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# MEGI

Master Degree Program in

**Statistics and Information Management**

***The Value of Public Procurement in Credit Risk Assessment***

*A Z-Score-Based Analysis of Financial Health in Portugal's  
Healthcare and Pharmaceutical Sector*

Inês Alexandra Nunes dos Santos

Master Thesis

presented as partial requirement for obtaining a Master's Degree in Statistics and Information  
Management

**NOVA Information Management School**  
**Instituto Superior de Estatística e Gestão de Informação**

Universidade Nova de Lisboa



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### **Supervised by**

Samuel Da-Rocha-Lopes, PhD, NOVA Information Management School

July, 2025

## **STATEMENT OF INTEGRITY**

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism, any form of undue use of information or falsification of results along the process leading to its elaboration. I further declare that I have fully acknowledged the Rules of Conduct and Code of Honor from the NOVA Information Management School.

*Lisbon, July 2025*

*Inês Santos*

## **DEDICATION**

To my family,

for their unwavering love, and unshakable faith in me.

To all those who, through their presence or words, helped me get to this point.

The path was mine, but I never walked it alone.

## ACKNOWLEDGEMENTS

This dissertation marks the culmination of two years of great effort, dedication, and, above all, learning. A journey that, although challenging and demanding, represented, especially as it neared its end, a significant academic and personal growth. This would not have been possible without the support of the people who have accompanied me over the years, and the institutions to which I am deeply grateful.

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To all of these people and institutions: my deepest thank you.



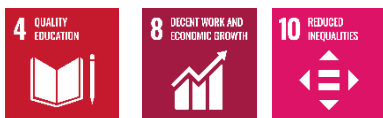
## ABSTRACT

This study investigates the relationship between public procurement and the financial performance of Portuguese companies that participated as providers of goods and services in the healthcare and pharmaceutical sectors between 2022 and 2024. It shows that firms that participate in public contracts exhibit higher credit risk compared to firms from the same sectors not active in public contracts. Statistical and regression analyses reveal that, contrary to expectations, public contract participation is associated with weaker financial indicators. Larger companies with higher asset returns, but potentially more moderate liquidity and solvency, are more frequently involved in public procurement. This pattern underscores the strategic relevance of public contracts as a revenue stabilizing mechanism, particularly for firms that combine scale with active market engagement. These findings contribute to a deeper understanding of the financial implications of public procurement, offering insights for both credit risk assessment and public policy.

## KEYWORDS

Credit Scoring; Credit Risk, Z-Score, Public procurement, Health Sector

### Sustainable Development Goals (SDG):



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## **LIST OF ABBREVIATIONS AND ACRONYMS**

<b>BIS</b>	Bank for International Settlements
<b>CET1</b>	Common Equity Tier 1
<b>CMVM</b>	Portuguese Securities Market Commission
<b>CPV</b>	Common Procurement Vocabulary
<b>EU</b>	European Union
<b>IFB</b>	The Portuguese Banking Training Institute
<b>IMPIC</b>	Instituto dos Mercados Públicos do Imobiliário e da Construção
<b>NACE</b>	Statistical Classification of Economic Activities in the European Community



# 1. INTRODUCTION

Credit risk remains a significant concern within the banking sector, playing a central role not only in the decision-making process for granting financing, which necessitates rigorous analysis, but also in preserving the stability of the financial system as a whole. From a corporate perspective, accurately assessing a company's ability to fulfill its financial obligations is, therefore, a fundamental task for any credit institution, which seeks to balance profitability with the mitigation of risk associated with credit allocation.

At the same time, the public sector plays a structural role in the Portugal economy, particularly through the regular acquisition of goods and services from the private sector. This dynamic is especially evident in strategic areas such as healthcare, where public procurement constitutes a significant portion of economic activity. For many companies, especially those in the healthcare and pharmaceutical sectors, which are the focus of analysis in this thesis, contracts with the state can represent a stable and predictable source of revenue, effectively serving as a seal of institutional trust and credibility. However, the extent to which this relationship influences, or does not influence, corporate credit risk and financial health remains an underexplored area in the literature, limiting a complete understanding of stability and risk factors in this context.

It is precisely within this framework that the present investigation is situated. Its primary objective is to ascertain whether a relationship exists between companies' participation in public procurement and their financial health, as measured through statistical tests and the application of a financial scoring model. The analysis focuses on Portuguese companies from the healthcare and pharmaceutical sectors, with financial data extracted from the ORBIS database and contractual information taken from the Portal BASE, which aggregates public contracts concluded in the country.

Specifically, the Z-Score model, widely employed in insolvency risk analysis, will be applied to evaluate whether companies with public contracts have, on average, better financial indicators and, consequently, a lower credit risk. The aim is, therefore, to test for a correlation between presence in the public procurement universe and greater financial robustness.

This research contributes to literature by intersecting two areas that, despite being naturally linked and often analysed independently, are rarely explored in conjunction: public procurement and bank risk assessment. By bringing these two domains, this research seeks to contribute to a broader understanding of the impact that public expenditure can have on the sustainability of the corporate health sector and on the perception of risk by financial institutions. We found the strategic relevance of participating in public contracts as a revenue stabilizing mechanism for corporates that combine scale with active market engagement. In addition, we provide evidence that public procurement information contributes to improvements in risk scoring estimations and with useful insights to credit risk management.

The research stands out for its originality in applying an insolvency risk model to companies involved in public contracting, contributing fresh evidence that can help public institutions and policymakers in Portugal more effectively evaluate the financial profiles of their contractors.

This master's thesis proposes an innovative perspective, not yet reviewed by existing literature, which explores the relationship between public procurement and the banking perspective, along with a strong analysis of the financial health of the companies involved in contracting. As far as we have analyzed, this perspective is unprecedented in the context of the European Union and represents a relevant advance in the analysis of this highly significant area. By creating this model, this dissertation provides a significant academic contribution and increases the depth of study into the public sector and the financial performance of the companies involved. Furthermore, it opens space for future research that can further develop this area.

This dissertation is structured as follows: Chapter 2 provides a literature review and theoretical framework, summarising the main concepts of credit risk assessment, public procurement dynamics, and the relevance of the Z-Score model. Chapter 3 describes the data sources, sample selection, and methodological procedures applied to develop the analysis. Chapter 4 presents the empirical results, including descriptive statistics, regression outputs, and robustness checks. Finally, Chapter 5 discusses the main findings, their implications, and limitations, and concludes by suggesting avenues for future research.

## 2. LITERATURE REVIEW

### 2.1. CREDIT RISK

In the last decades of the 20th century, the banking and financial system, both in Portugal and worldwide, have experienced profound transformations and a context of significant reconfiguration that required a substantial adaptation of the banking sector.

These changes were driven by various phenomena, which the IFB (Portuguese Banking Training Institute) primarily highlights. One key phenomenon was the specialization trend that began in the USA. Due to severe legislative constraints on traditional banking activities, created a clear window of opportunity for the emergence of unregulated firms, such as fintech companies and shadow banking entities. These new players entered the financial market, offering more competitive services and alternatives to conventional bank credit, often with significantly more favourable terms for clients. Technological evolution is another critical phenomenon underscored by the IFB, enabling these new entrants to operate in the market at reduced costs, while simultaneously but which on the other hand has also been a driving force for change in the financial system.

Another phenomenon identified was the heightened competition from these aforementioned companies, which “led to a sharp reduction in the bank’s market share in financing services, which, given that bank credit is the main source of banks’ income, led to a decline in results” (IFB, 2010).

This entire process culminated in a trend of deregulation, defined as the “transfer of regulatory powers from the Government to entities closer to the market (CMVM, Banco de Portugal, ISP)” (IFB, 2010). This deregulation was accompanied by a liberalization that lifted previous limits on banking activity, and a crucial process of disintermediation. This disintermediation primarily involved the migration of financial operations from traditional banking to direct channels within the capital markets, thereby diminishing the intermediary role of banks.

With the change of the financial system and the evolving banking paradigm, significant changes became imperative for banks themselves in recent years, largely driven by the aggressive pursuit of credit service sales that characterized this era.

Consequently, financial institutions are increasingly obliged to adhere to stringent prudential rules. This is essential for ensuring their solvency and liquidity, thereby safeguarding the financial stability of credit institutions and protecting depositors.

Thus, the activity of credit risk analysis and its associated regulation have progressively become more demanding in response to financial crises and the evolving landscape, aiming to secure the stability of the financial system. Banking supervision, particularly within the

European Union (EU), currently operates under a rigorous normative framework that delineates minimum capital requirements, internal control mechanisms, risk disclosure procedures, and evaluation methodologies.

Credit risk analysis has gained increased importance in banking management, driven by increasingly stringent regulatory requirements. With the advent of Basel III reforms, the focus on credit risk has become unavoidable, not just as a prudential exercise, but as a strategic requirement, a tool for strategic differentiation in credit granting, due to its capacity to better assess and price risk, with a direct impact on the capital structure of financial institutions. These measures, as illustrated in Table A.1 (Annex A) – Basel Committee on Banking Supervision reforms – Basel III, sourced from the official website of the Basel Committee on Banking Supervision (BIS), aim to strengthen the resilience of the financial system by requiring banks to maintain adequate capital levels in relation with the risks undertaken, especially credit risk.

In this context, legislation requires banks to adopt rigorous internal models for credit risk assessment. The application of metrics such as Probability of Default (PD), Loss Given Default (LGD), and Exposure at Default (EAD) has become standard practice in the construction of rating and scoring models, which are essential for quantifying the risk associated with each client or operation. These parameters not only feed internal evaluation systems but are also crucial for defining regulatory capital requirements and for aligning with institutions' risk appetite.

According to the adopted methodology, banks can opt for the Standardized Approach, which follows risk weightings established in the Capital Requirements Regulation (CRR), relying on ratings assigned by external credit rating agencies. Alternatively, they can use the Internal Ratings-Based Approach (IRB), which demands a considerably greater effort in terms of modeling and statistical validation, requiring mandatory demonstration of the robustness and stability of the parameters used to the regulator. The adoption of this latter method, therefore, implies a degree of technical sophistication and an internal governance capability that few banks can implement without significant investment.

The emphasis on Basel III requirements underscores how minimum capital ratios, notably the Common Equity Tier 1 (CET1), are directly impacted by the quality and risk profile of the credit portfolio. This association imposes constant pressure on banks to carefully calibrate their lending policies, ensuring both profitability and compliance with prudential ratios. From this perspective, credit risk is not merely a variable to be mitigated, but a foundational element in defining an institution's commercial and capital strategy.

Transparency in risk disclosure and the continuous assessment of each counterparty's risk profile, as stipulated by the guidelines, reflect a new supervisory culture based on data and behaviour. This paradigm implies a profound reconfiguration of the banking business model,

where information quality, predictive modelling and alignment with regulatory practices become fundamental pillars of activity.

In Portugal, the responsibility for banking supervision is shared between the Bank of Portugal, which ensures micro-prudential supervision and national regulation, and the European Central Bank (ECB), within the framework of the Single Supervisory Mechanism, responsible for the direct supervision of systemically important institutions. The European Banking Authority (EBA) contributes with technical standards and coordinated guidelines that ensure the harmonization of supervisory criteria across the European area. This institutional architecture guarantees that the principles and requirements of Basel III are effectively incorporated into the daily banking operations nationwide.

The increasing complexity of credit risk management and the rigorous regulatory requirements, as detailed here, underscore the necessity of comprehending all factors that influence the financial health of companies, including their relationship with public procurement, which will be the focus of the present investigation.

## **2.2. SCORING MODELS**

The global financial sector was profoundly marked by a transformation starting in 2004 with the introduction of the Basel II Accord, lending to a new era of regulatory requirements in banking risk management. This reform introduced three fundamental pillars, minimum capital requirements, prudential supervision, and market discipline, imposing an increased obligation on financial institutions to justify the solvency of their credit portfolios based on rigorous internal models (Basel Committee on Banking Supervision, 2004). Regulatory evolution was further intensified with the implementation of Basel III, in response to the 2007-2008 global financial crisis, which significantly strengthened capital requirements and introduced new liquidity and leverage indicators, aiming to enhance the resilience of financial institutions (Basel Committee on Banking Supervision, 2010).

The current financial landscape has forced banks into a period of rapid and profound adaptation. What once relied heavily on individual intuition and personal experience is now underpinned by a far more rigorous and quantitative approach. The objective is clear: to demonstrate, with maximum objectivity, the solvency of clients.

Imagine the past, when the decision to grant credit largely depended on a manager's subjective judgment. That was the norm. However, as Altman and Saunders (1998) described, the financial sector underwent a remarkable transition, which necessitated advanced statistical models capable of predicting the likelihood of client default.

This shift was dramatically accelerated by the introduction of Basel II requirements. As Resti and Sironi (2007) evidenced, the assignment of regulatory risk weights began to demand increasingly detailed quantitative justification from financial institutions.

Thus, what started as a valuable internal tool for risk management evolved into a fundamental requirement for complying with prudential standards. In essence, quantitative models ceased to be an option and became the foundation of trust and stability in the financial sector.

In the current business environment, characterized by notable instability, the economic and financial analysis of companies has emerged as an essential pillar for banking credit decisions. This approach helps mitigate information asymmetries between creditors and debtors, a problem extensively documented by Stiglitz and Weiss (1981), who demonstrated how these asymmetries can lead to credit rationing, even in competitive markets. By integrating this analysis with other risk assessment tools, financial institutions are able to make more informed and strategic decisions, oriented towards debtors with higher reliability profiles and lower probabilities of default.

Among the most common methodologies for assessing credit risk are rating systems and scoring models. Rating systems rely on expert analysis, combining qualitative and quantitative information to provide an evaluation of the client's payment capacity. Scoring models, on the other hand, use statistical algorithms that assign a risk score based on historical data and financial indicators, that indicates the level of risk (Thomas, Crook & Edelman, 2017).

Scoring models are valued for their objectivity, scalability, and automation capabilities. In these systems, a higher score typically indicates a lower probability of default (Anderson, 2007). The calculation of the score often includes important financial ratios such as liquidity, profitability, solvency, and capital structure, in addition to considering relevant socioeconomic and sector-specific factors.

Among the various scoring models, Altman's Z-score (1968) stands out as one of the precursors of quantitative insolvency risk analysis. Initially developed based on a sample of North American industrial companies, the model combines five financial ratios into a linear discriminant function, allowing for a highly accurate prediction of bankruptcy probability within two years.

Subsequently, the model was adapted, including private companies (Altman, 1983) and then emerging markets. Thanks to its simplicity, statistical stability, and predictive power, the Z-score has become a benchmark in credit models, being widely used today by both banks and regulatory entities.

In Portugal, the application and adaptation of the Z-score model to national companies has been the subject of relevant contributions. An important example is the article "Um modelo de scoring para as empresas portuguesas" (A Scoring Model for Portuguese Companies) by Antunes & Martinho (2012), which proposes a statistical approach based on accounting and financial data. This study uses variables such as third-party debt, equity, sales, and operating results, all expressed as a percentage of total assets. The work of Antunes and Martinho (2012) also introduces the financial effort ratio as a key variable, adapting the model to the reality of

national SMEs—which measures the proportion of a company's income allocated to amortization and interest payments.

Furthermore, it is important to note that in the national economic literature, formal bankruptcy is not always the most relevant event of interest. The article “Efeitos de um choque de consumo público” (Effects of a Public Consumption Shock) by Banco de Portugal (2006) highlights that default episodes can precede and signal the deterioration of companies' financial health earlier, making them more sensitive indicators of credit risk. By detecting defaults, banks can act preventively, adjusting credit limits or interventions, which allows for more sensitive and proactive risk management.

### **2.2.1. – THE Z-SCORE MODEL AS A MEASURE OF RISK**

For this investigation, we adopted the adjusted Z-score, a widely used quantitative tool to measure companies' insolvency risk from the creditor's perspective, especially banks and financial institutions. This metric allows for the assessment of companies' financial stability by combining factors that reflect their capacity to generate profit, absorb losses, and maintain operational stability.

The Z-Score is calculated by the formula:

$$Z - Score = \frac{\mu + k}{\sigma}$$

Where

- $\mu$  : ROAA (Return on Average Assets) indicates the company's efficiency in generating profit from its assets.
- K (Capital Ratio) is the ratio between the bank's regulatory capital and its risk-weighted assets, representing the company's ability to absorb losses without defaulting.
- $\sigma$ (ROA) is the standard deviation of returns on assets, measuring the variability of profits and thus signaling financial instability.

It is important to highlight that in this research, we decided to use both the capital ratio and the shareholder funds instead of the simpler equity to assets measure. This choice was made to ensure a more comprehensive assessment of each firm's financial structure and risk profile. The capital ratio, in particular, offers a better capacity to reflect the underlying risk of assets, as recommended by international banking regulations such as Basel III (BIS, 2011). At the same

time, considering shareholder funds provides an additional perspective on the resources available to cover potential losses.

This methodological approach was chosen to strengthen the robustness of the analysis. By including these metrics, the study stays in line with current supervisory practices and improves how financial stability and credit risk are assessed.

The robustness of the Z-score has been confirmed by various studies that demonstrate its effectiveness in predicting bankruptcies and evaluating companies' financial health across different contexts and markets (Laeven & Levine, 2009; Berger, Klapper & Turk-Ariss, 2009). Beck, Demirgüç-Kunt & Merrouche (2013) also emphasize its utility as a continuous variable for econometric analysis, enabling more precise modelling of banking risk associated with corporate credit with greater precision.

