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Analysis of capital structure and roundaboutness. The case of colombian firms

Análisis de la estructura del capital e intensidad de capital. El caso de las empresas colombianas

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ABSTRACT

Standard financial theories assume that investment and financing decisions are intertwined. Investment decisions involve selecting assets that generate positive cash flows and maximize shareholder value, while financing decisions involve identifying the optimal mix of debt and equity financing to fund these investments. The main objective of this paper is to analyze the interdependence of assets and liabilities in a sample of Colombian manufacturing firms with varying degrees of roundaboutness (capital-intensive nature). This study employs canonical correlation analysis to determine the interaction between balance sheet components. Subsequently, a threshold regression model is employed to evaluate the influence of financial indicators on the financial performance of firms with heterogeneous capital intensity. The findings reveal that low-capital intensity firms match the maturity structure of assets and liabilities. In firms with low roundaboutness there is a significant relation between throughput, working capital turnover and the proportion of capital expenditure to operating cash flow with ROIC. However, this relationship becomes non-significant at high levels of indebtedness. Conversely, capital-intensive firms exhibit a mismatch between asset and liability maturities, relying on shareholders' funds to finance long-term assets and inventories. In this group of companies, throughput is positively associated with ROIC regardless of the level of debt, whereas the relationship between working capital turnover and ROIC is not significant until a certain debt threshold is exceeded. The impact of the capital expenditure to operating cash flow ratio on ROIC varies depending on debt levels. Companies with high roundaboutness that exceeds a debt threshold experience a negative impact.

PALABRAS CLAVE

Correlación canónica
Finanzas corporativas
Estructura de capital
Intensidad de capital
Duración de Macaulay
Regresión umbral

RESUMEN

Las teorías financieras estándar asumen que las decisiones de inversión y financiamiento están entrelazadas. Las decisiones de inversión implican seleccionar activos que generen flujos de efectivo positivos y maximicen el valor para los accionistas, mientras que las decisiones de financiación implican identificar la combinación óptima de financiación con deuda y capital propio para financiar estas inversiones. El objetivo principal de este artículo es analizar la interdependencia de activos y pasivos en una muestra de empresas manufactureras colombianas clasificadas según su grado de roundaboutness (naturaleza intensiva en capital). Este estudio utiliza el análisis de correlación canónica para determinar la interacción entre los componentes del balance.

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Posteriormente, se estima un modelo de regresión de umbral para examinar el impacto de los indicadores financieros en la rentabilidad del capital invertido para empresas con alto y bajo roundaboutness. Los hallazgos revelan que las empresas de baja intensidad de capital alinean la estructura de vencimientos de activos y pasivos, con activos a largo plazo sirviendo como garantía para obligaciones a largo plazo. En estas empresas se observa una relación significativa entre el rendimiento sobre el capital invertido, throughput, la rotación del capital de trabajo y la proporción de gasto de capital y el flujo de efectivo operativo. Sin embargo, esta relación no es significativa en niveles altos de endeudamiento. Por otro lado, las empresas intensivas en capital exhiben un desajuste entre los vencimientos de activos y pasivos, dependiendo de los fondos de los accionistas para financiar inventarios y activos a largo plazo. En este grupo de empresas, el throughput se asocia positivamente con el ROIC independientemente del nivel de endeudamiento, mientras que la relación entre la rotación del capital de trabajo y el ROIC no es significativa hasta superar cierto umbral de deuda. La influencia de la proporción de gasto de capital al flujo de efectivo operativo en el ROIC depende del nivel de endeudamiento, resultando en un efecto negativo para empresas con alto roundaboutness que superan un umbral de deuda.

1. INTRODUCTION

In a non-ergodic environment characterized by structural instability, market imperfections, and recurrent economic fluctuations, resource planning becomes a crucial aspect of aggregate planning. This process enables the allocation of business resources while also determining the optimal levels of indebtedness and liquidity for each time horizon. The components of capital structure are “vehicles” that maximize cash flows and optimize shareholder returns (Al-Shubiri, 2010).

The strategic planning of a company’s capital structure is fundamental for enhancing the organization’s capabilities and securing financial resources in a way that balances assets and liabilities. Both internal and external factors can impact a firm’s financial risk and expected profitability. Internal determinants include factors related to management decisions, financial attributes, and firm characteristics such as size, age, capital structure, and sales growth. External determinants, on the other hand, encompass variables associated with the market, industry, and broader economic environment.

The market environment’s risks and the specific nature of a business impact its capital structure. For instance, manufacturing firms tend to distribute their investments evenly between fixed assets and current assets. In contrast, logistics companies hold considerable amounts of cash, inventories, and accounts receivable. Retail businesses, on the other hand, need substantial inventory levels to accommodate a diverse range of products. Utilities generally have lower working capital requirements due to their predominantly cash-based transactions. Likewise, financial companies must maintain significant cash reserves to fulfill their working capital needs (Marita & Permatasari, 2019).

An excessive amount of current assets can have a detrimental impact on a company’s profitability, while an insufficient level can compromise its liquidity position (Adamu & Haruna, 2020). Deviating from the optimal level of debt or equity can hinder overall firm performance and profitability, as well as distort the preferences of shareholders (Bruyland *et al*., 2019).

The capital intensity and the capital structure of a firm are intrinsically linked. The concept of “roundaboutness” provides insight into this connection. From a static perspective, the production structure describes the structural relationship between the quantity and distribution of capital goods input at each stage of production. As the roundaboutness of production escalates, the production structure will persistently expand in a vertical direction.

Typically, fixed assets have a longer duration and need significant upfront investment. Nevertheless, certain firms may face limitations or higher costs in securing long-term funding sources such as long-term debt or equity.

Capital-intensive firms may face financial hurdles due to the potential constraints or higher costs associated with long-term funding, which may not match the lifespan of their fixed assets.

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If a company with a high level of capital intensity cannot obtain long-term financing for its fixed assets, it may have to turn to short-term financing options, such as bank loans or commercial paper, to fulfill its capital requirements.

Empirical research in emerging markets has predominantly centered on the identification of macroeconomic and financial factors that influence companies' capital structures. However, the analysis of balance sheet composition and corporate investment decisions is hindered by the limited availability of standardized accounting information in public-access databases.

This research aims to assess the effect of capital intensity on the financial and accounting structures of Colombian manufacturing firms. By examining the balance sheets of 249 strategic business units from 2019 to 2021, this study fills a gap in the current literature and provides insights into the relationship between capital intensity and firms' financial and balance sheet structures.

This paper employs Canonical correlation analysis to investigate the cross-balance sheet relationships for a sample of firms with different levels of roundaboutness. The CCA is used to evaluate linear associations between the asset-side components (including fixed assets, current assets, and investments) and the liability-side components (comprising short-term debt, long-term debt, and equity) within the balance sheets.

In the next phase, the study employed the threshold model of Hansen (1999) to assess the impact of working capital turnover, CAPEX to operating cash flow, and throughput on ROIC. The threshold variable in this study is the Debt-to-EBITDA ratio, which allows for the asymmetric effect of the exogenous variables on ROIC, depending on whether this variable is above or below the unknown threshold.

This paper is structured into various sections. The introduction provides a brief overview of the scope and limitations of this investigation into the relationship between working capital management and ROIC, with a focus on the threshold effect of financial leverage. The following section offers a comprehensive and structured review of capital theory. The methodology section provides a detailed explanation for the roundaboutness and justifies the use of the threshold regression model to analyze non-linear relationships and identify threshold levels between ROIC and the explanatory variables. It also explains the theoretical underpinnings of canonical correlation analysis. The results of the empirical analysis, including the estimation of the threshold model and the canonical correlation analysis, are presented in the following section. The discussion section highlights the key findings and their implications. The paper concludes with overall remarks, a discussion of methodological limitations, and directions for further research.

2. LITERATURE REVIEW

The marginalist theory of distribution proposes that variables such as wages, rent, and interest are essentially the prices that firms pay for employing different factors of production, including labor, land, and capital. Initially, the interest rate was seen as the cost incurred for using capital. From this perspective, when the interest rate decreases, it incentivizes businesses to shift towards more capital-intensive production methods, as they are able to substitute one factor of production for another

The measurement of capital utilization in both specific commodity production and the overall economy was often associated with the average length of the production process. The prevailing belief assumed that more "roundabout" processes would yield greater productivity. Nevertheless, this perspective faced criticism during the 1960s, as the Cambridge capital controversy unfolded.

Samuelson (1947) argued that a decrease in interest rate does not automatically result in the adoption of more roundabout and mechanized processes. In his seminal work on capital theory, Samuelson explicitly dismissed the idea that the interest rate represents the price of capital.

The idea of capital as a factor of production and the interest rate as the cost for its use remains appealing, despite any criticisms. Many applied economists continue to believe that income distribution is determined by the productivity of factors. In this view, the interest rate is seen as equivalent to the 'marginal product of capital'.

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The ratio of GO (Gross Output) to GDP (Gross Domestic Product) can be used as a proxy of roundaboutness. As this metric increase, a larger share of savings is being allocated towards progressively raising the capital intensity of production over time. This business cycle theory aligns with Minsky's Financial Instability Hypothesis (FIH), which postulates that the expansion of credit by lenders and the accumulation of debt by borrowers generate a mutually destructive relationship that resembles a prisoner's dilemma scenario.

Overextension of credit results in both moral hazard and adverse selection problems, as margin lending attracts 'bad' entrepreneurs and borrowers with poor creditworthiness. Informational cascades or Cantillon effects also create a disparity between investors and consumers due to a gap of knowledge, which is further exacerbated by the influence of the financial sector. This results in the misallocation of resources along the production structure, diverting them away from the real economy (Fratini, 2019).

Wicksell's integration of Austrian capital theory and the neoclassical theory of investment relied on certain restrictive assumptions, such as the hypothesis of a stationary state (long-run equilibrium), a uniform one-year production period, and the technical impossibility of adjusting the investment period. Wicksell (1893) argued that a rise in the natural rate is caused by external factors like technological progress or population growth, while the money rate remains constant. As long as there is a discrepancy between the natural and money rates, it would result in a continuous upward cumulative process.

In contrast to Wicksell's perspective, authors such as Jevons and Böhm-Bawerk suggest that a decrease in the money rate of interest would lead to an increase in the 'period of production' or the roundaboutness of capital.

In Sraffa's theoretical framework, the length of the 'period of production' is not independent of distribution or the rate of profits. Sraffa argued that multiple equilibrium positions could coexist with the same physical capital structure and capital goods. Therefore, in the long-run, the equilibrium position becomes indeterminate (Hamberger, 2001).

