaluated.	*TOPSIS* Mean-Variance MIQP Goal Programming, *MOIP* *PROMETHEE* Genetic algorithm Python programming language	
People who work on a construction project in Halkidiki, Greece	A supervising project executive was needed to evaluate each criterion (Fuzzy TOPSIS). The analysis is examined through accurate information on the accidents, taken from ELSTAT, covering the period 2014-2016 (*PRAT* methodology).	Fuzzy TOPSIS Proportional Risk Assessment Technique (*PRAT*)	Koulinas et al. (2019)

2.5 Conclusion

In recent years, some **research** has been developed about Multi-Criteria Decision Making (MCDA) to benefit decision-makers and get better outcomes when investing in a project. The ranking establishment between options is essential to save short- or long-term capital. The investigations have had different aims, such as: Evaluating the network, oil palm biomass, Babao Coal Mine ignition sources, and payment service provider organization risk, assessing design alternatives to produce the best prototype, and the impact of the choice of financial strategies on crisis development, identifying and optimizing the best investment portfolios, selecting the best zone to build an expressway and the most suitable plan for the maintenance of a production line, saving capital and improve the productivity of a Road Transport Corporation, developing a network index system to examine investments, ranking risk and determining the factors that got significant impact in the study.

Some of the methodologies that have been applied from the period 2018-2022 are: Analytic Hierarchy Process (*AHP*), Analytic Network Process (*ANP*), DEMATEL, Technique for Order of Preference by Similarity to Ideal Solution (*TOPSIS*), *VIKOR*, Goal Programming (*GP*), Grey Relational Analysis (*GRA*), PROMETHEE, PROMETHEE II, ELECTRE, ELECTRE III, Fuzzy *AHP*, Fuzzy *TOPSIS*, Fuzzy Analytic Network Process (*FANP*), Neutrosophic Data Analytic Hierarchy Process (*NDAHP*), Intuitionistic Fuzzy Analytic Network Process *(IFANP), MAUT* y Fuzzy Bayesian Network (*FBN*); however, it has not been evidenced their application for the estimation of cost of capital for companies or competitors that do not trade shares in the Stock Exchange, especially in Latin America countries. So, it would be interesting the development a study that could be useful for financers who wish to make an efficient investment decision in those cases.

3. COST OF CAPITAL FOR NON-TRADING STOCK COMPANIES IN ECUADOR

3.1 Antecedentes

En el presente artículo se aplica la metodología del Proceso Analítico Jerárquico para estimar el costo de capital de compañías ecuatorianas que no cotizan acciones, a través de las Bolsas de Valores del Ecuador. Además, se evalúan los factores o criterios que mayoritariamente inciden sobre estas organizaciones. A continuación, se muestra la producción científica.

Abstract

The estimation of the cost of capital is important for the valuation of companies, and investment decisions, as it is one of the variables of the Weighted Average Cost of Capital *(WACC*), that reflects the opportunity cost of an organization; for this reason its calculation is so relevant for entrepreneurs, businessmen and managers who would like to risk capital in new projects; but it is the case of Quito and Guayaquil Stock Exchange where trading shares are scarce for most of the companies in Ecuador, complicating the measure of an asset volatility, since without the information of stock prices, the beta coefficient can´t be calculated. That´s why the purpose of this investigation is to estimate the cost of capital through the Analytic Hierarchy Process (*AHP*), which it is an alternative methodology that can be used in countries where there is a lack of information about quotes on stock markets. The study result can be used by national or international investors, because this finance indicator is compared with the Internal Rate of Return (*IRR*), to accept or reject business financing options.

Keywords: *WACC, AHP*, *IRR*, Stock Exchange and beta coefficient

Resumen

La estimación del costo de capital es importante para la valoración de empresas y decisiones de inversión, ya que es una de las variables del Costo Promedio Ponderado de Capital (*WACC*), que refleja el costo de oportunidad de una organización; por eso su cálculo es tan relevante para emprendedores, empresarios y directivos que quieran arriesgar capital en nuevos proyectos; pero es el caso de las Bolsas de Valores de Quito y Guayaquil donde las acciones negociables son escasas para la mayoría de las empresas del Ecuador, complicando la medida de la volatilidad de un activo, ya que sin la información de los precios de las acciones no se puede calcular el coeficiente beta. Es por ello que el propósito de esta investigación es estimar el costo de capital a través del Proceso Analítico Jerárquico (*AHP*), el cual es una metodología alternativa que puede ser utilizada en países donde se carecer de información sobre las cotizaciones en los mercados bursátiles. El resultado del estudio puede ser utilizado por inversionistas nacionales o internacionales, debido a que este indicador financiero se compara con la Tasa Interna de Retorno (*TIR*), para aceptar o rechazar opciones de financiamiento empresarial.

Palabras clave: *WACC*, *AHP*, *IRR*, Bolsa de Valores and coeficiente beta.

3.2 Introduction

Los Investors can finance their projects through their own or third-party capital, in which these different types of financial costs can influence in the total percentage required by future or current shareholders for a given project. The weighting of both components gives as a result a discount rate. It is calculated through the Weighted Average Cost of Capital *(WACC*) and it is developed by a simple linear weighting of two rates. The formula is the following: $fd.id + (1 - fd)\ ie$, where fd is the debt fraction, id is the real interest rate on debt, and ie in the real rate of return on equity (Chrysafis & Papadopoulos, 2021; Harvey, 2020; Mauleón, 2019; Vartiainen et al., 2020). The last variable is usually estimated through the traditional Capital Asset Pricing Model (*CAPM)* model develop by Sharpe (1964), in which includes two sensitive parameters, known as risk-free rate and risk premium, that it is defined as the difference between the expected returns of the market and the risk-free rate of an asset. This methodology also incorporates a beta coefficient as a systematic factor. Its equation is $Rf + \beta\ (Rm - Rf)$(Kellner & Rösch, 2021; Nasir et al., 2021; Vayas-Ortega et al., 2020).

The purpose to estimate this discounted rate is calculating the fair price of an organization and choose the best option of an investment project. There are three basic categories to estimate a company valuation: Balance Sheet, Income Statement, and value creation approaches. The third set includes the Discounted Cash Flow (*DCF*) and Residual Income Model (*RIM*), and both of them discounts a rate (Vayas-Ortega et al., 2020) in order to get an asset`s value.

The Internal Rate of Return (*IRR*) measures the profitability of a business (Fang et al., 2018; Vroomen & Desa, 2018; Xue et al., 2019), but investors before taking a finance decision must compare it with the opportunity cost of each alternative investment, and there are other techniques that complement the final selection of a project, such as: payback period (*PP*), discounted payback period (*DPP*) and Net Present Value (*NPV*), because it is necessary to know the real time that the shareholder will get the investment back, beside that is important to consider the time value of money, because future cash flows tends to worth less than now (Aniello et al., 2021; Evison, 2018; Hohne et al., 2019; Jorissen et al., 2020; Peña & Rovira-Val, 2020), since consumers lose purchasing power when external factors incise their incomes, like economic measures, technical issues, environmental problems, government policies, stakeholder management or market tendencies (Gao et al., 2021), so inefficiency actions taken by States can affect the inflation, or even natural disasters, global pandemics, new technological advances and fashion changes can also generate an economic impact on companies.

Actually, there are some methods to calculate the cost of capital of a company, such as: Arbitrage Pricing Theory (*APT*) developed by Stephen A. Ross (1976), Modigliani & Miller`s proposition II (1958), Price-earnings Growth Model (*PEG)* by Easton (2004), Cost of equity based on beta and accounting information investigated by Hill & Stone (1980) and Ball & Brown (1968) and applied by Vélez (2002), Gordon`s Wealth Growth Model by Gordon and Shapiro (1956), Fama and French Three-Factor Model (1993), and Analytical Hierarchy Process by Cotner y Fletcher (2002) (Ardalan, 2017; Ball & Brown, 1968; Barillas et al., 2019; Cotner & Fletcher, 2000; P. Easton, 2009; P. D. Easton, 2004; Fama & French, 1993; Gerged et al., 2020; Hill & Stone, 1980; Nhleko & Musingwini, 2016; Pachón, 2013; Vélez, 2002)

The calculation of the cost of capital becomes complicated when the researcher wants to estimate the beta variable, and the market lacks information regarding share prices; as is the case of Ecuador, in which companies that have a level of stock market presence greater than 10%, amounts to 9 listed organizations, through the Quito Stock Exchange, but in Guayaquil Stock Exchange, there are only 5 (Bolsa de Valores de Quito, 2022). The Favorite Corporation is the one with the highest degree of participation in both Stock Exchanges, with 93.44% and 52.46% respectively. At the end of 2022, there are 20,665 medium and large companies, 1150,627 microenterprises and 57,123 small ones (*INEC*, 2022), so, it is evident the necessity to apply an ideal method to estimate the rate required by the shareholder at the time of investing their capital.

John S. Cotner and Harold D. Fletcher (2000) consider that the Analytical Hierarchy Process (*AHP*) is an adequate method to estimate the risk premium to calculate the cost of equity, which involves the identification of the factors that affect the risk of companies (Cotner & Fletcher, 2000). The method is called as the theory of measurement (Saaty, 2000) and adopts the principles of decomposition, comparative judgements and synthesis.

The first one is focused on the construction of hierarchy where the problem`s goal is placed at the top, and criteria, sub-criteria and alternatives, which differ on the investigator`s preference are shown in a descending order. The second is related to the development of comparison matrix to compare pairs of (sub) criteria or alternatives. Also, pairwise comparisons ranges are used for the evaluation, from 1 that means indifference to 9, that refers to extreme importance, likelihood or preference. The last one, indicates relative priorities` estimation for the project`s alternatives, so that`s why pairwise comparison matrices must be synthesized. At the end of the application of this academic tool, a rank order and relative value are shown on an absolute scale for each decision alternative (Millet & Saaty, 2000; Saaty, 1977; Saaty & Shang, 2011; Saaty & Vargas, 2013).

The methodology has not only been used to estimate de cost of capital for sectors. It is also suitable for decision making, and has been applied in different companies around the world, with the purpose to resolve economic, political, social and technological environment problems (Saaty, 2009), with the help of judgements given by experts; that`s why it is very important to choose the best ones according to the area, since the results tend to be more accurately if the multiple criteria are chosen correctly. One of the weaknesses of investigators when using this method, is to reduce all factors to a few ones, because they consider they are the most important, but the problem is that sometimes there are numerous, which are not so relevant determinants that influence in the final outcome (Saaty & Vargas, 2013).

Sensitivity analysis is also used in order to examine the effects on results, which depend on different judgements. Relative priorities are derived on absolute scales from paired comparisons in multilevel hierarchic structures. In this method, it is not necessary the use of syllogism, being a nonlinear framework to develop a deductive and inductive thinking (Saaty, 2006, 2016).

In the recent years, high impact articles about *AHP* methodology have been published through web of science database. Some of them have been applied for different purposes, such as: To select the best financial investment instrument in Turkey with the help of an Autoregressive Distributed Lag (*ARDL*), determining that EURO was a the most suitable option (Atmaca & Karadaş, 2020). To develop improved indices from Dow Jones Industrial Average (*DJIA*) and Standard & Poor´s 500 (*S&P500*), whereby the concept of Cumulative Utility Area Ratio (*CUAR*) criterion was developed, in order to amend investments' utility regarding to benchmark index (Clark et al., 2019). To strengthen satellite industry and Korean space with strategies' development, taking in consideration the analysis of internal and external factors. SWOT-AHP was adopted to examine their priorities and suggest action plans (Lee et al., 2021).

To prioritize Waqf lands according to religious, residential, agriculture and commercial sectors and categorize them, taking account strategic locations and economic variables. The study is useful for finance resource allocation efficiency (Shabbir, 2018). To develop an assessment model of competitive and innovative tourism practices with the use of the Fuzzy Rasch, and Crisp and Fuzzy *AHP* model. The research was done in Portugal, based on information entropy (Teixeira et al., 2021). To find out what are the threats which have a higher impact on the security of Serbian natural gas supply and identify strategic measure´s prioritization. Fuzz *AHP* was worked in this investigation (Pavlović et al., 2021). To prioritize the principal criteria and sub-criteria of social sustainability barriers in healthcare supply chains in the United Arab Emirates (*UAE*), in order to

discover the factors that affect this industry, and overcome these external threats (Hussain et al., 2019).

There are other relevant articles where prioritization for different alternatives are shown, which represent substantial heterogeneity and especially an advanced investigation about *AHP* literature. Shang and Sueyoshi (1995) applied this model to choose the best Flexible Manufacturing System (*FMS*) for a company. Simulation models were also needed for Data Envelopment Analysis (*DEA*), where Decision Making Units (*DMUs*) were detected for its solution (Shang & Sueyoshi, 1995). Sueyoshi et al. (2009) used the method to find out the business units that requires audit in a rental car organization, which corporate and franchised stores are geographically located in United States and Canada.

This research also applied Data Envelopment Analysis to improve company´s financial and operational evaluation, with the purpose that internal auditing resources can be administered more efficiently (Sueyoshi et al., 2009). Tjader et al. (2010) developed a research in order to discover the most suitable governing policy in the United States for offshore outsourcing commercial activities. The *ANP* software Super Decisions was useful for the model and *BOCR* (Benefits, opportunities, costs, and risks) subnets were necessary for decision framework (Tjader et al., 2010).

Researches about the estimation of cost of capital through this alternative methodology also have been done in some countries. In Central Europe-Czech Republic, the risk premium and cost of capital was calculated for OKD company, and a Mining Build-up model was developed to evaluate mining companies risk (Bora & Vaněk, 2017). In South Africa, multi-criteria model was applied as an alternative methodology by Ralph Palliam (2005).

Subjective thoughts about criteria were taken from managers and the advantage to discover inconsistencies with this method, allowed the researcher to do adjustments during the process (Palliam, 2005a). In the same year, the author published two articles: The first one was about the theory of the estimation of cost of capital for small companies (Palliam, 2005b), and the second was focused on its application. In Colombia, the investigation was done to thirty companies, which were taken from the most representative ones in terms of total assets (Pachón, 2013). Cotner & Fletcher (2000) developed this type of study to Gemini Foods Corporation in the Mid-Atlantic of the United States to assess risk and calculate the equity risk premium (Cotner & Fletcher, 2000).

The objective for this study, is to calculate the cost of capital through the Analytic Hierarchy Process (*AHP*), which it is an alternative methodology that can be used in countries where there is a lack of information about quotes on stock markets. The results can be used by national or international investors who would like to finance projects in nations where the culture of trading shares is scarce.