In summary, the adjusted Z-score is an essential tool for banks when evaluating credit risk. By supporting more informed and transparent decisions, it allows financial institutions align their practices with international prudential guidelines and contributes to the overall stability of the banking system and the economy.

## **2.3 PUBLIC PROCUREMENT**

Public procurement is a widely studied and increasingly explored topic in the academic literature, given its economic and institutional relevance. It represents a significant portion of public spending, being a key tool for implementing public policies and fostering a country's economic development. In percentage terms, public procurement accounts for 19% of GDP in the European Union, while in Portugal — according to data from the 2023 Annual Public Procurement Report published by IMPIC — the figure reached 5.73% of Portuguese GDP, representing an increase of 0.48 percentage points compared to the previous year. The evolution and results of public procurement between 2019 and 2023 can be found in Figure A.1, Table A.2, and Graph A.1 of Annex A.

A more in-depth and accessible study of this area became possible after the entry into force of Decree-Law No. 18/2008, which approved the Public Contracts Code (CCP). This legal framework regulates the formation and execution of contracts entered into by public entities in Portugal, requiring their mandatory disclosure. In accordance with Articles 127 to 133 of the CCP, and with European Directives 2014/24/EU and 2014/25/EU, publication of contract information on the BASE Portal ([www.base.gov.pt](http://www.base.gov.pt)) became mandatory. This platform, launched in 2009, aims to ensure transparency, public scrutiny, and the sound management of public funds. It has been essential for the present research, offering open access to extensive data on public contracts in Portugal, as all contracting authorities are required to publish the full process for monitoring purposes.

Between 2019 and 2023, more than 810,000 public contracts were registered in Portugal, totaling approximately 60 billion euros. According to the report *Public Procurement: Companies that Sell to the State* (Informa D&B, 2024), 94% of this value was awarded to private companies. During this period, 6,446 contracting authorities awarded contracts to 73,983 awarded companies. Two sectors alone accounted for nearly half of the total amount awarded: Construction, and Medical Equipment and Services. These figures are illustrated in Graph A.2 of Annex A.

In recent years, public procurement in Portugal has increasingly aligned with European strategic priorities — with particular focus on environmental sustainability, innovation, and social inclusion. The Council of the European Union (2024) encourages Member States to use public procurement as a tool to accelerate the green transition, support innovation, and promote social cohesion. In Portugal, this strategy has been formalized through ENCPPE 2030 (National Strategy for Green Public Procurement), which sets clear goals for sustainability and the adoption of circular criteria in procurement processes (Government of Portugal, 2023).

The digitalization of public procurement has also gained prominence, with growing interest in the use of artificial intelligence and automation of procurement processes. As of October 2024, all public procurement notices must use standardized electronic forms (eForms), introduced to enhance data quality and comparability across the EU (European Commission, 2022). This evolution represents a significant step towards automating risk analysis, making it easier to cross-check contractual information with the financial data of awarded companies — an aspect particularly relevant to this research.

Finally, it is important to highlight the high sectoral concentration and the strong dependence that some companies have on public sector clients. Such exposure can directly affect a company's credit risk profile. Firms highly dependent on public contracts within a single sector may become more vulnerable to payment delays, long collection periods, legislative changes, or budget cuts. This dimension will be considered in the empirical analysis of this study by cross-referencing BASE Portal data with financial indicators.

Within this context, the academic literature has also sought to identify which economic and financial characteristics are most commonly associated with success in public procurement. One of the most cited variables is firm size, typically measured by the natural logarithm of total assets. Karjalainen (2011) and Piga and Thai (2007) suggest that larger firms are better equipped to handle the administrative and financial demands of public procurement, benefiting from economies of scale, stronger financial resilience, and more robust internal processes.

Albano and Sparro (2010) argue that the centralization of public procurement strengthens the State's bargaining power, often leading companies to accept significantly lower profit margins

compared to what they would accept in other types of contracts, simply to secure public contracts in a highly competitive environment. They also note that large-scale contracts can prevent smaller companies from participating due to their inability to meet the more demanding technical and financial requirements.

When it comes to financial indicators such as Return on Assets (ROA) and Return on Equity (ROE), although these are commonly used to assess a company's financial health and managerial efficiency, they may not always reflect the company's actual financial reality. In the case of ROE, for example, special care is needed because it can be significantly influenced by the company's level of debt. Al-Zoubi and Al-Hajaya (2022) show in their study that higher financial leverage can artificially inflate ROE by reducing the equity base without any real improvement in performance. Therefore, a positive association between ROE and public procurement success may reflect financial strategy more than genuine competitive advantage based on structural soundness.

### 3. DATA AND METHODOLOGY

This study adopts a quantitative explanatory approach, using secondary data, specifically public information on public procurement and financial data of Portuguese companies belonging to the same sector of activity. The goal is to examine whether firms that make business in the health and pharmaceutical sectors benefit financially from securing public contracts, and whether this relationship holds relevance in bank credit risk assessments.

The methodology was designed to allow for a robust empirical analysis of the selected financial variables, through the application of statistical tests and the Z-Score scoring model. The nature of the study justifies resorting to an explanatory approach, oriented towards identifying causal relationships between participation in public procurement and companies' credit risk levels (Creswell & Creswell, 2018). This approach aligns with the central objective of the investigation: to quantitatively test hypotheses and analyze patterns between companies with and without public contract awards.

#### 3.1- SECTOR SELECTION

As previously discussed, and drawing on data from the Informa D&B Report (2024) and the IMPIC Annual Public Procurement Report (2023), the sectors with the highest concentration of public procurement contracts, both in number and in total value, are those related to health equipment and services, and the construction industry.

Even so, the expressiveness of these two areas, the present study deliberately focuses on the health and pharmaceutical sector. This encompasses activities such as the provision of medical care, social support services, and the manufacture of medicines, in accordance with their respective NACE Rev. 2 codes. This choice, in preference over other sectors with similarly high procurement volumes, is supported by several justifications.

Firstly, the health sector demonstrates a more stable and enduring relationship with the public sector, often through multi-annual contracts that are tied to the delivery of essential services. This relative stability allows for a more consistent assessment of the financial implications of public procurement on corporate structures. In contrast, even though construction represents a significant portion of public procurement, the sector faces greater budget fluctuations, stronger economic cycles, and a highly enterprise fragmentation. These characteristics, along with a frequent reliance on subcontracting and often fragile business structures, would likely compromise the statistical robustness required for this study.

Secondly, the economic classification of entities operating within the health sector tends to be clearer and more objective. This facilitates the construction of a coherent and homogeneous sample, particularly suited to the application of credit risk models such as the

Z-Score. Moreover, these firms typically display greater financial regularity, more robust solvency indicators, and capital structures that are relatively stable across time, which improves the reliability of inter-firm comparisons.

Lastly, this sector bears significant social and political relevance. Analyzing the financial impact of public procurement on companies that deliver essential services to the population contributes not only to the academic literature on financial performance and public policy but also to the broader debate around the sustainability of the healthcare system. In this light, the role of the State as a strategic buyer gains further analytical importance, adding both societal and academic relevance to the research.

### **3.2. DATA CONSTRUCTION AND INTEGRATION**

The empirical analysis in this study is grounded in two primary datasets. The first encompasses public procurement records for the years 2022 to 2024, obtained from the official Portal BASE platform. The second consists of the full register of companies operating in Portugal, along with their accounting data for the years 2021 to 2023. The use of financial data from the year preceding the observation period ( $n-1$ ) aligns with standard practices in the banking sector, where risk assessments are typically based on the most recently closed financial statements.

To ensure sectoral consistency, all firms classified under the National Classification of Economic Activities (NACE) codes corresponding to the health and pharmaceutical sectors were included in the sample, regardless of their size or participation in public procurement activities. This comprehensive approach ensures a representative and comparative framework for analyzing the financial effects of public contracting across firms with varying degrees of state engagement.

To supplement and validate the financial information, the ORBIS database was employed, offering detailed company-level accounting data. This platform enabled the extraction of key financial indicators including total assets, equity, turnover, and profitability ratios, which were essential for the construction of solvency and financial stability measures used in the study.

The integration of the ORBIS financial data with the public procurement records from Portal BASE was conducted using IBM SPSS Statistics software. This matching process relied on a common identifier, typically the company's TIN (tax identification number), and resulted in a comprehensive, structured dataset comprising 165,749 observations. The final database includes firms with and without public contract awards, allowing for a robust comparison across the two groups.

Following this consolidation, the original set of 37 descriptive variables related to public contract characteristics was expanded through enrichment procedures, ultimately yielding a total of 68 variables, as we can see in Table 1. These encompass both financial metrics and derived analytical indicators necessary for the empirical phases of the research, such as Z-Score, ROAA (Return on Average Assets), and capital ratios, as well as binary variables such as

Firm\_PublicContracts\_d, indicating whether a firm had received any public procurement award during the observation period.

This integrated dataset serves as the foundation for testing the central research question: whether public procurement contracts influence the financial structure and resilience of firms, and whether such contracts should be considered in credit risk scoring systems used by financial institutions in Portugal. The rigorous construction of this database ensures both the internal validity of the econometric models and the external relevance of the findings.

Table 1 - Description Variables

Variable Information		
Variable		Label
OrbisIDnumber	1	Orbis ID number
CompanynameLatinalphabet	2	Company name Latin alphabet
NACERev.2corecode4digits	3	NACE Rev. 2, core code (4 digits)
Year_contract	4	Year_contract = Year + 1
Year	5	Year
Total_Assets	6	Total assets
Turnover	7	Operating revenue (Turnover)
r_Turnover_TotalAssets	8	r_Turnover_TotalAssets=Turnover/Total_Assets
ROE_v1_perc	9	ROE_v1_perc=ROE_v1/100
Firm_PublicContracts_d	10	1=if Firm with Public Contracts; 0=otherwise (according to chosen NACEs)
NIF_ADJUDICATARIO	11	NIF ADJUDICATARIO=Orbis Tax Identification Number (TIN)
NOME_ADJUDICATARIO	12	Name of the Awarded Contractor
Ano	13	<none>
dataCelebracaoContrato	14	Contract Signing Date
idcontrato	15	Contract ID
nAnuncio	16	Announcement Number
TipoAnuncio	17	Announcement Type
idINCM	18	<none>
tipoContrato	19	Contract Type
tipocontrato_2	20	Contract Type 2
tipocontrato_3	21	Contract Type 3
tipoprocedimento	22	Procedure Type
objectoContrato	23	Contract Object
descContrato	24	<none>
NIF_ADJUDICANTE	25	Tax Identification Number of the Contracting Authority
NOME_ADJUDICANTE	26	Name of the Contracting Authority
dataPublicacao	27	Publication Date
precoContratual	28	Contract Price
CPV_NUMERO	29	Common Procurement Vocabulary (CPV) Code
CPV	30	Common Procurement Vocabulary (CPV) Description
prazoExecucao	31	Execution Period
localExecucao	32	Execution Location
fundamentacao	33	Justification
ProcedimentoCentralizado	34	Centralized Procedure
numAcordoQuadro	35	Framework Agreement Number
DescrAcordoQuadro	36	Framework Agreement Description
precoBaseProcedimento	37	Base Price of the Procedure
dataDecisaoAdjudicacao	38	Award Decision Date
dataFechoContrato	39	Contract Closing Date
PrecoTotalEfetivo	40	Actual Total Price
regime	41	Regime
justifNReducEsctrContrato	42	Justification for Not Reducing the Contract to Writing
tipoFimContrato	43	Type of Contract Termination
CritMaterials	44	Material Criteria
concorrentes	45	Competitors
linkPecasProc	46	Link to Procedure Documents
Observacoes	47	Remarks
filter_\$	48	Firm_PublicContracts_d = 1 (FILTER)
ID_Firm_mean	49	Firm Mean ID
PLforperiodNetincomeEUR2023	50	P/L for period [=Net income] EUR 2023
PLforperiodNetincomeEUR2022	51	P/L for period [=Net income] EUR 2022
PLforperiodNetincomeEUR2021	52	P/L for period [=Net income] EUR 2021
PLforperiodNetincomeEUR2020	53	P/L for period [=Net income] EUR 2020
PLforperiodNetincomeEUR2019	54	P/L for period [=Net income] EUR 2019
ShareholdersfundsEUR2023	55	Shareholders funds EUR 2023
ShareholdersfundsEUR2022	56	Shareholders funds EUR 2022
ShareholdersfundsEUR2021	57	Shareholders funds EUR 2021
CapitalEUR2023	58	Capital EUR 2023
CapitalEUR2022	59	Capital EUR 2022
CapitalEUR2021	60	Capital EUR 2021
OthershareholdersfundsEUR2023	61	Other shareholders funds EUR 2023
OthershareholdersfundsEUR2022	62	Other shareholders funds EUR 2022
OthershareholdersfundsEUR2021	63	Other shareholders funds EUR 2021
TotalshareholdersfundsandliabilitiesEUR2023	64	Total shareholders' funds and liabilities EUR 2023
TotalshareholdersfundsandliabilitiesEUR2022	65	Total shareholders' funds and liabilities EUR 2022
TotalshareholdersfundsandliabilitiesEUR2021	66	Total shareholders' funds and liabilities EUR 2021
TotalassetsEUR2020	67	Total assets EUR 2020
TotalassetsEUR2019	68	Total assets EUR 2019

Variables in the working file

### **3.3 VARIABLE DEFINITION AND DATA PREPARATION**

In order to evaluate the impact of public procurement on the financial health and credit risk of companies, it was necessary to construct a robust and coherent dataset. This section outlines the methodology adopted for defining key variables and preparing the data for analysis, ensuring consistency with the theoretical framework.

#### **Temporal Alignment of Financial Data**

The public procurement data refers to the period between 2022 and 2024, while the financial data, obtained from the ORBIS database, pertains to 2021 to 2023. This one-year lag aligns with standard banking practices, where financial analysis for credit scoring purposes typically considers the most recent completed fiscal year (n-1).

To unify the temporal scope across both datasets, a normalized Year variable was constructed to link each procurement observation (n) with the corresponding financial data from the previous year (n-1). This alignment was critical for ensuring that financial metrics used in risk evaluation reflect the actual financial situation prior to the awarding of public contracts.

#### **Sample Construction and De-duplication**

The integrated dataset initially included 165,749 records resulting from the match between companies with public procurement data and those listed in the ORBIS financial records. The dataset included both companies with and without public contracts, across the healthcare and pharmaceutical sectors, based on the NACE codes.

As shown in Table 2, the most prominent sectors were:

- 8690 – Other human health activities (24.4%)
- 8622 – Specialist medical practice activities (21.2%)
- 8623 – Dental practice activities (17.0%)
- 8621 – General medical practice activities (11.2%)

These four alone represented over 73% of the sample. Other relevant sectors included hospital activities (8610), manufacture of pharmaceutical products (2120), and a variety of residential care activities (8730, 8790, etc.).

Table 2 - Distribution of the Sample by NACE Code

<b>NACE Rev. 2, core code (4 digits)</b>					
		Frequência	Porcentagem	Porcentagem válida	Porcentagem acumulativa
Válido	2110	366	,2	,2	,2
	2120	7591	4,6	4,6	4,8
	8610	2312	1,4	1,4	6,2
	8621	18497	11,2	11,2	17,4
	8622	35066	21,2	21,2	38,5
	8623	28167	17,0	17,0	55,5
	8690	40482	24,4	24,4	79,9
	8710	390	,2	,2	80,2
	8720	252	,2	,2	80,3
	8730	10535	6,4	6,4	86,7
	8790	1522	,9	,9	87,6
	8810	7126	4,3	4,3	91,9
	8891	5070	3,1	3,1	94,9
	8899	8373	5,1	5,1	100,0
	Total	165749	100,0	100,0	

Regarding the nature of awarded contracts, CPV codes revealed a high concentration in:

- 33600000-6 – Pharmaceutical products (34.2%)
- 33000000-0 – Medical equipment (30.3%)
- 33690000-3 – Miscellaneous medical products (13.4%)

Together, these accounted for more than 75% of all healthcare-related contract awards (Table 3).

After a de-duplication process using the TIN (company tax identification number), the sample was filtered to identify unique firms. This resulted in a final sample of 52,833 unique firms, used for all subsequent descriptive and inferential statistical analyses.

Table 3 - Distribution of the Sample by CPV

		CPV_NUMERO			
		Frequência	Porcentagem	Porcentagem válida	Porcentagem acumulativa
Válido	33000000-0	2383	30,3	30,3	30,3
	33100000-1	160	2,0	2,0	32,4
	33140000-3	745	9,5	9,5	41,9
	33169000-2	18	,2	,2	42,1
	33600000-6	2687	34,2	34,2	76,3
	33690000-3	1050	13,4	13,4	89,7
	33696500-0	28	,4	,4	90,1
	50400000-9	3	,0	,0	90,1
	85000000-9	420	5,3	5,3	95,4
	85100000-0	165	2,1	2,1	97,5
	85147000-1	193	2,5	2,5	100,0
	Total	7852	100,0	100,0	

### Sectoral Classification

The sectoral segmentation was performed using the NACE Rev. 2 codes at the 4-digit level, to ensure analytical precision and sectoral coherence. Particular focus was placed on:

2120 – Manufacture of pharmaceutical products  
8622 – Specialist medical practice activities

8690 – Other human health activities

8621 – General medical practice activities

8610 – Hospital activities

8730 – Residential care for the elderly and disabled

8790 – Other residential care activities

This targeted classification improved the internal consistency of the analysis and enabled more meaningful comparisons across business types.

