The Anáhuac Journal, Vol. 25, núm. 2, 2025 | ISSN-e 2683-2690 | https://doi.org/10.36105/theanahuacjour.2025v25n2.2999 | e2999 (pp. 106-122) | https://revistas.anahuac.mx/index.php/the_anahuac_journal

Exploring Interest Rate Dynamics on Real Option Valuation for Private Equity

Explorar la dinámica de las tasas de interés en la valoración de opciones reales para el capital privado

Luisa Alejandra Vilches Murillo, Tecnológico de Monterrey, Mexico, (lavilches@tec.mx) https://orcid.org/0000-0002-4611-2361

Dr. Iván Adolfo Valdovinos Hernández, Tecnológico de Monterrey, Mexico, (ivaldovinos@tec.mx) https://orcid.org/0000-0002-6319-1735

Abstract

This study analyzes the impact of interest rates on real option valuation in private equity, a highly volatile sector. Unlike traditional models such as discounted cash flows (DCF) or internal rate of return (IRR), real options incorporate not only the discounting of future cash flows, but also the possibility of exercising or deferring the investment as expected returns change. Using the Black-Scholes model, the results show that interest rates significantly influence valuations: put options reveal potential losses and decline as interest rates increase, while call options remain practically stable. These findings suggest that real options provide a more comprehensive view of the impact of monetary policy on private equity investments and allow the valuation to incorporate the sector's inherent uncertainty.

Resumen

Este trabajo analiza el impacto de las tasas de interés sobre la valoración mediante opciones reales en el capital privado, un sector altamente volátil. A diferencia de los modelos tradicionales, como los flujos de flujos descontados (DCF) o la tasa interna de retorno (IRR), las opciones reales consideran no solo el descuento de flujos futuros, sino también la posibilidad de ejercer o posponer la inversión conforme cambian los rendimientos esperados. Mediante el modelo de Black-Scholes, los resultados muestran que las tasas de interés influyen de forma significativa en las valoraciones, donde las opciones de venta reflejan pérdidas potenciales y disminuyen conforme aumentan las tasas, mientras las opciones de compra permanecen prácticamente estables. Estos hallazgos sugieren que las opciones reales ofrecen una visión más completa del impacto de la política monetaria en las inversiones de capital privado y permiten incorporar en la valuación la incertidumbre característica del sector.

KEYWORDS / PALABRAS CLAVE

Private equity, valuation, interest rates, real options / Capital privado, valuación, tasas de interés, opciones reales.

JEL Classification / Clasificación JEL: *G11, G17.*

Received: July 30, 2025 | Reviewed: October 30, 2025 | Approved: November 3, 2025 | Published: December 1, 2025.

1. Introduction

Private equity (PE) has been a catalyst providing an important and needed boost to promising enterprises that are relevant players across diverse sectors of the economy. According to data from the Eikon Refinitiv platform (LSEG Data & Analytics, 2024), a total of $402.09 billion was raised in the US in 2024. Forecasts indicate there will be $7.7 billion in assets under management by fund strategy in 2029 (PitchBook, 2024).

The growing appetite for private equity raises the question of whether there is a standardized valuation method among investors to make informed, rational decisions. However, in practice, methodologies vary depending on the valuation firm's approach and the company being evaluated. Most commonly used methodologies include discounted cash flow (DCF) and comparable companies' analysis (Hooke, 2024). Others use performance metrics, such as internal rate of return (IRR), total value paid-in capital (TVPI), or public market equivalent (PME) measures (Kaplan & Schoar, 2005). Private equity has proven challenging for traditional methods, as cash flows can be volatile (Robinson & Sensoy, 2016). Also, there is strong recognition that private equity involves significant exposure to multiple sources of aggregate risk (Gupta & Van Nieuwerburgh, 2021), that valuation of illiquid assets tends to be difficult, and that some fund managers report inflated valuations to raise more capital (Cumming & Walz, 2010). Valuations can also yield different results across companies, depending on their sector, corporate governance, and country of origin (Smolarski et al., 2011).

In PE, investors allocate their resources to a PE firm that invests in companies with strong growth potential, not only pouring capital but also providing managerial expertise. This unique market provides a higher level of complexity and challenge to traditional valuation methods. By using real options, valuations are more realistic and efficient, as they include the volatility PE carries in its process.