Sraffa (1932) contended that there is no strong theoretical basis for a monotonic inverse relationship between the 'period of production' (capital) and the interest rate. In his vision, the marginal productivity of capital is the marginal productivity of roundaboutness

In "The General Theory", Keynes (1936) transitioned from his prior conception of a long-run natural interest rate to a novel interest theory grounded in liquidity preference, influenced by Sraffa's critique of Hayek. Since out of the long-run equilibrium position, there are many natural rates as there are commodities and capital goods (i.e., many different spot and forward prices for all commodities and heterogeneous capital goods), the highest of the own-rates is the one that, at the margin, sets the limit to the level of investment.

This rate is commonly viewed as the money rate due to its minimal carrying costs and the associated liquidity premium. This perspective enabled Keynes to incorporate the role of expectations in an environment characterized by radical uncertainty, thereby shaping the determination of the long-term interest rate in the bond market.

The concept of a single Wicksellian natural interest rate that aligns with some form of intertemporal equilibrium between consumers' time preference and the marginal productivity of capital is no longer applicable. Rather, the observed environment is highly fluid, characterized by expectations and conventions, where multiple equilibrium positions can emerge (Telles, 2023).

The Neoclassical model emphasizes the significance of intermediate business-to-business transactions within a system of accounts. This serves as the foundation for Gertsen's (2019) operationalization, where both Gross Output (GO) and Gross Domestic Product (GDP) are employed as empirical proxies to measure roundaboutness in the economic system.

In recent decades, there has been a renewed discussion on capital theory and related topics.

Cachanosky and Lewin (2014) employed the Economic Value Added (EVA) terminology to reformulate the notion of roundaboutness and the average period of production in Austrian capital theory. The authors provided a financial interpretation of Böhm-Bawerk's concept of the average period of production.

In another study, Xiaodong *et al*. (2022) developed a model using survey data from 315 enterprises located in 10 robotics industrial parks in the Yangtze River Delta region of China. Their findings revealed that the roundaboutness of the production structure has a positive impact on the innovation capability of high-tech

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enterprises. This impact is mediated through technology absorption paths, which include independent development, technology acquisition, and government policy compliance in high-tech enterprises.

In their research, Wei and Yao (2022) investigated the micro-level impact mechanisms of environmental regulation on industrial structure transformation and upgrading in China, with a particular focus on the role of production roundaboutness. Using panel data from 31 provinces and cities in China covering the period from 2003 to 2017, the study employs a panel threshold model to empirically examine the relationship between environmental regulation, production roundaboutness, and their combined effect on industrial structure transformation. The findings show that the effect of environmental regulation on the improvement of industrial structure is contingent upon the level of production roundaboutness.

3. CHARACTERIZATION OF THE INDUSTRIAL SECTOR IN THE CARIBBEAN COAST

The industrial sector plays a crucial role in the Caribbean region's economy, accounting for 12.2% of the GDP in 1997 and 12.3% in 2016. As illustrated in table 1, the secondary sector, which includes industry, energy, gas, water, sanitation, and construction, is a major contributor to the region's overall economic output. The region has seen significant growth in the manufacturing industry, particularly in the departments of Atlantico and Bolivar, which are important hubs for industrial production (Reina Aranza *et al*., 2017).

The industrial sector has experienced significant growth, and simultaneously, various segments of the tertiary sector - including commerce, transportation, communications, financial intermediation, real estate, business services, and public administration - have a considerable impact on the regional economy. In particular, the tertiary sector has emerged as the primary contributor to the overall GDP, with a larger percentage in 2016 compared to 1997.

According to the departmental accounts provided by DANE, between 1997 and 2016, Atlántico and Bolívar contributed an average of 84.5% to the gross manufacturing production of the Colombian Caribbean. Specifically, Atlantico accounted for 36.9% and Bolívar accounted for 47.6% of the total manufacturing production. The remaining six departments combined contributed only 15.5% to the total manufacturing production.

Over the past few decades, Atlantico has experienced a decrease in its contribution to the regional aggregate, while Bolívar has solidified its position as the primary contributor. This shift can be attributed to the growth trends in the manufacturing of chemicals, coke, and refined petroleum products.

The regional industry experienced notable expansion in both gross production and value-added from 1997 to 2015, with average annual growth rates of 4.1% and 2.8% respectively. The growth rate in gross production marginally exceeded the national average of 4.0%, however, the increase in value-added fell short of the national average of 3.0%.

In 2014, the regional industrial production underwent a significant contraction due to the halt of operations at Reficar. Despite this setback, the regional manufacturing activity was able to increase its contribution to the national industrial GDP from 13.6% in 1997 to 13.9% in 2016, with refineries operating at full capacity.

Between 2013 and 2014, gross production saw a decline of 15.7%, while value-added decreased by 25.0%. From 2014 to 2015, production experienced a slight increase of 0.6%, driven by a rise in intermediate consumption, while value-added decreased by 11.3%. At the individual level, the manufacturing of chemicals and chemical products held the top position in 2014 and 2015 as the largest contributor in terms of both gross production and value-added.

In 2015, the region had 651 industrial establishments, accounting for 7.2% of the national total. Other industries and manufacturing, food products, non-metallic minerals, plastic products, and chemicals and chemical products collectively made up 41.8% of the industrial establishments in the region.

In terms of employment, the region employed 67,541 workers, contributing 9.5% to the national total. Significant employment concentration was observed in the manufacturing of food and beverages (27.7%), other manufacturing industries (12.0%), rubber and plastic products (7.7%), chemicals and chemical products (7.4%), and non-metallic minerals (6.0%).

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Table 1. Evolution of the industrial sector in the Colombian Caribbean coast.

ACTIVITY	Billions of current pesos (1997)	Percentage share (1997)	Billions of current pesos (2016)	Percentage share (2016)
Primary sector	3.856	20.8	20.361	15.6
Agriculture, forestry, and fishing	1.174	6.3	5.181	4.0
Livestock	1.595	8.6	4.288	3.3
Mining	1.087	5.9	10.892	8.4
Secondary sector	3.933	21.2	34.102	26.2
Industry	2.272	12.2	16.014	12.3
Energy, gas, water, and sanitation	660	3.6	5.924	4.5
Construction	1.001	5.4	12.164	9.3
Tertiary sector	9.518	51.3	65.972	50.6
Commerce	1.629	8.8	7.486	5.7
Hotels and restaurants	636	3.4	6.843	5.2
Transportation	1.076	5.8	6.721	5.2
Communications	379	2.0	2.199	1.7
Financial intermediation	109	0.6	3.985	3.1
Real estate	865	4.7	5.131	3.9
Business services	368	2.0	7.626	5.8
Public administration	1.661	9.0	8.689	6.7
Education and health services	2.175	11.7	13.167	10.1
Other services	622	3.3	4.125	3.2
Value added	17.307	92.9	120.435	92.4
Taxes	1.249	7.1	10.570	8.1
GDP	18.556	100.0	130.399	100.0

Source: Reina Aranza *et al.* (2017).

4. METHODOLOGY

This section presents the methodological design of the research, including the research design, employed techniques, and procedures for data collection. It also outlines any limitations, units of analysis, the target population, and the operationalization process for variables.

The primary objective of this research is to analyze the balance sheet and evaluate the capital intensity of companies located in the Caribbean region between the years 2019 and 2021.

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Following the data collection phase, an exploratory analysis is conducted to detect any unusual behavior within specific subgroups of companies. This analysis involves calculating summary statistics for each variable.

In the first stage of the study, canonical correlation analysis (CCA) will be employed to evaluate the relationship between two sets of variables, specifically assets and liabilities. It's important to note that CCA is an exploratory technique and does not impose any structure on the data or assume a causal direction between the variable sets. Despite this, the method is suitable for describing financial management strategies related to investment and financing decisions (Cheong & Ryu, 2006).

This study employs a threshold regression model to examine the relationship between return on capital investment and various explanatory variables, such as throughput, working capital turnover, and CAPEX to Operating cash flow ratio, in companies with different degrees of roundaboutness (Eyerci, 2021; Luther, 2021).

Table 2 provides a summary of the research datasheet used in the study.

Table 2. Technical summary of investigation.

Geographic scope	Small caps in Bolivar and the Caribbean Coast
Sample size and characteristics	249 companies in the petrochemical-plastic sector in Colombia
Design type	Cross-sectional
Sampling type	Intentional sampling

Source: authors' elaboration.

Table 3 presents the balance sheet components that will be analyzed in this study. The companies are grouped based on their degree of "roundaboutness". The initial hypothesis is that companies with a higher capital-intensive production structure may exhibit a maturity mismatch between assets and liabilities (Eyerci, 2021; Luther, 2021). On the other hand, companies with lower capital intensity may show better alignment between asset and liability components (Dimand, 2010; Mareta *et al.,* 2021).

Table 3. Balance sheet structure.

	Item	Description	Roundaboutness
Asset	Cash and securities	Cash Short-term investments Cash and banks	−
	Inventory	Raw materials, Products in process Finished products	±
	Accounts receivable	Credit to customers	±
	Long-term assets	Real estate Machinery and equipment Land Long-term investments	+
Liabilities	Accounts payable	Overdrafts Bank obligations Accounts payable to suppliers Taxes and benefits	±
	Other current debt	Other liabilities	−
	Long-term liabilities	Bank loans. Long-term loans	+
Capital	Stockholders' equity	Capital stock Capital surplus Retained earnings	−

Source: authors' elaboration.

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4.1. Roundaboutness and capital structure

The term "roundaboutness" refers to (I) the "average production period" and (II) a more capital-intensive method of production. To understand the concept of roundaboutness, it is important to consider the notion of Economic Value Added (EVA), which measures the value created by a firm over a specific period of time. The level of roundaboutness is a combination of a time factor and the capital invested, and the EVA indicator captures both dimensions. Indirect production methods that require a large amount of capital tend to exhibit a heightened interest rate sensitivity, and this is reflected in the EVA indicator (Cachanosky & Lewin, 2014).

Free Cash Flow (FCF) is a relevant metric for evaluating both companies and investment projects. Essentially, it is equivalent to net operating profit after tax ($NOPAT$) minus net investments (NI); $FCF=NOPAT - NI$. The value of a company can be seen as the free cash flow (FCF) that is available to investors after all necessary investments have been made. In essence, EVA can be viewed as a algebraic rearrangement of FCF.

Given the return on invested capital ROA, and $NOPAT$ the ratio of invested capital to invested capital, EVA is calculated by multiplying the invested capital (K) by the difference between ROA and the opportunity cost of capital (). The Economic Value Added (EVA) is a financial metric that compares the value generated by an investment to the potential returns from an alternative investment. It is calculated by subtracting the total capital provided by investors, including both bondholders and shareholders, from the company's market value.