3.3 Methodology

The hierarchical analysis process was developed by Thomas Saaty (1980) with the purpose of providing a tool for solving complex problems, so that different individuals, groups or economic agents can make an optimal decision by analyzing different risks involved in the system (Wind & Saaty, 1980). The principal objective is to measure relative priorities which are derived on absolute scales, taking account some alternatives that depend on decision maker´s judgment. Expert choice is necessary, because group discussions tend to affect the information quality, especially when a specific aspect is being researched.

It also evaluates the consistency of the model, in order that the comparison of alternatives and results can be more accurately. Knowledge and experience are fundamental criteria for decision making. Multiple criteria decision-making (*MCDM*) is useful when the researcher considers more than one criterion, where designed problem is related to a chosen alternative taken from different ones in an investigation (Al-Harbi, 2001; Saaty, 2004). This method incorporates systematic, market or non-diversifiable and diversifiable, idiosyncratic or nonsystematic risk, because it also takes account specific and unique factors that affect organizations, due to their own condition (Haensly, 2020; Wu et al., 2007), such as inefficiency in process management, lack of personal control, finance or investment troubles.

In this investigation, the Analytical Hierarchy Process (*AHP*) is being applied to calculate the cost of capital for a group of companies in Ecuador. The result will benefit investors to wish to analyze and choose the best alternative, as the cost of capital can´t be applied with traditional methods, because of the lack of information of stock prices in Guayaquil and Quito stock market. The financial, technological, organizational, political-social, competition and economic risks are going to be evaluated in this model.

The summarized steps for the calculation of cost of capital with the application of *AHP* methodology are the following: 1) Define the problem and identify its solution 2) Structure the hierarchy from the highest level to the lowest limit, taking into consideration all the factors

involved for the problem solving 3) Survey among experts, and then pairwise comparison matrix is constructed to compare pair elements with the criterion in the highest level. 4) Weight the vectors of the priorities obtained from the matrix comparisons 5) Evaluate the consistency ratio of the whole hierarchy. If it is higher than 10%, the information quality should be revised again, because the problem must be accurately structured, being the elements well grouped in a specific criterion. 6) The *APH* method is principally useful to estimate the risk premium, which means the rate of return that investors expect to receive 7) Add the risk-free rate to risk premium to get final result of cost of capital (Pachón, 2013; Saaty, 2016; Trujillo & Martínez, 2016). Consistency Ratio and Cronbach Alpha were estimated in order to analyze the level of acceptance of data collection.

3.4 Results

The methodology was applied to two hundred and sixty-six managers of Ecuadorian companies, in order to calculate the risk premium and cost of capital with the support of Analytic Hierarchy Process (*AHP*). The first step is related to the definition of the investigation problem and the identification of the solution. So, in this case investigators use this alternative methodology, because most of the companies in Ecuador don´t trade shares through Guayaquil and Quito Stock Exchange, and this complicates financers at the time of calculating the beta coefficient. The following table shows the sectors in which the firms belong to:

Art. 3 Table 1: Economic sectors of evaluated firms

Economic sectors	Number or respondents	%
Accommodation and meal service activities	3	1,13%
Human health care and social assistance activities	29	10,90%
Administrative and support services activities	2	0,75%
Financial Servicies Activities, except insurance and pension funds.	3	1,13%
Financial and insurance activities	22	8,27%
Real estate activities	3	1,13%
Professional, scientific and technical activities	46	17,29%
Public Administration and defense; Mandatory social security plans	15	5,64%

Agriculture, livestock farming, forestry and fishing	14	5,26%
Wholesale trade	28	10,53%
Wholesale trade, except for motor vehicles and motorcycles	1	0,38%
Retail trade	21	7,89%
Retail trade, except for motor vehicles and motrocycles	4	1,50%
Trade and Repair of Motor Vehicles and Motorcycles	2	0,75%
Construction	5	1,88%
Teaching	11	4,14%
Exploitation of Mines and Quarries	1	0,38%
Manufacturing industries	29	10,90%
Information and communication	8	3,01%
Telecommunications	8	3,01%
Transportation and storage	10	3,76%
Other services	1	0,38%
Total	**266**	**100,00%**

Source: Surveys developed to ecuadorian companies (2021-2022)

The second step focuses on criteria establishment. So, in this investigation, Finance, technology, organizational structure, political/social, competition, and economic risk were considered for the assessment. The research also evaluated the sub-factors that affect each of the six categories. The following chart shows the detail each risk.

Art. 3 Table 2: Sub-factors for each risk category

Finance risk	Insufficient resources for the volume of operations, lack of liquidity, slow loan recovery, and lack of financing.
Technology risk	Failure in internal processes or systems, security and continuity of operation, information systems, installed capacity, process efficiency.
Economic risk	Inherent factors to the economy, inflation, treaties and international agreements, duties, globalization
Organizational structure risk	Negative influence of organizational culture on processes, inadequate staff training, high staff turnover, lack of leaders and succession planning.
Competence risk	Presence of companies that provide similar services, or related products in the market, greater advantages of companies in the sector, monopolies, and new entrants.
Political and social risk	External decisions imposed by the government, resolutions of regulatory bodies, failure of public services, natural disasters, attacks and criminal acts.

Source: Based on Modelo alternativo para calcular el costo de recursos propios- Pachón (2013)

The third step consists in evaluating the criteria for each company. The respondents weigh in a range of 1 to 100%, demonstrating the most and least influential factors that represent risk for the organization they manage. The format of the questionnaire in shown in this research (**See Annex 1**). The following chart shows the results related to assessment criteria (**See Annex 2**):

The percentages above allow investigators to develop a pairwise comparison matrix, in order to compare them amount each other, since the risk of the first organization is divided by second one, then by the next business result, so it ended up combining different alternatives. The following tables shows the outcomes (**See Annex 3**):

The fourth step consists in weighting the vectors of the priorities. So, it was necessary first to develop a normalization matrix, where it evidences the division between the pairwise comparison outcomes and the sum of their results. The following tables shows the corresponding information (**See Annex 4**):

The fourth step evaluates the consistency ratio of the whole hierarchy, where Consistency Index is divided by the Random Consistency Index (*RCI*). The formulas are the following:

Consistency Index = (λ max- n)/(n-1), where λ Max is considered as the largest eigenvalure, and n the number of attributes

λ max= $\sum$ consistency measures / Number of attributes

The Ramdom Consistency Index (IA)= 1,98 (n-2)/n, wheren is the data considered in the study.

To obtain the Consistency Measures, it is necessary to sum the multiplication of pairwise comparison and venctor, and the outcome is divided by the corresponding weighting. Another way to get λ max is through the sum of Geometric Consistency Index (*GCI*).

The estimation of Lambda Max is shown in the following charts (**See Annex 5**):

Art. 3 Table 22: Consistency Ratio estimation

Consistency index	0,00
The Random Consistency Index	1,97
Consistency Ratio	0,00

Source: Own elaboration

In this investigation, the Consistency Ratio is less than 10%, so we can conclude that information data is acceptable, according to studies of Thomas Saaty. In the next steps, investigators calculate the risk premium and the cost of capital, with and without the variable of Country Risk (**See Annex 6**). The Risk Premium weight was calculated through the average of vectors.

Then, taking consideration the **Risk-Free** rate and country risk, we can obtain the value of cost of capital for companies that don`t trade stocks in Guayaquil and Quito Stock Exchange, which value reached at 22,81%. The sub factors were evaluated from 1-10, where ten was considered as the highest risk and one, the lowest. The level of consistency of data is showed bellowed:

Ilustración 1. Cronbach estimation

Fiabilidad

[ConjuntoDatos2]

Escala: ALL VARIABLES

Resumen de procesamiento de casos

		N	%
Casos	Válido	265	99,6
	Excluido[a]	1	,4
	Total	266	100,0

a. La eliminación por lista se basa en todas las variables del procedimiento.

Estadísticas de fiabilidad

Alfa de Cronbach	N de elementos
,946	29

Source: IBM SPSS Statistics

As we can see, the level of data consistency is acceptable, since the result is higher than 0,70. So this application of this methods complements the one recommended by saaty. The type of risk that most affects the companies is the Finance Risk with 21,76%, and the principal cause is focused on the lack of liquidity (34%), then low portfolio recovery (23%), lack of financing (20%), and insufficient resources for the volume of operations (20%).

The second most influential factor is the Technology risk, which reaches at 17,78%. The factors that mostly affect that result are: Failure in computer systems (34%), processes or internal system troubles (24%), inefficiency in processes (22%). Then, security and operational continuity (19%) and lack of installed capacity (17%).

In the third place, we have the Organizational Structure risk with 16,77% of influence. The most critical factors are: Lack of leaders (30%), inadequate staff training (27%) and the nonexistence of succession plan (20%). The next ones that incises in this categories are: Negative influence of the organization´s culture on processes (19%) and High staff turnover (16%).

Economic risk is showed in the fourth place with 16,54%. The most critical aspects are: Inflation (17%), customs tariff (13%), Inherent factors in the economy (12%). Globalization (12%) and treaties and international agreements (7%) are the other factors that affect the outcome.

Competence risk is marked as the fifth place of all categories that influence over the companies, with a result of 14,31%. Monopolies are considered as the most relevant factor (24%), then presence in the market of companies that provide similar services (9%), greater advantages of organizations in the sector (8%), sale of related products (7%) and entry of new companies in the market (7%).

Despite Political and Social risk is the less influential criteria, it is important to take into consideration that attacks and criminal acts (32%) and occurrence of natural disasters (24%) are the most critical aspects in this evaluation section. Then, external decisions imposed by the government (18%), decisions of regulatory bodies (16%) and failure in public services (16%).

3.5 Conclusion

The *APH* method takes into account knowledge, experience and opinions of different agents involved in decision-making, which includes systematic, market or non-diversified risks, as well as non-systematic or diversifiable risks, incorporating own organization´s factors, but its applicability doesn´t consider the market price return, regarding to market index, that´s why despite having this limitation by not being able to calculate stochastic volatility, it is a very useful methodology in countries where there is a low participation of companies in the Stock Market. Ecuador is one of the nations where there are shares shortage transaction, that´s why the application of this methodology is suitable.

Finance and Technology risk are considered as the most critical factors that affect the companies involves in the evaluation study, which the most influence sub criteria are: the lack of liquidity, low portfolio recovery, failure in computer systems, processes or internal system troubles, and inefficiency in processes. So, that´s why it is important that organizations develop

efficient finance and market strategies to improve their profitability, in a way that the indicator can be higher than the cost of capital; and also it is relevant to incorporate advanced technology systems in order to control internal processes with a higher level of professionalism.

4. CONCLUSIONES

4.1 Antecedentes

Este apartado describe las conclusiones de cada uno de los objetivos de la investigación, y muestra las limitaciones de la tesis doctoral. Además, detalla las futuras líneas de acción, con el propósito que se desarrollen futuros artículos científicos relacionados al estudio realizado.

Los resultados se ven reflejados en el desarrollo de los artículos científicos, mismos que guardan relación con cada uno de los objetivos específicos. Por ende, esta sección detalla los métodos vanguardistas, tanto de costo de capital y multicriterios para la toma de decisión. Por último, muestra la estimación del costo de capital de compañías ecuatorianas que no cotizan acciones a través de las Bolsas de Valores en Ecuador, en la cual se aplicó la metodología del Proceso Analítico Jerárquico, además se evidencia la evaluación de factores o criterios que mayoritariamente inciden sobre estas organizaciones que formaron parte de la investigación.

A continuación, se muestran las evidencias bibliográficas que soportan las conclusiones de la investigación:

- San Andrés, P., Jimber del Río, J., Márquez, F. & Vergara-Romero, A. (2023). Hybrid and avant-garde methods for cost of capital evaluation. Revista Universidad y Sociedad, 15(4), 482-489.

  https://www.researchgate.net/publication/372461326_Hybrid_and_Avant-Garde_Methods_for_Cost_of_Capital_Evaluation

- San Andrés, P., Jimber del Río, J., Márquez, F. & Vergara-Romero, A. (2023). Avant-garde multicriteria decision-making methods for risk assessment. Por enviar a la revista Journal of Business Research

4.2 Conclusiones

La estimación de costo de capital es fundamental para la toma de decisiones de inversión, sin embargo, en el mercado accionario ecuatoriano, no se evidencia la cultura por parte de la mayoría de los empresarios en cotizar sus activos financieros a través de la Bolsa de Valores (Perez, Rivera & Solís, 2015; Fernández, 2019; Bolsa de Valores de Quito, 2022), influyendo en la escasez de registro de movimientos y transacciones en el mercado bursátil. Por tal motivo, la presente investigación valoró el costo de capital para compañías ecuatorianas que no cotizan

acciones a través de las Bolsas de Valores del Ecuador, a través de la metodología del Proceso Analítico Jerárquico (*PAJ*). Primero se realizó una revisión bibliográfica de los métodos vaguarditas de costo de capital y toma decisiones muticriterio para la evaluación de riesgo.

Los métodos híbridos y de vanguardia que se han desarollado durante el período 2017-2022 son: Simple Addictive Weighing and *COPRAS-G*, Analytic Hierarchy Process (*AHP*), 3SLS system approach (*DIV*, *LEV*, and *COC* models), regression tree, cost of capital-based con Support Vector Regression (*SVR*), Novel Artificial Intelligence model, Deep Neutral Network-based Ant Colony Optimization algorithm, Partial Least Squares equation (*PLS-SEM*), Least Squares multiple regression analysis, Accounted FOR (*VAF*), Implied cost of capital (*GLS*, *CT*, *OJ*, *MPEG* and *GD* models), Bayesian Markov chain Monte Carlo approach, stochastic valuation through Monte Carlo simulations, Stretchy econometric methodology, based on Panel Smooth Transition Regression (*PSTR*), Environmental Social and Governance (*ESG*), Hybrid beta approach, and *REIT* factor model.

Los artículos científicos se han publicado con diferentes propósitos, más allá de solo estimar el costo de capital, ya que en ellos se evidencia el análisis de la correlación entre el precio del capital y la estructura de capital, dividendos, gobierno corporativo, divulgación voluntaria para futuras inversions, y calidad contable y financiera, evaluación de la interrelación entre la mala calidad de la cartera y la estructura de capital, desarrollo de un procedimiento sistemático de toma de decisiones, comparación del impacto de diferentes metodologías híbridas, pronostico de un costo de capital con error confiable, predección los rendimientos del mercado de valores, estimación del costo implícito del capital donde los investigadores pueden incluir los criterios de tasas de descuento dinámicas, y cálculo de diferentes escenarios para valorar una empresa y contrastar los resultados del costo del capital de diferentes sectores.

