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Macroeconomic drivers of financial performance in power generation firms across emerging and developed markets

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Abstract

This study examines the impact of macroeconomic factors on the financial performance of power generation firms, comparing emerging Latin American economies with those of a developed market. Based on panel data from 106 companies across six countries (2018–2022), multilevel modeling is used to assess firm- and country-level effects, complemented by Dual Multiple Factor Analysis (DMFA) to identify latent relationships among financial and macroeconomic variables. The results indicate that exchange rate fluctuations and inflation are significant determinants of return on equity (ROE), with coefficients of 0.57 and −0.32, respectively. Internal indicators, such as gross profit margin (β = 0.30) and quick ratio (β = 0.22), also exhibit strong positive associations with ROE. Differences in macroeconomic sensitivity between developed and emerging markets underscore the importance of context-specific financial strategies in the energy sector.

Keywords

Financial performance; energy firms; multiple factor analysis; macroeconomic drivers.

Registration

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Impulsores macroeconómicos del desempeño financiero de las empresas de generación de energía en los mercados emergentes y desarrollados

Resumen

Este estudio analiza la influencia de factores macroeconómicos en el desempeño financiero de empresas generadoras de energía, comparando economías latinoamericanas emergentes con un mercado desarrollado. Con base en datos de panel de 106 empresas en seis países (2018-2022), se utiliza modelado multinivel para evaluar los efectos a nivel de empresa y país, complementado con Análisis Factorial Múltiple Dual (DMFA) para identificar relaciones latentes entre variables financieras y macroeconómicas. Los resultados indican que las fluctuaciones del tipo de cambio y la inflación son determinantes significativos del retorno sobre el capital (ROE), con coeficientes de 0,57 y -0,32, respectivamente. Indicadores internos como el margen de beneficio bruto (β = 0,30) y el índice de liquidez inmediata (β = 0,22) también muestran fuertes asociaciones positivas con el ROE. Las diferencias en la sensibilidad macroeconómica entre los mercados desarrollados y emergentes subrayan la importancia de las estrategias financieras específicas para cada contexto en el sector energético.

Palabras clave

Desempeño financiero; Empresas de energía; Análisis factorial múltiple; Factores macroeconómicos.

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1. Introduction

The link between energy systems and both economic growth and social development is well established. In particular, electricity generation plays a central role in supporting industrial activity and enabling progress toward sustainability goals. In Latin America and the Caribbean, the sector reflects a complex mix of public and private actors, with increasing attention to renewable sources. However, notable differences persist among countries in terms of access, regulation, and technological advancement (Organización Latinoamericana de Energía, 2021).

Over the past decades, the region's electricity sector has experienced substantial institutional shifts. After an initial phase dominated by private operators, many countries moved toward state control during the 20th century, followed by liberalization efforts in the 1990s (Moreno, 2012). This has resulted in a hybrid landscape combining public monopolies with private competition, framed by evolving regulatory schemes. These changes have coincided with growing electricity demand linked to demographic and economic expansion (Banco Interamericano de Desarrollo, 2016). As of 2020, over three-quarters of the region's electricity continued to rely on hydropower and fossil-based thermal sources (Organización Latinoamericana de Energía, 2021). Some countries, including Colombia-where about 68% of the electricity supply is hydro-based-have moved more decisively toward clean energy, although this also increases their exposure to climate-related risks (IEA, 2021).

The financial health of energy firms is deeply influenced by the surrounding macroeconomic context. Events such as the COVID-19 pandemic, rising inflation, and global geopolitical tensions have amplified financial uncertainty, particularly for firms operating in emerging economies. These conditions raise important questions about how firms in the power sector, subject to long-term capital investments and heavily influenced by regulatory and fiscal policy, adjust to fluctuations in macroeconomic indicators.

Despite the growing body of research on the financial performance of energy firms, most empirical evidence has focused on European and Asian markets, with relatively limited attention to Latin America (Ministerio de Relaciones Exteriores del Perú, 2018). This gap is significant given the institutional, regulatory, and economic particularities of emerging markets in the region. A nuanced understanding of how macroeconomic conditions affect firm-level financial outcomes in Latin America is essential for guiding policy, investment, and risk management strategies tailored to these environments. Latin America, as a region of emerging economies, provides a compelling case study. Countries such as Argentina, Brazil, Chile, Colombia, and Peru (classified as emerging markets by indices such as S&P Dow Jones Indices, 2022) exhibit distinct energy structures, levels of exposure to external shocks, and regulatory regimes. These nations are also part of the Pacific Alliance, a regional initiative, which, as of 2020, accounted for 41% of Latin America's GDP and 38% of its foreign direct investment (Alianza del Pacífico, 2022), and is projected to become the world's fifth-largest economy in the near future (PwC México, 2014).

In this context, a comparative financial analysis between emerging Latin American markets and a developed economy becomes not only relevant but necessary. It allows for the identification of internal determinants of profitability, such as operating margins, liquidity, and leverage, as well as the impact of macroeconomic forces like GDP growth, inflation, exchange rates, and interest rates.

This study contributes to the literature by assessing the financial performance of 106 power generation companies across six countries (United States, Argentina, Brazil, Chile, Colombia, and Peru) over the period 2018-2022. It adopts a dual-method approach, combining multilevel modeling to capture firm- and country-level effects with Dual Multiple Factor Analysis (DMFA) to identify latent structures among financial and macroeconomic variables. Methodologically, this study distinguishes itself by applying a dual approach that combines multilevel panel modeling with DMFA. This allows for the simultaneous estimation of firm-specific and country-level effects, capturing latent structures in the data that traditional single-level models may overlook. Such integration of hierarchical and factorial techniques remains scarce in regional studies, particularly those focusing on energy firms in Latin America.

The main objective is to identify the macroeconomic factors that significantly influence the profitability of energy firms, measured primarily by return on equity (ROE), and to examine whether firms in emerging

economies exhibit different sensitivities compared to those in a developed economy. The findings of this research have implications beyond academic inquiry. By revealing differential sensitivities to macroeconomic shocks between emerging and developed markets, the results offer practical guidance for energy firms aiming to enhance financial resilience. Moreover, the insights generated can inform the formulation of public policies that promote stability, competitiveness, and sustainable investment in the power sector.

First, a review of the relevant literature on financial performance determinants in the energy sector is presented, with emphasis on macroeconomic and firm-level factors. Then, the methodological framework is described, including the construction of a multilevel panel model, the implementation of a Dual Multiple Factor Analysis (DMFA), and an outline of the main findings from both quantitative approaches. Finally, the results are discussed in the concluding section.

This research offers practical value for a diverse set of stakeholders. For policymakers and regulatory agencies, the findings provide empirical insights that can inform the design of macroeconomic stabilization tools and financial oversight in the energy sector. For energy firms and investors, the differentiated sensitivity to macroeconomic variables across markets highlights the need for adaptive risk management strategies tailored to each context. Lastly, for researchers, the study demonstrates the potential of combining multilevel modeling with DMFA to capture structural and contextual effects, particularly in emerging economies that remain underrepresented in financial performance studies.

2. Literature review

The financial performance of firms in the energy sector has drawn increasing academic attention due to its central role in supporting economic growth and sustainable development (Unidad de Planeación Minero-Energética UPME, 2020). Prior studies have identified a range of firm-level and macroeconomic factors that influence profitability across various contexts. However, much of the literature focuses on European and Asian markets, leaving Latin American economies relatively underexplored (Morina, Ergün and Hysa, 2021). To better understand the drivers of profitability in this sector, researchers have commonly adopted two perspectives: internal firm indicators and external, country-level macroeconomic conditions.