Let V be the present value of the future cash flows. So, V can be written as follows:

$$V = \sum_{t=0}^{\infty} \frac{FCF_t}{(1+c)^t}$$

$$V = K_0 + \sum_{t=1}^{\infty} \frac{(ROA_t - c)K_{t-1}}{(1+c)^t} = K_0 + \sum_{t=1}^{\infty} \frac{EVA_t}{(1+c)^t}$$

Enterprise value is the total value of a company, defined in terms of its financing. It includes both the current share price (market capitalization) and the cost to pay off debt (net debt, or debt minus cash). This added value is determined by the cumulative return on the market over the initial value for each period. By reporting the initial capital value it's possible to track changes in economic value added (EVA) over time. Therefore, it is useful for assessing the impact of various project components, specifically K, T and D, on the net present value of a project. Expected market value added (MVA) of the company can be expressed as $MVA = V - K_0$.

$$MVA = \sum_{t=1}^{T} \frac{(ROIC_t - c)K_{t-1}}{(1+c)^t} = \sum_{t=1}^{T} \frac{EVA_t}{(1+c)^t}$$

According to Cachanosky and Lewin (2014), this representation has three key features: (I) it is oriented towards the future, (II) it emphasizes the duration of cash flows, and (III) it considers the "size of capital" represented by K.

The Macaulay duration (D) of a project provides a financial interpretation of the "average production period." It represents the average time required to receive one monetary unit from the selected project, serving as a forward-looking metric of value. Since D assigns weights to periods based on their present value, it eliminates the necessity to measure physical quantities.

The value of a combination of heterogeneous capital goods is equivalent to the present value of their expected future cash flows. The price of capital goods is inversely related to the discount rate.

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Wicksell's theory posits that the natural rate of interest balances the supply and demand for loanable funds under conditions of full employment. This natural rate of interest is determined by the time preference of economic agents. Ergo, in a competitive market at equilibrium, economic profits are zero, resulting in $ROIC = c$ and $MVA=0$. If the real interest rate at which investors can borrow declines, while all other factors remain unchanged, the market value added (MVA) rises, creating opportunities for generating profits that exceed the cost of capital. Strong demand for capital to invest in projects with positive MVA drives up the price of capital goods. The Wicksell effect predicts that at a lower real interest rate, the value of capital goods is higher because the present value of their output is discounted at a lower opportunity cost. The rise in production costs, attributed to higher prices of capital and intermediate goods is reflected as a decrease in net operating profit after tax $NOPAT$.

Those projects with a higher forward-looking nature ($T_{HR} > T_{HR}$) or higher capital intensive ($K_{HR} > K_{HR}$) tend to be more sensitive to variations in the value of c, ceteris paribus. Conversely, "modified duration" (MD) indicates that projects with greater roundaboutness exhibit heightened sensitivity to interest rate shifts. Modified duration serves as a measure of sensitivity of the product value to changes in the discount rate, where the yield to maturity (the internal rate of return) functions as the discount rate. Essentially, it represents the semi-elasticity of the MVA in relation to the project's yield.

$$MD = \frac{\partial \, log \, log \, MVA}{\partial IRR} = -\frac{D}{1 + IRR}$$

Being IRR the internal rate of return per period.

In other words, projects with a higher amount of financial capital are more susceptible to changes in interest rates, even if they report the same Macaulay duration. EVA can be calculated as the difference between $NOPAT$ and the opportunity cost of invested capital, $EVA_t = NOPAT_t - c_t \cdot K_{t-1}$), where $NOPAT$ is the net operating profit after tax. For each project, c, K and EVA remain constant across each period. Then,

$$MVA_{HR} = \sum_{t=1}^{T} \frac{(NOPAT_{HR} - c_{HR})K_{HR}}{(1 + c_{HR})^t}$$

$$MVA_{LR} = \sum_{t=1}^{T} \frac{(NOPAT_{LR} - c_{HR})K_{LR}}{(1 + c_{LR})^t}$$

Ceteris paribus, decreases of similar magnitude in c produce increases in MVA_{HR} more than MVA_{LR} because $K_{HR} > K_{LR}$. In other words, the more capital-intensive the project is (in terms of K) the more convex its relationship with the cost of capital. Consequently, the Market Value Added (MVA) of projects with a higher intensity of financial capital are more responsive to variations in the discount rate.

4.2. Canonical correlation analysis

Canonical correlation analysis is founded on three primary goals:

I) Quantifying the strength of linear relationships between two sets of variables that are observed on the same individuals or entities. II) Elucidating the nature of these relationships by evaluating the relative contribution of each predictor to the canonical functions. III) Deriving weights for each set of variables to maximize the correlation in their linear combinations. These linear combinations are known as canonical variates or canonical components (Castillo, 2017).

Let's consider a set of p variables represented by the random vector $X = [x_1, x_2 ..., x_p]$ of order $(p \times 1)$ and a second set of q variables represented by the random vector $Y = [y_1, y_2 ..., y_p]$ of order $(q \times 1)$ and where each variable is taken over n individuals. It is assumed that $p \leq q$. Both the vector X and Y can be represented in a matrix

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$$X = (x_{11}\ x_{12} \cdots x_{1p}\ x_{21}\ x_{22} \cdots x_{2p} \vdots\vdots \vdots x_{n1}\ x_{n2} \cdots x_{np}) \text{ and}$$

$$Y = (y_{11}\ y_{12} \cdots y_{1p}\ y_{21}\ y_{22} \cdots y_{2p} \vdots\vdots \vdots y_{n1}\ y_{n2} \cdots y_{np}).\ X \text{ and } Y \text{ are calculated as follows:}$$

$$E[X] = \mu_x, Var(X) = \Sigma_{XX}$$

$$E[Y] = \mu_y, Var(Y) = \Sigma_{YY}$$

$$Cov\,(X,Y) = \Sigma_{XY} = \Sigma'_{YX}$$

The first canonical vectors are those vectors of coefficients a and b that satisfies this condition. The *k-th* pair of canonical variables, is the pair of linear combinations U_k, V_k with unit variances, which maximize the correlation $\rho = corr(U,V)$) (k-th canonical correlation) and which are related to the (k-1) pairs of previous canonical variables. The canonical correlation analysis can be understood as a conditional-extremal problem. To solve this problem, Lagrange multipliers are employed. The process involves creating new variables, which are linear combinations of the original (primitive) variables. As the process continues, each subsequent new variable retains less information than the previous one.

$$U = a'\ X$$

$$V = b'\ Y$$

Being a y b vector coefficients.

The main objective of principal component analysis is to find the coefficient vectors that maximize $\rho = corr(U,V)$. It is known that ρ is given by

$$\rho = corr(U,V) = \frac{a'\Sigma_{XY}b}{\sqrt{a'\Sigma_{XX}a\ \sqrt{b'\Sigma_{XX}b}}}$$

Subject to $a'\Sigma_{XX}a = b'\ \Sigma_{XX}b = 1$

With

$$Var\,(U) = a'\Sigma_{XX}a$$

$$Var\,(V) = b'\ \Sigma_{XX}b$$

$$Cov\,(U,V) = a'\Sigma_{XX}b$$

Consider the following optimization problem:

$$f(a,b) = corr(U,V) = \frac{a'\Sigma_{XY}b}{\sqrt{a'\Sigma_{XX}a\ \sqrt{b'\Sigma_{XX}b}}}$$

Subject to:

$$g_1\,(a,b) = a'\Sigma_{XX}a - 1 = 0$$

$$g_2\,(a,b) = b'\Sigma_{XX}b - 1 = 0$$

Now we have the Lagrange function:

$$F(a,b,\lambda,\beta) = a'\Sigma_{XY}b - \frac{\lambda}{2}\left(a'\Sigma_{XX}a - 1\right) - \frac{\lambda}{2}\left(b'\Sigma_{YY}b - 1\right)$$

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Where λ and λ are the Lagrange multipliers
The Karush-Kuhn-Tucker conditions must be satisfied to obtain the maximum of the function:

$$\nabla_{a,b} F(a,b,\lambda,\beta) = 0$$
$$\nabla_{\lambda,\beta} F(a,b,\lambda,\beta) = 0$$

The function is derived with respect to each variable. Each resultant expression is equal to zero, then:

$$\frac{\partial F}{\partial a} = \Sigma_{XY} b - \lambda \Sigma_{XX} a = 0$$
$$\frac{\partial F}{\partial b} = \Sigma_{YX} a - \lambda \Sigma_{YY} b = 0$$
$$\frac{\partial F}{\partial \lambda} = -\frac{1}{2}\left(a' \Sigma_{XX} a - 1\right) = 0$$
$$\frac{\partial F}{\partial \beta} = \frac{1}{2}\left(b' \Sigma_{YY} b - 1\right) = 0$$

After several algebraic operations and assuming that is invertible we obtain:

$$\Sigma_{XY}(\lambda^{-1}\Sigma_{YY}^{-1}\Sigma_{YX} a) - \lambda \Sigma_{XX} a = 0$$
$$\Sigma_{XY}\Sigma_{YY}^{-1}\Sigma_{YX} a = \lambda^2 \Sigma_{XX} a$$

For b we obtain:

$$\Sigma_{XY}\Sigma_{XX}^{-1}\Sigma_{XY} b = \lambda^2 \Sigma_{YY} b$$

Under the assumption that Σ_{XX} and Σ_{YY} are invertible, canonical correlations and canonical vectors from $\Sigma_{XY}\Sigma_{YY}^{-1}\Sigma_{YX} a = \lambda^2 \Sigma_{XX} a$ are determined via singular value decomposition of matrix K:

$$K = \Sigma_{XX}^{-1/2} \Sigma_{XY} \Sigma_{YY}^{-1/2}$$

If we obtain the inverses of Σ_{XX} y Σ_{yy} en $\Sigma_{XY}\Sigma_{YY}^{-1}\Sigma_{YX} a = \lambda^2 \Sigma_{XX} a$ y $\Sigma_{XY}\Sigma_{XX}^{-1}\Sigma_{XY} b = \lambda^2 \Sigma_{YY} b$, respectively, it follows that:

$$M_1 = \Sigma_{XX}^{-1}\Sigma_{XY}\Sigma_{YY}^{-1}\Sigma_{YX} = \Sigma_{XX}^{-1/2} N_1 \Sigma_{XX}^{1/2}$$
$$M_2 = \Sigma_{YY}^{-1}\Sigma_{YX}\Sigma_{XX}^{-1}\Sigma_{XY} = \Sigma_{YY}^{-1/2} N_1 \Sigma_{YY}^{1/2}$$

Being N_1 = KK´ y N_2 = K' K. N_1 y M_1 are of order ($p \times p$), and N_2 y M_2 are of order ($q \times q$).