Se ha evidenciado investigaciones científicas, donde se utiliza la teoría del modelo de Fama y French para incluir otros factores que inciden en los resultados de costo de capital, tanto para industrias y organizaciones. Entonces, teniendo en cuenta que algunas variables específicas también pueden influir en los rendimientos de las acciones, sería interesante que los países de América Latina, donde el mercado de valores no está bien desarrollado, puedan considerar este modelo al momento de estimar el costo de capital, debido a la existencia de causas externas que los inversionistas evalúan al desarrollar futuras inversiones.

En los últimos años también se han desarrollado algunas investigaciones sobre la Toma de Decisiones Multicriterio para beneficiar a los tomadores de decisiones y obtener mejores resultados al invertir en un proyecto. Las investigaciones han tenido diferentes objetivos, tales como: Evaluar la red, la biomasa de palma aceitera, las fuentes de ignición de la Mina de Carbón de Babao, el riesgo de una organización proveedora de servicios de pago, alternativas de diseño para producir el mejor prototipo y el impacto de la elección de estrategias financieras en períodos de crisis, identificando y optimizando las mejores carteras de inversión, además de seleccionar la mejor zona para construir una autopista y el plan más adecuado para el mantenimiento de una línea de producción, ahorrando capital y mejorando la productividad de una Corporación de Transporte por Carretera, y desarrollar un sistema de índice de red para examinar las inversiones, clasificar el riesgo y determinar los factores que tuvieron un impacto significativo en el estudio.

Algunas de las metodologías que se han aplicado desde el periodo 2018-2022 son *AHP, ANP, DEMATEL, TOPSIS, VIKOR, GP, GRA, PROMETHEE, PROMETHEE II, ELECTRE, ELECTRE III, Fuzzy AHP* y *Fuzzy TOPSIS*; sin embargo, no se ha evidenciado su aplicación para la estimación del costo de capital para empresas o competidores que no transan acciones en Bolsa, especialmente en países de América Latina. Por lo que sería interesante desarrollar un estudio que pueda ser de utilidad para los financiadores que deseen tomar una decisión de inversión eficiente en esos casos.

Luego de haber aplicado la metodología del Proceso Analítico Jerárquico a las 266 compañías ecuatorianas, se obtuvo como resultado un costo de capital promedio de 22,81%, valor en la cual está incluido la prima de riesgo, tasa libre de riesgo y riesgo país del Ecuador al 24 de junio del 2023. Este método toma en cuenta conocimientos, experiencia y opiniones de diferentes agentes involucrados en la toma de decisiones, que incluye riesgos sistemáticos, de mercado o no diversificados, así como riesgos no sistemáticos o diversificables, incorporando factores propios de la organización, pero su aplicabilidad no considera el retorno del precio de mercado, respecto al índice de mercado, por lo que a pesar de tener esta limitación al no poder calcular la volatilidad estocástica, es una metodología muy útil en países donde hay una baja participación de las empresas en el mercado. Bolsa de Valores. Ecuador es uno de los países donde hay escasez de transacciones de acciones, por lo que es adecuada la aplicación de esta metodología.

El riesgo financiero y tecnológico se consideran como los factores más críticos que afectan a las empresas involucradas en el estudio de evaluación, en la cual representan un riesgo del 21,76% y 17,78% respectivamente. Los subcriterios de mayor influencia son: la falta de liquidez

(34%), la baja recuperación de la cartera (23%), fallas en los sistemas informáticos (34%), procesos o problemas del sistema interno (24%), y ineficiencia en los procesos (22%). Por eso es importante que las organizaciones desarrollen estrategias financieras y de mercado eficientes para mejorar su rentabilidad, de manera que el indicador pueda ser superior al costo de capital; y también es relevante incorporar sistemas de tecnología avanzada para controlar los procesos internos con un mayor nivel de profesionalismo.

4.3 Implicaciones

En la presente investigación se ha trabajado dos artículos científicos de revisión de literatura de métodos vanguardistas de costo de capital y toma de decisiones multicriterio para la evaluación de riesgo; ya que los analistas financieros suelen valorar diferentes indicadores para seleccionar la mejor inversión entre diferentes opciones de rentabilidad, siendo la estimación del costo de capital relevante para el cálculo de la tasa de descuento, misma que es determinada a través de Costo Promedio Ponderado de Capital; por tal motivo la importancia de la investigación bibliográfica de estas temáticas.

Sin embargo, a pesar de que en los últimos años se han desarrollado investigaciones científicas, respecto a la evaluación de riesgo; ha sido poco estudiado metodologías para la estimación de costo de capital en mercados, donde no existe una cultura bursátil en cotizar acciones a través de las Bolsas de Valores. Por ende, esto implica que se deben de estudiar métodos vaguardistas que complementen a la estimación del costo de capital para estas organizaciones que no cotizan activos de renta variable.

En el último artículo, se aplicó la metodología del Proceso Analítico Jerárquico para compañías ecuatorianas que no cotizan acciones a través de las Bolsas de Valores del país de origen, sin embargo, es de gran importancia que los investigadores que deseen replicar el método en este tipo de mercados, actualicen la investigación cuantitativa cada cierto tiempo; ya que la percepción del riesgo tiende a cambiar a través del tiempo.

Por ultimo, al identificar que el riesgo financiero y tecnológico son los factores de riesgo más criticos que consideran las compañías evaluadas, es fundamental que se desarrollen estrategias financieras y de mercado eficientes para mejorar su rentabilidad, de manera que el indicador pueda ser superior al costo de capital; y también es relevante incorporar sistemas de tecnología avanzada para controlar los procesos internos con una mayor eficiencia.

4.4 Limitaciones

Aplicar un cuestionario a funcionarios o representantes, que laboran en compañís pertenecientes a un sector específico de la economía ecuatoriana es complicado, ya que esto conlleva a que se extienda el tiempo para el desarrollo del estudio. Por tal motivo, sería interesante contar con el apoyo de las Cámaras de Comercio para que apoyen con la apertura para este tipo de investigación, que beneficia a futuros inversionistas que deseen colocar su capital en empresas que no cotizan a través de las Bolsas de Valores.

Por último, no se han desarrollado investigaciones de métodos vanguardistas que complementen a la estimación del costo de capital para compañías que no cotizan activos de renta variable; con lo que sería relevante contar con más estudios, enfocados a mercados donde no exista la cultura en emitir acciones en el mercado bursátil.

4.5 Futuras líneas de investigación

El presente trabajo incentiva tanto a financieros, como investigadores científicos a desarrollar estudios sobre costo de capital para mercados, donde no existe una cultura por parte de las organizaciones en cotizar acciones a través de la Bolsa de Valores. En este caso, la medodologías, como el Proceso Analítico Jeráquico y costo de capital pueden ser aplicadas en futuros artículos, donde se evalúe el riesgo para este tipo compañías. A continuación, se detalla las futuras líneas de investigación:

- Se ha evidenciado investigaciones científicas, donde se utiliza la teoría del modelo de Fama y French para incluir otros factores que inciden en los resultados de costo de capital, tanto para industrias y organizaciones. Entonces, teniendo en cuenta que algunas variables específicas también pueden influir en los rendimientos de las acciones, sería interesante que los países de América Latina, donde el mercado de valores no está bien desarrollado, puedan considerar este modelo al momento de estimar el costo de capital, debido a la existencia de causas externas que los inversionistas evalúan al desarrollar futuras inversiones.
- Desarrollar el Proceso Analítico Jerárquico para estimar el costo de capital por sector de compañías ecuatorianas que no cotizan acciones, a través de las Bolsas de Valores del país de origen.

- Desarrollar futuras investigaciones de métodos vanguardistas que puedan complementar a la estimación del costo de capital para organizaciones que no coticen activos de renta variable.

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ANEXOS

Annex 1. Survey model for risk assessment of ecuadorian companies

La finalidad de este instrumento metodológico es de carácter académico y servirá para un estudio que contribuirá al aservo científico sobre las decisiones económico-empresariales. El objetivo es valorar 6 tipos de riesgo que enfrenta el empresariado, para comprender de mejor manera la interacción en el Triángulo Empresa-Académia-Sociedad. El cuestionario se presenta por secciones donde debe valorarse del 1 al 10 cada componente, siendo 10 el máximo riesgo. Al final se presentna las 6 categorías de riesgo, las mimas que usted debe otorgarle un peso porcentual que no necesariamente deben ser iguales, pero al final la suma de todas las valoraciones individuales no debe exceder del 100%

Nombre de la Empresa

_____

1. Indique a que cámara o gremi pertenece su empresa:

- Cámara de Seguros
- Cámara de Agricultura de la Zona 1
- Cámara de Agricultura de la Zona 2
- Cámara de Comercio de Guayaquil
- Cámara de Comercio de Quito
- Cámara de Comercio de Cuenta
- Cámara de Comercio de Ambato
- Cámara de Minería del Ecuador
- Cámara de Industrias de Guayaquil
- Colegio de Contadores del Guayas y del Ecuador
- Colegio de Contadore, Bachilleres y Públicos del Guayas
- Asociación de Municipalidades Ecuatorianas
- Asociación de Canales de Televisión
- Asociación de Bancos Privados del Ecuador
- Cámara de Industrias y Producción (Quito)
- Cámara de Industrias y Producción de Tungurahua
- Otros

2. **Cargo en la empresa:**
   - Dueño
   - Gerente General
   - Gerente Área
   - Jefatura

3. **Edad**
   - Menor a 30 años
   - 31-40 años
   - 41-50 años
   - Mayor a 50 años

4. **Su empresa está clasificada dentro de:**
   - Actividades de Servicios Financieros y de Seguros
   - Actividades Profesionales, Científicas y Técnicas
   - Administración Pública y Defensa: Planes de Seguridad Social de afiliación obligatoria
   - Agricultura, Ganadería, Silvicultura y pesca
   - Explotación de Minas y Canteras
   - Industrias Manufactureras
   - Información y Comunicación
   - Comercio al por Mayor
   - Comerico al por Menor
   - Otros

5. **Valorar del 1 al 10 cada componente, siendo 10 el máximo riesgo:**

   Valoración de Riesgo Financiero

   a) Considera usted que la insuficiencia de recursos para el volumen de operaciones involucra:

b) Considera usted que la falta de liquidez involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

c) Considera usted que la lenta recuperación de cartera involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

d) Considera usted que la Ausencia de Financiamiento involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

Valoración de Riesgo Tecnológico

a) Considera usted que la falla en los procesos o sistemas internos involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

b) Considera usted que la falla en la seguridad y continuidad operativa involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

c) Considera usted que la falla en los sistemas informáticos involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

d) Considera usted que la falta de la capacidad instalda involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

e) Considera usted que la falta de eficiencia en los procesos involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

Valoración del Riesgo Organizacional

a) Considera usted que la influencia negativa de la cultura de la organización en los procesos involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

b) Considera usted que la inadecuada capacitación del personal involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

c) Considera usted que la alta rotación del personal involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

d) Considera usted que la falta de líderes involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

e) Considera usted que la falta de planes de sucesión involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

Valoración de Riesgo Político y Social

a) Considera usted que las decisiones externas impuestas por el gobierno involucran:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

b) Considera usted que las decisiones de los entes reguladores involucran:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

c) Considera usted que la falla en los servicios públicos involucan:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

d) Considera usted que la ocurrencia de los desastres naturales involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

e) Considera usted que los atentados y actos delictivos involucran:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

Valoración del Riesgo de la Competencia

a) Considera usted que la presencia en el mercado de empresas que prestan servicios similares involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

b) Considera usted que las empresas que venden productos afines involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

c) Considera usted que mayores ventajas de las empresas del sector involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

d) Considera usted que Monopolios involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

e) Considera usted que la entrada de nuevas empresas involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

Valoración de Riesgo Económico

a) Considera usted que factores inherentes a la economía involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

b) Considera usted que la inflación involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

c) Considera usted qué Tratados Internacionales involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

d) Considera usted los aranceles involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

e) Considera usted que la globalización involucra:

1 2 3 4 5 6 7 8 9 10

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Riesgo Máximo

Valoración del Riesgo Total

Determine un peso porcentual a cada categoría de riesgo. Recuerde que la suma es igual al 100%

A continuación, se muestra un ejemplo:

Categoría	**Valoración**
Riesgo Financiero	15%
Riesgo Tecnológico	20%
Riesgo Organizacional	23%
Riesgo Político Social	10%
Riesgo de Competencia	20%
Riesgo Económico	12%
Total	100%

Riesgo Financiero: _____

Riesgo Tecnológico: _____

Riesgo Organizacional: _____

Riesgo Político Social: _____

Riesgo de Competencia: _____

Riesgo Económico: _____

Annex 2: Risk assessment by company

Art. 3 Table 3: Risk assessment by company

COMPANIES	RF	RT	RO	RPS	RC	RE	SUM
A	20%	30%	25%	5%	10%	10%	100%
B	25%	10%	5%	20%	20%	20%	100%
C	20%	15%	15%	10%	10%	30%	100%
D	20%	15%	5%	20%	20%	20%	100%
E	20%	20%	15%	15%	10%	20%	100%
F	30%	15%	25%	10%	10%	10%	100%
G	25%	25%	15%	10%	15%	10%	100%
H	50%	10%	10%	10%	10%	10%	100%
I	50%	5%	5%	10%	5%	25%	100%
J	20%	20%	10%	20%	20%	10%	100%
K	18%	25%	22%	10%	13%	12%	100%
L	30%	10%	30%	20%	5%	5%	100%
M	15%	15%	15%	20%	20%	15%	100%
N	25%	20%	15%	10%	15%	15%	100%
Ñ	20%	20%	10%	10%	20%	20%	100%
O	15%	15%	20%	5%	20%	25%	100%
P	20%	40%	20%	5%	5%	10%	100%
Q	25%	10%	15%	10%	20%	20%	100%
R	30%	20%	30%	5%	10%	5%	100%
S	15%	20%	23%	10%	20%	12%	100%

T	20%	10%	20%	10%	20%	20%	100%
U	35%	10%	15%	10%	5%	25%	100%
V	30%	20%	10%	10%	5%	25%	100%
W	15%	15%	10%	20%	30%	10%	100%
X	20%	15%	10%	10%	25%	20%	100%
Y	30%	10%	15%	15%	20%	10%	100%
Z	15%	20%	25%	10%	20%	10%	100%
AA	35%	35%	10%	10%	5%	5%	100%
AB	20%	25%	10%	15%	15%	15%	100%
……	**……**	**……**	**……**	**……**	**……**	**……**	**……**
IT	25%	15%	15%	20%	5%	20%	100%
IU	20%	15%	15%	15%	15%	20%	100%

Source: Surveys developed to ecuadorian companies (2021-2022)

Annex 3: Pairwise comparison matrices

Art. 3 Table 4: Pairwise comparison matrix. Finance risk criteria.