Panel data methodologies are among the most frequently used approaches in this field. For example, Dopierała, Mosionek-Schweda and Laskowicz, (2022) analyzed the financial performance of renewable and conventional energy producers in the Baltic region using fixed and random effects models. Their findings revealed that privately owned firms generally outperform state-owned enterprises, and that asset size has an ambiguous effect on performance. Similarly, Asimakopoulos and Samitis (2009) examined Greek non-financial firms and found that profitability was positively affected by firm size, sales growth, and investment, and negatively impacted by leverage and current assets. These results align with Schabek (2020), who found a positive relationship between firm size and both ROE and return on assets (ROA), while noting that renewable energy use had no significant effect and that debt levels impacted ROA but not ROE. On the other hand, Apan and İslamoğlu (2018), using a sample of energy firms listed on the Istanbul Stock Exchange, reported that financial leverage, tangible fixed assets, and long-term debt had negative impacts on ROA, whereas asset turnover and liquidity ratios were positively associated with profitability. Capece, Di Pillo and Levialdi (2013) emphasized the role of geographical location by analyzing financial indicators such as cash flow, return on investment (ROI), return on sales (ROS), ROE, and leverage ratio (LR), showing that location significantly affects firm performance.

Other studies have compared renewable and fossil fuel energy firms. Tomczak (2019) found that while fossil fuel companies tend to exhibit higher profitability, renewable energy firms generally report greater liquidity and turnover efficiency. Akhtar (2012), analyzing firms in Pakistan's fuel and energy sector, reported a positive relationship between financial leverage and performance, using a broad set of financial and profitability ratios.

In the Latin American context, Rosso and Rodríguez (2021) employed panel data and cluster analysis to evaluate firms in the electricity, oil, and gas sectors across Colombia and other countries in the region.

They found that fixed asset investment plays a key role in large and medium-sized firms, while leverage significantly impacts small and medium-sized firms, negatively affecting ROA due to financial costs, but potentially improving ROE through tax shields. Their methodological framework incorporating both firm-level and country-level variables aligns closely with the approach used in this study, although their analysis employed clustering instead of principal component analysis (PCA) for dimensionality reduction.

Principal component analysis has also been applied in energy finance to uncover latent structures in financial indicators. Delen, Kuzey and Uyar (2013) extracted 11 components from 26 financial variables, identifying key dimensions such as liquidity, asset structure, and turnover efficiency. They complemented this with decision tree algorithms, highlighting associations between ROE and financial ratios related to leverage, asset turnover, and profit margins. Similarly, Al Asbahi, Gang, Iqbal, Abass, Moshin and Iram (2019) used PCA to evaluate national energy performance in the Energy Trilemma Index, emphasizing the method's objectivity and ability to extract relevant factor structures.

Macroeconomic and country-specific variables also play a significant role in shaping firm performance. Morina et al. (2021) highlighted the importance of GDP growth, inflation, and financial crises. Chang, Huang and Lee (2009) emphasized that economies with higher growth are better positioned to buffer external shocks, including energy price volatility. Gupta (2017) further identified GDP, technological readiness, electricity infrastructure, and innovation capacity as key macro-level determinants for the performance of alternative energy firms. Barakat, Elgazzar and Hanafy (2015) included market index performance, interest rates, exchange rates, and money supply among the factors influencing firm performance, noting that the effects of macroeconomic variables vary significantly even among similar economies.

Taken together, the existing literature demonstrates that both firm-specific characteristics and macroeconomic conditions significantly influence the financial performance of energy companies. However, there remains a notable gap in comparative research that systematically analyzes how these factors operate across different market contexts, particularly between emerging and developed economies. Most prior studies tend to focus on either developed markets or single-country analyses, often overlooking the heterogeneity of institutional environments, regulatory frameworks, and macroeconomic volatility that characterize emerging markets in Latin America.

The literature to date shows limited application of multilevel econometric approach that simultaneously captures within-country firm heterogeneity and between-country macroeconomic variation in the energy sector. Even fewer have complemented this with dimensionality reduction techniques such as DMFA to explore latent structures among financial and economic variables. This study addresses this gap by integrating both methods to assess not only which factors matter, but how their effects differ across market types. The contribution lies in bridging methodological sophistication with regional relevance. By focusing on 106 power generation firms operating in Latin America and the United States between 2018 and 2022, the study highlights the nuanced ways in which economic context shapes financial outcomes. The findings support to generate policies that are directly applicable to firm strategy and investor decision-making.

3. Methodology and data

To analyze the financial performance of power generation firms across different macroeconomic environments, a mixed-methods approach is adopted, combining econometric modeling with multivariate statistical analysis. This section describes the data sources, sample construction, and variable selection, followed by the methodological procedures used to evaluate firm- and country-level effects. First, a hierarchical panel model is estimated to quantify the impact of financial and macroeconomic variables on profitability. Then, the DMFA is applied to uncover latent structures and relationships among these variables, allowing for a complementary exploration of the data across emerging and developed markets.

3.1. Data

The financial performance of power generation firms in Latin America is evaluated under varying macroeconomic conditions, comparing emerging and developed markets. The analysis begins by identifying

key financial and macroeconomic indicators drawn from firm-level financial statements and national-level economic data. These variables are then integrated into a panel structure and analyzed through two complementary techniques: hierarchical (multilevel) modeling and DMFA. The dataset comprises 106 power generation firms classified under the NAICS Utilities sector, extracted from the Workspace LSEG database, covering six countries across five years (2018–2022), for a total of 530 firm-year observations. Table 1 summarizes the distribution of firms by market type. Macroeconomic indicators were obtained from the OECD database. All continuous variables were standardized using z-scores prior to estimation. This transformation ensures comparability across scales and mitigates potential multicollinearity, especially when combining financial and macroeconomic variables. The United States was selected as the reference developed market due to its large representation of power generation firms in the dataset and the availability of complete financial and macroeconomic data. While this limits generalizability, it offers a stable benchmark for comparison. Future studies could expand this analysis by incorporating additional developed economies or using continuous indicators of economic development.

Table 1.
Country distribution of firms in the sample.

Developed Market	Emerging Markets
United States (56)	Chile (10)
	Brazil (22)
	Argentina (7)
	Colombia (3)
	Peru (8)

Note: Author's own elaboration using data from LSEG Workspace and the OECD database.

In line with prior literature, the analysis includes firm-level variables related to profitability (ROE, ROA), capital structure (Total Debt, Total Liabilities), liquidity (Current Ratio, Quick Ratio), efficiency (Inventory Turnover), and size (Total Assets, Market Cap). Macroeconomic variables include GDP, inflation (CPI), exchange rate, and interest rate, as shown in Table 2.

Table 2.
Financial and Macroeconomic Variables Used

Factors		Authors
Company-level variables	Market Cap	
	Gross Profit Margin	(Akhtar, 2012), (Gadea-Lara, 2022), (Muller & Rego, 2021)
	Working Capital	
	Current Ratio	(Akhtar, 2012) (Apan, 2018) (Delen, Kuzey, & Uyar, 2013)
	Quick Ratio	
	Inventory Turnover	(Tomczak, 2019)
	Return On Equity	(G. Capece, 2013) (Schabek, 2020) (Rosso Murillo & Rodriguez Ramos, 2021) (Akhtar, 2012) (Dopierała, Mosionek-Schweda, & Laskowicz, 2022)
	Return On Assets	
	Total Assets	(Apan, 2018) (Dopierała, Mosionek-Schweda, & Laskowicz, 2022) (Rosso Murillo & Rodriguez Ramos, 2021)
	Total Debt	(Schabek, 2020) (Akhtar, 2012) (G. Capece, 2013)
	Total Liabilities	(Akhtar, 2012) (Apan, 2018) (Rosso Murillo & Rodriguez Ramos, 2021)

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Factors		Authors
Country-level variables	GDP	(Morina F. E., 2021), (Gupta, 2017), (Barakat, 2015), EMBER, 2021), (Fazekas, Bataille, & Vogt-Schi, 2022) (Joaqui-Barandica & Orozco-Cerón, 2023)
	Inflation (CPI)	(Morina F. E., 2021), (Barakat, 2015)
	Interest rate Exchange rate	(Barakat, 2015), (Bastidas-Orrego, 2008)

Note: Authors' elaboration based on Akhtar (2012), Apan (2018), Delen et al. (2013), Rosso & Rodríguez (2021), Morina (2021), Barakat et al. (2015)

Profitability is measured primarily through Return on Equity (ROE), calculated as earnings before taxes divided by total equity. ROE is selected as the main performance indicator due to its ability to reflect shareholder value and firm efficiency in utilizing capital.