4.3. Threshold regression

Consider a threshold regression with two regions defined by a threshold . This is written as

$$y_t = x_t\beta + z_t\delta_1 + \epsilon_t \ \ if -\infty < w_t \leq \gamma$$
$$y_t = x_t\beta + z_t\delta_2 + \epsilon_t \ \ if \ \gamma < w_t < \infty$$

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where y_t is the dependent variable, x_t is a $1 \times k$ vector of covariates possibly containing lagged values of y_t, β is a $k \times 1$ vector of region-invariant parameters, z_t is a vector of exogenous variables with region-specific coefficient vectors δ_1 and δ_2, w_t is a threshold variable that may also be one of the variables in x_t or z_t, and ϵ_t is an IID error with mean 0 and variance σ^2.

The estimated threshold ($\hat{\gamma}$) is one of the values in the threshold variable w_t. To estimate the threshold, we minimize the least squares of the following regression with T observations and two regions,

$$y_t = x_t \beta + z_t \delta_1 I(-\infty < w_t \leq \gamma) + z_t \delta_2 I(\gamma < w_t < \infty) + \epsilon_t$$

for a sequence of T_1 values in w_t, where $T_1 < T$. The default trimming percentage is set to 10%, which implies that T_1 corresponds to the number of observations between the 10 th and the 90 th percentile of w_t. The estimator for the threshold is

$$\hat{\gamma} = arg \min_{\gamma \in \Gamma} S_{T_1}(\gamma)$$

where $\Gamma = (-\infty, \infty)$,

$$S_{T_1}(\gamma) = \sum_{t=1}^{T} \{y_t - x_t\beta - z_t\delta_1 I(-\infty < w_t \leq \gamma) - z_t\delta_2 I(\gamma < w_t < \infty)\}^2$$

is a $T_1 \times 1$ vector of SSR, and γ is a $T_1 \times 1$ vector of tentative thresholds.

In general, a threshold regression model with m thresholds has $m+1$ regions. Let $j = 1, \ldots, m+1$ index the regions. We can write the model as

$$\begin{aligned} y_t &= x_t\beta + z_t\delta_1 I_1(\gamma_1, w_t) + \cdots + z_t\delta_{m+1} I_{m+1}(\gamma_{m+1}, w_t) + \epsilon_t \quad y_t \\ &= x_t\beta + \sum_{j=1}^{m+1} z_t\delta_j I_j(\gamma_j, w_t) + \epsilon_t \end{aligned}$$

where $\gamma_1 < \gamma_2 < \cdots < \gamma_m$ are ordered thresholds with $\gamma_0 = -\infty$ and $\gamma_{m+1} = \infty$. $I_j(\gamma_j, w_t) = I(\gamma_{j-1}) < w_t \leq \gamma_j)$ is an indicator for the j th region. Conditional on all estimated thresholds ($\hat{\gamma}_1, \ldots, \hat{\gamma}_m$, the threshold regression model is linear, and the remaining parameters are estimated using least squares.

The thresholds are estimated sequentially as described below. Let $\gamma_1^*, \cdots, \gamma_m^*$ represent the m thresholds in the order of estimation and are T consistent. The first threshold (γ_1^*) is estimated assuming a model with two regions as described. Conditional on the first threshold, the second threshold is estimated as the value that yields the minimum sum of squared errors over all observations w_t in excluding the first threshold. The estimator of the second threshold γ_2^* is obtained by minimizing the least squares of a regression with three regions conditional on the first estimated threshold $\hat{\gamma}_1^*$. The estimator is given by

$$\hat{\gamma}_2^* = arg \min_{\gamma_2^* \in \Gamma_2} S_{T_2}(\gamma_2^* \mid \hat{\gamma}_1^*)$$

where $\Gamma_2 = (\gamma_0, \hat{\gamma}_1^*) \cup (\hat{\gamma}_1^*, \gamma_3)$ and $T_2 < T_1$

In general, the l th threshold minimizes the SSR conditional on $l-1$ the estimated thresholds and is given by

$$\hat{\gamma}_l^* = arg \min_{\gamma_l^* \in \Gamma_l} S_{T_l}(\gamma_l^* \mid \hat{\gamma}_1^*, \ldots, \hat{\gamma}_{l-1}^*)$$

where $\Gamma_l = (\gamma_0, \gamma_{m+1})$ excluding $\hat{\gamma}_1^*, \ldots, \hat{\gamma}_{l-1}^*$

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$$AIC = \left(\frac{SSR}{T}\right) + 2k$$

$$BIC = \left(\frac{SSR}{T}\right) + (T)$$

$$HQIC = Tln\,(SSR/T) + 2kln\,\{ln\,(T)\}$$

where k is the number of parameters in the model.

When the number of thresholds is unknown a priori, the optimal number of thresholds can be determined using information criteria such as AIC, BIC, or HQIC. These criteria are based on the sum of squared residuals (SSR) from the fitted model

5. RESULTS

Table 4 presents a comprehensive summary of the independent variables used in the analysis, which includes both measures of central tendency and dispersion. The descriptive statistics are broken down into two subgroups. For the first subgroup, the components on the liability side of the balance sheet are represented as a percentage of total liabilities. For the second subgroup, the components on the right side of the balance sheet are represented as a fraction of total assets. 128 firms are identified as capital-intensive and 121 firms report low roundaboutness.

The results indicate that, on average, companies that are capital-intensive tend to have a lower cash-to-total-assets ratio compared to companies that are not capital-intensive. The analysis suggests that businesses with higher levels of roundaboutness generally have a higher percentage of accounts receivable relative to total assets.

The right side of the balance sheet includes accounts payable, which represents the obligations a business has to pay its suppliers or vendors for goods and services received on credit. Companies with lower capital intensity tend to have a greater reliance on supplier credit to support their standard operations. On average, companies with lower capital intensity tend to rely less on internal financing compared to companies with high capital intensity.

Table 4. Descriptive analysis.

	Low roundaboutness				High roundaboutness			
	Mean	Median	Range	Standard deviation	Mean	Median	Range	Standard deviation
Cash and securities	16,06%	22,46%	2,41%	15,81	9,89%	9,55%	27,32%	3,68
Inventory	17,13%	35,86%	8,74%	18,90	20,83%	21,45%	52,33%	10,69
Accounts receivable	3,49%	18,67%	2,22%	3,28	14,20%	6,95%	33,39%	10,71
Long-term assets	40,11%	58,14%	12,06%	37,74	48,02%	47,92%	45,33%	9,93
Accounts payable	20,61%	41,62%	8,15%	19,42	11,98%	12,31%	26,87%	4,67
Other current debt	43,07%	40,62%	6,48%	43,39	18,24%	17,29%	31,13%	6,50
Long-term debt	21,34%	33,70%	5,47%	20,89	52,34%	50,07%	33,03%	7,49
Stockholders' equity	14,98%	12,56%	2,78%	15,67	17,44%	18,05%	14,28%	2,71

Source: authors' elaboration.

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The derivation of successive canonical variates is similar to the procedure used with unrotated factor analysis. The first factor extracted accounts for the maximum amount of variance in the set of variables, then the second factor is computed so that it accounts for as much as possible of the variance not accounted for by the first factor, and so forth, until all factors have been extracted. Therefore, successive factors are derived from residual variance from previous factors. The result is that the first pair of canonical variates is derived so as to have the highest intercorrelation possible between the two sets of variables. The second pair of canonical variates is then derived so that it exhibits the maximum relationship between the two sets of variables (variates) not accounted for by the first pair of variates. In short, successive pairs of canonical variates are based on residual variance, and their respective canonical correlations (which reflect the interrelationships between the variates) become smaller as each additional function is extracted. That is, the first pair of canonical variates exhibits the highest intercorrelation, the next pair the second-highest correlation, and so forth (Badi *et al*., 2007).

Varimax rotation is not employed in order to preserve the fundamental properties of canonical correlation.

The bivariate correlations presented in table 5 have theoretical constraints, as pointed out by Stowe et al. (1980). This is due to the fact that the ideal equilibrium of an asset or liability account is jointly determined with other accounts on the same balance sheet side and the opposing side.

Short-term assets, which include cash, securities, inventories, and other current assets, show positive loadings on the asset component. On the other hand, short-term liabilities, such as accounts payable and other current liabilities, show positive loadings on the liability component.

For non-capital-intensive structures, both long-term assets and debt have negative loadings on the liabilities side. This implies that short-term assets are matched with short-term liabilities, while long-term assets are funded with long-term debt and companies with lower roundaboutness tend to match assets with liabilities. Fixed assets are commonly used as collateral to secure long-term loans. Additionally, inventories and accounts receivable are tied to accounts payable, which means that suppliers provide credit to partially finance these asset categories. High positive loadings on cash and equity reveal that firms in this subgroup tend to use less leverage and prioritize maintaining higher liquidity to minimize the risk of insolvency.

Conversely, in companies with high roundaboutness, long term assets and equity show positive loadings in the second canonical function. Long-term asset acquisitions are partially funded by owners' investment, which includes retained earnings. Stockholders' capital is also used to finance current assets, such as inventories. It can be inferred that these firms adopt a suboptimal "hedging strategy".

Long term assets (like fixed assets) are characterized by low liquidity and are insensitive to variations in interest rates, which contrasts to current assets that are generally more liquid and responsive to fluctuations in interest rates (Ben Said & Rim, 2018).

Table 5. Canonical correlations.

	Low roundaboutness		High roundaboutness	
	I	II	I	II
Cash and securities	0.683	-0.584	0,349	-0,933
Inventory	0.884	-0.063	0,742	0,282
Accounts receivable	0.297	-0.596	0,306	-0,145
Long-term assets	0.099	0.841	0,015	0,378
Accounts payable	0.672	-0.436	0,657	-0,210
Other current debt	0.842	-0.239	0,847	-0,323
Long-term debt	0.054	0.981	0,259	0,700
Stockholders' equity	0.494	-0.367	0,474	0,377

Source: authors' elaboration.

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Canonical scores represent the correlation between the canonical variates and the variables within each set. The calculation of these scores involves the multiplication of two matrices: the matrix of correlations between variables and the matrix of canonical coefficients. Canonical correlation captures the shared variance among linear combinations of multiple variable sets. These canonical functions are the canonical weights, which are unstable. The interpretation of these weights is not always clear-cut, since their primary purpose is to maximize the correlation between the linear combinations, rather than being explicitly designed for variance extraction.