COMPANIES	A	B	C	D	E	F	G	……	IV
A	1,00	1,25	1,00	1,00	1,00	1,50	1,25	……	1,25
B	0,80	1,00	0,80	0,80	0,80	1,20	1,00	……	1,00
C	1,00	1,25	1,00	1,00	1,00	1,50	1,25	……	1,25
D	1,00	1,25	1,00	1,00	1,00	1,50	1,25	……	1,25
E	1,00	1,25	1,00	1,00	1,00	1,50	1,25	……	1,25
F	0,67	0,83	0,67	0,67	0,67	1,00	0,83	……	0,83
G	0,80	1,00	0,80	0,80	0,80	1,20	1,00	……	1,00
H	0,40	0,50	0,40	0,40	0,40	0,60	0,50	……	0,50
I	0,40	0,50	0,40	0,40	0,40	0,60	0,50	……	0,50
J	1,00	1,25	1,00	1,00	1,00	1,50	1,25	……	1,25
K	1,11	1,39	1,11	1,11	1,11	1,67	1,39	……	1,39
L	0,67	0,83	0,67	0,67	0,67	1,00	0,83	……	0,83
M	1,33	1,67	1,33	1,33	1,33	2,00	1,67	……	1,67
N	0,80	1,00	0,80	0,80	0,80	1,20	1,00	……	1,00
Ñ	1,00	1,25	1,00	1,00	1,00	1,50	1,25	……	1,25
O	1,33	1,67	1,33	1,33	1,33	2,00	1,67	……	1,67
P	1,00	1,25	1,00	1,00	1,00	1,50	1,25	……	1,25
Q	0,80	1,00	0,80	0,80	0,80	1,20	1,00	……	1,00
R	0,67	0,83	0,67	0,67	0,67	1,00	0,83	……	0,83
S	1,33	1,67	1,33	1,33	1,33	2,00	1,67	……	1,67

T	1,00	1,25	1,00	1,00	1,00	1,50	1,25	**……**	1,25
U	0,57	0,71	0,57	0,57	0,57	0,86	0,71	**……**	0,71
V	0,67	0,83	0,67	0,67	0,67	1,00	0,83	**……**	0,83
W	1,33	1,67	1,33	1,33	1,33	2,00	1,67	**……**	1,67
X	1,00	1,25	1,00	1,00	1,00	1,50	1,25	**……**	1,25
Y	0,67	0,83	0,67	0,67	0,67	1,00	0,83	**……**	0,83
Z	1,33	1,67	1,33	1,33	1,33	2,00	1,67	**……**	1,67
AA	0,57	0,71	0,57	0,57	0,57	0,86	0,71	**……**	0,71
AB	1,00	1,25	1,00	1,00	1,00	1,50	1,25	**……**	1,25
……	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**
IU	1,00	1,25	1,00	1,00	1,00	1,50	1,25	**……**	1,25
IV	0,80	1,00	0,80	0,80	0,80	1,20	1,00	**……**	1,00
Sum(n=266)	**276,81**	**346,02**	**276,81**	**276,81**	**276,81**	**415,22**	**346,02**	**……**	**346,02**

Source: Own elaboration

Art. 3 Table 5: Pairwise comparison matrix. Technology risk criteria.

COMPANIES	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**……**	**IV**
A	1,00	0,33	0,50	0,50	0,67	0,50	0,83	**……**	0,17
B	3,00	1,00	1,50	1,50	2,00	1,50	2,50	**……**	0,50
C	2,00	0,67	1,00	1,00	1,33	1,00	1,67	**……**	0,33
D	2,00	0,67	1,00	1,00	1,33	1,00	1,67	**……**	0,33
E	1,50	0,50	0,75	0,75	1,00	0,75	1,25	**……**	0,25
F	2,00	0,67	1,00	1,00	1,33	1,00	1,67	**……**	0,33
G	1,20	0,40	0,60	0,60	0,80	0,60	1,00	**……**	0,20
H	3,00	1,00	1,50	1,50	2,00	1,50	2,50	**……**	0,50
I	6,00	2,00	3,00	3,00	4,00	3,00	5,00	**……**	1,00
J	1,50	0,50	0,75	0,75	1,00	0,75	1,25	**……**	0,25
K	1,20	0,40	0,60	0,60	0,80	0,60	1,00	**……**	0,20
L	3,00	1,00	1,50	1,50	2,00	1,50	2,50	**……**	0,50
M	2,00	0,67	1,00	1,00	1,33	1,00	1,67	**……**	0,33
N	1,50	0,50	0,75	0,75	1,00	0,75	1,25	**……**	0,25
Ñ	1,50	0,50	0,75	0,75	1,00	0,75	1,25	**……**	0,25
O	2,00	0,67	1,00	1,00	1,33	1,00	1,67	**……**	0,33
P	0,75	0,25	0,38	0,38	0,50	0,38	0,63	**……**	0,13
Q	3,00	1,00	1,50	1,50	2,00	1,50	2,50	**……**	0,50
R	1,50	0,50	0,75	0,75	1,00	0,75	1,25	**……**	0,25
S	1,50	0,50	0,75	0,75	1,00	0,75	1,25	**……**	0,25
T	3,00	1,00	1,50	1,50	2,00	1,50	2,50	**……**	0,50

U	3,00	1,00	1,50	1,50	2,00	1,50	2,50	**……**	0,50
V	1,50	0,50	0,75	0,75	1,00	0,75	1,25	**……**	0,25
W	2,00	0,67	1,00	1,00	1,33	1,00	1,67	**……**	0,33
X	2,00	0,67	1,00	1,00	1,33	1,00	1,67	**……**	0,33
Y	3,00	1,00	1,50	1,50	2,00	1,50	2,50	**……**	0,50
Z	1,50	0,50	0,75	0,75	1,00	0,75	1,25	**……**	0,25
AA	0,86	0,29	0,43	0,43	0,57	0,43	0,71	**……**	0,14
AB	1,20	0,40	0,60	0,60	0,80	0,60	1,00	**……**	0,20
……	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**
IU	2,00	0,67	1,00	1,00	1,33	1,00	1,67	**……**	0,33
IV	6,00	2,00	3,00	3,00	4,00	3,00	5,00	**……**	1,00
Sum(n=266)	**524,86**	**174,95**	**262,43**	**262,43**	**349,91**	**262,43**	**437,38**	**……**	**87,48**

Source: Own elaboration

Art. 3 Table 6: Pairwise comparison matrix. Organizational Structure risk criteria.

COMPANIES	A	B	C	D	E	F	G	……	IV
A	1,00	0,20	0,60	0,20	0,60	1,00	0,60	……	1,00
B	5,00	1,00	3,00	1,00	3,00	5,00	3,00	……	5,00
C	1,67	0,33	1,00	0,33	1,00	1,67	1,00	……	1,67
D	5,00	1,00	3,00	1,00	3,00	5,00	3,00	……	5,00
E	1,67	0,33	1,00	0,33	1,00	1,67	1,00	……	1,67
F	1,00	0,20	0,60	0,20	0,60	1,00	0,60	……	1,00
G	1,67	0,33	1,00	0,33	1,00	1,67	1,00	……	1,67
H	2,50	0,50	1,50	0,50	1,50	2,50	1,50	……	2,50
I	5,00	1,00	3,00	1,00	3,00	5,00	3,00	……	5,00
J	2,50	0,50	1,50	0,50	1,50	2,50	1,50	……	2,50
K	1,14	0,23	0,68	0,23	0,68	1,14	0,68	……	1,14
L	0,83	0,17	0,50	0,17	0,50	0,83	0,50	……	0,83
M	1,67	0,33	1,00	0,33	1,00	1,67	1,00	……	1,67
N	1,67	0,33	1,00	0,33	1,00	1,67	1,00	……	1,67
Ñ	2,50	0,50	1,50	0,50	1,50	2,50	1,50	……	2,50
O	1,25	0,25	0,75	0,25	0,75	1,25	0,75	……	1,25
P	1,25	0,25	0,75	0,25	0,75	1,25	0,75	……	1,25
Q	1,67	0,33	1,00	0,33	1,00	1,67	1,00	……	1,67
R	0,83	0,17	0,50	0,17	0,50	0,83	0,50	……	0,83
S	1,09	0,22	0,65	0,22	0,65	1,09	0,65	……	1,09
T	1,25	0,25	0,75	0,25	0,75	1,25	0,75	……	1,25

U	1,67	0,33	1,00	0,33	1,00	1,67	1,00	**……**	1,67
V	2,50	0,50	1,50	0,50	1,50	2,50	1,50	**……**	2,50
W	2,50	0,50	1,50	0,50	1,50	2,50	1,50	**……**	2,50
X	2,50	0,50	1,50	0,50	1,50	2,50	1,50	**……**	2,50
Y	1,67	0,33	1,00	0,33	1,00	1,67	1,00	**……**	1,67
Z	1,00	0,20	0,60	0,20	0,60	1,00	0,60	**……**	1,00
AA	2,50	0,50	1,50	0,50	1,50	2,50	1,50	**……**	2,50
AB	2,50	0,50	1,50	0,50	1,50	2,50	1,50	**……**	2,50
……	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**
IU	1,67	0,33	1,00	0,33	1,00	1,67	1,00	**……**	1,67
IV	1,00	0,20	0,60	0,20	0,60	1,00	0,60	**……**	1,00
Sum(n=266)	**461,36**	**92,27**	**276,82**	**92,27**	**276,82**	**461,36**	**276,82**	**……**	**461,36**

Source: Own elaboration

Art. 3 Table 7: Pairwise comparison matrix. Political/Social risk criteria.

COMPANIES	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**……**	**IV**
A	1,00	4,00	2,00	4,00	3,00	2,00	2,00	**……**	2,00
B	0,25	1,00	0,50	1,00	0,75	0,50	0,50	**……**	0,50
C	0,50	2,00	1,00	2,00	1,50	1,00	1,00	**……**	1,00
D	0,25	1,00	0,50	1,00	0,75	0,50	0,50	**……**	0,50
E	0,33	1,33	0,67	1,33	1,00	0,67	0,67	**……**	0,67
F	0,50	2,00	1,00	2,00	1,50	1,00	1,00	**……**	1,00
G	0,50	2,00	1,00	2,00	1,50	1,00	1,00	**……**	1,00
H	0,50	2,00	1,00	2,00	1,50	1,00	1,00	**……**	1,00
I	0,50	2,00	1,00	2,00	1,50	1,00	1,00	**……**	1,00
J	0,25	1,00	0,50	1,00	0,75	0,50	0,50	**……**	0,50
K	0,50	2,00	1,00	2,00	1,50	1,00	1,00	**……**	1,00
L	0,25	1,00	0,50	1,00	0,75	0,50	0,50	**……**	0,50
M	0,25	1,00	0,50	1,00	0,75	0,50	0,50	**……**	0,50
N	0,50	2,00	1,00	2,00	1,50	1,00	1,00	**……**	1,00
Ñ	0,50	2,00	1,00	2,00	1,50	1,00	1,00	**……**	1,00
O	1,00	4,00	2,00	4,00	3,00	2,00	2,00	**……**	2,00
P	1,00	4,00	2,00	4,00	3,00	2,00	2,00	**……**	2,00
Q	0,50	2,00	1,00	2,00	1,50	1,00	1,00	**……**	1,00
R	1,00	4,00	2,00	4,00	3,00	2,00	2,00	**……**	2,00
S	0,50	2,00	1,00	2,00	1,50	1,00	1,00	**……**	1,00
T	0,50	2,00	1,00	2,00	1,50	1,00	1,00	**……**	1,00

U	0,50	2,00	1,00	2,00	1,50	1,00	1,00	**……**	1,00
V	0,50	2,00	1,00	2,00	1,50	1,00	1,00	**……**	1,00
W	0,25	1,00	0,50	1,00	0,75	0,50	0,50	**……**	0,50
X	0,50	2,00	1,00	2,00	1,50	1,00	1,00	**……**	1,00
Y	0,33	1,33	0,67	1,33	1,00	0,67	0,67	**……**	0,67
Z	0,50	2,00	1,00	2,00	1,50	1,00	1,00	**……**	1,00
AA	0,50	2,00	1,00	2,00	1,50	1,00	1,00	**……**	1,00
AB	0,33	1,33	0,67	1,33	1,00	0,67	0,67	**……**	0,67
……	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**
IU	0,33	1,33	0,67	1,33	1,00	0,67	0,67	**……**	0,67
IV	0,50	2,00	1,00	2,00	1,50	1,00	1,00	**……**	1,00
Sum(n=266)	**123,48**	**493,91**	**246,96**	**493,91**	**370,44**	**246,96**	**246,96**	**……**	**246,96**

Source: Own elaboration

Art. 3 Table 8: Pairwise comparison matrix. Competition risk criteria.