3.2. Hierarchical panel model

Panel data techniques are widely used in the literature to assess the determinants of financial performance in the energy sector. As defined by Baltagi (2008), panel data combines cross-sectional and time-series dimensions, allowing for more accurate estimations of effects at different levels of analysis.

To address the nested structure of firms within countries, a multilevel model is adopted that incorporates both firm -and country- level variables. According to Schabek (2020), a standard linear panel model can be represented as:

$$Y_{it} = \beta_0 + \sum_{k=1}^{n} \beta_k X_{k,it} + \gamma_i + \delta_t + \varepsilon_{it} \quad (1)$$

Where β_0 is the intercept, β_k are the coefficients for the explanatory variables $X_{(k,it)}$, γ_i is the firm-specific effect, $\boldsymbol{\delta}_t$ is the time effect, and $\boldsymbol{\varepsilon}_{it}$ is the error term.

To operationalize this, the panelr package in R is employed, which facilitates the estimation of hybrid models combining features of both fixed and random effects within a multilevel framework (Long, 2020). The extended hierarchical model used is specified as follows:

$$ROE_{ijt} = \beta_0 + GPM_{ijt} + WC_{ijt} + CR_{ijt} + QR_{ijt} + Inv_{ijt} + TA_{ijt} + TD_{ijt} + TL_{ijt} + IT_{jt} * Country_j + GDP_{jt} + EX_{jt} + CPI_{jt} + \varepsilon_{ijt} \quad (2)$$

Where $\boldsymbol{ROE}_{(ijt)}$ is return on equity for firm $\boldsymbol{i}$ in country $\boldsymbol{j}$ at time $\boldsymbol{t}$. $\boldsymbol{GPM,WC,CR,QR,Inv,TA,TD,TL}$ are firm-level financial indicators.$\boldsymbol{Country}_j$ are country-level macroeconomic indicators. is a dummy variable indicating market type (emerging or developed) and $\boldsymbol{\varepsilon}_{ijt}$ the model error term.

This formulation allows for estimating the contribution of each variable while accounting for both within- and between-country variability in the financial performance of energy firms.

3.2. Dual Multiple Factor Analysis (DMFA)

To complement the econometric modeling and uncover structural relationships among variables, this study adopts DMFA, as proposed by Hervé, Lynne and Dominique (2013). DMFA is an extension of Principal Component Analysis (PCA) used when the same variables are measured across different groups of individuals, here, firms in developed versus emerging markets.

The goal is to transform the initial set of variables $X_1,X_2,...,X_p$ into a set of uncorrelated components $Z_1,Z_2,...,Z_p$, where each component is a normalized linear combination of the original variables:

$$Z_1 = \alpha_{11}X_1 + \alpha_{12}X_2 + \cdots + \alpha_{p1}X_p \quad (3)$$

The method seeks to maximize the explained variance of the components through the optimization of the factor loadings α_{jp} . Total variance is computed as:

$$\sum_{j=1}^{p} Var(X_j) = \sum_{j=1}^{p} \frac{1}{n} \sum_{i=1}^{n} x_{ij}^2 \quad (4)$$

And the proportion of variance explained by component is given by:

$$\frac{\sum_{i=1}^{n}\left(\sum_{j=1}^{p} \alpha_{jm} x_{ij}\right)^2}{\sum_{j=1}^{p}\sum_{i=1}^{n} x_{ij}^2} \quad (5)$$

A categorical variable indicating the economic classification of each country (“Developed” or “Emerging”) is introduced and DMFA is applied to assess the contribution and representation quality of each financial and macroeconomic variable across markets. The results are visualized through factor maps, enabling the identification of variable clusters and differences in firm performance based on economic context.

4. Results and discussion

This section presents the main findings, structured into four parts. First, the general behavior of the financial and macroeconomic variables included in the model is described using descriptive statistics and visualizations. Second, firm-level financial performance in terms of ROE and ROA is analyzed across the countries in the sample. Third, correlation patterns among key variables are examined to explore preliminary relationships. Finally, the results of the hierarchical panel model and DMFA are presented, which together allow for a comprehensive understanding of how firm- and country-level factors influence financial performance across emerging and developed markets.

4.1. Descriptive statistics

Table 3 summarizes the descriptive statistics for the firm-level financial indicators included in the model, disaggregated by country.

Table 3.
Descriptive Statistics – Firm-Level Financial Indicators

Indicator		Argentina	Brazil	Chile	Colombia	Peru	United States of America
Gross.PM	min	-0.34	-0.34	-0.40	-0.34	-0.34	-0.38
	max	3.50	5.76	0.70	2.21	-0.32	-0.29
	media	0.52	0.85	-0.26	0.31	-0.33	-0.32
	mediana	-0.21	-0.02	-0.33	-0.33	-0.33	-0.33
	desv_est	1.25	1.74	0.24	1.06	0.01	0.01

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Indicator		Argentina	Brazil	Chile	Colombia	Peru	United States of America
Working.C	min	-2.15	-0.02	-0.03	-13.04	0.00	-1.06
	max	2.64	0.62	8.86	0.00	-0.12	0.20
	media	0.16	0.05	0.46	-1.76	0.01	-0.03
	mediana	0.01	0.01	0.00	0.00	0.00	0.01
	desv_est	1.01	0.10	1.68	4.58	0.00	0.11
Current.R	min	-0.13	-0.14	-0.12	-0.12	-0.10	-0.14
	max	0.06	22.37	0.05	0.00	0.68	2.24
	media	-0.06	0.22	-0.07	-0.10	0.06	-0.07
	mediana	-0.08	-0.07	-0.09	-0.11	0.03	-0.10
	desv_est	0.05	2.17	0.04	0.03	0.16	0.17
Quick.R	min	-0.82	-5.52	-0.68	0.79	-0.64	-1.00
	max	2.30	10.16	2.20	0.00	3.88	7.60
	media	-0.06	0.22	-0.07	-0.10	0.06	-0.07
	mediana	-0.30	0.00	-0.17	-0.60	0.50	-0.35
	desv_est	0.63	1.40	0.63	0.19	1.17	0.78
Inventory	min	-0.10	-20.64	-0.10	-0.08	-0.59	-2.03
	max	1.43	3.55	5.28	1.54	1.02	0.25
	media	0.07	-0.05	0.21	0.17	0.03	-0.04
	mediana	-0.02	0.02	0.00	-0.05	-0.08	-0.07
	desv_est	0.31	2.09	0.80	0.46	0.37	0.16
Total.Assets	min	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12
	max	12.45	0.42	0.00	0.00	-0.12	0.10
	media	1.24	-0.06	-0.12	-0.09	-0.12	-0.09
	mediana	-0.12	-0.11	-0.12	-0.12	-0.12	-0.11
	desv_est	3.72	0.12	0.02	0.04	0.00	0.05
Total.Debt	min	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11
	max	0.31	13.04	0.00	0.00	-0.10	-0.08
	media	-0.05	0.36	-0.10	-0.09	-0.10	-0.10
	mediana	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10
	desv_est	0.13	2.16	0.01	0.03	0.00	0.00
Total.Liabilities	min	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11
	max	0.47	12.65	0.00	0.00	-0.11	-0.07
	media	-0.04	0.37	-0.11	-0.10	-0.11	-0.10
	mediana	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11
	desv_est	0.17	2.16	0.02	0.03	0.00	0.01

Note: Author's own elaboration using data from LSEG Workspace and the OECD database.