In real option valuation, the discount rate significantly affects the outcome, as the valuation is highly sensitive to interest rates: not only can the result change, but the timing of expiration and the valuation of the investment project can be affected as well (Ballestra et al., 2017).

In the last five years, some papers have examined how venture capital (VC) can be analyzed through real option models. Shuwaikh et al. (2024) argue that real options are an input to the behavioral and strategic investment framework. Deng

et al. (2025) developed a model to optimize investment and exit strategies in VC portfolios, focusing on the optimal period for maximizing returns. Gupta and Van Nieuwerburgh (2021) examine PE investment strategies, with an emphasis on value creation across investment stages and on strategic timing in response to economic changes.

This paper explores the use of real options as an alternative valuation method for private equity investments. It highlights the industry's inherent volatility and examines how interest rates affect private equity valuation using the Black-Scholes model. The model quantifies the impact of interest rate changes on the option value of PE deals, illustrating how variations in the risk-free rate influence the values of call and put options. Thus, reflecting the potential for upside gain (as represented by call options) and downside risk (as represented by put options) that are characteristic of PE transactions.

2. Literature Review

2.1 Real Options and Private Equity

Several valuation instruments are commonly used in private equity. As stated by Cumming and Walz (2010), although the International Private Equity and Venture Capital Valuation Guidelines (IPEV) provide recommendations for alternative funds, these recommendations are not mandatory for financial reporting standards regarding valuation techniques. Other instruments used include the Modigliani-Miller theorem and financial ratios such as the internal rate of return IRR, TVPI, and DCF valuation (Gupta & Van Nieuwerburgh, 2021). In addition to these recommendations, PE professionals use methodologies such as comparable public companies, comparable acquisitions, and leveraged buyouts (LBOs) (Hooke, 2024). Nevertheless, these methods do not reflect the uncertainty and volatility the private equity sector experiences. Therefore, the use of real options in valuing private equity provides a precise and flexible framework for assessing all available investment alternatives for the company, delivering long-term benefits and a robust valuation.

The opportunity to defer an option and the impact of time preference in investments can be traced back to Fisher (1930), who formalized the calculation of the potential future returns of investments. Samuelson (1965) introduced the

rational evaluation of a warrant, considering the value of the right to convert at any point of the interval and deducing the value of the stock that will pay to exercise the call (or the warrant). Black-Scholes (1973) tested their proposed formula for the theoretical value of an option to compare option values with actual option premiums. Merton (1974) extended this model, presenting the theory of the risk structure of interest rates, in which possible gains or losses to bondholders result from changes in the probability of default and do not include gains or losses from changes in interest rates.

Real options in the context of PE have been studied previously, even though they are often used in investment valuation. It has been recognized as a relevant valuation method, as it allows valuing risk investment projects by analyzing different strategic scenarios (McDonald & Siegel, 1985).

It has been recognized that PE investments are illiquid, long-term, and high-risk, requiring an additional premium. Thus, a proposed model by Sorensen et al. (2014) includes asset allocation for an institutional investment in PE that accounts for these volatile characteristics. For some industries, such as biotechnology companies, real option valuation has been explored using the decision-tree method and binomial-lattice method to illustrate the valuation is derived from expected profits and potential growth of the company with many portfolios or profitable products available (Kellogg & Charnes, 2000). Also, previous literature has provided evidence of situations where an investment opportunity with multiple real options evaluating each option individually and adding these separate option values as to defer, abandon, contract or expand the investment, can substantially overstate the value of a project (Trigeorgis, 1993).

2.2 Interest Rates and Private Equity

Interest rates play a pivotal role in the economy and financial markets. Besides being used as discount rates in DCFs, they play a central role in the calculation of cost of capital, loans, bond pricing, and, of course, option pricing. Central banks determine interest rates through monetary policy, which can introduce uncertainty into investment decisions. During the 2010s, interest rates remained low, and the question was how they would influence valuations, investments, and economic data. A study examining US equity markets and interest rates, as well as international markets in the United Kingdom, Germany, and Japan found little evidence to support a positive relationship between value factors and simultaneous changes in

long-term bond yields (Maloney & Moskowitz, 2021). Also, empirical investigations have examined the effect of interest rate uncertainty on the valuation of investment projects, with the interest rate specified as a Vasicek-type stochastic process, and such uncertainty reduces valuation (Ballestra et al., 2017).