COMPANIES	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**……**	**IV**
A	1,00	2,00	1,00	2,00	1,00	1,00	1,50	**……**	1,50
B	0,50	1,00	0,50	1,00	0,50	0,50	0,75	**……**	0,75
C	1,00	2,00	1,00	2,00	1,00	1,00	1,50	**……**	1,50
D	0,50	1,00	0,50	1,00	0,50	0,50	0,75	**……**	0,75
E	1,00	2,00	1,00	2,00	1,00	1,00	1,50	**……**	1,50
F	1,00	2,00	1,00	2,00	1,00	1,00	1,50	**……**	1,50
G	0,67	1,33	0,67	1,33	0,67	0,67	1,00	**……**	1,00
H	1,00	2,00	1,00	2,00	1,00	1,00	1,50	**……**	1,50
I	2,00	4,00	2,00	4,00	2,00	2,00	3,00	**……**	3,00
J	0,50	1,00	0,50	1,00	0,50	0,50	0,75	**……**	0,75
K	0,77	1,54	0,77	1,54	0,77	0,77	1,15	**……**	1,15
L	2,00	4,00	2,00	4,00	2,00	2,00	3,00	**……**	3,00
M	0,50	1,00	0,50	1,00	0,50	0,50	0,75	**……**	0,75
N	0,67	1,33	0,67	1,33	0,67	0,67	1,00	**……**	1,00
Ñ	0,50	1,00	0,50	1,00	0,50	0,50	0,75	**……**	0,75
O	0,50	1,00	0,50	1,00	0,50	0,50	0,75	**……**	0,75
P	2,00	4,00	2,00	4,00	2,00	2,00	3,00	**……**	3,00
Q	0,50	1,00	0,50	1,00	0,50	0,50	0,75	**……**	0,75
R	1,00	2,00	1,00	2,00	1,00	1,00	1,50	**……**	1,50
S	0,50	1,00	0,50	1,00	0,50	0,50	0,75	**……**	0,75
T	0,50	1,00	0,50	1,00	0,50	0,50	0,75	**……**	0,75

U	2,00	4,00	2,00	4,00	2,00	2,00	3,00	**……**	3,00
V	2,00	4,00	2,00	4,00	2,00	2,00	3,00	**……**	3,00
W	0,33	0,67	0,33	0,67	0,33	0,33	0,50	**……**	0,50
X	0,40	0,80	0,40	0,80	0,40	0,40	0,60	**……**	0,60
Y	0,50	1,00	0,50	1,00	0,50	0,50	0,75	**……**	0,75
Z	0,50	1,00	0,50	1,00	0,50	0,50	0,75	**……**	0,75
AA	2,00	4,00	2,00	4,00	2,00	2,00	3,00	**……**	3,00
AB	0,67	1,33	0,67	1,33	0,67	0,67	1,00	**……**	1,00
……	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**
IU	0,67	1,33	0,67	1,33	0,67	0,67	1,00	**……**	1,00
IV	0,67	1,33	0,67	1,33	0,67	0,67	1,00	**……**	1,00
Sum(n=266)	**234,57**	**469,14**	**234,57**	**469,14**	**234,57**	**234,57**	**351,85**	**……**	**351,85**

Source: Own elaboration

Art. 3 Table 9: Pairwise comparison matrix. Economic risk criteria.

COMPANIES	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**……**	**IV**
A	1,00	2,00	3,00	2,00	2,00	1,00	1,00	**……**	2,00
B	0,50	1,00	1,50	1,00	1,00	0,50	0,50	**……**	1,00
C	0,33	0,67	1,00	0,67	0,67	0,33	0,33	**……**	0,67
D	0,50	1,00	1,50	1,00	1,00	0,50	0,50	**……**	1,00
E	0,50	1,00	1,50	1,00	1,00	0,50	0,50	**……**	1,00
F	1,00	2,00	3,00	2,00	2,00	1,00	1,00	**……**	2,00
G	1,00	2,00	3,00	2,00	2,00	1,00	1,00	**……**	2,00
H	1,00	2,00	3,00	2,00	2,00	1,00	1,00	**……**	2,00
I	0,40	0,80	1,20	0,80	0,80	0,40	0,40	**……**	0,80
J	1,00	2,00	3,00	2,00	2,00	1,00	1,00	**……**	2,00
K	0,83	1,67	2,50	1,67	1,67	0,83	0,83	**……**	1,67
L	2,00	4,00	6,00	4,00	4,00	2,00	2,00	**……**	4,00
M	0,67	1,33	2,00	1,33	1,33	0,67	0,67	**……**	1,33
N	0,67	1,33	2,00	1,33	1,33	0,67	0,67	**……**	1,33
Ñ	0,50	1,00	1,50	1,00	1,00	0,50	0,50	**……**	1,00
O	0,40	0,80	1,20	0,80	0,80	0,40	0,40	**……**	0,80
P	1,00	2,00	3,00	2,00	2,00	1,00	1,00	**……**	2,00
Q	0,50	1,00	1,50	1,00	1,00	0,50	0,50	**……**	1,00
R	2,00	4,00	6,00	4,00	4,00	2,00	2,00	**……**	4,00
S	0,83	1,67	2,50	1,67	1,67	0,83	0,83	**……**	1,67
T	0,50	1,00	1,50	1,00	1,00	0,50	0,50	**……**	1,00

U	0,40	0,80	1,20	0,80	0,80	0,40	0,40	**……**	0,80
V	0,40	0,80	1,20	0,80	0,80	0,40	0,40	**……**	0,80
W	1,00	2,00	3,00	2,00	2,00	1,00	1,00	**……**	2,00
X	0,50	1,00	1,50	1,00	1,00	0,50	0,50	**……**	1,00
Y	1,00	2,00	3,00	2,00	2,00	1,00	1,00	**……**	2,00
Z	1,00	2,00	3,00	2,00	2,00	1,00	1,00	**……**	2,00
AA	2,00	4,00	6,00	4,00	4,00	2,00	2,00	**……**	4,00
AB	0,67	1,33	2,00	1,33	1,33	0,67	0,67	**……**	1,33
……	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**
IU	0,50	1,00	1,50	1,00	1,00	0,50	0,50	**……**	1,00
IV	0,50	1,00	1,50	1,00	1,00	0,50	0,50	**……**	1,00
Sum(n=266)	**188,35**	**376,70**	**565,05**	**376,70**	**376,70**	**188,35**	**188,35**	**……**	**376,70**

Source: Own elaboration

Annex 4: Weighting the vectors of the priorities

Art. 3 Table 10: Normalization matrix and estimation vectors. Finance risk criteria.

COMPANIES	A	B	C	D	E	F	G	……	IV	VECTORS
A	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	……	0,0036	0,0036
B	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	……	0,0029	0,0029
C	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	……	0,0036	0,0036
D	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	……	0,0036	0,0036
E	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	……	0,0036	0,0036
F	0,0024	0,0024	0,0024	0,0024	0,0024	0,0024	0,0024	……	0,0024	0,0024
G	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	……	0,0029	0,0029
H	0,0014	0,0014	0,0014	0,0014	0,0014	0,0014	0,0014	……	0,0014	0,0014
I	0,0014	0,0014	0,0014	0,0014	0,0014	0,0014	0,0014	……	0,0014	0,0014
J	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	……	0,0036	0,0036
K	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	……	0,0040	0,0040
L	0,0024	0,0024	0,0024	0,0024	0,0024	0,0024	0,0024	……	0,0024	0,0024
M	0,0048	0,0048	0,0048	0,0048	0,0048	0,0048	0,0048	……	0,0048	0,0048
N	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	……	0,0029	0,0029
Ñ	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	……	0,0036	0,0036
O	0,0048	0,0048	0,0048	0,0048	0,0048	0,0048	0,0048	……	0,0048	0,0048
P	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	……	0,0036	0,0036
Q	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	……	0,0029	0,0029
R	0,0024	0,0024	0,0024	0,0024	0,0024	0,0024	0,0024	……	0,0024	0,0024
S	0,0048	0,0048	0,0048	0,0048	0,0048	0,0048	0,0048	……	0,0048	0,0048
T	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	……	0,0036	0,0036
U	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	……	0,0021	0,0021

V	0,0024	0,0024	0,0024	0,0024	0,0024	0,0024	0,0024	**……**	0,0024	0,0024
W	0,0048	0,0048	0,0048	0,0048	0,0048	0,0048	0,0048	**……**	0,0048	0,0048
X	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	**……**	0,0036	0,0036
Y	0,0024	0,0024	0,0024	0,0024	0,0024	0,0024	0,0024	**……**	0,0024	0,0024
Z	0,0048	0,0048	0,0048	0,0048	0,0048	0,0048	0,0048	**……**	0,0048	0,0048
AA	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	**……**	0,0021	0,0021
AB	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	**……**	0,0036	0,0036
……	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**
IU	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	**……**	0,0036	0,0036
IV	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	**……**	0,0029	0,0029
Sum(n=266)	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**……**	**1,00**	**1,00**

Source: Own elaboration

Art. 3 Table 11: Normalization matrix and estimation vectors. Technology risk criteria.

COMPANIES	A	B	C	D	E	F	G	……	IV	VECTORS
A	0,0019	0,0019	0,0019	0,0019	0,0019	0,0019	0,0019	……	0,0019	0,0019
B	0,0057	0,0057	0,0057	0,0057	0,0057	0,0057	0,0057	……	0,0057	0,0057
C	0,0038	0,0038	0,0038	0,0038	0,0038	0,0038	0,0038	……	0,0038	0,0038
D	0,0038	0,0038	0,0038	0,0038	0,0038	0,0038	0,0038	……	0,0038	0,0038
E	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	……	0,0029	0,0029
F	0,0038	0,0038	0,0038	0,0038	0,0038	0,0038	0,0038	……	0,0038	0,0038
G	0,0023	0,0023	0,0023	0,0023	0,0023	0,0023	0,0023	……	0,0023	0,0023
H	0,0057	0,0057	0,0057	0,0057	0,0057	0,0057	0,0057	……	0,0057	0,0057
I	0,0114	0,0114	0,0114	0,0114	0,0114	0,0114	0,0114	……	0,0114	0,0114
J	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	……	0,0029	0,0029
K	0,0023	0,0023	0,0023	0,0023	0,0023	0,0023	0,0023	……	0,0023	0,0023
L	0,0057	0,0057	0,0057	0,0057	0,0057	0,0057	0,0057	……	0,0057	0,0057
M	0,0038	0,0038	0,0038	0,0038	0,0038	0,0038	0,0038	……	0,0038	0,0038
N	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	……	0,0029	0,0029
Ñ	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	……	0,0029	0,0029
O	0,0038	0,0038	0,0038	0,0038	0,0038	0,0038	0,0038	……	0,0038	0,0038
P	0,0014	0,0014	0,0014	0,0014	0,0014	0,0014	0,0014	……	0,0014	0,0014
Q	0,0057	0,0057	0,0057	0,0057	0,0057	0,0057	0,0057	……	0,0057	0,0057
R	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	……	0,0029	0,0029
S	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	……	0,0029	0,0029
T	0,0057	0,0057	0,0057	0,0057	0,0057	0,0057	0,0057	……	0,0057	0,0057
U	0,0057	0,0057	0,0057	0,0057	0,0057	0,0057	0,0057	……	0,0057	0,0057
V	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	……	0,0029	0,0029

W	0,0038	0,0038	0,0038	0,0038	0,0038	0,0038	0,0038	**……**	0,0038	0,0038
X	0,0038	0,0038	0,0038	0,0038	0,0038	0,0038	0,0038	**……**	0,0038	0,0038
Y	0,0057	0,0057	0,0057	0,0057	0,0057	0,0057	0,0057	**……**	0,0057	0,0057
Z	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	**……**	0,0029	0,0029
AA	0,0016	0,0016	0,0016	0,0016	0,0016	0,0016	0,0016	**……**	0,0016	0,0016
AB	0,0023	0,0023	0,0023	0,0023	0,0023	0,0023	0,0023	**……**	0,0023	0,0023
AC	0,0023	0,0023	0,0023	0,0023	0,0023	0,0023	0,0023	**……**	0,0023	0,0023
IU	0,0038	0,0038	0,0038	0,0038	0,0038	0,0038	0,0038	**……**	0,0038	0,0038
IV	0,0114	0,0114	0,0114	0,0114	0,0114	0,0114	0,0114	**……**	0,0114	0,0114
Suma(n=266)	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**……**	**1,00**	**1,00**

Source: Own elaboration

Art. 3 Table 12: Normalization matrix and estimation vectors. Organizational Structure risk criteria.

COMPANIES	A	B	C	D	E	F	G	……	IV	VECTORS
A	0,0022	0,0022	0,0022	0,0022	0,0022	0,0022	0,0022	……	0,0022	0,0022
B	0,0108	0,0108	0,0108	0,0108	0,0108	0,0108	0,0108	……	0,0108	0,0108
C	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	……	0,0036	0,0036
D	0,0108	0,0108	0,0108	0,0108	0,0108	0,0108	0,0108	……	0,0108	0,0108
E	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	……	0,0036	0,0036
F	0,0022	0,0022	0,0022	0,0022	0,0022	0,0022	0,0022	……	0,0022	0,0022
G	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	……	0,0036	0,0036
H	0,0054	0,0054	0,0054	0,0054	0,0054	0,0054	0,0054	……	0,0054	0,0054
I	0,0108	0,0108	0,0108	0,0108	0,0108	0,0108	0,0108	……	0,0108	0,0108
J	0,0054	0,0054	0,0054	0,0054	0,0054	0,0054	0,0054	……	0,0054	0,0054
K	0,0025	0,0025	0,0025	0,0025	0,0025	0,0025	0,0025	……	0,0025	0,0025
L	0,0018	0,0018	0,0018	0,0018	0,0018	0,0018	0,0018	……	0,0018	0,0018
M	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	……	0,0036	0,0036
N	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	……	0,0036	0,0036
Ñ	0,0054	0,0054	0,0054	0,0054	0,0054	0,0054	0,0054	……	0,0054	0,0054
O	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	……	0,0027	0,0027
P	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	……	0,0027	0,0027
Q	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	……	0,0036	0,0036
R	0,0018	0,0018	0,0018	0,0018	0,0018	0,0018	0,0018	……	0,0018	0,0018
S	0,0024	0,0024	0,0024	0,0024	0,0024	0,0024	0,0024	……	0,0024	0,0024
T	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	……	0,0027	0,0027
U	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	……	0,0036	0,0036

V	0,0054	0,0054	0,0054	0,0054	0,0054	0,0054	0,0054	**……**	0,0054	0,0054
W	0,0054	0,0054	0,0054	0,0054	0,0054	0,0054	0,0054	**……**	0,0054	0,0054
X	0,0054	0,0054	0,0054	0,0054	0,0054	0,0054	0,0054	**……**	0,0054	0,0054
Y	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	**……**	0,0036	0,0036
Z	0,0022	0,0022	0,0022	0,0022	0,0022	0,0022	0,0022	**……**	0,0022	0,0022
AA	0,0054	0,0054	0,0054	0,0054	0,0054	0,0054	0,0054	**……**	0,0054	0,0054
AB	0,0054	0,0054	0,0054	0,0054	0,0054	0,0054	0,0054	**……**	0,0054	0,0054
……	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**
IU	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	0,0036	**……**	0,0036	0,0036
IV	0,0022	0,0022	0,0022	0,0022	0,0022	0,0022	0,0022	**……**	0,0022	0,0022
Suma(n=266)	1,00	1,00	1,00	1,00	1,00	1,00	1,00	**……**	1,00	1,00

Source: Own elaboration

Art. 3 Table 13: Normalization matrix and estimation vectors. Political/Social risk criteria.