Regarding financial indicators, Brazil exhibits the highest variability in gross profit margin, followed by Argentina, with standard deviations of 1.74 and 1.25, respectively. This suggests notable differences in profitability across firms in those countries. Brazilian firms, in particular, show the highest gross profit margins, whereas firms in Chile, Peru, and the United States display negative average margins, indicating overall losses. In contrast, firms in Colombia and Argentina display positive average margins, highlighting more favorable financial performance. Working capital reveals significant differences across countries.

Colombian firms show the lowest average working capital (−1.76), pointing to potential liquidity issues. In contrast, Chilean firms display the highest maximum value (8.86), indicating stronger short-term financial flexibility.

Liquidity indicators (current ratio and quick ratio) are positive on average for firms in Brazil and Peru, reflecting a better ability to cover short-term liabilities. These two countries, along with the United States, also show the greatest variability in liquidity measures. In terms of inventory, Chile reports the highest average value, followed by Colombia. This could signal potential inefficiencies in inventory management that may affect financial performance. Argentina, on the other hand, stands out with the highest average value for total assets, while other countries tend to show lower or even negative means. With regard to debt levels, Brazil presents the highest average total debt and total liabilities, suggesting a heavier reliance on external financing. Argentina, by contrast, has the lowest averages in both indicators, which may reflect more conservative financial structures or limited access to debt markets. Table 4 presents the descriptive statistics of the macroeconomic indicators used in the analysis.

Table 4.
Descriptive Statistics – Country-Level Macroeconomic Variables

Indicador		Argentina	Brazil	Chile	Colombia	Peru	United States of America
IT	min	2.48	-0.39	-0.53	-0.40	-0.55	-0.50
	max	4.93	0.65	0.35	0.28	-0.23	-0.06
	media	3.50	0.03	-0.26	-0.13	-0.35	-0.35
	mediana	2.93	-0.05	-0.34	-0.15	-0.27	-0.39
	desv_est	0.99	0.35	0.32	0.24	0.12	0.15
GDP	min	-2.78	-1.35	-1.84	-2.09	-3.01	-1.08
	max	2.02	0.66	2.32	2.09	2.72	0.97
	media	-0.44	-0.12	0.16	0.37	0.10	0.04
	mediana	-0.90	-0.01	0.04	0.32	0.21	0.11
	desv_est	-0.90	0.67	1.35	1.47	1.85	0.66
CPI	min	1.64	-0.30	-0.36	-0.35	-0.42	-0.44
	max	1.93	0.06	0.30	0.20	0.07	0.04
	media	6.28	-0.18	0.30	0.20	0.07	0.04
	mediana	3.39	-0.26	-0.31	-0.28	-0.37	-0.36
	desv_est	2.95	0.14	0.25	0.21	0.19	0.18
EX	min	-0.24	-0.28	0.73	4.43	-0.28	-0.28
	max	-0.08	-0.28	1.11	6.51	-0.28	-0.28
	media	-0.17	-0.28	0.92	5.44	-0.28	-0.28
	mediana	-0.17	-0.28	0.92	5.61	-0.28	-0.28
	desv_est	0.06	0.00	0.13	0.73	0.00	0.00

Note: All indicators is given in percentage.

Source: Author's own elaboration using data from LSEG Workspace and the OECD database.

Among macroeconomic variables, Argentina exhibits the highest average interest and inflation rates compared to the rest of the countries. The United States, although more stable, shows slower economic growth. Positive GDP growth is observed in Chile and Colombia; however, both face inflationary pressures as a key economic challenge. Colombia also shows the highest variability in the exchange rate, which suggests greater exposure to currency risk. Peru's economy displays the most variability in GDP but relatively low average inflation, indicating instability in output but moderate price dynamics.

Overall, the macroeconomic environment from 2018 to 2022 posed challenges for all countries in the sample. These included global economic slowdowns, the COVID-19 pandemic, and geopolitical disruptions such as the war in Ukraine, which affected each country differently depending on the maturity and resilience of their economies.

Figures 1 and 2 present the average ROE and ROA of the power generation firms during the study period.

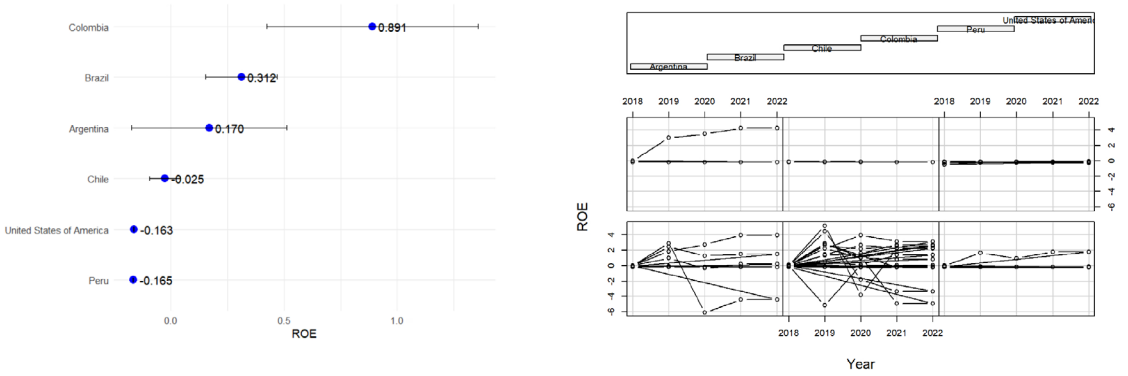

Figure 1. Average ROE of firms by country (2018–2022)

Note: Author's own elaboration using data from LSEG Workspace and the OECD database.

Average ROE values reveal positive performance in firms from Colombia, Brazil, and Argentina. Colombia shows the highest variability, with one firm exhibiting consistently high and increasing ROE values, while the rest hover around zero. Argentine firms also demonstrate high variability, maintaining a positive mean. In Brazil, the country with the largest number of firms in the sample, some companies recorded growth in ROE in 2019, while others showed a decline since 2018, reflecting a mixed but moderately positive trend. In Chile, some firms improved, but the national average remained negative. Firms in Peru and the United States generally recorded ROE values near or below zero, indicating weak or negative profitability in those markets.

These results suggest that financial performance, as measured by ROE, varies significantly across countries. Brazil and Argentina stand out, potentially due to favorable economic conditions, operational efficiency, regulatory advantages, or higher electricity prices.

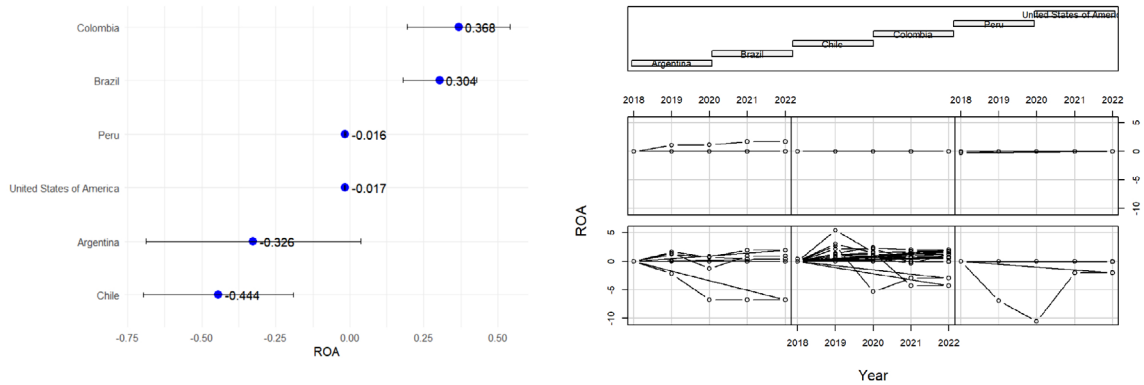

Figure 2. Average ROA of firms by country (2018–2022)

Note: Author's own elaboration using data from LSEG Workspace and the OECD database.