### CPV-Based Contract Segmentation

A complementary segmentation was carried out using CPV (Common Procurement Vocabulary) codes, allowing the identification of the specific nature of the goods and services procured. CPV codes linked to essential healthcare supplies and services, such as pharmaceutical products, medical equipment, and healthcare support services, were prioritized. This categorization was essential for aligning the contract information with the firms' operational sectors.

This structured and harmonized approach to variable definition and data preparation ensured a high level of consistency across the empirical analysis, enabling accurate testing of hypotheses regarding the relationship between public procurement participation and firms' financial performance and credit risk.

### 3.4 FINANCIAL RISK MEASUREMENT: Z-SCORE CONSTRUCTION

In order to measure the financial stability of the firms under study, the Z-Score was used as a composite indicator of return, capital strength, and risk. The following formulation was adopted:

$$Z - Score = \frac{\mu (ROA) + k(Capital Ratio)}{\sigma}$$

where:

- ROAA is the Return on Average Assets,
- Capital Ratio is calculated as Shareholders' Funds / Total Assets,
- $\sigma$  is the standard deviation of ROAA over three years.

To facilitate the calculations and reduce processing errors, a simplified dataset was created containing only the variables needed to calculate Z-Score. These included net income (PLforperiod\_Netincome), shareholders' funds (Shareholdersfunds\_EUR), capital (CapitalEUR), total assets (for the years 2020, 2021, 2022, and 2023) (TotalassetsEUR), and identifiers.

#### Calculation Process

##### 1. Data Cleaning and Deduplication

- Duplicate firms were removed based on NIPC.
- This reduced the dataset from 65 variables to a core of financial indicators and identifiers.
- The resulting sample size was 52,833 firms.

##### 2. ROAA and Capital Ratio Calculation

To operationalize the Z-Score formula, it was first necessary to calculate the Return on Average Assets (ROAA) and the Capital Ratio for each firm-year observation.

The ROAA serves as an indicator of how efficiently a company utilizes its assets to generate net income. It was computed as the ratio between net income and the average total assets for the corresponding year. Given the temporal scope of the data (2021–2023), average assets

were calculated as the mean between total assets at the end of year t-1 and year t, following the standard formulation:

1st Average Assets per year:

$$\text{Average Assets} = \frac{\text{Assets } t + \text{Assets } t - 1}{2}$$

2nd Once the average assets were determined, the ROAA was computed for each year (2021, 2022 and 2023) using:

$$\text{ROAA} = \frac{\text{Net Income}}{\text{Average Assets}}$$

This method ensures a temporally accurate representation of operational performance, capturing the firm's annual efficiency in turning its asset base into profits.

In parallel, the Capital Ratio was calculated to assess the solvency position of the firms, by dividing total shareholders' funds by total assets for each year. This metric reflects the company's leverage and financial structure:

3rd Capital Ratio

$$\text{Capital Ratio} = \frac{\text{Shareholder' Funds}}{\text{Total Assets}}$$

Or

$$\text{Capital Ratio} = \frac{\text{Capital}}{\text{Total Assets}}$$

An alternative version of the Capital Ratio, using Capital instead of Shareholders' Funds in the numerator, was also generated, although it was not the primary metric used in the Z-Score formula.

### 3. Volatility Measurement

The volatility term  $\sigma$ , essential for standardizing the score, was computed as the standard deviation of each firm's ROAA over the three-year period. This captures intra-firm risk, representing the fluctuation of operational performance over time. In a supplementary analysis, sector-level standard deviations were also calculated to allow for benchmarking of individual firms against their respective industries.

Once ROAA, Capital Ratio, and  $\sigma$  were obtained, year-specific Z-Scores were calculated for each firm:

#### 4. Z-Score Calculation

- Year-specific Z-Scores:
  - $ZScore_{2021} = (ROAA_{2021} + CapitalRatio_{2021}) / ROAA\_Stdev$
  - $ZScore_{2022} = (ROAA_{2022} + CapitalRatio_{2022}) / ROAA\_Stdev$
  - $ZScore_{2023} = (ROAA_{2023} + CapitalRatio_{2023}) / ROAA\_Stdev$

Overall ZScore\_Mean was computed to represent average financial stability across the three years.

$$ZScore\_Mean = (ROAA\_Mean + CapitalRatio\_Mean) / ROAA\_Stdev$$

This approach ensured that the financial risk metric accurately captured both performance and volatility over time. The use of yearly disaggregated ROAA and Capital Ratio figures allowed for temporal specificity, while the average Z-Score facilitated broader comparative analysis. The dual consideration of firm-level and sector-level risk further reinforced the robustness of the methodology.

#### Sectoral Volatility Benchmark (Optional)

- Sector-level standard deviation of ROAA was calculated to normalize firm risk against peers.
- Although this produced a high overall  $\sigma$  (9.077), it served as a robustness check for interpreting firm-level Z-Scores.

### **3.5. DATA CLEANING AND WINSORIZATION**

Prior to conducting the analyses, a comprehensive data cleaning process was carried out to ensure the consistency and quality of the dataset. Specifically, the behaviour of the financial risk indicator Z-Score over the three-year period (2021, 2022, and 2023) was examined.

All firms that recorded a Z-Score equal to zero for all three consecutive years were excluded from the sample, based on the rationale that persistently zero values likely indicated missing or non-representative financial information that could bias the results.

Applying this filter resulted in the exclusion of 32,908 firms, reducing the initial sample from 55,932 firms to a final dataset of 23,024 firms with complete financial information for the calculation of ROAA, Capital Ratio and Z-Score

Given the extreme asymmetry and presence of outliers in the dataset, as reflected in the high skewness and kurtosis values in the distributions of Z-Score and ZScoreVE, winsorization was applied to reduce the impact of outlier-driven distortions. Winsorization is a data transformation technique that reduces the influence of extreme observations by replacing extreme values with the closest value still inside the chosen percentile range. Unlike trimming, which discards data, winsorization preserves all observations while mitigating the disproportionate impact of outliers on statistical inference, particularly in models sensitive to non-normal distributions.

In this study, winsorization was applied specifically to the Z-Score and ZScoreVE variables, which serve as the main financial risk indicators. These two metrics are nearly identical in construction, differing only in the numerator of the capital adequacy ratio: ZScore uses Shareholders' Funds divided by Total Assets (the main formulation), while ZScoreVE uses Capital over Total Assets as an alternative specification. For each of the three years under analysis, the 5th and 95th percentiles were calculated separately, and all values exceeding these thresholds were capped accordingly. This approach effectively reduced excessive skewness and kurtosis while preserving the central tendency and relative rank of the majority of firms.

The impact of winsorization can be seen in the descriptive statistics reported in Table 4 , which show a substantial reduction in distributional extremes, as well as in the visual comparison of histograms and boxplots before and after the transformation (Appendix A). By enhancing the robustness of the key variables and maintaining the diversity of the sample without deleting observations, winsorization contributed to the empirical validity and reliability of the regression models and comparative analyses presented in this study. All subsequent analyses were conducted using the winsorized versions of ZScore and ZScoreVE to ensure consistency and minimize the risk of bias from data irregularities.

Table 4 - Descriptive Statistics for Financial and Performance Indicator After Winsorization

	Descriptive Statistics								
	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Current_Ratio_num	62983	,00	100,00	8,9344	14,55998	3,148	,010	11,308	,020
Solvency_Ratio_num	63518	-99,97	100,00	55,0507	38,40771	-1,030	,010	,900	,019
Profit_margin_num	63434	-99,95	99,96	14,1916	25,77933	,079	,010	1,992	,019
ROE_num	58368	-987,66	992,33	24,4930	78,61291	-,771	,010	44,570	,020
Number of employees	56911	1	8,601	13,22	164,511	32,192	,010	1258,801	,021
P/L for period [=Net income]	66692	-107,619,909	57,591,556	-4,052,66	1,574,271,077	-28,857	,009	1574,837	,019
Shareholders funds EUR 2021	66807	-275,540,897,6	259,323,748,0	356,446,939	4791319,0327	11,810	,009	1344,521	,019
Capital EUR	66809	-3,656	335,920,621	205,092,96	4,786,649,506	40,161	,009	1947,131	,019
Other shareholders funds EUR	66809	-541,800,343	250,023,748	151,343,31	7,200,003,690	-31,506	,009	2073,969	,019
Total shareholders' funds and liabilities EUR	66765	0	651,915,811	969,723,25	10716460,913	29,303	,009	1077,197	,019
Total assets EUR	66560	0	651,915,811	961,683,79	10708367,449	29,398	,009	1082,860	,019
AvgAssets	64810	,01	580941230,30	953610,3982	10486821,515	28,633	,010	1015,682	,019
ROAA	64706	-1840,92	20,39	-,0200	7,74054	-211,422	,010	49582,421	,019
CapitalRatio	66560	-2270220,00	30887,82	-34,9184	8800,79836	-257,883	,009	66522,654	,019
CapitalRatioVE	66567	-,01	100000,00	2,1581	389,50749	254,319	,009	65264,259	,019
ZScore_Winsor	69072	-4,78	119,48	25,0939	35,32602	1,618	,009	1,337	,019
ZScoreVE_Winsor	69072	-1,14	20,55	4,6365	6,12711	1,519	,009	1,042	,019
N_Contracts	502	1,00	1240,00	15,1434	78,44888	10,950	,109	144,962	,218
V_Contracts	502	,00	900323,89	11750,0194	62868,70340	9,316	,109	105,546	,218
Valid N (listwise)	412								

As already identified, winsorization was applied specifically to the Z-Score and ZScoreVE variables, which serve as the main financial risk indicators. These two indicators are nearly identical in construction, differing only in the numerator of the capital adequacy ratio:

- **ZScore** uses the ratio Shareholders' Funds / Total Assets (considered the main and most appropriate formulation),
- **ZScoreVE** uses the alternative Capital Ratio / Total Assets, included for comparative analysis.

Given the presence of extreme values (e.g., Z-Scores above 500 or below -40), we applied winsorization at the 5th and 95th percentiles, calculated separately for each year (2021, 2022, 2023). This decision was based on the actual distribution of values observed in the dataset and aimed to reduce excessive skewness and kurtosis without discarding valuable information. In the tables 5 and 6, we can observe the percentiles of both variables per year.

Table 5 - Percentile Distribution of ZScoreVE (2021-2023)

Statistics		
ZScoreVE		
N	Valid	21234
	Missing	1790
Percentiles	1	-3,1317
	5	-1,0747
	50	2,2768
	95	19,8014
	99	101,5589

Statistics		
ZScoreVE		
N	Valid	23011
	Missing	13
Percentiles	1	-3,3553
	5	-1,1391
	50	1,9997
	95	20,5525
	99	113,7048

Statistics		
ZScoreVE		
N	Valid	20461
	Missing	2563
Percentiles	1	-2,6122
	5	-1,1255
	50	1,8222
	95	18,0697
	99	86,0254

Table 6 - Percentile Distribution of ZScore (2021 - 2023)

Statistics		
ZScore		
N	Valid	21234
	Missing	1790
Percentiles	1	-29,6003
	5	-3,9985
	50	8,7603
	95	119,4755
	99	541,6676

Statistics		
ZScore		
N	Valid	23011
	Missing	13
Percentiles	1	-41,4838
	5	-4,5385
	50	8,1059
	95	118,7031
	99	565,1451

Statistics		
ZScore		
N	Valid	20461
	Missing	2563
Percentiles	1	-42,2212
	5	-4,7756
	50	7,7943
	95	96,5677
	99	404,0687

As a result, two new variables were generated:

- ZScore\_Winsor
- ZScoreVE\_Winsor

These transformed variables were used in all subsequent empirical tests to ensure more stable estimates and minimize the influence of anomalies.

### **Descriptive Statistics and Distribution Analysis**

Prior to and after winsorization, descriptive statistics, as we can see bellow, were computed for the original ZScore and ZScoreVE, including minimum, maximum, percentiles (1st, 5th,

50th, 95th, 99th), skewness, and kurtosis. These results confirmed the presence of substantial outliers before transformation and the effectiveness of the winsorization procedure.

Table 7 - Descriptive Statistics for ZScoreVE in 2021

<b>Descriptives</b>			Statistic	Std. Error
ZScoreVE	Mean		2,6656E+13	1,87797E+13
	95% Confidence Interval for Mean	Lower Bound	-1,0154E+13	
		Upper Bound	6,3465E+13	
	5% Trimmed Mean		3,2599	
	Median		2,2768	
	Variance		7,489E+30	
	Std. Deviation		2,73655E+15	
	Minimum		-3,07E+15	
	Maximum		3,46E+17	
	Range		3,49E+17	
	Interquartile Range		3,88	
	Skewness		113,055	,017
	Kurtosis		13341,826	,034

Table 8 - Descriptive Statistics for ZScoreVE in 2022

<b>Descriptives</b>			Statistic	Std. Error
ZScoreVE	Mean		2,4597E+13	1,73294E+13
	95% Confidence Interval for Mean	Lower Bound	-9,3697E+12	
		Upper Bound	5,8564E+13	
	5% Trimmed Mean		3,0954	
	Median		1,9997	
	Variance		6,910E+30	
	Std. Deviation		2,62877E+15	
	Minimum		-3,07E+15	
	Maximum		3,46E+17	
	Range		3,49E+17	
	Interquartile Range		3,91	
	Skewness		117,691	,016
	Kurtosis		14458,503	,032

Table 9 - Descriptive Statistics for ZScoreVE in 2023

<b>Descriptives</b>			Statistic	Std. Error
ZScoreVE	Mean		2,7663E+13	1,94891E+13
	95% Confidence Interval for Mean	Lower Bound	-1,0538E+13	
		Upper Bound	6,5863E+13	
	5% Trimmed Mean		2,8383	
	Median		1,8222	
	Variance		7,772E+30	
	Std. Deviation		2,78776E+15	
	Minimum		-3,07E+15	
	Maximum		3,46E+17	
	Range		3,49E+17	
	Interquartile Range		3,73	
	Skewness		110,978	,017
	Kurtosis		12856,069	,034

Table 10 - Descriptive Statistics for ZScore in 2021

<b>Descriptives</b>				
		Statistic	Std. Error	
ZScore	Mean	1,1104E+15	1,11036E+15	
	95% Confidence Interval for Mean	Lower Bound	-1,0660E+15	
		Upper Bound	3,2868E+15	
	5% Trimmed Mean	16,7009		
	Median	8,7603		
	Variance	2,618E+34		
	Std. Deviation	1,61801E+17		
	Minimum	-5,01E+16		
	Maximum	2,36E+19		
	Range	2,36E+19		
	Interquartile Range	21,05		
	Skewness	145,717	,017	
	Kurtosis	21233,698	,034	

Table 11 - Descriptive Statistics for ZScore in 2022

<b>Descriptives</b>				
		Statistic	Std. Error	
ZScore	Mean	1,0244E+15	1,02437E+15	
	95% Confidence Interval for Mean	Lower Bound	-9,8344E+14	
		Upper Bound	3,0322E+15	
	5% Trimmed Mean	16,1771		
	Median	8,1059		
	Variance	2,415E+34		
	Std. Deviation	1,55391E+17		
	Minimum	-5,01E+16		
	Maximum	2,36E+19		
	Range	2,36E+19		
	Interquartile Range	20,77		
	Skewness	151,692	,016	
	Kurtosis	23010,673	,032	

Table 12 - Descriptive Statistics for ZScore in 2023

<b>Descriptives</b>				
		Statistic	Std. Error	
ZScore	Mean	1,1518E+15	1,15176E+15	
	95% Confidence Interval for Mean	Lower Bound	-1,1058E+15	
		Upper Bound	3,4093E+15	
	5% Trimmed Mean	14,5712		
	Median	7,7943		
	Variance	2,714E+34		
	Std. Deviation	1,64750E+17		
	Minimum	-5,01E+16		
	Maximum	2,36E+19		
	Range	2,36E+19		
	Interquartile Range	19,43		
	Skewness	143,040	,017	
	Kurtosis	20460,709	,034	

The empirical results derived from the winsorized data, including distributional improvements and impacts on key financial indicators, are further examined in Chapter 4, where the implications for firm performance and credit risk assessment are discussed in detail.

### **3.6 SAMPLE STRUCTURING AND CONTROL VARIABLES**

To enable a valid and unbiased comparison between firms with and without public procurement contracts, a Propensity Score Matching (PSM) approach was employed. This method helps mitigate selection bias by constructing a control group of firms that are statistically comparable to those that engaged in public procurement, based on structural firm characteristics.

The propensity score (PRE\_1) was calculated through a binary logistic regression, where the dependent variable indicated whether a firm had received public contracts (1 = yes, 0 = no). The independent variables included:

- Total Assets
- Shareholders' Funds
- Number of Employees

These variables were chosen as proxies for firm size and capital structure, which are crucial determinants of both access to public procurement and financial resilience. Importantly, outcome variables such as profitability or financial distress indicators were deliberately excluded to reduce endogeneity risk and ensure ex-ante comparability.