In order to resolve this matter, some researchers propose using canonical cross-loadings as an alternative approach. This procedure consists of correlating each of the original observed dependent variables directly with the independent canonical variate, and vice versa. Recall that conventional loadings correlate the original observed variables with their respective variates after the two canonical variates (dependent and independent) are maximally correlated with each other (Badi *et al.,* 2007). This technique is analogous to multiple regression analysis, where each individual dependent variable is correlated with the canonical independent variable.

The findings outlined in table 6 provide support for the prior argument: companies with high roundaboutness are susceptible to illiquidity risk.

Table 6. Correlations between factors and canonical variables.

	Low roundaboutness		High roundaboutness	
	I	II	I	II
Cash and securities	0.679	-0.377	0,343	-0,655
Inventory	0.878	-0.032	0,927	-0,037
Accounts receivable	0.295	-0.385	-0,014	0,102
Long-term assets	0.099	0.543	0,015	0,265
Accounts payable	0.668	-0.282	0,645	-0,218
Other current debt	0.837	-0.154	0,521	-0,183
Long-term debt	-0.054	0.634	0,831	-0,226
Stockholders' equity	0.491	-0.237	0,465	0,264

Source: authors' elaboration.

Table 7 presents the significance test of canonical correlations. The F-statistic, based on Rao's approximation, is commonly used to assess the overall significance of models of this nature. Additionally, a multivariate test can be employed to evaluate the statistical significance of the canonical roots. To assess the significance of the discriminant functions various measures are computed, including Wilks' lambda given by $\Lambda_1 = \prod_{i=1}^{m}(1 - r_i^2)$, Hotelling's trace, $V^m = \sum_{i=1}^{m} r_i^2$, Pillai's trace $V^m = \sum_{i=1}^{m} r_i^2$ and Roy´s test $\theta = r_i^2$.

For firms with low roundaboutness, all four statistics—Wilks' lambda, Pillai's trace, Lawley-Hotelling trace, and Roy's largest root— report exceptionally low p-values. For firms with high roundaboutness, all test results were also highly significant.

Individual canonical correlations' significance is assessed employing Wilk's Lambda, the multivariate generalization of R-Squared. The Wilks' lambda statistic is interpreted just the opposite of R-Squared: a value close to zero suggests high correlation, while a value close to one suggests low correlation. As depicted in both sections of table 8, the pairs of canonical correlations are statistically significant at a 95% confidence level.

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Table 7. Overall significance test of canonical correlations.

Factors	Statistic	Degrees of freedom 1	Degrees of freedom 2	F	$p > F$
Low roundaboutness					
Wilks' lambda	0.007	16	345.858	89.025	0,000
Pillai's trace	1.415	16	464	15.874	0,000
Lawley-Hotelling trace	84.394	16	446	588.119	0,000
Roy's largest root	83.668	4	116	2426.365	0,000
High roundaboutness					
Wilks' lambda	0,018	16	364,189	62,251	0,000
Pillai's trace	1,505	16	488	18,406	0,000
Lawley-Hotelling trace	27,031	16	470	198,513	0,000
Roy's largest root	26,008	4	122	793,252	0,000

Source: authors' elaboration.

Table 8. Significance test of individual canonical correlations.

Factors	Statistic	Degrees of freedom 1	Degrees of freedom 2	F	$p > F$	Factors
Low roundaboutness						
Wilks' lambda (Canonical Correlation I)	0,068	0,9941	16	345,858	89,025	0,000
Wilks' lambda (Canonical Correlation II)	0,577	0,6461	9	277,597	7,8163	0,000
High roundaboutness						
Wilks' lambda (Canonical Correlation I)	0,021	0,981	16	370,299	59,2549	0,000
Wilks' lambda (Canonical Correlation II)	0,561	0,633	9	297,067	8,8715	0,000

Source: authors' elaboration.

5.1. Threshold model

As mentioned in the methodology section, a threshold regression model is employed to examine the relationship between ROIC and explanatory variables, including throughput, working capital turnover, and CAPEX to Operating cash flow ratio. The Debt-to-EBITDA ratio is employed as the threshold variable.

The following tables (table 9 and 10) present summary statistics for financial indicators, distinguishing between firms with low roundaboutness and firms with high roundaboutness.

ROIC is determined by the interaction of turnover and profit margin.

Turnover is a metric used to evaluate the effectiveness of resource allocation to a portfolio of business assets. It calculates the revenue generated per monetary unit of invested capital.

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Profit margin equals revenue minus the cost of goods sold and operating expenses, which typically include general, and administrative costs; sales and marketing; research and development

The Working Capital Turnover Ratio is a financial metric designed to gauge how proficiently a company manages its working capital to maintain sales and promote growth. To compute this ratio, net sales is divided by the working capital, which is derived by subtracting current liabilities from current assets. Typically, this calculation is performed on an annual or trailing 12-month basis.

Throughput is the pace at which an entire organization generates revenue from the sales of a product or service. It is determined by deducting the "total variable cost" from sales. The "total variable cost" generally includes the cost of raw materials involved in the production of the sold item. In other terms, throughput is an indirect indicator of net income generated after deducting direct manufacturing costs.

Finally, the CAPEX to Operating cash flow ratio is a financial metric that is equivalent to dividing capital expenditures by operating cash flow. This ratio provides insights into a company's capability to fund its capital expenditures using the operational cash generated within a specific period.

Table 9. Financial indicators for low roundaboutness firms.

	Mean	Median	Range	Standard deviation	Coefficient of variation
ROIC	1,89	1,77	0,46	0,15	8,33%
Debt-to-EBITDA ratio	0,41	0,40	0,22	0,08	13,33%
Working capital turnover ratio	7,22	6,50	1,53	0,60	8,57%
Throughput	4,43	3,80	8,21	2,00	50,00%
CAPEX to Operating cash flow ratio	0,38	0,20	0,18	0,05	16,67%

Source: authors' elaboration.

Table 10. Financial indicators for high roundaboutness firms.

	Mean	Median	Range	Standard deviation	Coefficient of variation
ROIC	2,53	2,34	0,69	0,20	8,00%
Debt-to-EBITDA ratio	0,72	0,66	0,34	0,10	11,11%
Working capital turnover ratio	8,04	9,52	3,52	1,20	15,00%
Throughput	10,11	8,33	11,20	3,00	29,70%
CAPEX to Operating cash flow ratio	0,51	0,41	0,64	0,10	20,00%

Source: authors' elaboration.

Table 9 suggests that firms with low roundaboutness generally have lower profitability (ROIC), lower throughput and moderate levels of debt and working capital turnover. In contrast, table 10 reveals that firms with high roundaboutness tend to exhibit higher profitability, elevated debt levels, a higher working capital turnover ratio, and higher throughput.

Table 11 presents a threshold regression model estimated for firms with low roundaboutness. The threshold value divides high roundaboutness firms into two distinct regimes: region 1 (characterized by low indebtedness) and region 2 (characterized by high indebtedness). In both subsections of the output, the threshold value and corresponding tables of coefficients for each region are displayed. In these models, the dependent variable is Return on Invested Capital (ROIC), and the threshold variable is the Debt-to-EBITDA ratio.

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In Region 1, a significant positive relationship is observed between ROIC and three key variables: Throughput, Working Capital Turnover, and CAPEX to Operating Cash Flow Ratio. An increase in Throughput (coefficient: 0.187) and Working Capital Turnover (coefficient: 0.229) leads to a positive change in ROIC. A higher ratio of Capital Expenditure (CAPEX) to Operating Cash Flow (coefficient: 0.309) is also positively associated with ROIC. These relationships are highly statistically significant at a 95% confidence level.

In Region 2, The variables analyzed, including Throughput, working capital turnover ratio and CAPEX to Operating cash flow ratio, all show insignificant p-values (0.865, 0.953, and 0.9623) at 95% confidence level.

Table 11. Threshold model for low roundaboutness firms.

Threshold (Debt-to-EBITDA ratio)	0.474					
SSR	16.5837					
Order	1					
ROIC	Coefficient	Std. Err.	Z	P>z	[95% conf. Interval]	
REGION 1						
Throughput	0.187	0.018	10.451	<0.001	[0.1522	0.222]
Working capital turnover ratio	0.229	0.012	19.073	<0.001	[0.2053	0.252]
CAPEX to Operating cash flow ratio	0.309	0.042	7.315	<0.001	[0.2257	0.392]
Constant	1.378	1.158	1.19	0.234	[0.891	3,646]
REGION 2						
Throughput	1.153	6.751	0.1708	0.865	[-12.366	14.6726]
Working capital turnover ratio	-0.0026	0.043	-0.06	0.953	[-0.088	0.083]
CAPEX to Operating cash flow ratio	3.412	3.601	1.786	0.9623	[-0.223	4.857]
Constant	0.116	0.038	3.05	0.002	[0.0419	0.192]

Source: authors' elaboration.

Table 12 presents a threshold model that has been estimated for firms with high roundaboutness.

In Region 1, (companies with low indebtedness), the variables "Throughput" and "CAPEX to Operating Cash Flow ratio," are strongly related with Return on Invested Capital (ROIC). Throughput has a coefficient of 0.417, and the CAPEX to Operating Cash Flow ratio has a coefficient of 0.323. However, the variable "Working capital turnover ratio" is not statistically significant at a 95% confidence level.

In Region 2, there is a positive and statistically significant relationship between Throughput and Return on Invested Capital (ROIC) at a 95% confidence level. Likewise, the variable "Working capital turnover" also exhibits a significant positive relationship with ROIC, with a coefficient of 0.729. The working capital turnover ratio is associated with higher ROIC in Region 2, but this relationship is only observed when the ratio exceeds the threshold of 0.619. On the other hand, the variable "CAPEX to Operating Cash Flow ratio" does not appear to show a statistically significant impact on ROIC in this region.

In firms with high levels of indebtedness (Region 2), the relationship between various variables and ROIC differs from Region 1. Notably, only two variables, "CAPEX to Operating cash flow ratio" and "working capital turnover," exhibit a significant relationship with ROIC. For these highly indebted companies, a higher working capital turnover ratio is associated with a higher ROIC, but only when it exceeds a certain threshold

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value. In contrast, there is a negative relationship between ROIC and the proportion of capital expenditure (CAPEX) relative to operating cash flow.

Table 12. Threshold model for high roundaboutness firms.