In terms of ROA, positive average performance is noted in Brazil and Colombia. Argentina, however, shows the greatest variability, with an overall negative ROA trend driven by a decline in several firms. Brazilian firms again show strong positive financial outcomes, supporting their competitive standing in the region. Colombian firms echo the ROE findings, with one firm notably outperforming its peers. In Chile, one firm recovered after a decline in 2020 but did not achieve positive values. ROA values for the United States and Peru are similar, with low variability and slightly negative means. Taken together, these results suggest that ROA performance is generally weak across the sample, with Brazil leading in asset efficiency, while firms in Argentina, Chile, and the U.S. underperform. The poor results in Chile and Argentina may reflect structural inefficiencies, asset-heavy operations, or adverse macroeconomic conditions.

Finally, correlation analysis, as shown in Figure 3, reveals several patterns. A positive correlation is observed between interest rates and inflation across all years. ROE shows a consistent positive correlation with total assets, debt, and liabilities, suggesting the use of financial leverage to enhance profitability. In 2018, gross profit margin correlated strongly with ROE, while, in 2020, working capital showed a negative correlation with ROA. A negative relationship between interest rates and GDP was evident in 2019, and in 2022, a moderate positive correlation was observed between GDP growth and exchange rates.

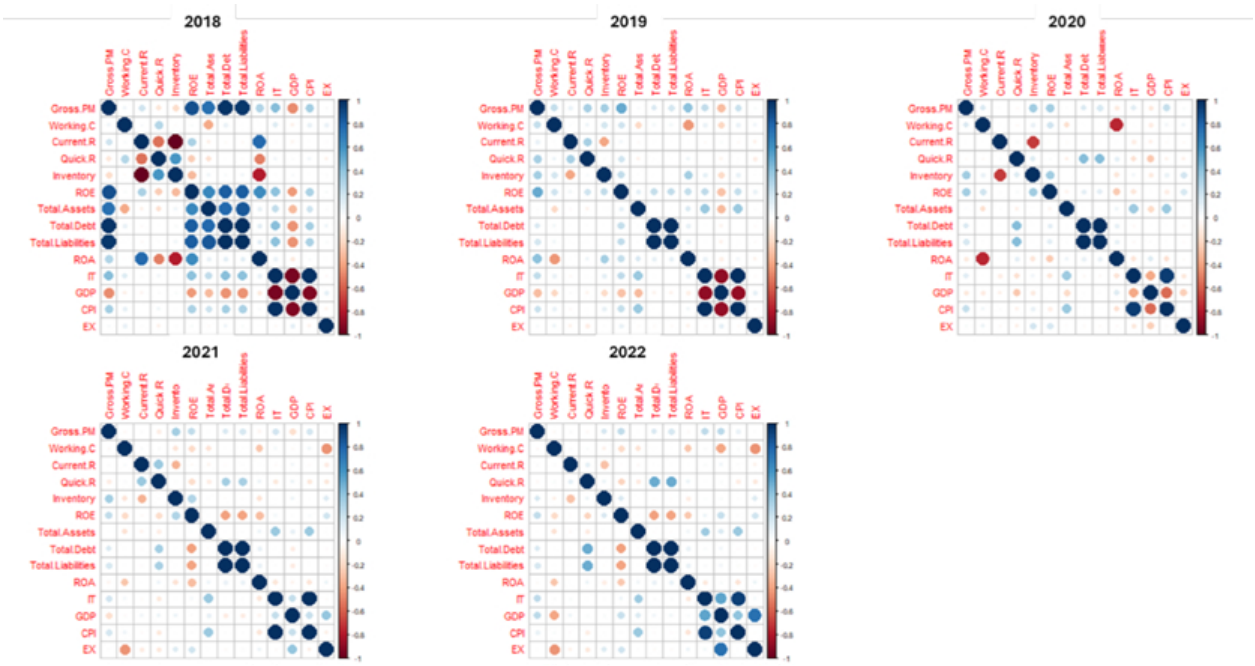

Figure 3. Correlation analysiz

Note: Author's own elaboration using data from LSEG Workspace and the OECD database.

4.2 Hierarchical panel model results

Table 5 presents the results of the linear mixed-effects model used to assess the impact of both firm-level and country-level macroeconomic variables on the financial performance of 106 power generation companies between 2018 and 2022.

The pseudo values indicate that the fixed effects in the model explain approximately 32% of the variance in ROE, while the total explained variance reaches 53%. The intraclass correlation coefficient (ICC) suggests that 32% of the total variance is attributable to between-firm differences nested within countries, supporting the use of a multilevel approach. Model fit statistics include an AIC of 1,353.4 and a BIC of 1,494.4.

Among the time-varying firm-level variables, four factors show statistical significance ($p < 0.05$): Gross Profit Margin (GPM), Quick Ratio, Total Debt, and Total Liabilities. Specifically, the coefficients for GPM and Quick Ratio are positive (0.30 and 0.22, respectively), indicating that a one-unit increase in either variable is associated with an improvement in ROE. These results suggest that operational efficiency and short-term liquidity contribute positively to financial performance in the energy sector. In contrast, Total Debt has a strong negative effect on ROE (−6.93), implying that increased leverage substantially decreases profitability. Total Liabilities shows a positive coefficient (6.65), suggesting that when financial leverage is used prudently, it can support firm profitability-consistent with the results reported by Akhtar, Javed, Maryam, and Sadia (2012). This contrast with the negative effect of Total Debt highlights that not all liabilities carry the same financial implications; some, such as those with tax benefits or flexible terms, may actually contribute to improved performance.

At the group level, three variables stand out: imean(Current Ratio), imean(Quick Ratio), and imean(Inventory). Firms with higher average liquidity and inventory levels across the sample tend to perform better, as indicated by the positive effects of the current ratio (0.65) and inventory (0.78). However, the negative coefficient for the average quick ratio (−0.18) suggests that holding excessive highly liquid assets-especially if underutilized-might point to inefficiencies in short-term resource management.

Table 5.
Determinants of Financial Performance (Mixed Effects Model)

Within-Firm Effects					
	Est.	S.E.	t val.	d.f.	p
Gross.PM	0,30	0,07	4,12	407,00	0,00
Working.C	-0,05	0,05	-1,06	407,00	0,29
Current.R	0,13	0,11	1,13	407,00	0,26
Quick.R	0,22	0,05	4,51	407,00	0,00
Inventory	0,07	0,12	0,63	407,00	0,53
Total.Assets	0,00	0,07	-0,02	407,00	0,98
Total.Debt	-6,93	0,80	-8,67	407,00	0,00
Total.Liabilities	6,65	0,82	8,15	407,00	0,00
Between-Firm (Group-Level) Effects					
	Est.	S.E.	t val.	d.f.	p
(Intercept)	0,01	0,16	0,05	482,06	0,96
imean(Gross.PM)	0,14	0,09	1,50	92,00	0,14
imean(Working.C)	0,01	0,09	0,13	92,00	0,90
imean(Current.R)	0,65	0,23	2,79	92,00	0,01
imean(Quick.R)	-0,18	0,09	-1,95	92,00	0,05
imean(Inventory)	0,78	0,23	3,40	92,00	0,00
imean(Total.Assets)	0,02	0,07	0,28	92,00	0,78
imean(Total.Debt)	-4,99	2,73	-1,83	92,00	0,07
imean(Total.Liabilities)	4,86	2,72	1,79	92,00	0,08
IT	0,02	0,32	0,07	407,00	0,94
GDP	0,04	0,04	0,95	407,00	0,34
EX	0,57	0,29	1,93	407,00	0,05
CPI	-0,32	0,13	-2,46	407,00	0,01
CountryChile	-0,65	0,44	-1,47	494,03	0,14
CountryBrazil	0,22	0,21	1,03	171,75	0,29
CountryArgentina	-1,17	0,52	-2,25	486,97	0,03

Continued on the next page

Between-Firm (Group-Level) Effects					
	Est.	S.E.	t val.	d.f.	p
CountryColombia	-2,52	1,77	-1,42	442,67	0,16
CountryPeru	0,20	0,41	0,49	418,35	0,63
IT:CountryChile	0,15	0,48	0,32	407,00	0,75
IT:CountryBrazil	0,06	0,39	0,15	407,00	0,88
IT:CountryArgentina	0,64	0,41	1,56	407,00	0,12
IT:CountryColombia	-0,53	0,94	-0,56	407,00	0,58
IT:CountryPeru	0,26	0,96	0,28	407,00	0,78
Random effects					
Group	Parameter	Std. Dev.			
Name	(Intercept)	0,4788			
Residual		0,7025			

Note: Author's own elaboration using data from LSEG Workspace and the OECD database.