COMPANIES	A	B	C	D	E	F	G	……	IV	VECTOR
A	0,0081	0,0081	0,0081	0,0081	0,0081	0,0081	0,0081	……	0,0081	0,0081
B	0,0020	0,0020	0,0020	0,0020	0,0020	0,0020	0,0020	……	0,0020	0,0020
C	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	……	0,0040	0,0040
D	0,0020	0,0020	0,0020	0,0020	0,0020	0,0020	0,0020	……	0,0020	0,0020
E	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	……	0,0027	0,0027
F	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	……	0,0040	0,0040
G	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	……	0,0040	0,0040
H	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	……	0,0040	0,0040
I	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	……	0,0040	0,0040
J	0,0020	0,0020	0,0020	0,0020	0,0020	0,0020	0,0020	……	0,0020	0,0020
K	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	……	0,0040	0,0040
L	0,0020	0,0020	0,0020	0,0020	0,0020	0,0020	0,0020	……	0,0020	0,0020
M	0,0020	0,0020	0,0020	0,0020	0,0020	0,0020	0,0020	……	0,0020	0,0020
N	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	……	0,0040	0,0040
Ñ	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	……	0,0040	0,0040
O	0,0081	0,0081	0,0081	0,0081	0,0081	0,0081	0,0081	……	0,0081	0,0081
P	0,0081	0,0081	0,0081	0,0081	0,0081	0,0081	0,0081	……	0,0081	0,0081
Q	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	……	0,0040	0,0040
R	0,0081	0,0081	0,0081	0,0081	0,0081	0,0081	0,0081	……	0,0081	0,0081
S	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	……	0,0040	0,0040
T	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	……	0,0040	0,0040
U	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	……	0,0040	0,0040
V	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	……	0,0040	0,0040

W	0,0020	0,0020	0,0020	0,0020	0,0020	0,0020	0,0020	**……**	0,0020	0,0020
X	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	**……**	0,0040	0,0040
Y	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	**……**	0,0027	0,0027
Z	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	**……**	0,0040	0,0040
AA	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	**……**	0,0040	0,0040
AB	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	**……**	0,0027	0,0027
……	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**
IU	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	**……**	0,0027	0,0027
IV	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	0,0040	**……**	0,0040	0,0040
Suma(n=266)	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**……**	**1,00**	**1,00**

Source: Own elaboration

Art. 3 Table 14: Normalization matrix and estimation vectors. Competition risk criteria.

COMPANIES	A	B	C	D	E	F	G	……	IV	VECTOR
A	0,0043	0,0043	0,0043	0,0043	0,0043	0,0043	0,0043	……	0,0043	0,0043
B	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	……	0,0021	0,0021
C	0,0043	0,0043	0,0043	0,0043	0,0043	0,0043	0,0043	……	0,0043	0,0043
D	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	……	0,0021	0,0021
E	0,0043	0,0043	0,0043	0,0043	0,0043	0,0043	0,0043	……	0,0043	0,0043
F	0,0043	0,0043	0,0043	0,0043	0,0043	0,0043	0,0043	……	0,0043	0,0043
G	0,0028	0,0028	0,0028	0,0028	0,0028	0,0028	0,0028	……	0,0028	0,0028
H	0,0043	0,0043	0,0043	0,0043	0,0043	0,0043	0,0043	……	0,0043	0,0043
I	0,0085	0,0085	0,0085	0,0085	0,0085	0,0085	0,0085	……	0,0085	0,0085
J	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	……	0,0021	0,0021
K	0,0033	0,0033	0,0033	0,0033	0,0033	0,0033	0,0033	……	0,0033	0,0033
L	0,0085	0,0085	0,0085	0,0085	0,0085	0,0085	0,0085	……	0,0085	0,0085
M	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	……	0,0021	0,0021
N	0,0028	0,0028	0,0028	0,0028	0,0028	0,0028	0,0028	……	0,0028	0,0028
Ñ	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	……	0,0021	0,0021
O	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	……	0,0021	0,0021
P	0,0085	0,0085	0,0085	0,0085	0,0085	0,0085	0,0085	……	0,0085	0,0085
Q	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	……	0,0021	0,0021
R	0,0043	0,0043	0,0043	0,0043	0,0043	0,0043	0,0043	……	0,0043	0,0043
S	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	……	0,0021	0,0021
T	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	……	0,0021	0,0021
U	0,0085	0,0085	0,0085	0,0085	0,0085	0,0085	0,0085	……	0,0085	0,0085
V	0,0085	0,0085	0,0085	0,0085	0,0085	0,0085	0,0085	……	0,0085	0,0085

W	0,0014	0,0014	0,0014	0,0014	0,0014	0,0014	0,0014	**……**	0,0014	0,0014
X	0,0017	0,0017	0,0017	0,0017	0,0017	0,0017	0,0017	**……**	0,0017	0,0017
Y	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	**……**	0,0021	0,0021
Z	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	**……**	0,0021	0,0021
AA	0,0085	0,0085	0,0085	0,0085	0,0085	0,0085	0,0085	**……**	0,0085	0,0085
AB	0,0028	0,0028	0,0028	0,0028	0,0028	0,0028	0,0028	**……**	0,0028	0,0028
……	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**
IU	0,0028	0,0028	0,0028	0,0028	0,0028	0,0028	0,0028	**……**	0,0028	0,0028
IV	0,0028	0,0028	0,0028	0,0028	0,0028	0,0028	0,0028	**……**	0,0028	0,0028
Suma(n=266)	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**……**	**1,00**	**1,00**

Source: Own elaboration

Art. 3 Table 15: Normalization matrix and estimation vectors. Economic risk criteria.

RE	A	B	C	D	E	F	G	.....	IV	VECTOR
A	0,0053	0,0053	0,0053	0,0053	0,0053	0,0053	0,0053	.....	0,0053	0,0053
B	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	.....	0,0027	0,0027
C	0,0018	0,0018	0,0018	0,0018	0,0018	0,0018	0,0018	.....	0,0018	0,0018
D	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	.....	0,0027	0,0027
E	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	.....	0,0027	0,0027
F	0,0053	0,0053	0,0053	0,0053	0,0053	0,0053	0,0053	.....	0,0053	0,0053
G	0,0053	0,0053	0,0053	0,0053	0,0053	0,0053	0,0053	.....	0,0053	0,0053
H	0,0053	0,0053	0,0053	0,0053	0,0053	0,0053	0,0053	.....	0,0053	0,0053
I	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	.....	0,0021	0,0021
J	0,0053	0,0053	0,0053	0,0053	0,0053	0,0053	0,0053	.....	0,0053	0,0053
K	0,0044	0,0044	0,0044	0,0044	0,0044	0,0044	0,0044	.....	0,0044	0,0044
L	0,0106	0,0106	0,0106	0,0106	0,0106	0,0106	0,0106	.....	0,0106	0,0106
M	0,0035	0,0035	0,0035	0,0035	0,0035	0,0035	0,0035	.....	0,0035	0,0035
N	0,0035	0,0035	0,0035	0,0035	0,0035	0,0035	0,0035	.....	0,0035	0,0035
Ñ	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	.....	0,0027	0,0027
O	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	.....	0,0021	0,0021
P	0,0053	0,0053	0,0053	0,0053	0,0053	0,0053	0,0053	.....	0,0053	0,0053
Q	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	.....	0,0027	0,0027
R	0,0106	0,0106	0,0106	0,0106	0,0106	0,0106	0,0106	.....	0,0106	0,0106
S	0,0044	0,0044	0,0044	0,0044	0,0044	0,0044	0,0044	.....	0,0044	0,0044
T	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	.....	0,0027	0,0027
U	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	.....	0,0021	0,0021
V	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	0,0021	.....	0,0021	0,0021

W	0,0053	0,0053	0,0053	0,0053	0,0053	0,0053	0,0053	**……**	0,0053	0,0053
X	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	**……**	0,0027	0,0027
Y	0,0053	0,0053	0,0053	0,0053	0,0053	0,0053	0,0053	**……**	0,0053	0,0053
Z	0,0053	0,0053	0,0053	0,0053	0,0053	0,0053	0,0053	**……**	0,0053	0,0053
AA	0,0106	0,0106	0,0106	0,0106	0,0106	0,0106	0,0106	**……**	0,0106	0,0106
AB	0,0035	0,0035	0,0035	0,0035	0,0035	0,0035	0,0035	**……**	0,0035	0,0035
……	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**
IU	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	**……**	0,0027	0,0027
IV	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	0,0027	**……**	0,0027	0,0027
Suma(n=266)	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**……**	**1,00**	**1,00**

Source: Own elaboration

Annex 5: Estimation of Lambda Max

Art. 3 Table 16: λ max estimation- Finance Risk.

VECTOR	A	B	C	D	E	……	IV	Geometric Consistency Index (GCI)	Consistency Measure
	0,004	0,003	0,004	0,004	0,004	……	0,003		
A	0,004	0,004	0,004	0,004	0,004	……	0,004	0,961	266
B	0,003	0,003	0,003	0,003	0,003	……	0,003	0,769	266
C	0,004	0,004	0,004	0,004	0,004	……	0,004	0,961	266
D	0,004	0,004	0,004	0,004	0,004	……	0,004	0,961	266
E	0,004	0,004	0,004	0,004	0,004	……	0,004	0,961	266
F	0,002	0,002	0,002	0,002	0,002	……	0,002	0,641	266
G	0,003	0,003	0,003	0,003	0,003	……	0,003	0,769	266
H	0,001	0,001	0,001	0,001	0,001	……	0,001	0,384	266
I	0,001	0,001	0,001	0,001	0,001	……	0,001	0,384	266
J	0,004	0,004	0,004	0,004	0,004	……	0,004	0,961	266
K	0,004	0,004	0,004	0,004	0,004	……	0,004	1,068	266
L	0,002	0,002	0,002	0,002	0,002	……	0,002	0,641	266
M	0,005	0,005	0,005	0,005	0,005	……	0,005	1,281	266
N	0,003	0,003	0,003	0,003	0,003	……	0,003	0,769	266
Ñ	0,004	0,004	0,004	0,004	0,004	……	0,004	0,961	266
O	0,005	0,005	0,005	0,005	0,005	……	0,005	1,281	266
P	0,004	0,004	0,004	0,004	0,004	……	0,004	0,961	266
Q	0,003	0,003	0,003	0,003	0,003	……	0,003	0,769	266
R	0,002	0,002	0,002	0,002	0,002	……	0,002	0,641	266

S	0,005	0,005	0,005	0,005	0,005	**……**	0,005	1,281	266
T	0,004	0,004	0,004	0,004	0,004	**……**	0,004	0,961	266
U	0,002	0,002	0,002	0,002	0,002	**……**	0,002	0,549	266
V	0,002	0,002	0,002	0,002	0,002	**……**	0,002	0,641	266
W	0,005	0,005	0,005	0,005	0,005	**……**	0,005	1,281	266
X	0,004	0,004	0,004	0,004	0,004	**……**	0,004	0,961	266
Y	0,002	0,002	0,002	0,002	0,002	**……**	0,002	0,641	266
Z	0,005	0,005	0,005	0,005	0,005	**……**	0,005	1,281	266
AA	0,002	0,002	0,002	0,002	0,002	**……**	0,002	0,549	266
……	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**
IU	0,004	0,004	0,004	0,004	0,004	**……**	0,004	0,961	266
IV	0,003	0,003	0,003	0,003	0,003	**……**	0,003	0,769	266
							λ max	**266**	**266**

Source: Own elaboration

Art. 3 Table 17: λ max estimation- Technology Risk.

VECTOR	A	B	C	D	E	……	IV	Geometric Consistency Index (GCI)	Consistency Measure
	0,002	0,006	0,004	0,004	0,003	……	0,011		
A	0,002	0,002	0,002	0,002	0,002	**……**	0,002	0,507	266
B	0,006	0,006	0,006	0,006	0,006	**……**	0,006	1,520	266
C	0,004	0,004	0,004	0,004	0,004	**……**	0,004	1,014	266
D	0,004	0,004	0,004	0,004	0,004	**……**	0,004	1,014	266
E	0,003	0,003	0,003	0,003	0,003	**……**	0,003	0,760	266
F	0,004	0,004	0,004	0,004	0,004	**……**	0,004	1,014	266
G	0,002	0,002	0,002	0,002	0,002	**……**	0,002	0,608	266
H	0,006	0,006	0,006	0,006	0,006	**……**	0,006	1,520	266
I	0,011	0,011	0,011	0,011	0,011	**……**	0,011	3,041	266
J	0,003	0,003	0,003	0,003	0,003	**……**	0,003	0,760	266
K	0,002	0,002	0,002	0,002	0,002	**……**	0,002	0,608	266
L	0,006	0,006	0,006	0,006	0,006	**……**	0,006	1,520	266
M	0,004	0,004	0,004	0,004	0,004	**……**	0,004	1,014	266
N	0,003	0,003	0,003	0,003	0,003	**……**	0,003	0,760	266
Ñ	0,003	0,003	0,003	0,003	0,003	**……**	0,003	0,760	266
O	0,004	0,004	0,004	0,004	0,004	**……**	0,004	1,014	266
P	0,001	0,001	0,001	0,001	0,001	**……**	0,001	0,380	266
Q	0,006	0,006	0,006	0,006	0,006	**……**	0,006	1,520	266
R	0,003	0,003	0,003	0,003	0,003	**……**	0,003	0,760	266
S	0,003	0,003	0,003	0,003	0,003	**……**	0,003	0,760	266
T	0,006	0,006	0,006	0,006	0,006	**……**	0,006	1,520	266

U	0,006	0,006	0,006	0,006	0,006	**……**	0,006	1,520	266
V	0,003	0,003	0,003	0,003	0,003	**……**	0,003	0,760	266
W	0,004	0,004	0,004	0,004	0,004	**……**	0,004	1,014	266
X	0,004	0,004	0,004	0,004	0,004	**……**	0,004	1,014	266
Y	0,006	0,006	0,006	0,006	0,006	**……**	0,006	1,520	266
Z	0,003	0,003	0,003	0,003	0,003	**……**	0,003	0,760	266
AA	0,002	0,002	0,002	0,002	0,002	**……**	0,002	0,434	266
……	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**
IU	0,004	0,004	0,004	0,004	0,004	**……**	0,004	1,014	266
IV	0,011	0,011	0,011	0,011	0,011	**……**	0,011	3,041	266
							λ max	**266**	**266**

Source: Own elaboration

Art. 3 Table 18: λ max estimation- Organizational Structure Risk.