Once the scores (PRE\_1) were computed, the sample of firms without public contracts was filtered using Python scripting within SPSS, selecting those firms whose propensity scores most closely matched those of the treatment group (firms with public contracts). No tolerance margin or fixed percentage deviation was applied; instead, matches were selected purely based on score proximity, ensuring high alignment in structural characteristics.

This process resulted in a matched control group (Sample B) that mirrors the treated group (Sample A) in terms of operational scale and financial structure, while differing only in public procurement participation. This facilitates a more accurate estimation of the impact of public contracts on firms' financial stability and credit risk.

The matching process also helped control potential heterogeneity across firms, thus enhancing the internal validity of subsequent statistical tests and regression analyses. The quality of the matching procedure was evaluated using post-match balance diagnostics, confirming strong comparability across the matched samples.

The final matched dataset includes both groups—contracted and non-contracted firms—balanced in terms of size and structure and is used throughout Chapter 4 for inferential testing and modeling.

### 3.7 STATISTICAL TESTING FRAMEWORK

To rigorously evaluate the relationship between public procurement participation and firms' financial resilience, a detailed statistical testing framework was adopted. This approach combines both parametric and non-parametric methods, as well as regression-based modelling, in order to account for data asymmetries and enhance the robustness of the conclusions. The objective is not only to test for mean differences between firms making business with and without public contracts, but also to examine the extent to which public sector engagement may influence financial health after controlling for firm-specific structural characteristics.

The analysis begins with univariate inferential testing. Independent samples t-tests are employed to compare the average Z-Score (winsorized), profitability (ROAA), and solvency (Capital Ratio) between firms making business with public procurement contracts and those without. These tests are performed under the assumption of approximate normality and equality of variances, which are verified using Levene's test for homogeneity of variances. In cases where these assumptions are not met—particularly due to the skewness and kurtosis observed in financial indicators—non-parametric alternatives are applied. Specifically, the Mann-Whitney U test is used as a robustness check to validate the results under weaker distributional assumptions.

Beyond these comparisons, the study implements multiple linear regression models to further assess the relationship between public procurement and financial risk. The dependent variable in these models is the Z-Score (winsorized), while the main independent variable is a binary indicator denoting whether the firm was awarded a public contract. Control variables include total assets, number of employees, and shareholders' funds, selected to reflect firm size and capital structure. These models aim to isolate the marginal effect of public sector contracting, net of structural firm characteristics.

The full results of these statistical procedures—along with detailed interpretation of coefficients, significance levels, and robustness indicators—are presented in Chapter 4: Empirical Study.

## 4. EMPIRICAL STUDY

### 4.1. STATISTICAL TESTING

This chapter examines the relationship between public procurement and firms' financial performance in Portugal, focusing on the 2022–2024 period, particularly in the health and pharmaceutical sectors. The objective is to compare two firm categories: those making business using public contracts and those without. This study investigates some key financial indicators to assess performance differences.

To enable this comparison, a binary variable was created, Firm\_PublicContracts\_d which equals 1 for firms with public contracts within a year and 0 otherwise. This variable ensures segmentation of the dataset and allows the application of comparative statistical methods.

As a fundamental step in the analysis, these descriptive statistics and comparative tests were applied to the raw dataset, prior to any data cleaning or transformation. This approach ensures a comprehensive understanding of the data's original characteristics and supports the integrity and transparency of subsequent analyses.

#### Statistical Testing Feasibility

In this context, we began by assessing the assumption of normality, which is a prerequisite for the use of parametric statistical tests. To this end, the Kolmogorov-Smirnov test was applied to the main financial variables under study: Total Assets, Operating Revenue (Turnover),  $r\_Turnover\_TotalAssets$ , and Return on Equity (ROE). The results consistently indicated p-values below 0.001 for all variables in both groups (firms with and without contracts), leading to the rejection of the null hypothesis of normality (see Table 13). The decision to employ this test was further supported by the large sample size and its robustness in detecting deviations from normality, as well as by the extreme skewness and kurtosis observed in the descriptive statistics, indicating the presence of outliers and highly asymmetric distributions.

Given these findings, the analysis proceeded with the use of non-parametric tests, which are more appropriate when the assumptions of normality and constant variance of the errors are not satisfied. Specifically, the Mann-Whitney U test was adopted, as it enables the comparison of two independent groups without requiring the data to follow a normal distribution. Beyond identifying whether statistically significant differences exist, the use of these tests also facilitates the assessment of the magnitude and direction of such differences. This makes it possible to have a more detailed understanding interpretation of the financial dynamics between firms, considering the real-world variability observed in the data.

The reliability of the results is further supported by the large sample size and by the sector-specific focus (health and pharmaceutical), which ensures greater comparability between firms. Ultimately, these statistical tests provide a solid basis for understanding how

participating in public procurement affects financial outcomes. The conclusions drawn from this initial stage will be complemented by more advanced econometric methods in the following sections, deepening our understanding of the observed patterns and their potential causal relationships.

Table 13 - Results of the Kolmogorov-Smirnov test for normality by group. All p-values <0.001.

<b>Tests of Normality</b>				
	1=if Firm with Public Contracts; 0=otherwise (according to chosen NACEs)	Kolmogorov-Smirnov <sup>a</sup>		
		Statistic	df	Sig.
Total assets	0	,463	65745	<,001
	1	,152	7556	<,001
Operating revenue (Turnover)	0	,465	65745	<,001
	1	,142	7556	<,001
r_Turnover_TotalAssets=Turnover/Total_Assets	0	,235	65745	<,001
	1	,282	7556	<,001
ROE_v1_perc=ROE_v1/100	0	,235	65745	<,001
	1	,225	7556	<,001

a. Lilliefors Significance Correction

## Data Overview

These figures are based on the 165,749 total records, of which 65,749 observations relate to firms without public contracts and 7,556 to firms with contracts. The descriptive statistics and Kolmogorov-Smirnov normality test results used to support these conclusions are provided in Table 13.

Table 14 - Case Processing Summary

	1=if Firm with Public Contracts; 0=otherwise (according to chosen NACEs)	Casos					
		Válido		Omisso		Total	
		N	Porcentagem	N	Porcentagem	N	Porcentagem
ROE_v1_perc=ROE_v1/100	0	65745	41,6%	92152	58,4%	157897	100,0%
	1	7556	96,2%	296	3,8%	7852	100,0%
Operating revenue (Turnover)	0	65745	41,6%	92152	58,4%	157897	100,0%
	1	7556	96,2%	296	3,8%	7852	100,0%
Total assets	0	65745	41,6%	92152	58,4%	157897	100,0%
	1	7556	96,2%	296	3,8%	7852	100,0%
r_Turnover_TotalAssets=Turnover/Total_Assets	0	65745	41,6%	92152	58,4%	157897	100,0%
	1	7556	96,2%	296	3,8%	7852	100,0%

## Descriptive Overview by Group

### 1. Total Assets

- Group 0 (No Contracts): Mean = €734,500; Median = €120,123; Skewness = 40.816; Kurtosis = 2,209.19
- Group 1 (With Contracts): Mean = €124,727,368; Median = €126,206,914; Skewness = 0.721; Kurtosis = -0.121

Group 1 firms (with contracts) are financially larger and exhibit more homogeneous asset distributions, while Group 0 firms (no contracts) are smaller and more dispersed.

Table 15 - Descriptive Statistics of Total Assets

	<b>GROUP 0</b>	<b>GROUP 1</b>
<b>MEAN (€)</b>	734.500	124.727.368
<b>MEDIAN (€)</b>	120.123	126.206.913,57
<b>SKEWNESS</b>	40,816	0,721
<b>KURTOSIS</b>	2209,190	-0,121

### 2. Operating Revenue (Turnover)

- Group 0 (No contracts): Mean = €529,881; Median = €100,599; Skewness = 38.145; Kurtosis = 1,948
- Group 1 (With contracts): Mean = €104,606,179; Median = €121,663,690; Skewness = 0.354; Kurtosis = -0.709

Again, firms with public contracts display more consistency and significantly higher turnover.

Table 16 - Descriptive Statistics of Turnover

	<b>GROUP 0 (NO CONTRACTS)</b>	<b>GRUPO 1 (WITH CONTRACTS)</b>
<b>MEAN</b>	529.881 €	104.606.179 €
<b>MEDIAN</b>	100.599 €	121.663.690 €
<b>SKEWNESS</b>	38,145	0,354
<b>KURTOSIS</b>	1948	-0,709

### **3. Return on Assets (r Turnover TotalAssets)**

- Group 0 (No contracts): Mean = 1.4633; Median = 0.9609; Skewness = 14.811; Kurtosis = 665.808
- Group 1 (With contracts): Mean = 0.9078; Median = 0.9127; Skewness = 5.288; Kurtosis = 54.703

Outliers inflate Group 0's mean, while Group 1's profitability is more stable and symmetric.

Table 17 - Descriptive Statistics of Return on Assets

	<b>GROUP 0 (NO CONTRACTS)</b>	<b>GRUPO 1 (WITH CONTRACTS)</b>
<b>MEAN</b>	1,4633	0,9078
<b>MEDIAN</b>	0,9609	0,9127
<b>SKEWNESS</b>	14,811	5,288
<b>KURTOSIS</b>	665,808	54,703

### **4. Return on Equity (ROE)**

- Group 0 (No contracts): Mean = 0.2840; Median = 0.1866; Skewness = -0.811; Kurtosis = 40.904

- Group 1 (With contracts): Mean = 0.1780; Median = 0.1486; Skewness = 1.135; Kurtosis = 110.706

Group 0 shows higher average ROE. Both groups show extreme values, reinforcing the choice of non-parametric tests.

Table 18 - Descriptive Statistics of Return on Equity

	<b>GROUP 0</b>	<b>GROUP 1</b>
<b>MEAN</b>	0,2840	0,1780
<b>MEDIAN</b>	0,1866	0,1486
<b>SKEWNESS</b>	-0,811	1,135
<b>KURTOSIS</b>	40,904	110,706

### **Mann-Whitney U Test Results**

The Mann-Whitney U test, applied to all four indicators, confirmed statistically significant differences ( $p < 0.001$ ) between the two groups:

- Firms with public contracts tend to have higher assets and revenue.
- Firms without public contracts exhibit greater efficiency in asset usage and higher ROE.

These findings suggest structural differences and challenge the assumption that public contracting is associated with better financial health. Instead, they highlight the possibility of operational or financial risk exposure linked to public procurement, possibly due to state-dependence, payment delays, or contract rigidity.

A deeper econometric analysis will follow to explore causal effects using matched samples and regression models.

Table 19 - Descriptive Rank Statistics by Public Contract Status (Mann-Whitney Test)

<b>Ranks</b>				
	1=if Firm with Public Contracts; 0=otherwise (according to chosen NACEs)	N	Mean Rank	Sum of Ranks
Total assets	0	79678	40069,74	3192676425,5
	1	7617	81078,61	617575734,50
	Total	87295		
r_Turnover_TotalAssets=Turnover/Total_Assets	0	75573	42110,84	3182442289,5
	1	7609	36433,42	277221863,50
	Total	83182		
ROE_v1_perc=ROE_v1/100	0	67317	37706,82	2538310199,5
	1	7558	35043,67	264860050,50
	Total	74875		
Operating revenue (Turnover)	0	75735	38075,74	2883666017,5
	1	7609	77472,31	589486822,50
	Total	83344		

Table 20 - Mann-Whitney U Test Results for Group Differences Based on Public Contract Status

<b>Test Statistics<sup>a</sup></b>				
	Total assets	r_Turnover_TotalAssets=Turnover/Total_Assets	ROE_v1_perc=ROE_v1/100	Operating revenue (Turnover)
Mann-Whitney U	18344744,500	248269618,50	236294589,50	15733037,500
Wilcoxon W	3192676425,5	277221863,50	264860050,50	2883666017,5
Z	-135,689	-19,658	-10,157	-136,160
Asymp. Sig. (2-tailed)	<,001	<,001	<,001	<,001

a. Grouping Variable: 1=if Firm with Public Contracts; 0=otherwise (according to chosen NACEs)

Following the initial descriptive and comparative analysis conducted on the raw dataset, this chapter applies the same statistical procedures to the dataset after winsorization, to mitigate the impact of extreme values. As in the previous analysis, we begin by assessing the normality of the main variables using the Kolmogorov-Smirnov test (Table 21).

Table 21 - Tests of Normality

	Firm_PublicContracts_d	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
r_Turnover_TotalAssets=Turnover/Total_Assets	,00	,268	6645	<,001			
	1,00	,166	456	<,001	,708	456	<,001
Operating revenue (Turnover)	,00	,427	6645	<,001			
	1,00	,376	456	<,001	,347	456	<,001
Total assets	,00	,470	6645	<,001			
	1,00	,377	456	<,001	,348	456	<,001
ROE_num	,00	,220	6645	<,001			
	1,00	,219	456	<,001	,731	456	<,001

a. Lilliefors Significance Correction

Tests of normality were performed separately for firms with and without public contracts using the Kolmogorov-Smirnov and Shapiro-Wilk tests. In all cases, the null hypothesis of normality was rejected ( $p < 0,001$ ), confirming that the main financial variables exhibit significant departures from a normal distribution in both groups.

In this section, descriptive statistics were calculated separately for firms with and without public contracts, to assess the distributional properties and central tendencies of key financial variables. The results highlight marked differences between the two groups, both in scale and in distributional shape, as summarized below.

Regarding Total Assets, firms without public contracts (Group 0) exhibited a mean of €426,839.83 and a median of €110,143.67, indicating a distribution strongly influenced by extreme values. This is evident in the high skewness (45.259) and kurtosis (2,096.583). In contrast, firms with public contracts (Group 1) had a much higher mean of €19,648,031.59 and a median of €508,549.45. Although the skewness (4.719) and kurtosis (24.801) were still high, the distribution appeared relatively more balanced compared to Group 0. This suggests that involved in public procurement tends to be substantially larger and show less pronounced dispersion in asset size.

For Operating Revenue (Turnover), a similar pattern was observed. Group 0 firms showed an average turnover of €118,008.84 and a median of €53,619.46, with extreme skewness (31.124) and kurtosis (1,182.242). This suggests that while most firms reported modest turnover, a small number achieved exceptionally high revenues. Conversely, Group 1 firms recorded an average turnover of €18,163,978.21 and a median of €432,576.49. Skewness (5.172) and kurtosis (32.861) remained significant but were markedly lower than in Group 0, reinforcing the observation of more consistent performance among public contractors.

When analysing Return on Assets (r\_Turnover\_TotalAssets), Group 0 firms had a mean of 0.8360 and a median of 0.4995, again demonstrating substantial skewness (14.296) and kurtosis (497.951). This underscores the prevalence of extreme profitability outliers among firms without public contracts. Group 1 firms presented a slightly higher mean of 1.2535 and a median of 0.9649, with skewness (3.474) and kurtosis (19.152) also indicating deviations

from normality, though less severe than in Group 0. These results suggest that public contracts may be associated with somewhat more stable profitability levels.

Finally, for Return on Equity (ROE\_num), Group 0 exhibited a mean of 27.4489 and a median of 17.4310, with skewness close to zero (0.067) but very high kurtosis (48.833), indicating a peaky distribution with occasional extreme values. Group 1 firms showed a similar mean of 26.3237 and a slightly higher median of 20.0485, with negative skewness (-2.524) and kurtosis of 28.003. Both groups therefore displayed substantial departures from normality in ROE, reinforcing the appropriateness of non-parametric methods for subsequent statistical testing.

Overall, these descriptive insights confirm that firms with public contracts are not only larger on average but also tend to have less extreme variability in financial indicators compared to firms without such contracts.

Although firms with public contracts exhibit higher total assets and turnover, their Z-Scores are often lower. This reflects the fact that the Z-Score integrates multiple financial dimensions, including liquidity and profitability, which may be negatively affected by structural characteristics of public procurement, such as lower margins, longer payment cycles, and higher leverage. As a result, size alone does not necessarily translate into better overall financial stability as measured by composite risk indicators.

## 4.2 REGRESSION ANALYSIS

To investigate whether participation in public procurement as providers of goods or services influences firms' financial risk and performance, a linear regression model was estimated using the winsorized Z-Score (ZScore\_Winsor) as the dependent variable. This indicator captures firms' financial health while reducing the impact of extreme outliers (winsorization) was applied at the 5th and 95th percentiles for each year in the dataset (2021–2023).

The main independent variable is Firm\_PublicContracts\_d, a binary indicator equal to 1 if the firm received at least one public contract between 2022 and 2024, and 0 otherwise.

- *How public procurement participation relates to firm's financial health?*

Control variables included:

- proxies for firm size (Total Assets, Shareholders' Funds, Number of Employees),

- profitability indicators (ROAA, ROE, Profit Margin),
- liquidity and solvency measures (Current Ratio, Solvency Ratio),
- operational efficiency (Turnover to Total Assets ratio),
- and sectoral classification (NACE Rev.2 codes at 4 digits).