Among the macroeconomic indicators, only the exchange rate (EX) and inflation (CPI) show a significant association with return on equity (ROE). A positive relationship with the exchange rate (coefficient = 0.57) may reflect advantages from export revenues or cost efficiencies in foreign-currency transactions. In contrast, inflation exerts a negative influence (coefficient = −0.32), likely due to rising input costs, erosion of purchasing power, or heightened uncertainty. These results align with the evidence presented by Morina et al. (2021) and Barakat et al. (2015).

In this model, neither GDP nor the interest rate (IT) emerges as a significant determinant of ROE. This suggests that broader economic growth or shifts in monetary policy may not directly impact firm-level profitability in the energy sector -possibly due to regulatory protections or the capital- intensive nature of the industry. The dummy variable for Argentina presents a statistically significant negative effect (−1.17), pointing to a lower average ROE compared to the United States. This result likely reflects Argentina's macroeconomic instability, including persistent inflation and exchange rate volatility. The effects for other countries -Chile, Brazil, Colombia, and Peru- are not statistically different from the baseline, indicating similar average performance once other factors are controlled for.

Overall, the model confirms the importance of firm-specific variables-particularly those related to profitability, liquidity, and financial structure-n shaping financial outcomes in the energy sector. Specifically, operational efficiency and prudent liquidity management contribute positively to ROE, while excessive debt reduces it. At the macro level, exchange rate fluctuations and inflation significantly influence firm profitability, underscoring the importance of the broader economic environment. Importantly, the findings highlight that country-specific conditions, particularly in the case of Argentina, must be considered when assessing financial outcomes in the power generation sector. Appendix Table A1 reports a robustness check using a linear model.

4.3 DMFA results

To further explore structural relationships among financial and macroeconomic indicators across countries, DMFA was applied to the standardized dataset. This technique enabled the extraction of latent factors that summarize the underlying structure of the variables while highlighting differences between firms in developed and emerging markets.

Based on the proportion of variance explained, the first four components were retained, which jointly account for 57.35% of the total variance in the data. The interpretation of the four retained components, informed by the loadings in Table 6, reveals distinct dimensions of financial dynamics. The first component is shaped primarily by interest rates and inflation (CPI), capturing the broader macroeconomic conditions that frame firm activity. This dimension is especially useful for understanding how fluctuations at the country level -such as monetary shocks or price instability- can influence firm outcomes. The second component reflects the structure of financial leverage, dominated by total debt and total liabilities. It highlights firms' dependence on

external funding and the weight of financial commitments. This factor is particularly important in emerging economies, where credit conditions tend to be less stable and access to capital more constrained. The third component relates to operational efficiency, with strong contributions from inventory levels and the current ratio. It underscores the value of managing day-to-day liquidity and productive assets efficiently-key traits of firms that can better withstand external disruptions. The fourth component is closely tied to working capital and exchange rate exposure. These two variables dominate the dimension, which likely reflects how firms adjust their liquidity strategies in environments with significant currency fluctuations. This is especially relevant in countries where exchange rate volatility is a persistent challenge and short-term financial management becomes critical to sustaining performance.

Table 6.
Variable Contributions to Principal Components

Contribution to factor							
	PC1		PC2		PC3		PC4
IT	18,78	Total,Debt	25,54	Inventory	38,53	Working,C	26,3
CPI	18,05	Total,Liabilities	25,45	Current,R	31,48	EX	19,53
Total,Liabilities	14,09	CPI	17,43	ROA	17,35	ROE	9,85
Total,Debt	13,9	IT	15,7	Working,C	5,48	ROA	8,84
Gross,PM	13,02	Quick,R	7,71	Quick,R	2,57	Quick,R	7,6
Total,Assets	8,12	ROA	2,36	Total,Assets	2,27	GDP	7,52
GDP	7,33	GDP	2,33	EX	0,85	Total,Assets	6,6
ROE	4,68	Total,Assets	1,66	IT	0,5	Inventory	5,02
Inventory	0,88	Gross,PM	1,02	CPI	0,42	Current,R	3,63
Quick,R	0,56	Current,R	0,36	ROE	0,3	Gross,PM	3,37
Working,C	0,25	Working,C	0,24	Gross,PM	0,19	CPI	0,63
EX	0,16	EX	0,08	GDP	0,04	Total,Debt	0,48
ROA	0,09	Inventory	0,06	Total,Debt	0	Total,Liabilities	0,34
Current,R	0,08	ROE	0,05	Total,Liabilities	0	IT	0,29

Note: Author's own elaboration using data from LSEG Workspace and the OECD database.

Table 7 shows the quality of factor representation by economy and year, helping identify which components most strongly characterize each context. The results suggest that Component 1 (Macroeconomic Conditions) best explains the year 2019 for both developed and emerging economies, likely due to fluctuations in interest rates and inflation. Component 2 (Leverage Structure) dominates in 2021, reflecting financial strategies during the post-pandemic recovery. While Component 3 (Operational Efficiency) shows limited differentiation between economies overall, it becomes relevant in 2020 (emerging) and 2022 (developed), possibly due to shifts in supply chains and government support mechanisms. Component 4 (Working Capital and Exchange Rate) is more consistently influential in emerging economies across all years, highlighting persistent challenges related to currency volatility and liquidity management.

Table 7.
Factor representation by economy and year

	Macroeconomic Conditions	Leverage Structure	Operational Efficiency	Working Capital and Exchange Rate
Developed	0.08	0.09	0.01	0.21
Emerging	0.08	0.09	0.01	0.21
DevelopedGr2018	0.01	0.09	0.01	0.11
DevelopedGr2019	0.68	0.00	0.01	0.00
DevelopedGr2020	0.18	0.03	0.22	0.30
DevelopedGr2021	0.06	0.47	0.01	0.18
DevelopedGr2022	0.17	0.05	0.34	0.00

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EmergingGr2018	0.02	0.07	0.18	0.21
EmergingGr2019	0.62	0.00	0.00	0.00
EmergingGr2020	0.21	0.00	0.26	0.11
EmergingGr2021	0.00	0.70	0.01	0.13
EmergingGr2022	0.05	0.06	0.02	0.21

Note: Author's own elaboration using data from LSEG Workspace and the OECD database.

Figure 4 shows the projection of variables in the space of the first two principal components. The results show that macroeconomic conditions -specifically, interest rate and inflation- consistently play a stronger role than leverage in explaining firm performance. As expected, leverage maintains a positive association with total debt and total liabilities across all years. In 2018, ROE and gross profit margin (GPM) show strong positive contributions to both components, indicating favorable conditions for the energy sector. GDP, however, is not strongly represented in Component 1, suggesting that macroeconomic shocks (e.g., interest rate and inflation) may distort the impact of GDP on firm profitability.

In 2019 and 2020, macroeconomic factors increasingly influence ROE, total assets, and liabilities, while GPM declines, indicating pressure on operating margins. Post-pandemic years (2021–2022) reveal a decline in ROE and GDP, further emphasizing the role of inflationary pressures and policy uncertainty.