VECTOR	A	B	C	D	E	……	IV	Geometric Consistency Index (GCI)	Consistency Measure
	0,002	0,011	0,004	0,011	0,004	……	0,002		
A	0,002	0,002	0,002	0,002	0,002	……	0,002	0,577	266
B	0,011	0,011	0,011	0,011	0,011	……	0,011	2,883	266
C	0,004	0,004	0,004	0,004	0,004	……	0,004	0,961	266
D	0,011	0,011	0,011	0,011	0,011	……	0,011	2,883	266
E	0,004	0,004	0,004	0,004	0,004	……	0,004	0,961	266
F	0,002	0,002	0,002	0,002	0,002	……	0,002	0,577	266
G	0,004	0,004	0,004	0,004	0,004	……	0,004	0,961	266
H	0,005	0,005	0,005	0,005	0,005	……	0,005	1,441	266
I	0,011	0,011	0,011	0,011	0,011	……	0,011	2,883	266
J	0,005	0,005	0,005	0,005	0,005	……	0,005	1,441	266
K	0,002	0,002	0,002	0,002	0,002	……	0,002	0,655	266
L	0,002	0,002	0,002	0,002	0,002	……	0,002	0,480	266
M	0,004	0,004	0,004	0,004	0,004	……	0,004	0,961	266
N	0,004	0,004	0,004	0,004	0,004	……	0,004	0,961	266
Ñ	0,005	0,005	0,005	0,005	0,005	……	0,005	1,441	266
O	0,003	0,003	0,003	0,003	0,003	……	0,003	0,721	266
P	0,003	0,003	0,003	0,003	0,003	……	0,003	0,721	266
Q	0,004	0,004	0,004	0,004	0,004	……	0,004	0,961	266
R	0,002	0,002	0,002	0,002	0,002	……	0,002	0,480	266
S	0,002	0,002	0,002	0,002	0,002	……	0,002	0,627	266
T	0,003	0,003	0,003	0,003	0,003	……	0,003	0,721	266

U	0,004	0,004	0,004	0,004	0,004	**……**	0,004	0,961	266
V	0,005	0,005	0,005	0,005	0,005	**……**	0,005	1,441	266
W	0,005	0,005	0,005	0,005	0,005	**……**	0,005	1,441	266
X	0,005	0,005	0,005	0,005	0,005	**……**	0,005	1,441	266
Y	0,004	0,004	0,004	0,004	0,004	**……**	0,004	0,961	266
Z	0,002	0,002	0,002	0,002	0,002	**……**	0,002	0,577	266
AA	0,005	0,005	0,005	0,005	0,005	**……**	0,005	1,441	266
……	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**
IU	0,004	0,004	0,004	0,004	0,004	**……**	0,004	0,961	266
IV	0,002	0,002	0,002	0,002	0,002	**……**	0,002	0,577	266
							λ max	**266**	**266**

Source: Own elaboration

Art. 3 Table 19: λ max estimation- Political/Social Risk.

VECTOR	A	B	C	D	……	IV	Geometric Consistency Index (GCI)	Consistency Measure
	0,008	0,002	0,004	0,002	……	0,004		
A	0,008	0,008	0,008	0,008	……	0,008	2,154	266
B	0,002	0,002	0,002	0,002	……	0,002	0,539	266
C	0,004	0,004	0,004	0,004	……	0,004	1,077	266
D	0,002	0,002	0,002	0,002	……	0,002	0,539	266
E	0,003	0,003	0,003	0,003	……	0,003	0,718	266
F	0,004	0,004	0,004	0,004	……	0,004	1,077	266
G	0,004	0,004	0,004	0,004	……	0,004	1,077	266
H	0,004	0,004	0,004	0,004	……	0,004	1,077	266
I	0,004	0,004	0,004	0,004	……	0,004	1,077	266
J	0,002	0,002	0,002	0,002	……	0,002	0,539	266
K	0,004	0,004	0,004	0,004	……	0,004	1,077	266
L	0,002	0,002	0,002	0,002	……	0,002	0,539	266
M	0,002	0,002	0,002	0,002	……	0,002	0,539	266
N	0,004	0,004	0,004	0,004	……	0,004	1,077	266
Ñ	0,004	0,004	0,004	0,004	……	0,004	1,077	266
O	0,008	0,008	0,008	0,008	……	0,008	2,154	266
P	0,008	0,008	0,008	0,008	……	0,008	2,154	266
Q	0,004	0,004	0,004	0,004	……	0,004	1,077	266
R	0,008	0,008	0,008	0,008	……	0,008	2,154	266
S	0,004	0,004	0,004	0,004	……	0,004	1,077	266
T	0,004	0,004	0,004	0,004	……	0,004	1,077	266

U	0,004	0,004	0,004	0,004	**……**	0,004	1,077	266
V	0,004	0,004	0,004	0,004	**……**	0,004	1,077	266
W	0,002	0,002	0,002	0,002	**……**	0,002	0,539	266
X	0,004	0,004	0,004	0,004	**……**	0,004	1,077	266
Y	0,003	0,003	0,003	0,003	**……**	0,003	0,718	266
Z	0,004	0,004	0,004	0,004	**……**	0,004	1,077	266
AA	0,004	0,004	0,004	0,004	**……**	0,004	1,077	266
……	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**
IU	0,003	0,003	0,003	0,003	**……**	0,003	0,718	266
IV	0,004	0,004	0,004	0,004	**……**	0,004	1,077	266
						λ max	**266**	**266**

Source: Own elaboration

Art. 3 Table 20: λ max estimation- Competence Risk.

VECTOR	A	B	C	D	……	IV	Geometric Consistency Index (GCI)	Consistency Measure
	0,004	0,002	0,004	0,002	……	0,003		
A	0,004	0,004	0,004	0,004	……	0,004	1,134	266
B	0,002	0,002	0,002	0,002	……	0,002	0,567	266
C	0,004	0,004	0,004	0,004	……	0,004	1,134	266
D	0,002	0,002	0,002	0,002	……	0,002	0,567	266
E	0,004	0,004	0,004	0,004	……	0,004	1,134	266
F	0,004	0,004	0,004	0,004	……	0,004	1,134	266
G	0,003	0,003	0,003	0,003	……	0,003	0,756	266
H	0,004	0,004	0,004	0,004	……	0,004	1,134	266
I	0,009	0,009	0,009	0,009	……	0,009	2,268	266
J	0,002	0,002	0,002	0,002	……	0,002	0,567	266
K	0,003	0,003	0,003	0,003	……	0,003	0,872	266
L	0,009	0,009	0,009	0,009	……	0,009	2,268	266
M	0,002	0,002	0,002	0,002	……	0,002	0,567	266
N	0,003	0,003	0,003	0,003	……	0,003	0,756	266
Ñ	0,002	0,002	0,002	0,002	……	0,002	0,567	266
O	0,002	0,002	0,002	0,002	……	0,002	0,567	266
P	0,009	0,009	0,009	0,009	……	0,009	2,268	266
Q	0,002	0,002	0,002	0,002	……	0,002	0,567	266
R	0,004	0,004	0,004	0,004	……	0,004	1,134	266
S	0,002	0,002	0,002	0,002	……	0,002	0,567	266
T	0,002	0,002	0,002	0,002	……	0,002	0,567	266

U	0,009	0,009	0,009	0,009	**……**	0,009	2,268	266
V	0,009	0,009	0,009	0,009	**……**	0,009	2,268	266
W	0,001	0,001	0,001	0,001	**……**	0,001	0,378	266
X	0,002	0,002	0,002	0,002	**……**	0,002	0,454	266
Y	0,002	0,002	0,002	0,002	**……**	0,002	0,567	266
Z	0,002	0,002	0,002	0,002	**……**	0,002	0,567	266
AA	0,009	0,009	0,009	0,009	**……**	0,009	2,268	266
……	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**
IU	0,003	0,003	0,003	0,003	**……**	0,003	0,756	266
IV	0,003	0,003	0,003	0,003	**……**	0,003	0,756	266
						λ max	**266**	**266**

Source: Own elaboration

Art. 3 Table 21: λ max estimation- Economic Risk.

VECTOR	A	B	C	D	……	IV	Geometric Consistency Index (GCI)	Consistency Measure
	0,005	0,003	0,002	0,003	……	0,003		
A	0,005	0,005	0,005	0,005	……	0,005	1,412	266
B	0,003	0,003	0,003	0,003	……	0,003	0,706	266
C	0,002	0,002	0,002	0,002	……	0,002	0,471	266
D	0,003	0,003	0,003	0,003	……	0,003	0,706	266
E	0,003	0,003	0,003	0,003	……	0,003	0,706	266
F	0,005	0,005	0,005	0,005	……	0,005	1,412	266
G	0,005	0,005	0,005	0,005	……	0,005	1,412	266
H	0,005	0,005	0,005	0,005	……	0,005	1,412	266
I	0,002	0,002	0,002	0,002	……	0,002	0,565	266
J	0,005	0,005	0,005	0,005	……	0,005	1,412	266
K	0,004	0,004	0,004	0,004	……	0,004	1,177	266
L	0,011	0,011	0,011	0,011	……	0,011	2,825	266
M	0,004	0,004	0,004	0,004	……	0,004	0,942	266
N	0,004	0,004	0,004	0,004	……	0,004	0,942	266
Ñ	0,003	0,003	0,003	0,003	……	0,003	0,706	266
O	0,002	0,002	0,002	0,002	……	0,002	0,565	266
P	0,005	0,005	0,005	0,005	……	0,005	1,412	266
Q	0,003	0,003	0,003	0,003	……	0,003	0,706	266
R	0,011	0,011	0,011	0,011	……	0,011	2,825	266
S	0,004	0,004	0,004	0,004	……	0,004	1,177	266
T	0,003	0,003	0,003	0,003	……	0,003	0,706	266

U	0,002	0,002	0,002	0,002	**……**	0,002	0,565	266
V	0,002	0,002	0,002	0,002	**……**	0,002	0,565	266
W	0,005	0,005	0,005	0,005	**……**	0,005	1,412	266
X	0,003	0,003	0,003	0,003	**……**	0,003	0,706	266
Y	0,005	0,005	0,005	0,005	**……**	0,005	1,412	266
Z	0,005	0,005	0,005	0,005	**……**	0,005	1,412	266
AA	0,011	0,011	0,011	0,011	**……**	0,011	2,825	266
……	**……**	**……**	**……**	**……**	**……**	**……**	**……**	**……**
IU	0,003	0,003	0,003	0,003	**……**	0,003	0,706	266
IV	0,003	0,003	0,003	0,003	**……**	0,003	0,706	266
						λ max	**266**	**266**

Source: Own elaboration

Annex 6: Estimation of Cost of Capital

Art. 3 Table 23: Estimation of cost of capital.

Companies	Risk Premium Weight	Risk Free Rate- 24/07/2023	Cost of Capital Without Country Risk	Country Risk -24 junio 2023	Cost of capital, incluiding the Country Risk
A	0,42%	3,86%	4,28%	18,57%	22,85%
B	0,44%	3,86%	4,30%	18,57%	22,87%
C	0,35%	3,86%	4,21%	18,57%	22,78%
D	0,42%	3,86%	4,28%	18,57%	22,85%
E	0,33%	3,86%	4,19%	18,57%	22,76%
F	0,37%	3,86%	4,23%	18,57%	22,80%
G	0,35%	3,86%	4,21%	18,57%	22,78%
H	0,44%	3,86%	4,30%	18,57%	22,87%
I	0,64%	3,86%	4,50%	18,57%	23,07%
J	0,36%	3,86%	4,22%	18,57%	22,79%
K	0,34%	3,86%	4,20%	18,57%	22,77%
L	0,52%	3,86%	4,38%	18,57%	22,95%
M	0,33%	3,86%	4,19%	18,57%	22,76%
N	0,33%	3,86%	4,19%	18,57%	22,76%
Ñ	0,35%	3,86%	4,21%	18,57%	22,78%
O	0,39%	3,86%	4,25%	18,57%	22,82%
P	0,49%	3,86%	4,35%	18,57%	22,92%

Q	0,35%	3,86%	4,21%	18,57%	22,78%
R	0,50%	3,86%	4,36%	18,57%	22,93%
S	0,34%	3,86%	4,20%	18,57%	22,77%
T	0,35%	3,86%	4,21%	18,57%	22,78%
U	0,43%	3,86%	4,29%	18,57%	22,86%
V	0,42%	3,86%	4,28%	18,57%	22,85%
W	0,38%	3,86%	4,24%	18,57%	22,81%
X	0,35%	3,86%	4,21%	18,57%	22,78%
Y	0,36%	3,86%	4,22%	18,57%	22,79%
Z	0,36%	3,86%	4,22%	18,57%	22,79%
AA	0,54%	3,86%	4,40%	18,57%	22,97%
AB	0,34%	3,86%	4,20%	18,57%	22,77%
AC	0,39%	3,86%	4,25%	18,57%	22,82%
AD	0,40%	3,86%	4,26%	18,57%	22,83%
AE	0,40%	3,86%	4,26%	18,57%	22,83%
AF	0,37%	3,86%	4,23%	18,57%	22,80%
AG	0,37%	3,86%	4,23%	18,57%	22,80%
AH	0,34%	3,86%	4,20%	18,57%	22,77%
AI	0,42%	3,86%	4,28%	18,57%	22,85%
AJ	0,35%	3,86%	4,21%	18,57%	22,78%
AK	0,33%	3,86%	4,19%	18,57%	22,76%
AL	0,39%	3,86%	4,25%	18,57%	22,82%
AM	0,37%	3,86%	4,23%	18,57%	22,80%

AN	0,42%	3,86%	4,28%	18,57%	22,85%
AÑ	0,34%	3,86%	4,20%	18,57%	22,77%
AO	0,67%	3,86%	4,53%	18,57%	23,10%
AP	0,34%	3,86%	4,20%	18,57%	22,77%
AQ	0,34%	3,86%	4,20%	18,57%	22,77%
AR	0,34%	3,86%	4,20%	18,57%	22,77%
AS	0,33%	3,86%	4,19%	18,57%	22,76%
AT	0,38%	3,86%	4,24%	18,57%	22,81%
AU	0,33%	3,86%	4,19%	18,57%	22,76%
AV	0,34%	3,86%	4,20%	18,57%	22,77%
AW	0,32%	3,86%	4,18%	18,57%	22,75%
AX	0,37%	3,86%	4,23%	18,57%	22,80%
AY	0,33%	3,86%	4,19%	18,57%	22,76%
AZ	0,39%	3,86%	4,25%	18,57%	22,82%
BA	0,34%	3,86%	4,20%	18,57%	22,77%
BB	0,46%	3,86%	4,32%	18,57%	22,89%
BC	0,42%	3,86%	4,28%	18,57%	22,85%
BD	0,35%	3,86%	4,21%	18,57%	22,78%
BE	0,39%	3,86%	4,25%	18,57%	22,82%
BF	0,33%	3,86%	4,19%	18,57%	22,76%
BG	0,34%	3,86%	4,20%	18,57%	22,77%
BH	0,34%	3,86%	4,20%	18,57%	22,77%
BI	0,37%	3,86%	4,23%	18,57%	22,80%