The regression equation estimated is expressed as follows:

$$\text{ZScore\_Winsor} = \alpha + \beta_1(\text{Firm\_PublicContracts\_d}) + \beta_2(\text{Total Assets}) + \beta_3(\text{Shareholders' Funds}) + \beta_4(\text{Number of Employees}) + \beta_5(\text{ROAA}) + \beta_6(\text{ROE}) + \beta_7(\text{Profit Margin}) + \beta_8(\text{Current Ratio}) + \beta_9(\text{Solvency Ratio}) + \beta_{10}(\text{Turnover/Total Assets}) + \beta_{11}(\text{NACE Sector}) + \epsilon$$

To make the results more reliable and include additional financial indicators as recommended, an expanded linear regression model was estimated. This procedure aimed to test whether the previously observed relationship between public contract participation and financial stability remained significant once detailed firm characteristics were controlled for.

The model summary is presented in Table 22, which reports the R<sup>2</sup> and the standard error of the estimate. The adjusted R<sup>2</sup> reached 13.9%, indicating that the model explains a meaningful proportion of the variability in firms' financial health.

Table 22 - Model Summary

<b>Model Summary</b>				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,404 <sup>a</sup>	,163	,139	25,74407

a. Predictors: (Constant),  
 r\_Turnover\_TotalAssets=Turnover/Total\_Assets,  
 Numberofemployees, Firm\_PublicContracts\_d, ROAA,  
 Current\_Ratio\_num, NACERev.2corecode4digits,  
 ROE\_num, Shareholdersfunds\_EUR, Solvency\_Ratio\_num,  
 Profit\_margin\_num, TotalassetsEUR

The ANOVA table (Table 23) confirms that the set of predictors is statistically significant (F = 6.869; p < 0.001), indicating that these combined factors meaningfully explain variation in the Z-Score. It reflects whether adding these variables genuinely helps us understand the data better. Since the F value is high and the p-value is well below 0.001, it's very unlikely this result happened by chance. This strongly suggests that the combination of factors in the model plays a real role in explaining variation in the Z-Score.

Table 23 - ANOVA TABLE

ANOVA <sup>a</sup>						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	50076,121	11	4552,375	6,869	<,001 <sup>b</sup>
	Residual	257149,687	388	662,757		
	Total	307225,807	399			

a. Dependent Variable: ZScore\_Winsor

b. Predictors: (Constant), r\_Turnover\_TotalAssets=Turnover/Total\_Assets, Numberofemployees, Firm\_PublicContracts\_d, ROAA, Current\_Ratio\_num, NACERev.2corecode4digits, ROE\_num, Shareholdersfunds\_EUR, Solvency\_Ratio\_num, Profit\_margin\_num, TotalassetsEUR

Looking at the coefficients (Table 24), the main findings are:

- The coefficient for Firm\_PublicContracts\_d remained negative (-22.732), suggesting a tendency toward lower Z-Scores among firms holding public contracts. However, this effect was not statistically significant ( $p = 0.383$ ) once all other variables were controlled for.
- The sector variable (NACERev.2corecode4digits) emerged as the strongest predictor ( $p < 0.001$ ), highlighting that sectoral characteristics have a strong influence over financial stability.
- Some liquidity and profitability indicators approached significance, namely Current Ratio ( $p = 0.055$ ) and ROAA ( $p = 0.084$ ), suggesting potential relevance worth exploring in further analyses.
- The remaining variables—including Total Assets, Shareholders' Funds, Number of Employees, ROE, Profit Margin, Solvency Ratio, and r\_Turnover\_TotalAssets—did not show statistically significant coefficients in this extended model.

Table 24 - Coefficients and Collinearity Diagnostics of the Regression Model

		Coefficients <sup>a</sup>								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	66,243	26,820		2,470	,014	13,512	118,975		
	Firm_PublicContracts_d	-22,732	26,047	-,041	-,873	,383	-73,944	28,480	,979	1,021
	Numberofemployees	5,127E-5	,003	,001	,015	,988	-,007	,007	,513	1,949
	TotalassetsEUR	-5,280E-8	,000	-,120	-,908	,365	,000	,000	,123	8,161
	Shareholdersfunds_EUR	1,006E-7	,000	,123	,998	,319	,000	,000	,142	7,023
	NACERev.2corecode4digits	-,003	,001	-,295	-5,301	<,001	-,005	-,002	,695	1,439
	ROAA	-11,352	6,555	-,103	-1,732	,084	-24,240	1,536	,605	1,652
	ROE_num	-,009	,028	-,020	-,335	,737	-,065	,046	,619	1,616
	Profit_margin_num	,080	,100	,055	,802	,423	-,117	,277	,457	2,190
	Current_Ratio_num	,286	,148	,105	1,927	,055	-,006	,578	,724	1,381
	Solvency_Ratio_num	,100	,063	,100	1,591	,112	-,024	,223	,544	1,838
	r_Turnover_TotalAssets=Turnover/Total_Assets	-2,268	1,273	-,090	-1,781	,076	-4,772	,236	,853	1,173

a. Dependent Variable: ZScore\_Winsor

The collinearity statistics (Table 24) and variance proportions diagnostics (Table 25) indicate that while some VIFs are higher among size-related variables (TotalassetsEUR, Shareholdersfunds\_EUR), no severe multicollinearity issues were detected that would invalidate the model. Nevertheless, caution is advisable when interpreting these predictors jointly, given their natural intercorrelation.

The Variance Inflation Factor (VIF) is used to check whether predictors are too closely related to each other. It indicates how much multicollinearity increases the uncertainty of the coefficient estimates. Higher VIFs mean more collinearity. In this case, while some VIFs were higher, they did not exceed the levels usually seen as a serious issue.

Table 25 - Collinearity Diagnostics and Variance Proportions

		Collinearity Diagnostics <sup>a</sup>														
Model	Dimension	Eigenvalue	Condition Index	Variance Proportions												
				(Constant)	Firm_PublicContracts_d	Numberofemployees	TotalassetsEUR	Shareholdersfunds_EUR	NACERev.2corecode4digits	ROAA	ROE_num	Profit_margin_num	Current_Ratio_num	Solvency_Ratio_num	r_Turnover_TotalAssets=Turnover/Total_Assets	
1	1	5,951	1,000	,00	,00	,00	,00	,00	,00	,00	,01	,00	,00	,01	,00	,01
	2	2,177	1,653	,00	,00	,05	,02	,02	,00	,01	,01	,00	,00	,00	,00	,00
	3	1,207	2,220	,00	,00	,01	,00	,01	,00	,07	,10	,04	,01	,00	,00	,03
	4	,784	2,755	,00	,00	,00	,00	,00	,00	,01	,06	,01	,43	,01	,07	,07
	5	,653	3,018	,00	,00	,38	,00	,03	,00	,13	,04	,03	,00	,00	,01	,01
	6	,468	3,565	,00	,00	,15	,00	,01	,00	,15	,49	,00	,16	,01	,02	,02
	7	,343	4,165	,00	,00	,00	,00	,00	,01	,39	,01	,15	,18	,00	,31	,31
	8	,205	5,386	,00	,00	,00	,00	,01	,01	,18	,15	,64	,01	,00	,52	,52
	9	,113	7,264	,00	,00	,16	,12	,04	,05	,03	,13	,11	,14	,63	,00	,00
	10	,056	10,294	,00	,00	,23	,84	,77	,00	,01	,00	,00	,06	,32	,03	,03
	11	,041	12,085	,01	,01	,00	,01	,12	,92	,01	,00	,01	,01	,02	,00	,00
	12	,001	70,396	,99	,99	,00	,00	,00	,01	,00	,00	,01	,00	,01	,00	,00

a. Dependent Variable: ZScore\_Winsor

In substantive terms, these results suggest that public contract participation does not exhibit a statistically robust effect on the Z-Score when controlling for other financial and sectoral factors. This conclusion does not mean that there is no relationship at all. It simply shows that when factors like sector of activity, liquidity, and operational profitability are taken into account, being a public supplier carries less weight in explaining financial outcomes.

This pattern is consistent with previous evidence indicating that firms’ structural factors, not only their status as public contractors, are the main determinants of financial risk. Still, it is important to note that the persistently negative coefficient may reflect an underlying trend, which could be further investigated through more rigorous causal methods or sub-sample analyses.

**Regression Analysis Using ZScoreVE\_Winsor as Dependent Variable**

To complement the previous regression using the ZScore\_Winsor indicator, an additional linear regression model was estimated adopting the alternative version of the Z-Score (ZScoreVE\_Winsor) as the dependent variable. This specification was implemented to ensure the robustness of the results and to verify whether the observed relationships persisted when using an alternative financial resilience metric.

The model included the same set of independent variables and controls: firm size indicators (Total Assets, Shareholders’ Funds, Number of Employees), profitability ratios (ROAA, ROE, Profit Margin), solvency measures (Current Ratio, Solvency Ratio), the efficiency indicator (Return on Assets over Total Assets), and sectoral fixed effects (NACE Rev.2 four-digit codes). The main independent variable of interest remained the binary variable Firm\_PublicContracts\_d, indicating whether a company had received at least one public procurement contract during the observation period.

The overall model fit was moderate, with an adjusted R<sup>2</sup> of 0.113 and an F-statistic significant at p < 0.001, suggesting that the explanatory variables collectively accounted for approximately 11% of the variance in the ZScoreVE\_Winsor indicator.

Table 26 - Model Summary (Alternative Z-Score Specification)

<b>Model Summary</b>				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,371 <sup>a</sup>	,137	,113	4,98171

a. Predictors: (Constant), r\_Turnover\_TotalAssets=Turnover/Total\_Assets, Numberofemployees, Firm\_PublicContracts\_d, ROAA, Current\_Ratio\_num, NACERev.2corecode4digits, ROE\_num, Shareholdersfunds\_EUR, Solvency\_Ratio\_num, Profit\_margin\_num, TotalassetsEUR

Regarding the primary variable of interest, the coefficient associated with Firm\_PublicContracts\_d was negative (B = -5.052) but not statistically significant (p = 0.317). This indicates that, after controlling for size, profitability, and sector, there is no evidence that firms with public contracts systematically present higher or lower financial resilience compared to those without contracts, when measured via this alternative formulation of the Z-Score.

Table 27 - Coefficients of the Regression Model (Alternative Z-Score Specification)

Model	Coefficients <sup>a</sup>									
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Collinearity Statistics		
	B	Std. Error				Beta	Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	13,874	5,190		2,673	,008	3,670	24,078		
	Firm_PublicContracts_d	-5,052	5,040	-,048	-1,002	,317	-14,962	4,858	,979	1,021
	Numberofemployees	,001	,001	,102	1,548	,122	,000	,002	,513	1,949
	TotalassetsEUR	-1,228E-8	,000	-,147	-1,091	,276	,000	,000	,123	8,161
	Shareholdersfunds_EUR	3,409E-8	,000	,218	1,749	,081	,000	,000	,142	7,023
	NACERev.2corecode4digits	-,001	,000	-,268	-4,746	<,001	-,001	,000	,695	1,439
	ROAA	1,382	1,268	,066	1,090	,276	-1,111	3,876	,605	1,652
	ROE_num	-,001	,005	-,012	-,193	,847	-,012	,010	,619	1,616
	Profit_margin_num	,026	,019	,095	1,361	,174	-,012	,065	,457	2,190
	Current_Ratio_num	-,008	,029	-,015	-,270	,787	-,064	,049	,724	1,381
	Solvency_Ratio_num	-,003	,012	-,014	-,221	,826	-,027	,021	,544	1,838
	r_Turnover_TotalAssets=Turnover/Total_Assets	-,126	,246	-,026	-,511	,610	-,610	,359	,853	1,173

a. Dependent Variable: ZScoreVE\_Winsor

Among the control variables, sector classification (NACERev.2corecode4digits) remained statistically significant (p < 0.001), confirming that industry-specific characteristics continue to be a relevant determinant of firms’ financial health. Other variables, such as Shareholders’ Funds (p = 0.081) and Number of Employees (p = 0.122) came close to typical significance levels, suggesting some marginal predictive power.

Overall, the absence of a significant coefficient for public contracting in this specification reinforces the idea that the differences in financial stability between firms are largely attributable to sectoral and structural features rather than to public procurement participation per se.

Collinearity diagnostics showed acceptable Variance Inflation Factors (VIFs), with all values below 10, indicating that multicollinearity was not a critical concern in the estimation. The condition index also remained within reasonable limits, supporting the reliability of coefficient estimates.

Table 28 - ANOVA Table of the Regression Model (Alternative Z-Score Specification)

ANOVA <sup>a</sup>						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1533,554	11	139,414	5,618	<,001 <sup>b</sup>
	Residual	9629,155	388	24,817		
	Total	11162,709	399			

a. Dependent Variable: ZScoreVE\_Winsor

b. Predictors: (Constant), r\_Turnover\_TotalAssets=Turnover/Total\_Assets, Numberofemployees, Firm\_PublicContracts\_d, ROAA, Current\_Ratio\_num, NACERev.2corecode4digits, ROE\_num, Shareholdersfunds\_EUR, Solvency\_Ratio\_num, Profit\_margin\_num, TotalassetsEUR

Table 29 - Collinearity Diagnostics of the Regression Model (ZScoreVE\_Winsor)

Model	Dimension	Eigenvalue	Condition Index	(Constant)	Firm_PublicContracts_d	Numberofemployees	TotalassetsEUR	Shareholdersfunds_EUR	Variance Proportions						r_Turnover_TotalAssets=Turnover/Total_Assets
									NACERev.2corecode4digits	ROAA	ROE_num	Profit_margin_num	Current_Ratio_num	Solvency_Ratio_num	
1	1	5,951	1,000	,00	,00	,00	,00	,00	,00	,01	,00	,00	,01	,00	,01
	2	2,177	1,653	,00	,00	,05	,02	,02	,00	,01	,01	,00	,00	,00	,00
	3	1,207	2,220	,00	,00	,01	,00	,01	,00	,07	,10	,04	,01	,00	,03
	4	,784	2,755	,00	,00	,00	,00	,00	,00	,01	,06	,01	,43	,01	,07
	5	,653	3,018	,00	,00	,38	,00	,03	,00	,13	,04	,03	,00	,00	,01
	6	,468	3,565	,00	,00	,15	,00	,01	,00	,15	,49	,00	,16	,01	,02
	7	,343	4,165	,00	,00	,00	,00	,00	,01	,39	,01	,15	,18	,00	,31
	8	,205	5,386	,00	,00	,00	,00	,01	,01	,18	,15	,64	,01	,00	,52
	9	,113	7,264	,00	,00	,16	,12	,04	,05	,03	,13	,11	,14	,63	,00
	10	,056	10,294	,00	,00	,23	,84	,77	,00	,01	,00	,00	,06	,32	,03
	11	,041	12,085	,01	,01	,00	,01	,12	,92	,01	,00	,01	,01	,02	,00
	12	,001	70,396	,99	,99	,00	,00	,00	,01	,00	,00	,01	,00	,01	,00

a. Dependent Variable: ZScoreVE\_Winsor

In sum, this additional regression using the ZScoreVE\_Winsor indicator corroborates the findings of the primary model. While firms with public contracts are often larger in size and more exposed to operational complexity, these attributes alone do not systematically translate into higher or lower financial resilience as measured by Z-Score metrics once other relevant variables are accounted for.

The table below (Table 30) compares the results obtained using the Z-Score and the adjusted Z-Score (ZScoreVE), showing that the main findings are consistent across both models.

Table 30 - Comparative Summary of Regression Models Using ZScore\_Winsor and ZScoreVE\_Winsor as Dependent Variables

<i>Statistic / Variable</i>	<i>Model 1ZScore_Winsor</i>	<i>Model 2ZScoreVE_Winsor</i>
<b>Adjusted R Square</b>	0.139	0.113
<b>F-statistic (p-value)</b>	6.869 ( <i>p &lt; 0.001</i> )	5.618 ( <i>p &lt; 0.001</i> )
<b>Coefficient (B)</b> <i>Firm_PublicContracts_d</i>	-22.732	-5.052
<b>Significance</b> <i>Firm_PublicContracts_d</i>	p = 0.383 ( <i>Not significant</i> )	p = 0.317 ( <i>Not significant</i> )
<b>Sector Variable (NACE)</b> <b>Significance</b>	p < 0.001 ( <i>Significant</i> )	p < 0.001 ( <i>Significant</i> )
<b>Highest VIF Observed</b>	8.161 ( <i>Total Assets</i> )	8.161 ( <i>Total Assets</i> )
<b>Interpretation</b>	No significant effect of public contracts; sector variables remain the strongest predictors.	No significant effect of public contracts; similar pattern confirmed.
<b>Dependent Variable</b>	ZScore_Winsor	ZScoreVE_Winsor

### Complementary Logistic Regression Analysis

In order to broaden the analytical perspective, an additional logistic regression model was estimated. While the linear regressions presented in the previous sections focused on understanding how public procurement participation relates to financial health (proxied by the Z-Score and ZScoreVE), the logistic regression addresses a complementary question:

- *Which financial and structural variables are most predictive of a firm's likelihood of holding public contracts?*

This two-model approach offers a clearer view of how financial factors connect with public procurement activity. The logistic model focuses on whether a firm's financial situation in the previous year can help predict its involvement in public contracting the following year.

By examining the significance and relative weight of variables such as Return on Assets (ROA), Return on Equity (ROE), Profit Margin, Current Ratio, Solvency Ratio, and firms' Size (as measured by the logarithm of total assets), this analysis provides insight into the structural profiles of participants in public tenders. This is particularly relevant in the context of credit

risk assessment, as it helps to clarify whether more solvent and profitable firms are systematically more likely to secure public contracts, or whether these engagements are distributed independently of financial performance.