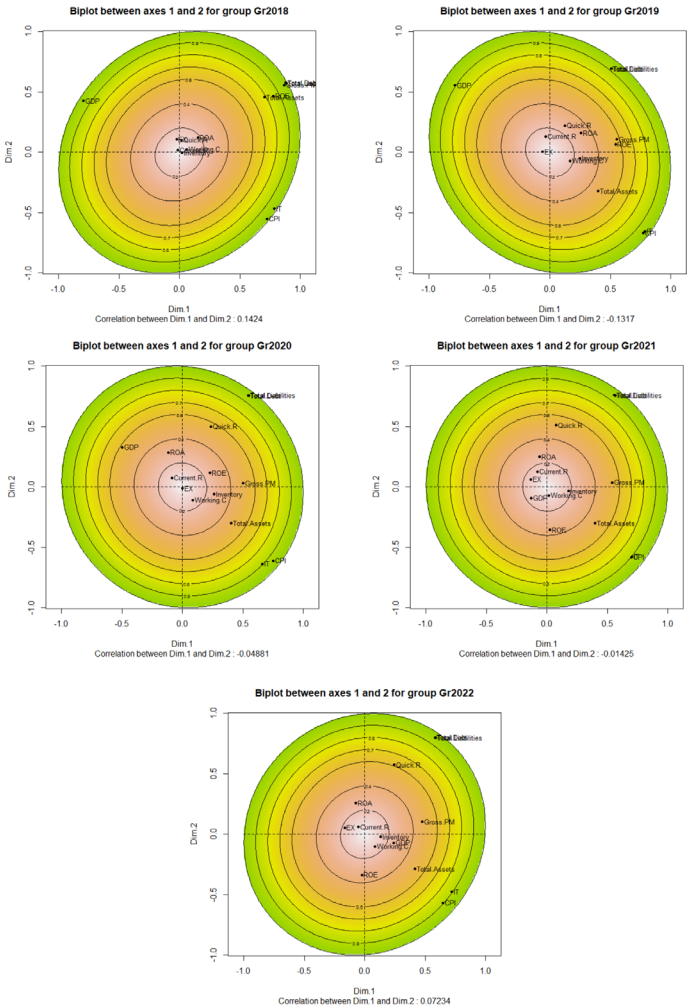

Figure 4. Variable projection on principal components 1 and 2 (Macroeconomic Conditions and Leverage).
Note: Author's own elaboration using data from LSEG Workspace and the OECD database.

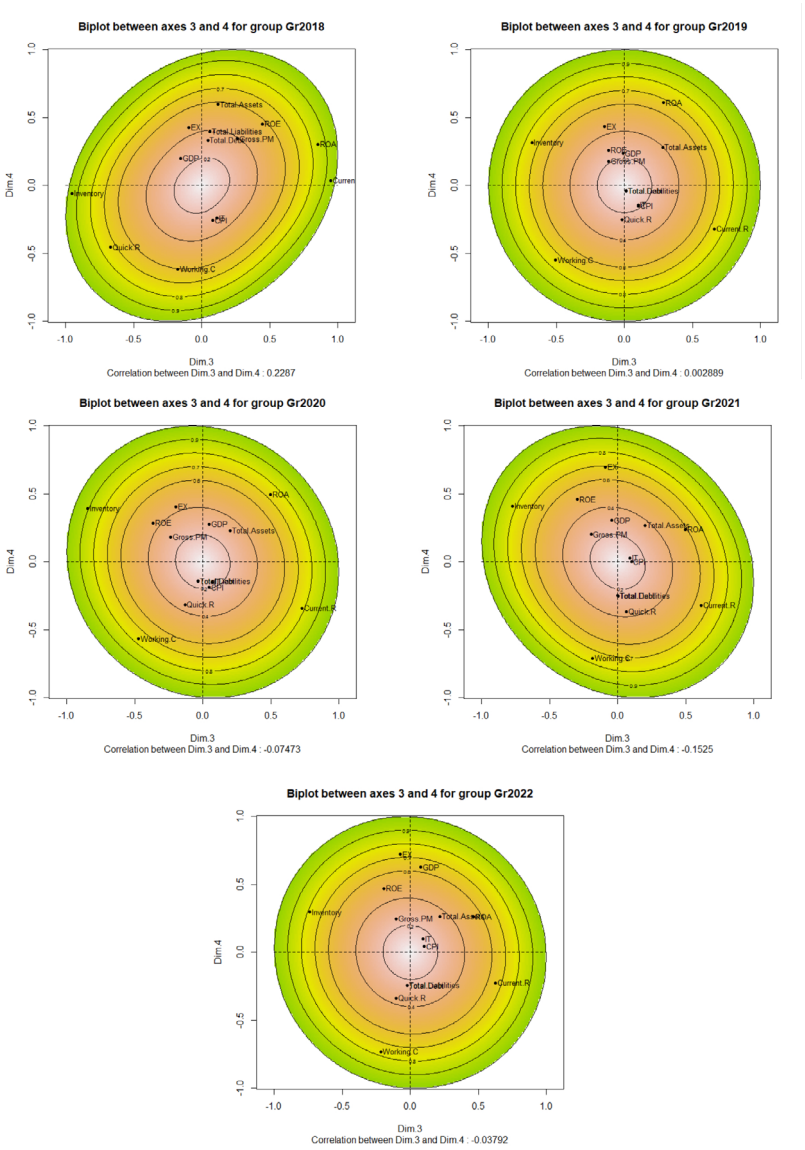

Figure 5. Variable projection on principal components 3 and 4 (Operational Efficiency and Working Capital Management).

Note: Author's own elaboration using data from LSEG Workspace and the OECD database.

Over time, a consistent pattern emerges: inventory levels and current ratio exhibit an inverse relationship in Component 3. This suggests that excessive inventory may impair short-term liquidity. Component 4 shows that working capital is negatively influenced by the quick ratio but positively associated with exchange rate movements.

Profitability indicators show differentiated behavior. ROA correlates positively with both Components 3 and 4, reinforcing the idea that inventory and liquidity management drive asset efficiency. ROE and GPM, while positively associated in 2018, display weaker -or even negative- relationships in subsequent years, particularly after 2019.

Figures 6 and 7 present the distribution of economies within the space defined by the first four components.

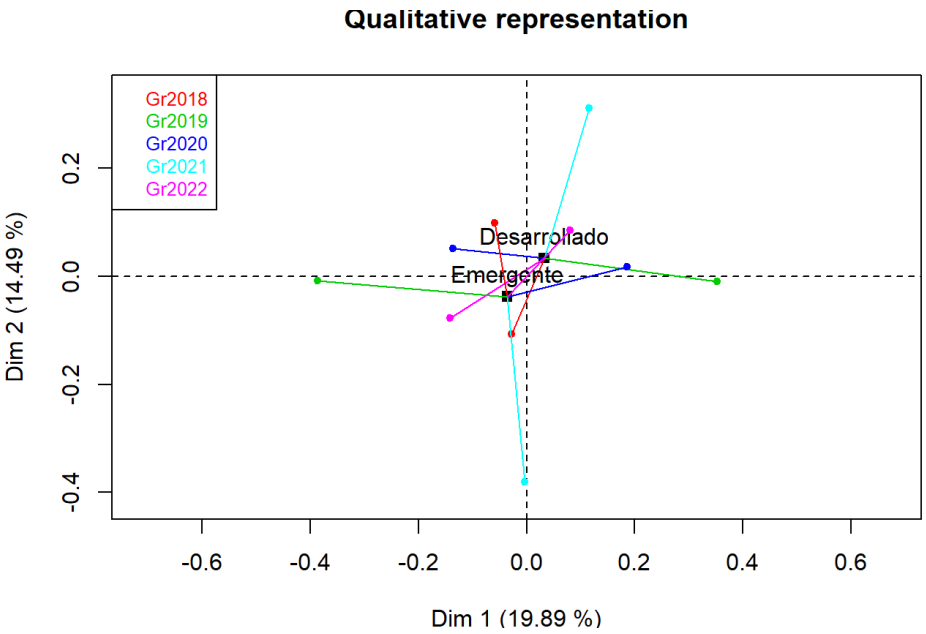

Figure 6. Country Mapping on Components 1 and 2
Note: Author's own elaboration using data from LSEG Workspace and the OECD database.