The low level of interest rates has provided diminished risk premiums and boosted demand for PE, as investors saw it as an opportunity to increase returns. Further, the low cost of financing provided an attractive environment for LBOs, and a reduced cost of capital has been actively used to increase PE funds.

Even though economic growth has seemed to improve, and inflation has been reduced, in 2024, monetary policy moved towards a rate cut, with a strong indication that the US Federal Reserve is in no hurry to implement such an adjustment in 2025. If a recession does not occur, cutting rates will not be an option to control inflation (Modigliani & Cohn, 1979).

Thus, when considering the methodology of real option valuation and the relevance of interest rates in valuation, there is a need to measure PE deals using these inputs to provide a dynamic framework for understanding how interest rates impact the strategy and timing of such transactions.

3. Methodology

The methodology is based in part on the valuation model of Schwartz and Moon (2000), as their proposal articulates that companies (their approach is for internet companies) should reflect growth as a key driver in their valuation (Schosser & Ströbele, 2019).

This situation can be studied by analyzing data from recent PE deals involving companies that were delisted. The sample is based on data availability, deal size, and completion between 2019 and 2024, as such transactions provided sufficient public information for the valuation modeling. A significant part of the firms examined are from the technology sector, reflecting the strong presence of this sector in private equity deals. This industry's high volatility is well-suited for analyzing the sensitivity of interest rates to PE valuations, as shown in Table 1 (Table 1).

Table 1. Information on Company Deals

Company	Buyers	Deal Size ($B)	Deal Announcement	Deal Completion
Qualtrics International Inc.	Silver Lake	10.00	03/12/23	06/29/23
Toshiba Tec Corp.	Japan Industrial Partners	16.00	23/03/23	12/20/23
Univar Solutions LLC	Apollo Funds	8.10	14/03/23	01/08/23
Coupa Software Inc.	Thoma Bravo	6.10	12/12/22	01/03/23
Dell Technologies Inc.	Silver Lake	24.40	02/05/23	12/09/23
Refinitiv (London Stock Exchange Group PLC)	Blackstone	27.00	08/01/19	01/29/21
McAfee Corp.	Permira	14.00	11/08/21	01/03/22
Squarespace Inc.	Permira	7.20	05/01/24	10/17/24

Source: Prepared by the authors based on information from Pitchbook (2024) and Bloomberg (2024).

The Black-Scholes option pricing model (1973) is introduced as a benchmark for valuing European style options. For this study, this model is proposed as it was developed for financial options, providing a useful framework for valuing investment opportunities under uncertainty. The formula for a European call option is:

$$C = N(d_1)S_0 - N(d_2)K \cdot e^{-rT} \quad (1)$$

Where:

$$d_1 = \frac{ln\left(\frac{S_0}{K}\right) + (r + \frac{\sigma^2}{2}) \cdot T}{\sigma \cdot \sqrt{T}}$$

$$d_2 = d_1 - \sigma \cdot \sqrt{T}$$

To make this estimation, the input parameters are:

1. (K) Strike or Price. Deal size.

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https://doi.org/10.36105/theanahuacjour.2025v25n2.2999
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2. (S) Current value of investment: Value of target firm in discounted cash flow method before the change in interest rates, as in 2019.

$$DCF = \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \cdots + \frac{CF_n}{(1+r)^n} \quad (2)$$

Legend:

DCF= discounted cash flow

CF_i= cash flow period i

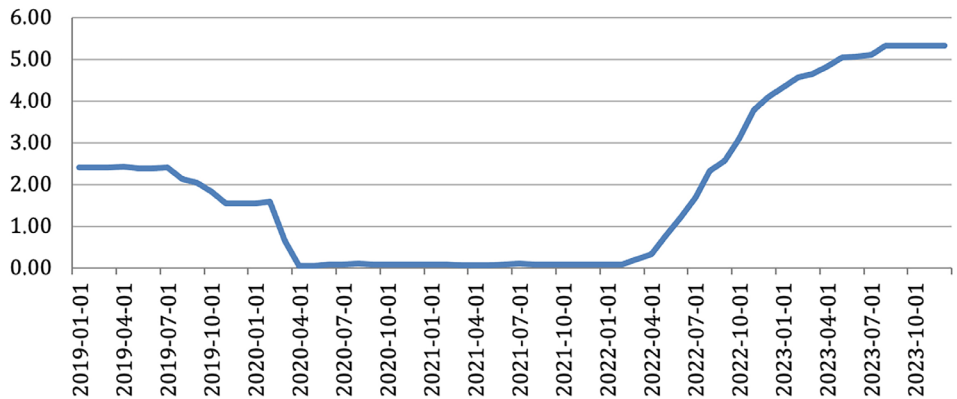
r = interest rate

n = time

3. (T) Time of expiration. Average time holding period of the PE firm. According to a S&P Global study, the average holding period in 2023 was 7.1 years (FRED, 2024).

4. (r) Risk-free rate. Proxy for this study. Valuation is made for the interest rates presented in January from 2019 to 2023, as shown in Figure 1 and Table 2 (see Figure 1 and Table 2).

Figure 1. FED Interest Rates 2019-2023



Source: Prepared by the authors.

Table 2. Federal Funds Effective Rate (FEDFUNDS)

Observation Date	FEDFUNDS
Jan-2019	2.16
Jan-2020	0.38
Jan-2021	0.08
Jan-2022	1.68
Jan-2023	5.02

Source: Prepared by the authors based on information from FRED (2024).

5. (sigma) Volatility = standard deviation for the price of the stock of daily returns over the last two years prior to the private equity deal, as shown in Table 3 (see Table 3):

Table 3. Company Volatility

Company	Sigma
Qualtrics International Inc	0.430
Toshiba Tec Corp	13.407
Univar Solutions LLC	0.159
Coupa Software Inc	2.316
Dell Technologies Inc	0.226
Refinitiv (London Stock Exchange Group PLC)	19.299
McAfee Corp	0.154
Squarespace Inc	0.372

Source: Prepared by the authors based on information from LSEG Data & Analytics (2024).

4. Results

Compared with traditional valuation models such as DCF, real option valuations obtained in this study tend to produce lower present values at high interest rates but higher relative values when volatility is high. The difference is due to DCF methodology, which discounts expected cash flow at a fixed rate, while real option valuation models incorporate uncertainty and the option to defer or abandon the investment. This can be appreciated in Table 4 (see Table 4).

Table 4. Results of Black-Scholes Valuation as Applied to Private Equity

Company	r Interest Rate	S Current price of investment	X Deal size	SX Ratio	CallPrice	PutPrice
Qualtrics International Inc. (software [system & application])	0.0216	0.000145	10	0.00001	0	9.17213
	0.038					8.58974
	0.008					9.68492
	0.0168					9.34994
	0.0502					8.18062
Toshiba Tec Corp. (electrical equipment)	0.0216	0.007921	16	0.0005	0.00792	14.67564
	0.038					13.74381
	0.008					15.49611
	0.0168					14.96013
	0.0502					13.08922
Univar Solutions LLC (chemical [basic])	0.0216	0.001702	8.1	0.00021	0	7.26908
	0.038					6.69667
	0.008					7.78069
	0.0168					7.44569
	0.0502					6.30028
Coupa Software Inc. (software [system & application])	0.0216	0.000145	6.1	0.00002	0.00006	5.595
	0.038					5.23975
	0.008					5.90781
	0.0168					5.70347
	0.0502					4.99018
Dell Technologies Inc. (computers/ peripherals)	0.0216	0.008344	24.4	0.00034	0	22.372
	0.038					20.95097
	0.008					23.62322
	0.0168					22.80586
	0.0502					19.95271

Company	r Interest Rate	S Current price of investment	X Deal size	SX Ratio	CallPrice	PutPrice
Refinitiv (financial services [non-bank & insurance])	0.0216	0.011874	27	0.00044	0.01187	25.85844
	0.038					25.02404
	0.008					26.57144
	0.0168					26.10787
	0.0502					24.42084
McAfee Corp. (software [system & application])	0.0216	0.007158	14	0.00051	0	13.11441
	0.038					12.48445
	0.008					13.66084
	0.0168					13.30473
	0.0502					12.03553
Squarespace Inc. (software [system & application])	0.0216	0.000346	7.2	0.00005	0	6.60369
	0.038					6.18437
	0.008					6.9729
	0.0168					6.73171
	0.0502					5.8898

Source: Prepared by the authors based on data from LSEG Data & Analytics (2024), modeled using R.