Table 31 shows the results of the analysis. The model includes key financial indicators such as firm size (measured by the log of Total Assets), profitability (ROA, ROE, and Profit Margin), liquidity (Current Ratio), and solvency (Solvency Ratio).

Table 31 - Logistic Regression Coefficients and Odds Ratios (Variables in the Equation)

		Variables in the Equation					95% C.I. for EXP(B)		
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1 <sup>a</sup>	ROA=PLforperiod_Netincome / TotalassetsEUR	1,102	,217	25,722	1	<,001	3,011	1,966	4,609
	ROE=ROE_num/100	,150	,083	3,278	1	,070	1,162	,988	1,366
	Profit_Margin=Profit_margin_num/100	-1,235	,210	34,452	1	<,001	,291	,193	,439
	Current_Ratio=Current_Ratio_num / 100	-,801	,411	3,799	1	,051	,449	,201	1,004
	Solvability=Solvency_Ratio_num/100	-1,823	,201	82,551	1	<,001	,162	,109	,239
	In_Total_Assets=ln(TotalassetsEUR)	,524	,028	358,359	1	<,001	1,690	1,600	1,784
	Constant	-7,720	,378	416,846	1	<,001	,000		

a. Variable(s) entered on step 1: ROA=PLforperiod\_Netincome / TotalassetsEUR, ROE=ROE\_num/100, Profit\_Margin=Profit\_margin\_num/100, Current\_Ratio=Current\_Ratio\_num / 100, Solvability=Solvency\_Ratio\_num/100, In\_Total\_Assets=ln(TotalassetsEUR).

The logistic regression results offer a detailed perspective on how firms’ financial characteristics are associated with the likelihood of participating in public procurement. As shown in Table 31, several variables show statistically significant relationships, whose signs and magnitudes provide relevant insights when contrasted with theoretical expectations and prior research.

Starting with firm size, measured by the natural logarithm of total assets, the model reveals a strong positive and highly significant coefficient (B = 0.524; p < 0.001). This means that, holding all other factors constant, a one-unit increase in log-assets raises the odds of obtaining a public contract by approximately 69% (Exp (B) = 1.690). This result is consistent with the findings of Karjalainen (2011) and Piga and Thai (2007), who emphasize that scale allows firms to better absorb the administrative and financial requirements of public procurement, such as compliance costs and extended payment cycles.

In the case of Return on Assets (ROA), our results are clear: we observe a positive and highly significant effect. Statistical analysis shows a coefficient of B = 1.102, with a p < 0.001 value, which confirms the relevance of this indicator. More specifically, an odds ratio of 3.011 reveals that, for every unit increase in ROA, the probability of a company being awarded public contracts increases by approximately 201%.

This result can be interpreted as a direct reflection of how ROA is perceived in the market. This indicator is widely recognized for its ability to measure the effectiveness of a company's management in utilizing its resources, that is how well it manages to transform its assets into results and profits.

Although the Public Contracts Code doesn't explicitly mention ROA, it grants contracting entities the autonomy to assess the financial and organizational capacity of companies during the qualification phase. This assessment aims precisely to mitigate the risk of contractual non-compliance. The concern with financial soundness is, moreover, a point consistently highlighted by the Court of Accounts, which emphasizes its importance for the proper execution of contracts.

Therefore, the positive association between ROA and success in public contract awards can be seen as a validation of the importance that public entities attribute to the efficiency and financial robustness of suppliers. It's a clear sign that companies with better performance in managing their assets are perceived as more reliable partners, capable of ensuring the fulfillment of commitments made.

The table also shows that Return on Equity (ROE) presents a positive coefficient ( $B = 0.150$ ), although only marginally significant ( $p = 0.070$ ). The odds ratio of 1.162 indicates that for each unit increase in ROE, the likelihood of a company engaging in public procurement increases by approximately 16%. It is worth noting that, although ROE is a widely used measure of shareholder profitability, it can be significantly affected by capital structure decisions particularly financial leverage. Al-Zoubi and Al-Hajaya (2022) demonstrate that high levels of debt can artificially inflate ROE by reducing the equity base, without corresponding improvements in operational performance. Therefore, the positive relationship observed between ROE and public procurement engagement may reflect, at least in part, financing strategies rather than actual efficiency.

A variable that allows for an interesting interpretation of the result is the Profit Margin, which shows a statistically significant negative association with the probability of public procurement ( $B = -1.235$ ;  $p < 0.001$ ), with an odds ratio of 0.291. This means that for each additional unit of Profit Margin, the probability of a company engaging in public procurement decreases by approximately 71%  $(1 - 0.291) \times 100$ . This interpretation of the odds ratio is consistent with the existing literature on public procurement, which indicates that public contracts tend to involve price pressure and reduced margins, due to the strong competition in public tenders and the significant purchasing power of the State.

As noted by Albano and Sparro (2010), the centralisation of public procurement reinforces the State's bargaining power, leading suppliers to offer lower prices in order to secure the contract. Thus, it is plausible that companies more oriented towards public clients accept lower levels of profitability in exchange for higher business volumes and the stability associated with supplying the public sector.

The Current Ratio, an indicator of liquidity, has a negative and marginally significant coefficient ( $B = -0.801$ ;  $p = 0.051$ ), with an odds ratio of 0.449. This suggests that higher liquidity reduces the odds of holding a public contract by roughly 55% ( $1 - 0.449$ ). While this appears counterintuitive, it can be interpreted as an indication that less liquid firms may be more inclined to pursue public procurement to stabilize cash flows through predictable revenues, even if payments are delayed. Similar dynamics are discussed by Karjalainen (2011), who notes that liquidity constraints often motivate firms to seek contractual relationships with public institutions.

Finally, the Solvency Ratio demonstrates a strong and negative relationship ( $B = -1.823$ ;  $p < 0.001$ ). The odds ratio of 0.162 implies that a one-unit increase in solvency reduces the odds of public contract participation by about 84%. This unexpected result may be explained by the tendency of highly solvent firms to diversify their client base and rely less on public sector contracts, preferring flexibility, and higher margin opportunities in the private market. Moreover, firms with weaker solvency may view public procurement as an accessible and stable revenue source despite potentially lower margins.

Taken together, these findings reflect the nuanced and sometimes paradoxical effects of financial structure on public procurement engagement. While profitability (ROA) and scale strongly enhance the probability of obtaining contracts—confirming theoretical expectations—other indicators such as solvency and liquidity reveal that firms with constrained financial profiles may deliberately seek the stability of public clients, even at the cost of profitability or flexibility.

These insights contribute to a richer understanding of the mechanisms at play in public procurement markets and align with the broader literature that portrays public contracts as both an opportunity and a constraint, depending on the firm's strategic positioning. By integrating credit risk metrics such as the Z-Score framework into this analysis, this research helps bridge the gap between traditional insolvency prediction and the study of public procurement participation—a methodological contribution rarely explored in the Portuguese context.

In addition, the logistic regression results allow a more precise understanding of model fit and predictive power. For example, the Hosmer and Lemeshow test did not reject the null hypothesis of good fit ( $p > 0.05$ ), indicating that the model's predicted probabilities align closely with observed outcomes across deciles of risk.

Table 32 - Hosmer and Lemeshow Goodness-of-Fit Test

<b>Hosmer and Lemeshow Test</b>			
Step	Chi-square	df	Sig.
1	13,545	8	,094

Table 33 - Hosmer and Lemeshow Test Contingency Table

<b>Contingency Table for Hosmer and Lemeshow Test</b>						
		Firm_PublicContracts_d = ,00		Firm_PublicContracts_d = 1,00		Total
		Observed	Expected	Observed	Expected	
Step 1	1	634	635,300	7	5,700	641
	2	626	630,567	15	10,433	641
	3	624	627,401	17	13,599	641
	4	618	624,170	23	16,830	641
	5	618	620,252	23	20,748	641
	6	607	615,219	34	25,781	641
	7	612	607,906	29	33,094	641
	8	606	594,629	35	46,371	641
	9	575	564,981	66	76,019	641
	10	428	427,576	210	210,424	638

The pseudo-R<sup>2</sup> measures, including Cox & Snell R Square and Nagelkerke R Square, reported values of approximately 10% and 24.7%, respectively. Although these values are modest compared to linear models, they are common in logistic regression settings, especially in models predicting rare events or binary outcomes, and suggest that the included variables contribute meaningfully to explaining the likelihood of public contracting.

Table 34 - Logistic Regression Model Summary (Pseudo-R<sup>2</sup> Measures)

<b>Model Summary</b>			
Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	2631,504 <sup>a</sup>	,100	,247

a. Estimation terminated at iteration number 7 because parameter estimates changed by less than ,001.

The classification table showed an overall correct classification rate of 94%, highlighting the model’s capacity to identify firms without public contracts correctly. However, it is important to note that this high accuracy partly reflects the underlying distribution of the dependent variable, with many firms not holding contracts.

Table 35 - Logistic Regression Classification Table

**Classification Table<sup>a</sup>**

Observed		Predicted		Percentage Correct
		Firm_PublicContracts_d ,00	1,00	
Step 1	Firm_PublicContracts_d ,00	5928	20	99,7
	1,00	367	92	20,0
Overall Percentage				94,0

a. The cut value is ,500

Altogether, the logistic regression model confirms that firm size and profitability are relevant predictors of public contract participation, while liquidity and solvency indicators tend to be inversely related to this likelihood. These findings highlight that larger companies with higher asset returns, but potentially more moderate liquidity and solvency, are more frequently involved in public procurement. This pattern underscores the strategic relevance of public contracts as a revenue stabilizing mechanism, particularly for firms that combine scale with active market engagement.

The analysis contributes to a more comprehensive understanding of the financial profiles that characterize firms engaged in public contracting. In conjunction with the linear regressions, these results offer a robust empirical foundation to inform both academic research and policy discussions on the financial dynamics of public procurement.

An additional evaluation of the model's predictive capacity was performed using the Receiver Operating Characteristic (ROC) curve analysis. After estimating the logistic regression, a new variable (PRE\_2) was generated to capture the predicted probabilities that each observation belonged to the positive class, that is, firms with public procurement engagements. This predicted probability variable was then employed as the test variable in the ROC procedure, which provides a graphical and numerical assessment of the model's discriminative ability.

The ROC curve plots sensitivity (true positive rate) against 1 - specificity (false positive rate), illustrating how effectively the model differentiates between companies that do and do not hold public contracts across all possible classification thresholds. Table 36 presents the case processing summary and shows that 6,407 observations were included in the analysis, out of which 459 were positive cases and 5,948 were negative cases.

Table 36 - Case Processing Summary of the Dependent Variable

<b>Case Processing Summary</b>	
Firm_PublicContracts_d	Valid N (listwise)
Positive <sup>a</sup>	459
Negative	5948
Missing	8075
<b>Total</b>	<b>14482</b>

Larger values of the test result variable(s) indicate stronger evidence for a positive actual state.

a. The positive actual state is 1,00.

The ROC graph visualizes the performance of the model (blue curve) relative to a purely random classifier (diagonal reference line). The closer the blue curve approaches the upper left corner of the plot, the better the model's predictive accuracy.

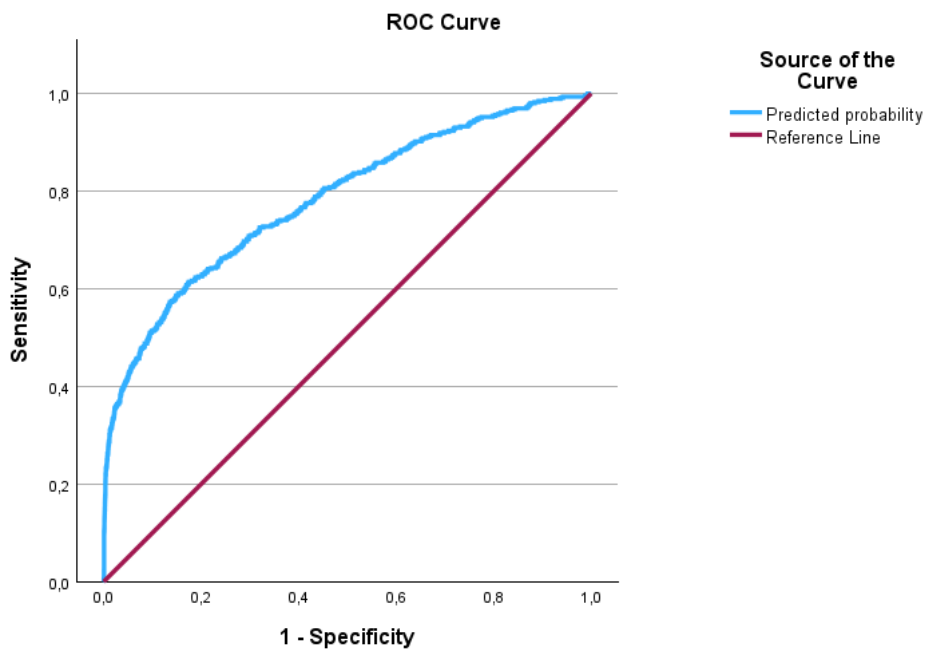


Figure 1 - ROC Curve for Logistic Regression Model

The area under the curve (AUC) was estimated at 0.782, as reported in the output table.

Table 37 - Area Under the ROC Curve (AUC) for the Logistic Regression Model

<b>Area Under the ROC Curve</b>	
Test Result Variable(s): Pr	
Area	
	,782
The test result variable (s): Predicted probability has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.	

This result indicates that if one were to randomly select a firm with public contracts and a firm without them, there would be approximately a 78.2% chance that the model would assign a higher predicted probability to the firm that holds public contracts. This level of AUC is generally interpreted as acceptable to good, suggesting that the model is reasonably capable of distinguishing between firms that engage in public procurement and those that do not.

This complementary analysis helps to synthesize the predictive power of the model beyond simply examining logistic regression coefficients or classification tables. It also provides an intuitive metric for evaluating the model’s robustness when applied to unseen cases or varying decision thresholds. Importantly, the predicted probability variable (PRE\_2) not only enables this ROC assessment but could also serve as a basis for further scoring or segmenting firms by their likelihood of contracting with public entities. These scoring estimations provide useful insights to credit risk management.

Overall, this approach reinforces the interpretation of the logistic regression, demonstrating that key predictors such as firm size, profitability, and solvency do not merely show statistically significant associations with public contract participation but also contribute meaningfully to the model’s ability to discriminate between firms that participate and those that do not.

### 4.3 INDEPENDENT SAMPLES T-TEST RESULTS

To complement the regression models and deepen the understanding of potential differences in financial health and performance between firms with and without public contracts, independent samples t-tests were conducted. This approach allows a direct comparison of means across the two groups, providing insight into whether participation in public procurement is associated with systematic differences in key indicators.

Table 38 reports descriptive statistics for each variable, displaying the mean, standard deviation, and standard error for firms with and without public contracts. As can be seen, firms that participate in public procurement tend to have a noticeably lower average Z-Score (Z-

Score and Z-ScoreVE with mean = 22.51 and 4.99, respectively) compared to non-public contracting firms (Z-Score and Z-ScoreVE with mean = 41.90 and 7.51, respectively), suggesting a potentially weaker health situation.

Table 38 - Descriptive statistics – Z-Score and financial indicators by public procurement status (non-public contracting firms and public contracting firms)

<b>Group Statistics</b>					
	Firm_PublicContracts_d	N	Mean	Std. Deviation	Std. Error Mean
Solvability=Solvency_Ratio_num/100	,00	11006	,6145	,39371	,00375
	1,00	492	,5038	,33772	,01523
ZScore_Winsor	,00	13980	41,9008	43,89027	,37121
	1,00	502	22,5063	31,86280	1,42211
ZScoreVE_Winsor	,00	13980	7,5108	7,77243	,06574
	1,00	502	4,9882	5,84397	,26083
ln_Total_Assets=ln(TotalassetsEUR)	,00	11469	11,5139	1,96427	,01834
	1,00	501	13,4514	2,68811	,12010
ROA=PLforperiod_Netincome / TotalassetsEUR	,00	11414	-1,28845	62,611107	,586047
	1,00	501	,09153	,513441	,022939
ROE=ROE_num/100	,00	10169	,1914	,72793	,00722
	1,00	473	,2617	,56437	,02595
Profit_Margin=Profit_margin_num/100	,00	9832	,2275	,33002	,00333
	1,00	489	,1438	,22116	,01000
Current_Ratio=Current_Ratio_num / 100	,00	9879	,1237	,18613	,00187
	1,00	487	,0673	,12202	,00553

To formally assess whether these differences are statistically significant in case of variables calculated for two or more groups, we applied both Levene's test and t-tests for equality of means (which assume equal variances). Levene's test is a precursor to t-tests, helping determine if the assumption of equal variances, i.e. homogeneity of variance, is met before conducting t-tests (helps determine if those t-tests are appropriate for this data). For t-test we use independent samples t-test (that is, two groups being compared and being independent). Table 39 summarizes these results.