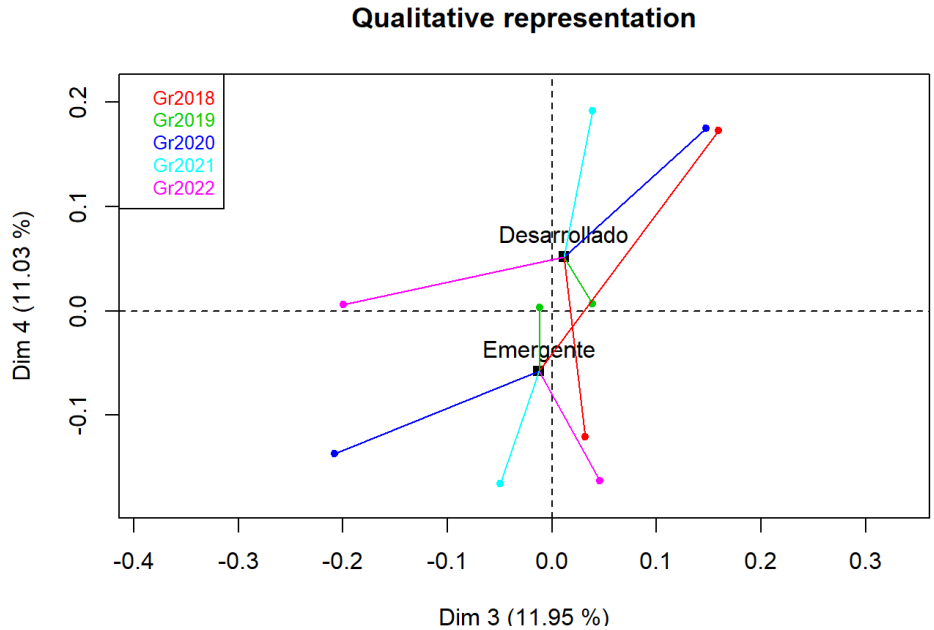

Figure 7. Country Mapping on Components 3 and 4
Note: Author's own elaboration using data from LSEG Workspace and the OECD database.

Developed economies, particularly the United States, show stronger alignment with macroeconomic conditions (Component 1), especially in 2019. In contrast, emerging economies exhibit less sensitivity to these conditions but show greater variability in leverage across time. For instance, in 2021, the developed economy relied more heavily on debt for recovery, while emerging economies struggled to access financing. Differences are also evident in Components 3 and 4. Developed economies consistently exhibit higher operational efficiency and stronger capital management. Emerging markets display greater fluctuation and

lower performance, partly due to vulnerability to exchange rate volatility and weaker liquidity positions. While the U.S. faced operational challenges in 2022 due to fuel prices and supply chain disruptions, emerging markets began improving operational efficiency but continued to face difficulties in managing capital and navigating a stronger U.S. dollar.

5. Conclusions

Understanding the profitability of power generation firms requires looking beyond internal metrics. It is equally important to consider the broader macroeconomic context, especially when drawing comparisons between firms in emerging and developed economies. This dual-level approach allows for a richer interpretation of financial performance by capturing structural and institutional differences across countries.

Prior research has consistently emphasized the role of firm -level characteristics- such as profitability indicators, capital structure, liquidity, and operational efficiency—in shaping financial outcomes. However, macroeconomic factors like GDP growth, inflation, interest rates, and exchange rates also play a crucial role by influencing the external environment in which these firms operate. This study contributes to the literature by examining the financial performance of energy firms in Latin America, focusing on the role of macroeconomic conditions and contrasting them with patterns observed in a developed market. Panel data from 106 firms across six countries between 2018 and 2022 were analyzed using a hierarchical modeling framework that captures both firm -and country- level effects. Additionally, DMFA was applied to identify latent relationships among variables and to compare structural patterns across economic contexts.

The hierarchical model results suggest that Gross Profit Margin, Quick Ratio, and Total Liabilities have a positive impact on firm performance (measured by ROE), while Total Debt negatively affects profitability. These findings challenge the conventional inverse relationship between leverage and profitability, especially in emerging economies, where high-performing firms may benefit from greater financial leverage. This insight may guide firms in developing strategies that optimize controllable variables to enhance financial outcomes. At the macroeconomic level, exchange rate and inflation emerged as significant determinants of ROE. Notably, the case of Argentina illustrates how adverse macroeconomic conditions, such as high inflation and interest rates, can lead to significant deviations in firm performance relative to other countries, even when profitability itself does not appear immediately negative.

The DMFA reduced the dataset into four interpretable components: macroeconomic conditions, leverage, operational efficiency, and working capital management and exchange rate. The results revealed inverse relationships between GDP and macroeconomic conditions (driven by interest and inflation), and between inventory levels and liquidity ratios. Interestingly, total debt and liabilities were not strongly associated with operational efficiency, indicating that financial structure and day-to-day management may operate independently in this sector.

Early in the study period, firms exhibited positive profitability with moderate leverage, but post-pandemic years saw declines in ROE and national GDP, reflecting broader economic disruptions. Over time, emerging and developed economies followed divergent paths. Emerging markets displayed a tendency toward higher leverage and were more vulnerable to economic crises and macroeconomic volatility. In contrast, developed economies generally benefited from more favorable macroeconomic conditions, better operational efficiency, and more robust working capital management. Overall, the hierarchical modeling approach effectively captured the significance of both firm-level and macro-level variables. It confirmed existing literature regarding macroeconomic influences while challenging the standard assumption of a negative relationship between leverage and profitability in emerging contexts. The DMFA, in turn, provided a meaningful dimensionality reduction and allowed for a comparative analysis across economies, revealing distinct financial trajectories and sensitivities.

Future research should aim to expand the analysis of financial performance in emerging markets by incorporating additional macroeconomic and financial variables, exploring longer time horizons, and potentially introducing firm-level qualitative dimensions. Such efforts would further enrich the understanding of how structural and contextual factors shape profitability in the global energy sector.

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Data availability

The authors declare that the article contains all the data necessary and sufficient for understanding the research.

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Disclaimer

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Appendix

Table A1 Robustness check – Linear model

Coefficients:				
	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-118.902	0.58276	-2.040	0.041835
Gross.PM	0.19169	0.04701	4.078	5.27e-05
Working.C	-0.02323	0.04200	-0.553	0.580430
Current.R	0.37493	0.10294	3.642	0.000298
Quick.R	0.02486	0.04336	0.573	0.566774
Inventory	0.40671	0.10519	3.866	0.000125
Total.Assets	0.01815	0.04060	0.447	0.655141
Total.Debt	-628.280	0.84087	-7.472	3.49e-13
Total.Liabilities	608.866	0.84233	7.228	1.81e-12
CountryBrazil	138.501	0.57882	2.393	0.017082
CountryChile	0.57225	0.72611	0.788	0.431002
CountryColombia	-125.098	209.613	-0.597	0.550906
CountryPeru	118.553	0.70228	1.688	0.092002
CountryUnited States of America	117.772	0.57236	2.058	0.040134
IT	0.70738	0.25371	2.788	0.005500
GDP	0.03515	0.04537	0.775	0.438842
EX	0.56833	0.34883	1.629	0.103885
CPI	-0.35225	0.15733	-2.239	0.025593
CountryBrazil:IT	-0.65174	0.34602	-1.884	0.060201
CountryChile:IT	-0.77692	0.44042	-1.764	0.078327
CountryColombia:IT	-109.888	109.126	-1.007	0.314424
CountryPeru:IT	-0.51265	114.861	-0.446	0.655554
CountryUnited States of America:IT	-0.75979	0.50197	-1.514	0.130745

Note: Author's own elaboration using data from LSEG Workspace and the OECD database.