Among the eight private equity transactions across different sections using the Black-Scholes model, as interest rates rise from 0.0216 to 0.0502, put option values decline across all firms (for example, Qualtrics from 9.17 to 8.18, Dell from 22.37 to 19.95), confirming that higher discount rates reduce the present values of expected profits. In contrast, call values remain stable and low, with almost no change, suggesting that the upside potential in PE is not as sensitive to rate increases. Software firms, such as Qualtrics, Coupa, and Squarespace, show slightly more variation in call options between low and high interest rates and between industrial and financial companies, suggesting that software company valuations are more sensitive to changes in interest rates. Overall, these results confirm that interest rate dynamics alter valuation outcomes in PE, validating the hypothesis that real option valuation models can capture the monetary policy impact that is often overlooked in traditional valuation models, which can be observed in Figure 2 and Table 4 (see Figure 2, below, and Table 4, above).

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https://doi.org/10.36105/theanahuacjour.2025v25n2.2999
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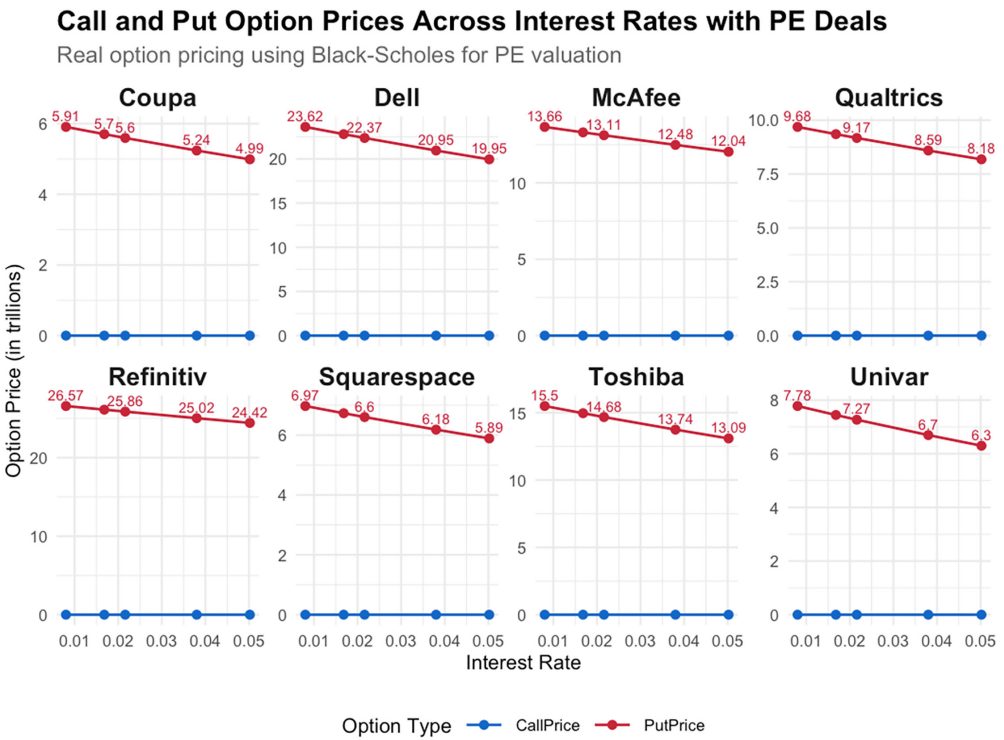
Figure 2. Plotted Results of Black-Scholes Valuation as Applied to Private Equity



Source: Prepared by the authors based on data from LSEG Data & Analytics (2024), modeled using R.

Figure 2 illustrates how, as interest rates increase, the put value slope moves downward, proving the inverse relationship between rates and valuation. Call values have a flat behavior, demonstrating stability on the upside. There is wider dispersion among software firms, reinforcing the role of volatility in valuation. This graph confirms the negative relationship between interest rates and put options across sectors. As interest rates increase, put option values decrease across all sectors. The decline is steeper for technology firms, showing their valuations are more sensitive to changes in interest rates. Industrial and financial companies, on the other hand, show smaller changes, which suggest their valuations are more stable. In contrast, call option values remain almost unchanged, showing little reaction to changes in interest rates.