Table 39 - Independent Samples Test: Levene’s test for equality of variances and T-Tests for equality of means

		Independent Samples Test										
		Levene's Test for Equality of Variances				t-Test for Equality of Means						
		F	Sig.	t	df	Significance		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		
						One-Sided p	Two-Sided p			Lower	Upper	
Solvability=Solvency_Ratio_num/100	Equal variances assumed	20,579	<.001	6,140	11496	<.001	<.001	,11077	,01804	,07541	,14613	
	Equal variances not assumed			7,064	552,379	<.001	<.001	,11077	,01568	,07996	,14157	
ZScore_Winsor	Equal variances assumed	423,970	<.001	9,808	14480	<.001	<.001	19,39444	1,97740	15,51848	23,27039	
	Equal variances not assumed			13,196	571,501	<.001	<.001	19,39444	1,46975	16,50766	22,28122	
ZScoreVE_Winsor	Equal variances assumed	349,229	<.001	7,199	14480	<.001	<.001	2,52254	,35041	1,83570	3,20939	
	Equal variances not assumed			9,378	566,584	<.001	<.001	2,52254	,26899	1,99421	3,05087	
ln_Total_Assets=ln(TotalassetsEUR)	Equal variances assumed	145,311	<.001	-21,228	11968	<.001	<.001	-1,93754	,09127	-2,11645	-1,75863	
	Equal variances not assumed			-15,948	523,585	<.001	<.001	-1,93754	,12149	-2,17621	-1,69888	
ROA=PLforperiod_Netincome / TotalassetsEUR	Equal variances assumed	,816	,366	-.493	11913	,311	,622	-1,379985	2,797374	-6,863295	4,103325	
	Equal variances not assumed			-2,353	11447,384	,009	,019	-1,379985	,586496	-2,529618	-.230353	
ROE=ROE_num/100	Equal variances assumed	1,020	,313	-2,072	10640	,019	,038	-.07030	,03394	-.13682	-.00378	
	Equal variances not assumed			-2,610	547,722	,005	,009	-.07030	,02694	-.12321	-.01739	
Profit_Margin=Profit_margin_num/100	Equal variances assumed	107,492	<.001	5,544	10319	<.001	<.001	,08366	,01509	,05408	,11324	
	Equal variances not assumed			7,937	601,706	<.001	<.001	,08366	,01054	,06296	,10436	
Current_Ratio=Current_Ratio_num / 100	Equal variances assumed	86,201	<.001	6,615	10364	<.001	<.001	,05638	,00852	,03967	,07309	
	Equal variances not assumed			9,658	603,494	<.001	<.001	,05638	,00584	,04491	,06785	

If the p-value from Levene’s test is below a chosen significance level (usually 0.05), it suggests that the variances are not equal, and the assumption of equal variances is violated. In the table, this corresponds to the “Sig.” column under “Levene’s Test for Equality of Variances.” For example, ROA shows a Levene’s p-value of 0.366 and ROE shows 0.313, both above 0.05, indicating that the variances are roughly equal, and the assumption of homogeneity of variance is met. Therefore, for these variables, the row “Equal variances assumed” of the t-test is used.

On the contrary, the remaining variables show significant Levene’s test ( $p < 0.05$ ), visible in the same “Sig.” column, indicating unequal variances, and suggesting the need for alternative statistical approaches such as Welch’s t-test (using the row “Equal variances not assumed”) or transformations of the data.

The independent samples t-test shows the following: for ROA, the p-value for the difference in means is 0.311 (from the “Sig. (2-tailed)” column in the “Equal variances assumed” row), which is above 0.05. Therefore, the observed difference between the means of the two groups (with public contracts and without public contracts) is likely due to random chance and not a true population difference. This means the null hypothesis (that the means are equal) cannot be rejected, not providing enough evidence to say that the groups are different. Conversely, for ROE, the p-value is 0.038 (also in the “Equal variances assumed” row), below 0.05. Therefore, the null hypothesis is rejected, indicating a statistically significant difference between the means of the two groups of firms.

For the remaining variables (Z-Score, Z-ScoreVE, solvency ratio, liquidity ratio, firm size), Levene’s test indicated unequal variances ( $p < 0.05$ ), and therefore Welch’s t-test was applied (“Equal variances not assumed” row). The analysis compares firms participating in public

procurement contracts and those not participating. The results confirm that the difference in Z-Score is highly significant ( $p < 0.001$ ). Z-ScoreVE shows a similar pattern of statistically significant differences. Furthermore, significant differences emerged for solvency and liquidity ratios, as well as for firm size, as measured by the log of total assets. This suggests that participation in public procurement is associated with distinctive characteristics in these dimensions.

For variables where Levene's test indicated unequal variances, Welch's t-test results are reported:

- For the Solvency Ratio, Welch's t-test indicated a significant difference ( $t(552.4) = 7.064$ ,  $p < 0.001$ , 95% CI [0.080;0.142]).
- For Z-Score, a highly significant difference was observed ( $t(14480) = 9.808$ ,  $p < 0.001$ , 95% CI [15.518;23.270]).
- Z-ScoreVE also differed significantly between groups ( $t(566.6) = 9.378$ ,  $p < 0.001$ , 95% CI [1.994;3.050]).
- For In Total Assets, Welch's t-test yielded a significant negative difference ( $t(523.5) = -15.948$ ,  $p < 0.001$ , 95% CI [-2.151;-1.758]), suggesting that firms engaged in public procurement tend to be larger.
- The Profit Margin was also significantly higher in firms with public contracts ( $t(547.7) = 7.937$ ,  $p < 0.001$ , 95% CI [0.063;0.104]).
- Similarly, the Current Ratio showed a significant difference ( $t(603.4) = 9.658$ ,  $p < 0.001$ , 95% CI [0.045;0.068]).

Table 40 - Effect Sizes for Independent Samples – Cohen’s d, Hedges’ correction, and Glass’s delta

<b>Independent Samples Effect Sizes</b>					
		Standardizer <sup>a</sup>	Point Estimate	95% Confidence Interval	
				Lower	Upper
Solvability=Solvency_Ratio_num/100	Cohen's d	,39148	,283	,193	,373
	Hedges' correction	,39151	,283	,193	,373
	Glass's delta	,33772	,328	,235	,420
ZScore_Winsor	Cohen's d	43,52966	,446	,356	,535
	Hedges' correction	43,53192	,446	,356	,535
	Glass's delta	31,86280	,609	,512	,705
ZScoreVE_Winsor	Cohen's d	7,71377	,327	,238	,416
	Hedges' correction	7,71416	,327	,238	,416
	Glass's delta	5,84397	,432	,338	,524
In_Total_Assets=ln(TotalassetsEUR)	Cohen's d	1,99977	-,969	-1,059	-,879
	Hedges' correction	1,99989	-,969	-1,059	-,879
	Glass's delta	2,68811	-,721	-,820	-,621
ROA=PLforperiod_Netincome / TotalassetsEUR	Cohen's d	61,283189	-,023	-,112	,067
	Hedges' correction	61,287048	-,023	-,112	,067
	Glass's delta	,513441	-2,688	-2,876	-2,498
ROE=ROE_num/100	Cohen's d	,72147	-,097	-,190	-,005
	Hedges' correction	,72152	-,097	-,190	-,005
	Glass's delta	,56437	-,125	-,217	-,032
Profit_Margin=Profit_margin_num/100	Cohen's d	,32569	,257	,166	,348
	Hedges' correction	,32571	,257	,166	,348
	Glass's delta	,22116	,378	,284	,472
Current_Ratio=Current_Ratio_num / 100	Cohen's d	,18363	,307	,216	,398
	Hedges' correction	,18364	,307	,216	,398
	Glass's delta	,12202	,462	,366	,557

a. The denominator used in estimating the effect sizes.  
 Cohen's d uses the pooled standard deviation.  
 Hedges' correction uses the pooled standard deviation, plus a correction factor.  
 Glass's delta uses the sample standard deviation of the control (i.e., the second) group.

While significance testing clarifies whether the differences are unlikely to have arisen by chance, it does not indicate whether they are practically relevant. To address this, Table 40 presents standardized effect size measures, including Cohen’s d, Hedges’ correction, and Glass’s delta.

The magnitude of the differences varies notably across indicators. The effect size for Z-Score is moderate (Cohen’s d = 0.446), supporting the interpretation that risk profile differences are substantial. In contrast, most other measures show small effect sizes, with Cohen’s d typically below 0.3, highlighting that although statistically detectable, the differences may not always translate into major practical distinctions. Notably, In Total Assets displays a relatively large negative effect size (Cohen’s d = -0.969), indicating that firms engaged in public contracting tend to be considerably larger on average.

Overall, these analyses suggest that while public procurement participation is associated with clear differences in certain financial dimensions—especially solvency, risk, and firm size—the differences in profitability and liquidity are more nuanced and less consistently pronounced. This nuanced pattern underlines the importance of considering multiple indicators to avoid overgeneralizing from any single measure.

**4.4 MANN-WHITNEY U TEST (ROBUSTNESS CHECK)**

To support the results obtained in the previous sections, the non-parametric Mann-Whitney U test was applied to the same variables analysed earlier. By using this test, we aim to ensure that the patterns observed previously remain consistent even without assuming normality and homogeneity of variances, which is particularly relevant given the financial data’s tendency toward skewed distributions.

**Table 41 - Mann-Whitney U Test Results**

	Test Statistics <sup>a</sup>							
	In_Total_Assets=ln (TotalassetsEUR)	ROA=PLforperiod_Netincome / TotalassetsEUR	ROE=ROE_num/100	Profit_Margin=Profit_margin_num/100	Current_Ratio=Current_Ratio_num / 100	Solvability=Solvency_Ratio_num/100	ZScore_Winsor	ZScoreVE_Winsor
Mann-Whitney U	1715439,000	2493381,000	1991548,500	1997225,000	1968155,000	2053404,000	2821740,000	3169591,500
Wilcoxon W	67490154,000	67638786,000	53700913,500	2117030,000	2086983,000	2174682,000	2947993,000	3295844,500
Z	-15,289	-4,855	-6,330	-6,324	-6,784	-9,081	-7,496	-3,702
Asymp. Sig. (2-tailed)	<,001	<,001	<,001	<,001	<,001	<,001	<,001	<,001

a. Grouping Variable: Firm\_PublicContracts\_d

As shown in Table 41, the results demonstrate clearly that there are statistically significant differences between firms engaged in public procurement and those that are not. For instance, the variable In Total Assets shows a pronounced difference in distributions ( $Z = -15.289$ ,  $p < 0.001$ ), confirming that firms with public contracts tend to be substantially larger. Significant differences were also observed in solvency ( $Z = -9.081$ ,  $p < 0.001$ ) and liquidity ratios ( $Z = -6.784$ ,  $p < 0.001$ ), highlighting the distinctive financial structure associated with participation in public procurement. Additionally, both measures of financial risk, Z-Score Winsor ( $Z = -7.496$ ,  $p < 0.001$ ) and Z-ScoreVE Winsor ( $Z = -3.702$ ,  $p < 0.001$ ), exhibited significant differences between the groups, further reinforcing the evidence of distinct risk profiles.

Regarding profitability, the Mann-Whitney test revealed statistically significant differences in ROA ( $Z = -4.855$ ,  $p < 0.001$ ), ROE ( $Z = -6.330$ ,  $p < 0.001$ ), and profit margin ( $Z = -6.324$ ,  $p < 0.001$ ). These findings contrast with the results of the parametric t-tests, in which the difference in ROA was not significant. This divergence suggests that, although the mean values may be similar, the overall distribution of profitability measures differs between the groups.

Overall, these results indicate that differences in financial performance and structure are not only statistically detectable through parametric tests but also remain robust when evaluated using non-parametric methods. This reinforces the evidence that participation in public procurement is associated with distinct financial characteristics across several dimensions.

Detailed descriptive statistics of the rank distributions used in the Mann-Whitney U test, including mean ranks and sum of ranks for all variables, are provided in Annex A.4 for reference.

While the Mann-Whitney U test confirms the statistical significance of differences in the distributions, it does not measure the practical magnitude of these differences. Therefore, standardized effect sizes, including Cohen's *d*, Hedges' correction, and Glass's delta, were calculated to assess their practical relevance.

## 5. CONCLUSIONS AND FUTURE RESEARCH

This dissertation aimed to investigate whether public procurement engagement is linked with better financial performance and greater resilience among firms operating in the health and pharmaceutical sectors in Portugal. Contrary to the initial expectation that public contracts would be linked to greater stability, the results consistently indicate that firms with public contracts tend to have lower Z-Scores, suggesting a higher level of financial risk.

Although some indicators of profitability and solvency were higher for firms with public contracts, these differences were generally modest or statistically insignificant. One possible explanation may relate to operational constraints and payment delays that often characterize public sector contracting, as well as the high degree of dependency that such contracts can create. These patterns highlight that public procurement can represent both an opportunity and a vulnerability, depending on the firm's structure and its sector.

At the same time, it is important to highlight that the evidence of lower Z-Scores among firms with public contracts should not be read as a simple indication of fragility. Rather, it reveals a nuanced reality: while public procurement can expose companies to payment delays and operational constraints, it also embeds a layer of security that is often undervalued. From a banking and credit-risk perspective, this dual nature presents a field of significant potential for future research. On the one hand, there is the challenge of managing working capital under less predictable cash inflows. On the other, the certainty that the public sector, even if delayed, ultimately honours its obligations can be leveraged as a foundation for innovative financing solutions. In practice, this context opens space to explore instruments such as supply chain finance and factoring specifically adapted to public contracts. For lenders and companies alike, this combination—stable demand, institutional credibility, and liquidity constraints—creates an opportunity to transform what appears as risk into a strategic advantage. This dimension, largely unexplored in prior studies, reinforces the relevance of this dissertation not only as an academic contribution but also as a prompt for further applied research and operational innovation in credit management.

This work is innovative in that it combines credit risk measurement tools—specifically, the Z-Score indicator, with public procurement data to assess whether state contracts correlate with firms' financial health. To the best of our knowledge, no prior study has systematically analyzed this relationship or integrated Z-Score modelling with procurement records. This approach not only offers new insights into credit risk dynamics but also provides a methodological reference for future studies in this area.

Looking ahead, several research paths could enhance this field. For instance, future studies could develop datasets that allow to identify firms that are regular providers of public

contracts, separating them from those with only occasional or marginal participation. Such a distinction would enable a deeper understanding of whether long-term engagement with the public sector, has different financial outcomes compared to occasional contracting.

Another promising research involves examining in greater detail how the average payment terms applied by public clients affect companies' liquidity and the evolution of their Z-Scores over time. This aspect is particularly relevant for small and medium-sized enterprises (SMEs), for which delayed payments from the State can have disproportionate consequences on cash flow management and the capacity to remain solvent.

Additionally, it would be valuable to explore whether the impact of public procurement varies according to firm size, contract volumes, or the nature of contracts (for example, long-term versus short-term agreements). Such analyses could reveal important nuances in how public contracting interacts with credit risk in different business contexts.

Overall, this study makes a substantial contribution to advancing the understanding of the financial implications of public procurement, offering an innovative perspective by integrating the Z-Score as a credit risk metric in the context of public contracting in Portugal. This approach enables, for the first time in a systematic way, the connection between traditional indicators of financial health and firms' participation in public procurement, representing an important methodological and analytical advance. Moreover, the research shows that the impact of public contracts is not homogeneous and may depend on factors such as firm size, sector structure, and payment practices. These contributions provide a solid foundation for future studies and strategic reflection by companies and policymakers on how to optimize engagement with public sector markets, balancing opportunities and challenges. In this way, the work emphasizes the importance of further exploring this topic and continuing to innovate in how the relationship between public procurement and financial risk is assessed.



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# ANNEX A

Table A. 1 - Basel III reforms of the Basel Committee on Banking Supervision. Source: Basel Committee official website (n.d.). Retrieved in July 2025.