BJ	0,37%	3,86%	4,23%	18,57%	22,80%
BK	0,41%	3,86%	4,27%	18,57%	22,84%
BL	0,33%	3,86%	4,19%	18,57%	22,76%
BM	0,34%	3,86%	4,20%	18,57%	22,77%
BN	0,32%	3,86%	4,18%	18,57%	22,75%
BÑ	0,35%	3,86%	4,21%	18,57%	22,78%
BO	0,36%	3,86%	4,22%	18,57%	22,79%
BP	0,35%	3,86%	4,21%	18,57%	22,78%
BQ	0,41%	3,86%	4,27%	18,57%	22,84%
BR	0,51%	3,86%	4,37%	18,57%	22,94%
BS	0,35%	3,86%	4,21%	18,57%	22,78%
BT	0,34%	3,86%	4,20%	18,57%	22,77%
BU	0,35%	3,86%	4,21%	18,57%	22,78%
BV	0,34%	3,86%	4,20%	18,57%	22,77%
BW	0,37%	3,86%	4,23%	18,57%	22,80%
BX	0,36%	3,86%	4,22%	18,57%	22,79%
BY	0,40%	3,86%	4,26%	18,57%	22,83%
BZ	0,40%	3,86%	4,26%	18,57%	22,83%
CA	0,34%	3,86%	4,20%	18,57%	22,77%
CB	0,37%	3,86%	4,23%	18,57%	22,80%
CC	0,36%	3,86%	4,22%	18,57%	22,79%
CD	0,35%	3,86%	4,21%	18,57%	22,78%
CE	0,32%	3,86%	4,18%	18,57%	22,75%

CF	0,32%	3,86%	4,18%	18,57%	22,75%
CG	0,33%	3,86%	4,19%	18,57%	22,76%
CH	0,33%	3,86%	4,19%	18,57%	22,76%
CI	0,34%	3,86%	4,20%	18,57%	22,77%
CJ	0,36%	3,86%	4,22%	18,57%	22,79%
CK	0,35%	3,86%	4,21%	18,57%	22,78%
CL	0,47%	3,86%	4,33%	18,57%	22,90%
CM	0,54%	3,86%	4,40%	18,57%	22,97%
CN	0,35%	3,86%	4,21%	18,57%	22,78%
CÑ	0,46%	3,86%	4,32%	18,57%	22,89%
CO	0,35%	3,86%	4,21%	18,57%	22,78%
CP	0,34%	3,86%	4,20%	18,57%	22,77%
CQ	0,38%	3,86%	4,24%	18,57%	22,81%
CR	0,35%	3,86%	4,21%	18,57%	22,78%
CS	0,41%	3,86%	4,27%	18,57%	22,84%
CT	0,34%	3,86%	4,20%	18,57%	22,77%
CU	0,37%	3,86%	4,23%	18,57%	22,80%
CV	0,37%	3,86%	4,23%	18,57%	22,80%
CW	0,47%	3,86%	4,33%	18,57%	22,90%
CX	0,32%	3,86%	4,18%	18,57%	22,75%
CY	0,41%	3,86%	4,27%	18,57%	22,84%
CZ	0,32%	3,86%	4,18%	18,57%	22,75%
DA	0,33%	3,86%	4,19%	18,57%	22,76%

DB	0,37%	3,86%	4,23%	18,57%	22,80%
DC	0,35%	3,86%	4,21%	18,57%	22,78%
DD	0,40%	3,86%	4,26%	18,57%	22,83%
DE	0,40%	3,86%	4,26%	18,57%	22,83%
DF	0,33%	3,86%	4,19%	18,57%	22,76%
DG	0,35%	3,86%	4,21%	18,57%	22,78%
DH	0,34%	3,86%	4,20%	18,57%	22,77%
DI	0,52%	3,86%	4,38%	18,57%	22,95%
DJ	0,34%	3,86%	4,20%	18,57%	22,77%
DK	0,49%	3,86%	4,35%	18,57%	22,92%
DL	0,36%	3,86%	4,22%	18,57%	22,79%
DM	0,37%	3,86%	4,23%	18,57%	22,80%
DN	0,40%	3,86%	4,26%	18,57%	22,83%
DÑ	0,40%	3,86%	4,26%	18,57%	22,83%
DO	0,58%	3,86%	4,44%	18,57%	23,01%
DP	0,36%	3,86%	4,22%	18,57%	22,79%
DQ	0,36%	3,86%	4,22%	18,57%	22,79%
DR	0,33%	3,86%	4,19%	18,57%	22,76%
DS	0,44%	3,86%	4,30%	18,57%	22,87%
DT	0,45%	3,86%	4,31%	18,57%	22,88%
DU	0,34%	3,86%	4,20%	18,57%	22,77%
DV	0,32%	3,86%	4,18%	18,57%	22,75%
DW	0,36%	3,86%	4,22%	18,57%	22,79%

DX	0,34%	3,86%	4,20%	18,57%	22,77%
DY	0,57%	3,86%	4,43%	18,57%	23,00%
DZ	0,34%	3,86%	4,20%	18,57%	22,77%
EA	0,36%	3,86%	4,22%	18,57%	22,79%
EB	0,34%	3,86%	4,20%	18,57%	22,77%
EC	0,36%	3,86%	4,22%	18,57%	22,79%
ED	0,34%	3,86%	4,20%	18,57%	22,77%
EE	0,34%	3,86%	4,20%	18,57%	22,77%
EF	0,33%	3,86%	4,19%	18,57%	22,76%
EG	0,35%	3,86%	4,21%	18,57%	22,78%
EH	0,32%	3,86%	4,18%	18,57%	22,75%
EI	0,36%	3,86%	4,22%	18,57%	22,79%
EJ	0,33%	3,86%	4,19%	18,57%	22,76%
EK	0,42%	3,86%	4,28%	18,57%	22,85%
EL	0,36%	3,86%	4,22%	18,57%	22,79%
EM	0,34%	3,86%	4,20%	18,57%	22,77%
EN	0,34%	3,86%	4,20%	18,57%	22,77%
EÑ	0,33%	3,86%	4,19%	18,57%	22,76%
EO	0,36%	3,86%	4,22%	18,57%	22,79%
EP	0,34%	3,86%	4,20%	18,57%	22,77%
EQ	0,36%	3,86%	4,22%	18,57%	22,79%
ER	0,36%	3,86%	4,22%	18,57%	22,79%
ES	0,36%	3,86%	4,22%	18,57%	22,79%

ET	0,32%	3,86%	4,18%	18,57%	22,75%
EU	0,36%	3,86%	4,22%	18,57%	22,79%
EV	0,37%	3,86%	4,23%	18,57%	22,80%
EW	0,34%	3,86%	4,20%	18,57%	22,77%
EX	0,34%	3,86%	4,20%	18,57%	22,77%
EY	0,34%	3,86%	4,20%	18,57%	22,77%
EZ	0,36%	3,86%	4,22%	18,57%	22,79%
FA	0,33%	3,86%	4,19%	18,57%	22,76%
FB	0,34%	3,86%	4,20%	18,57%	22,77%
FC	0,35%	3,86%	4,21%	18,57%	22,78%
FD	0,41%	3,86%	4,27%	18,57%	22,84%
FE	0,35%	3,86%	4,21%	18,57%	22,78%
FF	0,49%	3,86%	4,35%	18,57%	22,92%
FG	0,34%	3,86%	4,20%	18,57%	22,77%
FH	0,39%	3,86%	4,25%	18,57%	22,82%
FI	0,34%	3,86%	4,20%	18,57%	22,77%
FJ	0,33%	3,86%	4,19%	18,57%	22,76%
FK	0,34%	3,86%	4,20%	18,57%	22,77%
FL	0,35%	3,86%	4,21%	18,57%	22,78%
FM	0,34%	3,86%	4,20%	18,57%	22,77%
FN	0,33%	3,86%	4,19%	18,57%	22,76%
FÑ	0,35%	3,86%	4,21%	18,57%	22,78%
FO	0,34%	3,86%	4,20%	18,57%	22,77%

FP	0,37%	3,86%	4,23%	18,57%	22,80%
FQ	0,34%	3,86%	4,20%	18,57%	22,77%
FR	0,34%	3,86%	4,20%	18,57%	22,77%
FS	0,45%	3,86%	4,31%	18,57%	22,88%
FT	0,37%	3,86%	4,23%	18,57%	22,80%
FU	0,36%	3,86%	4,22%	18,57%	22,79%
FV	0,37%	3,86%	4,23%	18,57%	22,80%
FW	0,41%	3,86%	4,27%	18,57%	22,84%
FX	0,35%	3,86%	4,21%	18,57%	22,78%
FY	0,35%	3,86%	4,21%	18,57%	22,78%
FZ	0,36%	3,86%	4,22%	18,57%	22,79%
GA	0,33%	3,86%	4,19%	18,57%	22,76%
GB	0,35%	3,86%	4,21%	18,57%	22,78%
GC	0,36%	3,86%	4,22%	18,57%	22,79%
GD	0,34%	3,86%	4,20%	18,57%	22,77%
GE	0,35%	3,86%	4,21%	18,57%	22,78%
GF	0,35%	3,86%	4,21%	18,57%	22,78%
GG	0,35%	3,86%	4,21%	18,57%	22,78%
GH	0,33%	3,86%	4,19%	18,57%	22,76%
GI	0,37%	3,86%	4,23%	18,57%	22,80%
GJ	0,37%	3,86%	4,23%	18,57%	22,80%
GK	0,52%	3,86%	4,38%	18,57%	22,95%
GL	0,35%	3,86%	4,21%	18,57%	22,78%

GM	0,59%	3,86%	4,45%	18,57%	23,02%
GN	0,40%	3,86%	4,26%	18,57%	22,83%
GÑ	0,41%	3,86%	4,27%	18,57%	22,84%
GO	0,33%	3,86%	4,19%	18,57%	22,76%
GP	0,36%	3,86%	4,22%	18,57%	22,79%
GQ	0,35%	3,86%	4,21%	18,57%	22,78%
GR	0,34%	3,86%	4,20%	18,57%	22,77%
GS	0,35%	3,86%	4,21%	18,57%	22,78%
GT	0,36%	3,86%	4,22%	18,57%	22,79%
GU	0,34%	3,86%	4,20%	18,57%	22,77%
GV	0,38%	3,86%	4,24%	18,57%	22,81%
GW	0,34%	3,86%	4,20%	18,57%	22,77%
GX	0,32%	3,86%	4,18%	18,57%	22,75%
GY	0,34%	3,86%	4,20%	18,57%	22,77%
GZ	0,33%	3,86%	4,19%	18,57%	22,76%
HA	0,32%	3,86%	4,18%	18,57%	22,75%
HB	0,35%	3,86%	4,21%	18,57%	22,78%
HC	0,35%	3,86%	4,21%	18,57%	22,78%
HD	0,41%	3,86%	4,27%	18,57%	22,84%
HE	0,40%	3,86%	4,26%	18,57%	22,83%
HF	0,34%	3,86%	4,20%	18,57%	22,77%
HG	0,35%	3,86%	4,21%	18,57%	22,78%
HH	0,50%	3,86%	4,36%	18,57%	22,93%

HI	0,36%	3,86%	4,22%	18,57%	22,79%
HJ	0,34%	3,86%	4,20%	18,57%	22,77%
HK	0,41%	3,86%	4,27%	18,57%	22,84%
HL	0,50%	3,86%	4,36%	18,57%	22,93%
HM	0,34%	3,86%	4,20%	18,57%	22,77%
HN	0,34%	3,86%	4,20%	18,57%	22,77%
HÑ	0,34%	3,86%	4,20%	18,57%	22,77%
HO	0,50%	3,86%	4,36%	18,57%	22,93%
HP	0,38%	3,86%	4,24%	18,57%	22,81%
HQ	0,35%	3,86%	4,21%	18,57%	22,78%
HR	0,35%	3,86%	4,21%	18,57%	22,78%
HS	0,38%	3,86%	4,24%	18,57%	22,81%
HT	0,33%	3,86%	4,19%	18,57%	22,76%
HU	0,33%	3,86%	4,19%	18,57%	22,76%
HV	0,35%	3,86%	4,21%	18,57%	22,78%
HW	0,35%	3,86%	4,21%	18,57%	22,78%
HX	0,40%	3,86%	4,26%	18,57%	22,83%
HY	0,33%	3,86%	4,19%	18,57%	22,76%
HZ	0,32%	3,86%	4,18%	18,57%	22,75%
IA	0,37%	3,86%	4,23%	18,57%	22,80%
IB	0,41%	3,86%	4,27%	18,57%	22,84%
IC	0,47%	3,86%	4,33%	18,57%	22,90%
ID	0,33%	3,86%	4,19%	18,57%	22,76%

IE	0,35%	3,86%	4,21%	18,57%	22,78%
IF	0,34%	3,86%	4,20%	18,57%	22,77%
IG	0,35%	3,86%	4,21%	18,57%	22,78%
IH	0,41%	3,86%	4,27%	18,57%	22,84%
II	0,35%	3,86%	4,21%	18,57%	22,78%
IJ	0,33%	3,86%	4,19%	18,57%	22,76%
IK	0,36%	3,86%	4,22%	18,57%	22,79%
IL	0,59%	3,86%	4,45%	18,57%	23,02%
IM	0,41%	3,86%	4,27%	18,57%	22,84%
IN	0,49%	3,86%	4,35%	18,57%	22,92%
IÑ	0,39%	3,86%	4,25%	18,57%	22,82%
IO	0,52%	3,86%	4,38%	18,57%	22,95%
IP	0,33%	3,86%	4,19%	18,57%	22,76%
IQ	0,43%	3,86%	4,29%	18,57%	22,86%
IR	0,50%	3,86%	4,36%	18,57%	22,93%
IS	0,34%	3,86%	4,20%	18,57%	22,77%
IT	0,39%	3,86%	4,25%	18,57%	22,82%
IU	0,32%	3,86%	4,18%	18,57%	22,75%
IV	0,43%	3,86%	4,29%	18,57%	22,86%
Total	100%	**Average**	4,24%	**Average**	22,81%

Source: Own elaboration