Threshold	0.619					
SSR	28.483					
Order	1					
ROIC	Coefficient	Std. Err.	Z	P>z	[95% conf.	Interval]
REGION 1						
Throughput	0.417	0.156	2.670	0.008	[0.110,	0.723]
Working capital turnover ratio	0.133	0.176	0.749	0.454	[-0.215	0.454]
CAPEX to Operating cash flow ratio	0.323	0.097	3.332	0.001	[0.133	0.513]
Constant	-9,459	19, 559	-0.48	0.629	[-10.103	-0.816]
REGION 2						
Throughput	0.582	0.173	3.367	<0.001	[0.242	0.922]
Working capital turnover ratio	0.729	0.177	4.118	<0.001	[0.381	1.077]
CAPEX to Operating cash flow ratio	-2.871	1.359	-2.114	0.017	[-5.539	-0.203]
Constant	-7.432	2.389	-3.115	0.002	[-12.092	-2.773]

Source: authors' elaboration.

6. DISCUSSION

Eugen von Bohm-Bawerk argued that an expansionary monetary policy stimulates business investments, which consequently result in a more "roundabout economy". However, this shift towards a longer production structure creates a mismatch between the maturity of assets and liabilities.

Since the publication of the Modigliani-Miller theorem, scholars have been investigating the optimal capital composition of companies. The theory initially assumes that investment and financing decisions are independent of each other. However, upon closer scrutiny, it becomes apparent that there are interconnections between a company's investment (asset) side and financing (liability) side on its balance sheet (Castañeda & Contreras, 2017).

When a company is highly leveraged shareholders may be hesitant to invest more capital because a significant portion of the company's profits would go towards servicing the debt. High levels of debt can restrict the company's ability to pledge future income streams as collateral for new loans. These conflicts of interest are part of the broader agency problems in corporate finance.

The underinvestment problem can be addressed by issuing short-term debt. This approach prevents the occurrence of value transfer from shareholders to bondholders that often happens with new investment projects.

Different types of firms have unique needs and characteristics that influence their investment decisions and strategies. Capital-intensive companies require a significant amount of capital to purchase, maintain, and upgrade their fixed assets. Due to the high costs associated with these investments, capital-intensive companies often rely on external financing.

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Firms that require a substantial amount of capital investment have extended production cycles, which can result in the need to retain inventory for longer durations that remains tied up until the products are successfully sold. Consequently, these firms require a larger amount of working capital to support their stock of products.

Manufacturing companies, such as those examined in this study, frequently hold substantial amounts of accounts receivable and inventory. While this practice entails tying up capital, it is essential for ensuring continuous and smooth business operations. However, excessive investment in working capital compared to sales implies inefficient capital allocation.

On the other hand, firms with low capital intensity typically require less investment in fixed assets and fund their operations and growth using internally generated funds, such as retained earnings. Companies can utilize alternative financing methods to address their working capital needs, which can offer more flexibility than traditional long-term debt or equity financing (Hastutik *et al*., 2021).

Projects that require more capital and have longer-term outlooks generally have higher roundaboutness, meaning they are more sensitive to variations in discount rates compared to projects with lower capital intensity.

Capital-intensive firms tend to have lower liquidity, holding less cash, liquid assets, and short-term interest-bearing instruments. This lack of idle cash can limit their ability to finance normal operations or act as a buffer against market frictions. In contrast, companies with lower roundaboutness often maintain higher cash balances, which may be driven by speculative motives or to exploit future investment and arbitrage opportunities.

Companies facing higher business risk may opt for a lower debt ratio in their capital structure to ensure they can meet financial obligations. While a low debt ratio reduces the risk of bankruptcy, it also limits the company's ability to take advantage of higher profits. The Modigliani-Miller theorem establishes that a higher debt-equity ratio leads to higher expected returns due to the increased risk for shareholders and bondholders. On the other hand, the opportunity cost of assets remains unchanged regardless of the level of leverage. According to Proposition I of the Modigliani-Miller theorem, the firm's cost of capital (of assets) is independent of its capital structure. Unfortunately, these propositions hold under restrictive assumptions of no transaction costs, no bankruptcy costs, and borrowing at the same rates.

Interest rates vary continuously with the level of debt, and there are often legal and operational restrictions on the accumulation of debt beyond certain levels. The effect of financial leverage depends on the level of earnings before interest and taxes (EBIT). When EBIT is high, leverage can have beneficial effects by increasing shareholders' return measured by internal rate of return (IRR). Although, the heightened sensitivity of return on invested capital (ROIC) to fluctuations in EBIT levels can exacerbate future agency problems and potentially transmit misleading signals to investors and financial intermediaries. The financial risk premium, which varies depending on a company's level of indebtedness, tends to increase as leverage rises.

Other strategies to maintain a liquid position include reducing credit to customers, avoiding excessive inventory investment, and extending payment terms to suppliers.

The volume of current assets and cash reflect a firm's capacity to meet short-term obligations. Cash and cash equivalents act as a safeguard during liquidity crises, but allocating funds towards non-profitable assets represents an inefficient strategy for managing financial resources. One example of this inefficiency is the opportunity cost associated with excess inventory, as it represents the least liquid and least easily convertible portion among short-term assets (Chauhan, 2021).

By employing canonical cross-correlation analysis, interdependencies among balance sheet components can be identified. In business units with higher roundaboutness, the maturity structure of assets and liabilities is not aligned. Accounts receivables partially finance both short-term and long-term assets, and stockholders' equity is correlated with them. In contrast, less capital-intensive firms show a strong correlation between accounts receivable and accounts payable, with operating assets predominantly financed by current liabilities.

Long-term assets and long-term debt exhibit a negative association, implying that short-term liabilities are financed by short-term assets, while long-term debt are supported by long-term assets. Inventories and other current assets show a high correlation with accounts payables. Ergo, these current assets are partially financed through supplier credit. The strong correlation between first canonical function and inventories,

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other current assets, and stockholders' equity demonstrates that the firm's operations are heavily reliant on the investments made by its owners, including retained earnings. The utilization of accounts payable and receivable can provide alternative forms of financing beyond traditional intermediaries, representing implicit, non-interest bearing financing.

The presence of a liquidity buffer helps prevent disruptions in production processes without collecting accounts receivable. Consequently, in firms with lower roundaboutness, the correlation between cash and other variables is higher with the first canonical function compared to their counterparts.

It is also observed that capital-intensive firms partially finance inventories and the acquisition of long-term assets with stockholders' equity.

In the next section, some relevant results from the application of the threshold regression model are presented.

6.1. Relation between Throughput and ROIC

Some concepts from Lavoie's theory of the firm should be introduced and explained before proceeding to examine the evolution of throughput in different groups of companies. The author in question has introduced the concept of an expansive frontier, which establishes a maximum profitability limit for each investment rate.

The relationship between the investment rate and profitability is concave. As a company expands and invests more capital, positive profitability effects are observed until a certain threshold is reached. Beyond this point, negative effects arise due to management constraints in sustaining the pace of expansion. Once a company reaches its maximum profitability threshold, it will not be able to maintain or increase its throughput, which can be attributed to the non-monotonic relationship between the utilization rate and profitability (Dallery, 2009).

Capital intensive firms with significant levels of debt appear to operate below the expansive frontier. This situation may cause an excess of capacity and overinvestment in an attempt to sustain an unusually high utilization rate.

Firms that have accumulated a substantial amount of capital tend to exhibit high capacity stickiness, which means that their investment levels are less responsive to fluctuations in profit volume. When demand falls relative to capacity, the downward impact on ex-ante markups is smaller compared to the upward impact on ex-ante markups when demand rises relative to capacity. This implies that, given costs, prices tend to be more rigid downward than upwards.

During periods of rapid growth in "permanent sales," many businesses may find their investment response constrained by the absorptive capacity of their manufacturing system. A firm's management capacity can only handle a certain level of growth before becoming overwhelmed and jeopardizes operational efficiency. During economic booms, this limit creates a lag in the response of investment to changes in capacity utilization.

The decision to adjust the level of capital utilization is influenced by the trade-off between lower average capital cost associated with a higher level of capital utilization and the higher costs required as compensation for operating during non-normal times (Florian, 2017). Capital-intensive firms are likely to report higher capacity utilization rates compared to firms with lower capital intensity.

Gross profit margins tend to vary directly with the rate of capacity utilization. This relationship is further reinforced in capital-intensive firms by the impact of capacity utilization rates on ex-ante markups. Markups applied to standard costs and the deviation of actual from standard costs typically climb as capacity utilization exceeds normal levels and fall as utilization rates decline. Therefore, changes in capacity utilization tend to affect gross profit margins from both the cost and demand side.

It's also noticed that businesses with less capital intensity often depend less on tangible assets, enabling them to swiftly adjust their operations, either up or down, in response to fluctuations in demand. Nevertheless, the combined impact of operational constraints and high debt exposure can impose limitations on pro-

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duction capacity. As throughput increases, companies might face obstacles in scaling up their operational capacity, which can limit the potential impact on Return on Invested Capital (ROIC).

The Cash Conversion Cycle (CCC) can be accelerated by increasing throughput, which in turn can maximize available cash flow for a company. However, in the presence of technical rigidities, financing working capital and covering operating expenses throughout the production cycle can put pressure on a company's liquidity. This is especially important for less capital-intensive companies with higher levels of indebtedness.

Companies that are more vulnerable to financing constraints tend to utilize the trade credit channel more frequently to manage their growth potential. The profit margin obtained from sales growth serves as the most accurate, real-time indicator of end-market demand for most businesses. The delay between capital expenditure growth and profit margin shows that firms prefer to confirm demand trends before making long-term investment commitments.

As actual sales volumes grow, the permanent sales tend to be lower than the current sales levels. Investment decisions are often made using a more conservative, long-term sales measure in order to consider any potential volatility or changes in the market or business environment. Other delays dampen the response of actual investment outlays and throughput to changes in future investment strategies. During an expansion phase, actual capacity tends to lag behind optimum capacity, resulting in a backlog of profitable projects that serves as a buffer for the economy against potential shocks.

The procyclical volatility of inventories is explained by changes in operating cash flows. When firms experience internal finance deficiencies they often respond by drastically cutting inventory expenditures and reducing utilization. This reaction is particularly pronounced among companies that are more susceptible to information asymmetry problems and, as a result, face financing constraints, such as less capital-intensive firms.

Firms typically do not systematically alter their investment plans when capacity utilization rates are stressed; instead, they maintain tolerable intervals around their normal utilization rate. The more flexible a firm with low roundaboutness is, the flatter the average cost curve associated, (i.e., the less rapid unit costs increase in moving away from the optimal output level). In order to reduce the average cost, companies may choose to accept a higher unit cost than what could have been achieved at the optimal output level (Trezzini & Pignalosa, 2021).

Beyond the debt threshold, there is no statistically significant relationship between throughput and Return on Invested Capital (ROIC).

The profitability level is primarily influenced by shifting expectations, with no fixed threshold for what constitutes a desirable profit volume. As diminishing returns set in, throughput reaches a point where it fails to maximize ROIC and the utilization of productive capacity drops below the desired level. When the returns relative to financial interests fall below the expected level, the impetus behind investment decisions weakens.