5. Discussion

Call prices are nearly or exactly zero as the private equity funds are paying an elevated premium because the DCF value (S) is significantly lower than the acquisition price (K). Put options' value decreases as interest rates rise, and they reflect the protection PE funds have if the deal is not profitable from a financial perspective, as a put gives the right to sell the asset at the acquisition price (strike price). Volatility in the software industry is reflected in higher option prices, as companies with low cash flows before deals were made, indicating that the industry is usually unpredictable due to rapid technological change.

Private equity interventions in the electrical equipment, financial services, and computers sectors do not offer a clear path for the industry, as companies in the same categories show mixed results. What is consistent is that larger valuations, such as Refinitiv or Dell, result in more stable cash flows and relatively balanced risk measurement, as volatility. Deals with higher acquisition prices tend to have higher option prices and greater exposure to interest rate volatility, as capital is at risk and valuation errors can be quite expensive.

Call option values are generally low, as most DCF calculations are below the strike price and prices are low, reflecting expectations of growth—the central assumption in PE. Also, higher interest rates increase the value of the call option. Put option prices in McAfee, Dell, and Refinitiv are high, which implies an elevated risk of loss. These results confirm that interest rates affect the variation in call and put prices across sectors, showing that higher discount rates increase the feasibility of holding options.

These eight deals illustrate the importance of considering risk in PE and the value of strategic insights for the buyer, showing how PE interventions in large companies are exposed to rate discounting and how much downside risk these deals embody.

6. Conclusion

Real options present the value of a company as a dynamic set of alternatives, reflecting a flexibility value that is highly common in private equity, including the impact of changing interest rates. Volatility, as an important element in real options and PE, is consistent with higher option prices in the software industry. Also, companies that reported negative cash flows before PE intervention reflected

higher put option prices as a signal of risk. In almost all deals, the DCF valuation was below the price paid, showing that PE deals are not based on current values but on potential values driven by the opportunity for PE firms to intervene. The deals presented show low call option values, suggesting PE funds pay more based on the firm's long-term possible value, and this approach does not align with the commonly used DCF valuation. High put option values reflect the high risk of these investments, such as, for example, software companies in this study.

Call options are more valuable as interest rates rise, suggesting a potential incentive to keep the option open, while put options lose value. Changes in interest rates affect valuations, as monetary policy can change the cost of capital and reduce DCF valuations. Real option valuation can adjust to such changes, as the timing of acquisitions can align with monetary policy conditions.

These eight deals illustrate the relevance of considering risk in PE and the importance of getting strategic insights for the buyer, showing that the intervention of PE in large companies is exposed to rate discounting, as changes in monetary policy are a given in the current economic environment, providing parameters of certainty where decision-making must be strategic. This study goes beyond measuring how interest rates affect PE valuation; it shows that real options offer a broader view of how uncertainty and macroeconomic fluctuations affect investors' decisions. These findings suggest that changes in monetary policy affect how PE firms invest. Sectors such as technology, which are more volatile, are especially sensitive to interest rate changes and provide evidence that adopting option-based models is a suitable alternative when evaluating PE investments.

As discussed, real option valuation is a reliable alternative for providing accurate PE valuations. A future research opportunity that arises from this study is to explore a similar approach using the Cox et al. (1979) binomial lattice model, where their simple discrete-time model, assuming price evolves step by step, provides a more flexible valuation that may be suitable for an illiquid, high-risk market.

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The Anáhuac Journal, **Vol. 25, núm. 2, 2025.**
https://doi.org/10.36105/theanahuacjour.2025v25n2.2999
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About the Authors

Luisa Alejandra Vilches Murillo is a full-time professor at the Department of Accounting and Finance, Tecnológico de Monterrey, Mexico. She holds a bachelor's degree in Business Management and a master's degree in Finance. She is currently pursuing a Ph.D. in Financial Science at EGADE Business School. Her professional experience includes consulting, investment banking, and risk analysis for financial institutions.

Dr. Ivan Valdovinos is an associate professor in Accounting and Finance at EGADE Business School. He has a Ph.D. in Accounting and Finance, specializing in Managerial Accounting, from the University of Manchester. His research interests include valuation, administrative, and financial accounting.