After an expansionary phase, when leverage reaches a level that companies perceive as excessively risky, they may halt new investment initiatives, potentially obstructing direct access to external financing.

When a company faces limitations in production, it may not necessarily abandon its optimal plan, but rather choose to produce a quantity that is less than the output level that would maximize profits (Mielcarz *et al*., 2018). In other words, the question is whether the constraint specifies a particular quantity that the company is required to produce, or if it should be viewed as a ceiling on demand expansion, defined by production capacity.

For firms that are capital intensive and have high levels of debt, the relationship between throughput and Return on Invested Capital (ROIC) remains statistically significant in regions 1 and region 2. A company's capacity to attain a high throughput is a sign of its potential to achieve economies of scale and spread its fixed costs over a larger number of units. In such a situation, the financial frontier generates more than the minimum required profit margin to secure investment, even when there are constraints such as limited reversibility and a prolonged conversion process of transforming intermediate goods and inputs into final products (Sulistiani & Agustina, 2020).

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6.2. Working capital ratio and ROIC

The following arguments can be made regarding the relationship between working capital turnover and Return on Invested Capital (ROIC) in both groups of firms:

Working capital is the remaining value of all available cash or cash equivalents after settling all current debts. The working capital turnover ratio measures the efficiency of a firm's use of funds or current assets in its operational activities, which can be recouped in a short timeframe through sales. This allows the funds or capital to be circulated and reinvested to support ongoing operational activities.

Working capital, comprising both fixed and variable components, acts as a safeguard for companies against potential liquidity crises. This buffer enables firms to maintain smooth operations even during periods of financial turmoil.

If a company does not have a plan for short-term liquidity, the cost of adjusting working capital can be significant. This is because the company may need to rely on short-term borrowing or sell off assets at a discount to generate cash quickly, both of which can be costly (Osei, *et al*. 2023).

Companies with high roundaboutness consistently operate with a high working capital turnover ratio and require a smaller ongoing cash investment than their competitors to generate the same level of sales. These firms utilize short-term assets and liabilities to facilitate sales. In this case, the marginal rate of return from investment exceeds the cost of capital used to finance the current assets.

The length of working capital turnover periods is contingent upon the duration of the turnover period for each component of working capital.

Companies may need additional capital for specific assets, such as inventory. This capital can be obtained from current liabilities, short-term loans from suppliers, or equity. Long-term debt is generally associated with investment projects and is less commonly used for working capital financing. When inventory financing is obtained from external sources, it results in an increase in financial expenses and the company's net profit may experience a decline.

A decline in net profit margin resulting from increased operating expenses or decreased revenues also negatively impacts the working capital turnover ratio and the operating cycle of the company. If the operating cycle is lengthened due to the nature of the business, and is combined with high levels of debt that limit financial flexibility, it could further hinder the ability of firms with low roundaboutness to issue low-interest financial instruments to fund their expansion (Bolek *et al.*, 2012). It has been observed that the working capital of less capital-intensive firms rotates at a slower pace, which subsequently erodes the level of profitability. One reason is that these companies exhibit a strong preference for liquidity, and prioritize the accumulation of monetary resources and easily convertible assets.

High levels of working capital allow these companies to fulfill their financial obligations and allows companies to maintain sufficient inventory to meet customer demand, thereby preventing loss of sales due to stockouts.

According to the life operating cycle theory, the additional measures of liquidity reveal that the expectations of the lifespan of some components of working capital depend on how much production, distribution, and collection are either unsynchronized and non-instantaneous. Changes in collection and credit policies impact the average outstanding accounts receivable balance that a firm maintains relative to its annual sales (Nyachieo, 2017). The frequency at which average receivable investments are converted into cash is indicated by the accounts receivable turnover ratio.

Firms with lower capital intensity may be reluctant to offer generous credit terms, as doing so can result in the generation of significant and potentially illiquid receivables. To enhance their liquidity ratios (i.e., current ratio and the quick ratio) these firms might adopt strategies that involve maintaining larger average investments in accounts receivable over time. Firms with low roundaboutness may struggle to manage their cash cycle due to a tendency to hold onto cash rather than using it for reinvestment or operational expenses.

Transaction cost theory posits that firms aim to reduce the costs associated with search costs, negotiation costs, and enforcement costs. One application of this theory is in determining the optimal level of inventory by balancing the costs and benefits associated with the stock level.

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The findings of this research indicate that firms with low roundaboutness generally maintain smaller inventory levels compared to their more capital-intensive counterparts. The reason behind this lies in the fact that firms with lower capital intensity have reduced effective utilization rates and output levels and require fewer raw materials and work-in-progress inventory. The implementation of this streamlined inventory system provides several benefits, including lower inventory holding costs and the potential for a more efficient cash conversion cycle.

By avoiding substantial levels of debt, these companies preserve a greater degree of control over their operations. Nonetheless, this strategy could sacrifice their potential sales growth and market share If the capital market is imperfect. Firms with growth opportunities that are facing severe financial constraints may prefer to rent rather than own a fixed asset because and prefer to maintain some level of cash flow to self-insure against possible liquidity risk in the future (Resić *et al*., 2015).

Low roundaboutness may be associated with lower asset turnover. Even with a higher working capital turnover, the inability to generate revenue efficiently from assets could limit the positive impact on ROIC. A lower rate of long-term asset accumulation combined with a continuous hoarding of liquidity is consistent with a constant marginal profit. Consequently, the capital utilization rate decreases, approaching the desired level (Theissen *et al*., 2023).

This aligns with the pecking order theory, which posits that companies utilize cash or equivalents as a buffer between retained earnings and investment requirements. In accordance with this theory, companies maintain cash reserves as a safeguard against potential financial constraints, whether immediate or future, and to mitigate the impact of volatility in cash flows. The benefits of holding liquid assets include minimizing the transaction costs associated with raising external funds or liquidating assets ('the transactions motive') and being able to finance projects in case other sources become too costly ('the precautionary motive'). However, an excessive accumulation of cash and its equivalents without an increase in goods sold reduces profitability.

Firms with limited investment opportunities may opt to focus on optimizing deployed assets and distributing excess cash to shareholders. The more investment opportunities a firm anticipates in the future, the more valuable it becomes to retain a significant amount of cash on hand in the present. In such situations, investors tend to appreciate the buffer and option qualities of large cash holdings, recognizing their positive impact on the firm's ability to fully capitalize on current and future investment opportunities.

A suboptimal mix of debt and equity fails to capitalize on the advantages of an elevated profit margin. Debt overhang introduces negative externalities on shareholders' investment strategy and diminishes the incentives of the shareholder-management coalition in control of the firm to pursue positive net-present-value investment opportunities. This occurs because the benefits of such investments accrue, at least partially, to the bondholders rather than entirely to the shareholders. Consequently, highly leveraged firms with low capital intensity are less likely to capitalize on valuable growth opportunities compared to firms with lower levels of leverage (Aivazian *et al*., 2005).

Active management of receivables may help address the underinvestment problem engendered by risky debt contracted by these firms. For instance, selling pledgeable trade receivables may provide the necessary resources to smooth the investment function and mitigate the negative effect of debt structure on the value of growth opportunities embedded in real options.

Before exploring the behavior of firms characterized by high levels of indebtedness and low roundaboutness, it is essential to provide some clarifications

The level of investment in successive periods is influenced by the operational income or revenues generated in the preceding period, which serves as an indicator of available funds for investment. This acts as an earnings-driven incentive for future periods.

In companies with low roundaboutness, high indebtedness can adversely affect working capital turnover. In contrast, for companies with high roundaboutness, working capital turnover exhibits a significant relationship with ROIC only when they have surpassed a debt threshold. This can be attributed to various factors.

In line with the trade-off theory, a positive relationship exists between growth operating income and the level of debt. Companies experiencing rapid sales growth often need to expand their capital assets and retain higher profits.

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It is worth noting that capital-intensive companies might be in the early stage of their investment cycle, where significant investments are made in both short-term and long-term assets, but they have yet to achieve their full production capacity. During this stage, fixed costs tend to be high, and revenues might not be sufficient to cover the additional financing costs. A business that heavily relies on capital expenditure to sustain its operations tends to have more fixed costs, such as depreciation, due to the substantial amount of property, plant, and equipment (PPE). Once the debt threshold has been surpassed, mature assets can support operating income (Di Bucchianico, 2020).

In less capital-intensive firms, the optimal level of financial leverage is lower than in companies with high roundaboutness.

A company generates value when its Return on Invested Capital (ROIC) exceeds its cost of capital. In simpler terms, the firm enhances the market value of one monetary unit through its core operations, making it worth more than the original investment.

In capital-intensive firms, an increase in investment expenditures produce the depletion of cash reserves, an expansion in accounts payable, and a reduction in inventory investments and trade receivables. This ultimately causes a decline in working capital investments.

In light of this, working capital turnover might not have a noticeable effect on Return on Invested Capital (ROIC) until a certain debt threshold is reached.

Companies with higher capital intensity, characterized by significant capital investments compared to their revenue or sales, often experience prolonged average payback periods (APP). The Cash Conversion Cycle (CCC) is extended due to longer inventory storage periods. In response to a potential shortage of internal funds, these business units may be compelled to adopt an aggressive working capital management strategy, leading to lower levels of working capital investments, ceteris paribus.

Furthermore, aggressive expansion strategies can increase invested capital and raise the costs related to sold goods and inventory holdings. If capital markets are illiquid and there's a shortage of capital, a company with low capital intensity may be forced to pay higher costs to obtain the scarce capital.

Capital-intensive firms with high indebtedness can take advantage of the operating leverage effect (the proportion of fixed costs absorbed by each unit of output is higher). The operating leverage of a firm is directly related to the percentage of fixed costs in its total cost structure. In a firm with high operating leverage, even a minor change in sales can produce a significant change in operating income. Since fixed costs do not decrease when demand falls, a downturn in the economic cycle can have an amplified negative impact on profitability due to the large operating leverage. In contrast, variable costs can be adjusted to accommodate changes in revenue and a reduction in sales accelerates the adjustment of variable costs in order to match the reduced demand for output (Lee *et al*., 2009). The profit margin increases when the cost of debt before taxes is lower than the cost of equity capital, as debt is considered less risky than the company's own capital. This rise in profit margin, in turn, boosts the Return on Invested Capital (Thi *et al*., 2023).

According to the Pecking Order theory, firms tend to follow a specific hierarchy when financing investment projects, with internal funds being the first preference, followed by debt financing, and finally, equity issuance. If a firm primarily relies on internal funds, it may prioritize undertaking investments that align with its current cash reserves, potentially overlooking high-value projects that require additional financing but could yield substantial returns in the long run.

It can be reasonably argued that a company that solely relies on changes in liquidity to dictate its investment decisions, without considering debt financing, may miss out on high-value projects. Firms with high roundaboutness avoid this investment approach, as they can surpass the marginal returns on investment to the market cost of capital.

6.3. ROIC - Capex to Operating Cash Flow Ratio

The research reveals that companies with low indebtedness and high roundaboutness tend to allocate a more significant proportion of capital expenditures relative to operating cash flow. This strategic investment

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in assets, where returns surpass inventory costs (with a minimal liquidity premium), bolsters the Return on Invested Capital (ROIC).

Two key factors that influence the quantity and timing of capital expenditure are anticipated end-market demand and financing costs. Anticipated end-market demand affects the expected profitability of the investment, while financing costs determine the affordability of the investment. Companies with low levels of debt and high roundaboutness may have a higher tolerance for risk and invest more in capital expenditures. Once a debt threshold is exceeded, the ratio of CAPEX to operating cash flow becomes statistically significant.

As companies transition from low debt levels to high debt levels, their ability to invest in capital expenditures is significantly reduced. In such cases, they may end up on a suboptimal capital accumulation path, as they are unable to maximize the net worth of their production and investment activities over time.

The scenario described above is related to Kalecki's principle of increasing risk, which states that the marginal risk associated with fixed capital investment grows proportionately with the investment level. As a firm's investment level rises, lenders will demand higher interest rates to compensate for the increased risk. An inadequate margin of security can lead to involuntary default if the firm's expectations are not met. This, in turn, reduces investment demand especially when the investment level surpasses what can be financed internally. This dynamic is relevant to both firms with low and high roundaboutness, but its adverse effect is more pronounced in the latter.

For companies with high roundaboutness, the relationship between return on invested capital (ROIC) and the capital expenditure (CAPEX) to operating cash flow ratio is diametrically different. When indebtedness is at a moderate level, the relationship between these variables is significant. However, as debt surpasses the debt threshold and continues to escalate, the relationship becomes negative.

Various hypotheses can be proposed. It is common for companies to incur additional expenses when integrating new assets into existing processes. The costs of replacement may reduce the availability of capital for other purposes within the company, such as investments in working capital or high-return expansion projects.

Companies with high capital intensity allocate a substantial portion of their operating cash flow to capital investments to drive growth and expansion. However, this strategy may yield an unfavorable or negligible impact on their Return on Invested Capital (ROIC) in the short term.

If these firms experienced a negative shock to cash flows, ceteris paribus, the shadow value of finance will rise, and they will respond by decreasing their rate of asset accumulation. However, to equate returns across assets, firms do not cut investment proportionately in both fixed and working capital, because working capital is relatively liquid. In other words, the firm reduces adjustment costs and losses due to project perishability by choosing working-capital investment to absorb a larger share of temporary cash-flow fluctuations than fixed investment. Since working capital is reversible, it can even become a source of funds, with firms choosing a negative level of working-capital investment. Thus, the existence of working capital can be thought of as easing firms' short-run financing constraints (Fazzari & Petersen, 1993).

In companies with high roundaboutness, both fixed capital expenditure and working capital investments are anticipated to compete for the restricted cash flows. However, fixed investment typically is prioritized due to escalating adjustment costs. To counteract the adverse impact of cash flow disruptions, the company might consider five possible strategies: 1) deplete cash holdings; 2) decreasing accounts receivable; 3) cutting back on inventory investments; 4) expanding trade payables; and 5) taking on additional debt.

The extent of fixed investment smoothing depends on the initial stock of capital. Altering the fixed-investment trajectory can be expensive for firms due to various factors. Nevertheless, even financially constrained firms can mitigate the effects of cash-flow shocks on fixed investment by modifying their working capital. If the stock of working capital is unusually low in comparison to fixed capital –a circumstance frequently observed in firms with high capital intensity- it is anticipated that fixed-investment smoothing will be reduced, and cash-flow shocks will have a larger quantitative impact on fixed investment.

These constraints may impede this objective whenever firms cannot costlessly offset cash-flow fluctuations with external funds. Firms that face financial constraints, such as those with low roundaboutness, typically invest less capital compared to other firms. Capital expenditures like working capital investments,

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are sensitive to fluctuations in operating cash flow and the availability of external finance. In the presence of financing constraints, capital expenditures have a detrimental effect on working capital investments.

Apart from drawing on companies' cash reserves, investment smoothing is evidenced to be transmitted to the trade credit market with the trade payables' increase being a salient manifestation of the deficiency of internal financial resources for accommodating planned investment projects.

Firms strive to preclude fluctuations in capital expenditures due to rising marginal adjustment costs of investments. Under conditions of prevalent idiosyncratic risk combined with inherent irreversibility of capital expenditure, firms may intentionally delay investment projects, thereby smoothing the aggregate investment function (Nicolas, 2022).

The acceptance or rejection of investment projects based exclusively on the adequacy of internally generated funds constitutes a deviation from the strategy of shareholder value maximization and may considerably impede a company's growth potential (Mielcarz *et al*., 2018).

When a company expands its investment in long-term assets such as property, plant, and equipment, it may cause a decline in short-term assets and operational capital. This imbalance can have a negative effect on profitability and impair the company's ability to manage unforeseen expenses. However, the expansion of capital inputs in capital-intensive industries is more closely connected with permanent or anticipated changes in demand, rather than short-term or temporary changes (Nguyen, 2020).

Companies with high roundaboutness are expected to experience diminishing returns as capital investment (CAPEX) grows relative to operating cash flow. This decline is anticipated to occur with marginal increases in the capital stock, particularly when the threshold of Debt to EBITDA is surpassed.

According to Kalecki (1968), investment decisions are influenced by internal savings and profit growth, but are inversely related to the existing capital stock. Essentially, the creation of capital imposes a restriction on investment. This idea is pivotal as it implies that investment inherently sets boundaries, preventing the occurrence of linear and consistent accumulation processes. As long as stimulating factors persist, net investment will continue to rise until a point is reached (an upper limit) where companies either do not wish or cannot further invest due to the limitations imposed by stimulating factors.

All companies face a finance frontier, represented by a linear function that includes the minimum rate of profit required to achieve any rate of accumulation. The more a firm aims to invest, the higher the required profit rate (or profit margin) to finance its accumulation goal, considering the average interest rate payable on its capital. Similarly, a higher interest rate requires a corresponding higher rate of profit to achieve a given rate of accumulation. Likewise, a higher leverage ratio (the ratio of borrowed funds to retained earnings) requires a higher rate of profit to attain a specified rate of accumulation.

The key indicator of a firm's capacity to take on more debt is the "margin of security," which is tied to the level of a firm's interest obligations or cash commitments. Ceteris paribus, a higher margin of security results in a lower margin of safety and increases the risk of problems.

Companies with high roundaboutness and low leverage may operate near the optimal level, allowing them to obtain capital at a reduced cost. Ergo, a larger portion of operating cash flow is directed towards capital expenditures, resulting in a higher ROIC. However, as leverage exceeds the optimal level, the cost of capital increases, negatively affecting ROIC.

These firms may observe that capital expenditures have a detrimental effect on working capital investments, inducing them to adopt investment smoothing tactics such as lowering working capital investment or temporarily setting it at a negative level.

In line with the 'pecking-order' theory, management aims to address negative cash flow shocks using an internal pool of finance. Only after depleting internally generated resources does the possibility of taking on additional debt in incomplete capital markets come into consideration.

According to the neoclassical production theory, the present value or price of installed capital is equivalent to the present value of all future marginal contributions of capital to profits. These contributions are the sum of the direct marginal product of capital and the reduction in adjustment costs. In Keynesian terms, it represents the present value of profit flows that a firm anticipates from a marginal investment expenditure, after deducting financing costs. Thus, the investment decision involves adjusting the current capital stock to

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the desired level based on relative market prices, which is a process of temporal and sequential optimization (Carvalho & Carvalho, 2019).

In such cases, it is expected that firms will progressively increase their capital to attain a new desired level, taking into account proportional adjustment costs. Consequently, the diminishing returns associated with asset accumulation under high debt levels may cause a reduction in the marginal productivity of capital, thereby diminishing its impact on Return on Invested Capital (ROIC). Companies might reach a stage where they are unwilling or unable to continue investing due to constraints imposed by existing capital, even if profit growth and internal savings are positive.

This is known as the Penrosian effect, a phenomenon where a firm's profitability improves as it expands, but only up to a certain growth rate. If the firm exceeds this growth rate, it may face negative outcomes due to managerial constraints in sustaining the pace of expansion.

7. CONCLUSIONS

The marginalist theory posits that production is inherently roundabout and involves a temporal dimension. Capital, which is a result of prior production processes, is used to transform basic factors of production, such as land and labor, into final products. By using these roundabout production methods, the same input can yield a higher output.

This study employs canonical cross-correlation analysis to shed light on the interdependencies within the balance sheets of companies with heterogeneous levels of capital intensity. Companies characterized by high roundaboutness are incapable of aligning the maturity structure of their assets and liabilities. Specifically, they rely on stockholder's capital to fund both short-term and long-term assets. On the other hand, firms with lower capital intensity are successful in aligning accounts receivable with accounts payable and utilizing current liabilities to finance operating assets.

The analysis using threshold models reveals discernible patterns among firms with different levels of roundaboutness. In enterprises with low capital intensity, there is a significant relationship between productivity and working capital turnover ratio, the ratio of capital expenditure to operational cash flow, and a higher Return on Invested Capital (ROIC) when the level of debt is minimal. Conversely, when the level of debt is substantial, these relationships no longer hold statistical significance.

In firms with high levels of roundaboutness and low levels of indebtedness, the relationship between independent variables and Return on Invested Capital (ROIC) is more complex. Throughput has a significant relationship with Return on Invested Capital (ROIC) regardless of the debt level. Nonetheless, there is no significant relationship found between working capital turnover and ROIC and the effect of the ratio of capital expenditure to operating cash flow on ROIC is contingent on the level of debt.

This research has limitations, including potential inaccuracies in firm-level accounting data due to underreporting or the absence of standardized account information. Additionally, the study coincided with an economic recession, which could cause distortions in the financial performance of the firms under analysis. Another limitation is the relatively small size of the sample, attributed to the fact that few companies were willing to provide account information without restrictions.

Further research is necessary to explore the relationships between roundaboutness and other financial factors. By employing refined methodologies, such as time series analysis and panel data techniques, a comprehensive understanding of the long-term effects of roundaboutness on business outcomes can be achieved.

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Responsible declaration and conflict of interest

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