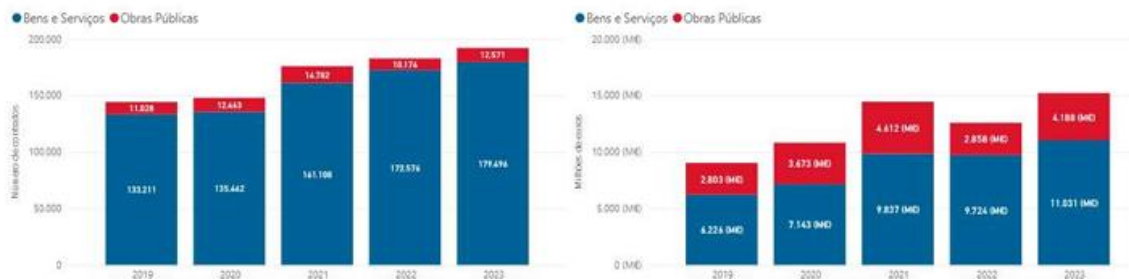
## Basel Committee on Banking Supervision reforms – Basel III

Strengthens microprudential regulation and supervision, and adds a macroprudential overlay that includes capital buffers

Capital					Liquidity
Pillar 1		Pillar 2		Pillar 3	
Capital	Risk coverage	Containing leverage	Risk management and supervision	Market discipline	Global liquidity standards and supervisory monitoring
<b>All Banks</b>  <b>Quality and level of capital</b> <ul style="list-style-type: none"> <li><b>Raising minimum common equity</b> to 4.5% of risk-weighted assets, after deductions.</li> <li><b>A capital conservation buffer</b> comprising common equity of 2.5% of risk-weighted assets brings the total common equity standard to 7%. Constraints on a bank's discretionary distributions will be imposed when it falls into the buffer range.</li> <li><b>A countercyclical buffer</b> within a range of 0-2.5% comprising common equity will apply when credit growth is judged to result in an unacceptable build-up of systematic risk.</li> </ul> <b>Capital loss absorption at the point of non-viability</b> Allowing capital instruments to be written off or converted to common shares if the bank is judged to be non-viable. This will reduce moral hazard by increasing the private sector's contribution to resolving future banking crises.	<b>Revisions to the standardised approaches</b> for calculating <ul style="list-style-type: none"> <li><b>credit risk;</b></li> <li><b>market risk;</b></li> <li><b>credit valuation adjustment risk;</b> and</li> <li><b>operational risk</b></li> </ul> <b>Constraints on using internal models</b> aim to reduce unwarranted variability in banks' calculations of risk-weighted assets.	A non-risk-based <b>leverage ratio</b> including off-balance sheet exposures is meant to serve as a backstop to the risk-based capital requirement. It also helps contain system-wide build-up of leverage.	<b>Supplemental Pillar 2 requirements</b> address firm-wide governance and risk management, including the risk of off-balance sheet exposures and securitisation activities, sound compensation practices, valuation practices, stress testing, corporate governance and supervisory colleges.	<b>Revised Pillar 3 disclosure requirements</b>  Consolidated and enhanced framework, covering all the reforms to the Basel framework. Introduces a dashboard of banks' key prudential metrics.	The <b>Liquidity Coverage Ratio (LCR)</b> requires banks to have sufficient high-quality liquid assets to withstand a 30-day stressed funding scenario that is specified by supervisors.  The longer-term, structural <b>Net Stable Funding Ratio (NSFR)</b> is designed to address liquidity mismatches. It covers the entire balance sheet and provides incentives for banks to use stable sources of funding.  The Committee's 2008 guidance <b>Principles for Sound Liquidity Risk Management and Supervision</b> takes account of lessons learned during the crisis. It is based on a fundamental review of sound practices for managing liquidity risk in banking organisations.  <b>Supervisory monitoring</b> The liquidity framework includes a common set of intraday and longer-term monitoring metrics to assist supervisors in identifying and analysing liquidity risk trends at both the bank and system-wide level.
	<b>Capital requirements for exposures to central counterparties (CCPs) and equity investments in funds</b> to ensure adequate capitalisation and support a resilient financial system.  A <b>revised output floor</b> , based on Basel III standardised approaches, limits the regulatory capital benefits that a bank using internal models can derive relative to the standardised approaches.	<b>Counterparty credit risk</b> More stringent requirements for measuring exposure; capital incentives to use central counterparties for derivatives; a new standardised approach; and higher capital for inter-financial sector exposures.	<b>Interest rate risk in the banking book (IRRBB)</b> Extensive guidance on expectations for a bank's IRRBB management process: enhanced disclosure requirements; stricter threshold for identifying outlier banks; updated standardised approach.		
<b>SIBs</b>  The Committee identifies global systemically important banks (G-SIBs) using a methodology that includes both quantitative indicators and qualitative elements. In addition to meeting the Basel III risk-based capital and leverage ratio requirements, G-SIBs must have higher loss absorbency capacity to reflect the greater risks that they pose to the financial system. The Committee also developed principles on the assessment methodology and the higher loss absorbency requirement for domestic systemically important banks (D-SIBs).					<b>Large exposures</b>  Large exposures regime established to mitigate systemic risks arising from interlinkages across financial institutions and concentrated exposures.

Figure A 1 - Annual distribution of the number of contracts (left) and the contracted amounts in million euros (right), within the scope of public procurement between 2019 and 2023.

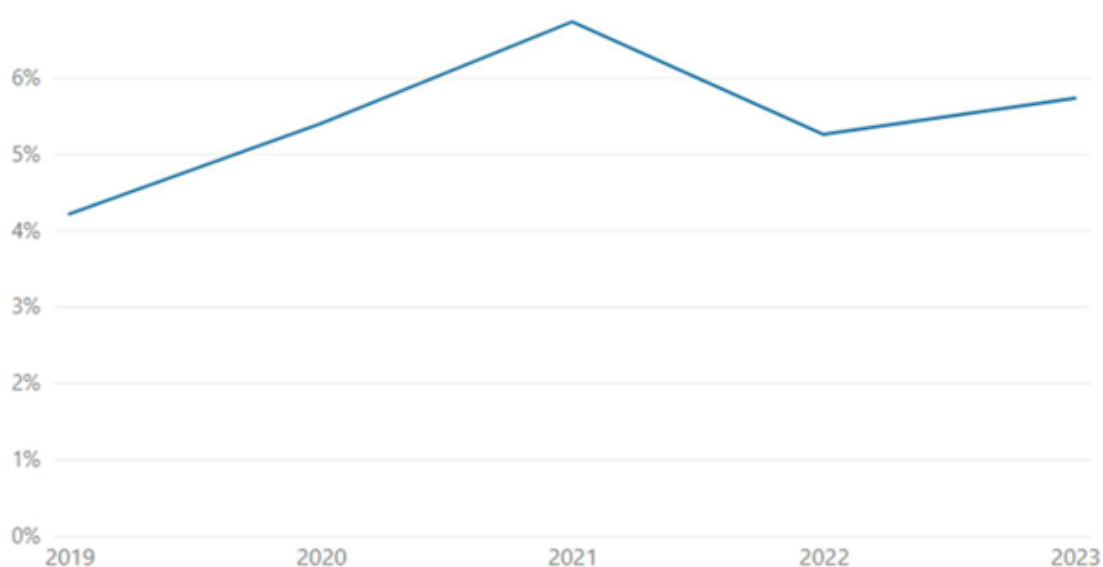
Source: Instituto dos Mercados Públicos, do Imobiliário e da Construção. (2024). *Annual report on public contracts 2023*. IMPIC. <https://www.impic.pt>



Ano	PIB (M€)	PIB Var. %	Valor Contratual (M€)	Peso Contratação face ao PIB	Valor Contratual - Var. Homóloga em %
2023	265.741,90 €	10,97%	15.218,48 (M€)	5,73%	20,96%
2022	239.478,80 €	11,52%	12.581,41 (M€)	5,25%	-12,93%
2021	214.741,00 €	7,09%	14.449,46 (M€)	6,73%	33,59%
2020	200.518,90 €	-6,46%	10.815,97 (M€)	5,39%	19,79%
2019	214.374,62 €	4,48%	9.029,26 (M€)	4,21%	28,04%
<b>Total</b>	<b>1.134.855,22 €</b>	<b>5,64%</b>	<b>62.094,57 (M€)</b>	<b>5,47%</b>	<b>15,14%</b>

Table A. 2 - Evolution of GDP and public procurement contract value (2019–2023).

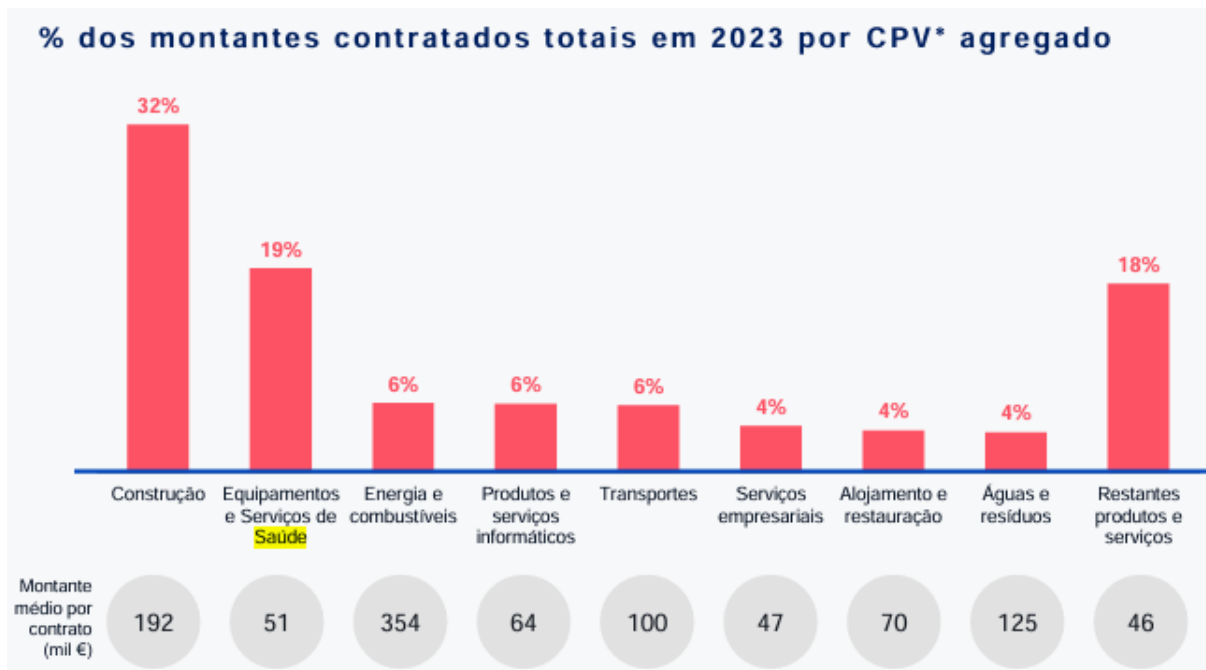
**Source:** Instituto dos Mercados Públicos, do Imobiliário e da Construção. (2024). *Annual report on public contracts 2023*. IMPIC. <https://www.impic.pt>



Fonte: portal BASE (setembro 2024)  
INE Contas Nacionais Trimestrais

Graph A. 1 - Public procurement as a percentage of GDP (2019–2023).

**Source:** Portal BASE. (2024, September). *Public procurement data*. Instituto Nacional de Estatística (INE). *Quarterly National Accounts*. <https://www.ine.pt>



Graph A. 2 - Percentage of total contracted amounts by aggregated CPV category in 2023, with average contract value (in € thousand).

**Source:** Informa D&B. (2024, April). *Public procurement in Portugal – Annual overview 2023*. [https://blog.informadb.pt/wp-content/uploads/2024/04/202402\\_InformaDB\\_Contratacao\\_Publica.pdf](https://blog.informadb.pt/wp-content/uploads/2024/04/202402_InformaDB_Contratacao_Publica.pdf)

Figure A 2 - Overview of the dataset “BASE COM DADOS Z SCORE.sav” in IBM SPSS Statistics, showing 68 variables and 165,749 cases. Measurement levels: 25% scale and 75% nominal.

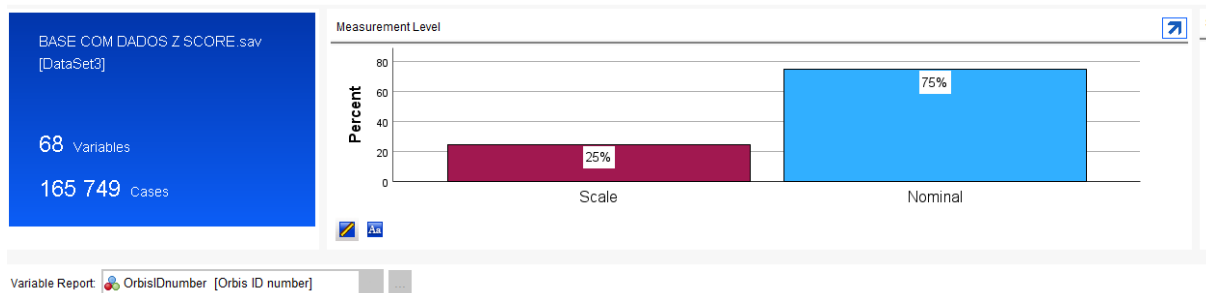


Figure A.3 - Valid and missing cases for the variable Orbis ID number: 52,833 valid cases and 0 missing.

### Estadísticas

Orbis ID number		
N	Válido	52833
	Omisso	0

Figure A.4 - Distribution of valid cases by NACE Rev. 2 (4-digit) codes. Frequencies and percentages based on a total of 165,749 observations.

**NACE Rev. 2, core code (4 digits)**

		Frequência	Porcentagem	Porcentagem válida	Porcentagem acumulativa
Válido	2110	366	,2	,2	,2
	2120	7591	4,6	4,6	4,8
	8610	2312	1,4	1,4	6,2
	8621	18497	11,2	11,2	17,4
	8622	35066	21,2	21,2	38,5
	8623	28167	17,0	17,0	55,5
	8690	40482	24,4	24,4	79,9
	8710	390	,2	,2	80,2
	8720	252	,2	,2	80,3
	8730	10535	6,4	6,4	86,7
	8790	1522	,9	,9	87,6
	8810	7126	4,3	4,3	91,9
	8891	5070	3,1	3,1	94,9
	8899	8373	5,1	5,1	100,0
	Total	165749	100,0	100,0	

Table A. 3 - Descriptive statistics by group (0 = firms without public contracts, 1 = firms with public contracts), for ROE, turnover, total assets, and turnover-to-assets ratio.

	1=if Firm with Public Contracts, 0=otherwise (according to chosen NACEs)		Estadística	estatística do teste Padrão
ROE_v1_perc=ROE_v1/100	0	Média	,2840	,00317
		95% de Intervalo de Confiança para Média	Limite inferior ,2778 Limite superior ,2902	
		5% da média aparada	,2901	
		Mediana	,1866	
		Variância	,659	
		Erro Padrão	,81169	
		Mínimo	-9,94	
		Máximo	9,92	
		Amplitude	19,86	
		Amplitude interquartil	,47	
	Assimetria	-,811	,010	
	Curtose	40,904	,019	
	1	Média	,1780	,00266
		95% de Intervalo de Confiança para Média	Limite inferior ,1728 Limite superior ,1832	
		5% da média aparada	,1611	
		Mediana	,1486	
		Variância	,053	
		Erro Padrão	,23125	
		Mínimo	-5,36	
		Máximo	4,58	
Amplitude		9,94		
Amplitude interquartil		,10		
Assimetria	1,135	,028		
Curtose	110,706	,056		
Operating revenue (Turnover)	0	Média	529881,59	23876,507
		95% de Intervalo de Confiança para Média	Limite inferior 483083,65 Limite superior 576679,53	
		5% da média aparada	170103,90	
		Mediana	100599,96	
		Variância	3,748E+13	
		Erro Padrão	6122124,536	
		Mínimo	-546002	
		Máximo	513071657	
		Amplitude	513617659	
		Amplitude interquartil	177291	
	Assimetria	38,145	,010	
	Curtose	1948,623	,019	
	1	Média	104606719,50	918265,890
		95% de Intervalo de Confiança para Média	Limite inferior 102806663,04 Limite superior 106406775,95	
		5% da média aparada	101651893,81	
		Mediana	121663690,77	
		Variância	6,371E+15	
		Erro Padrão	79820496,887	
		Mínimo	5160	
		Máximo	528264575	
Amplitude		528259415		
Amplitude interquartil		138589868		
Assimetria	,354	,028		
Curtose	-,709	,056		
Total assets	0	Média	734500,19	30535,546
		95% de Intervalo de Confiança para Média	Limite inferior 674650,54 Limite superior 794349,85	
		5% da média aparada	246240,50	
		Mediana	120123,10	
		Variância	6,130E+13	
		Erro Padrão	7829554,588	
		Mínimo	0	
		Máximo	651915811	
		Amplitude	651915811	
		Amplitude interquartil	306678	
	Assimetria	40,816	,010	
	Curtose	2209,190	,019	
	1	Média	124727368,03	1165659,390
		95% de Intervalo de Confiança para Média	Limite inferior 122442351,53 Limite superior 127012384,53	
		5% da média aparada	119414553,11	
		Mediana	128206913,57	
		Variância	1,027E+16	
		Erro Padrão	101325240,00	
		Mínimo	3151	
		Máximo	472753119	
Amplitude		472749968		
Amplitude interquartil		150666392		
Assimetria	,721	,028		
Curtose	-,121	,056		
r_Turnover_TotalAssets=Turnover/Total_Assets	0	Média	1,4633	,00791
		95% de Intervalo de Confiança para Média	Limite inferior 1,4478 Limite superior 1,4788	
		5% da média aparada	1,2135	
		Mediana	,9609	
		Variância	4,113	
		Erro Padrão	2,02796	
		Mínimo	-,15	
		Máximo	135,48	
		Amplitude	135,63	
		Amplitude interquartil	1,28	
	Assimetria	14,811	,010	
	Curtose	665,808	,019	
	1	Média	,9078	,00424
		95% de Intervalo de Confiança para Média	Limite inferior 8995 Limite superior 9161	
		5% da média aparada	,8731	
		Mediana	,9127	
		Variância	,136	
		Erro Padrão	,36813	
		Mínimo	,11	
		Máximo	7,85	
Amplitude		7,74		
Amplitude interquartil		,19		
Assimetria	5,288	,028		
Curtose	54,703	,056		

### Ranks

	Firm_PublicContracts_d	N	Mean Rank	Sum of Ranks
In_Total_Assets=ln (TotalassetsEUR)	,00	11469	5884,57	67490154,00
	1,00	501	8295,97	4156281,00
	Total	11970		
ROA=PLforperiod_Netinco me / TotalassetsEUR	,00	11414	5925,95	67638786,00
	1,00	501	6688,19	3350784,00
	Total	11915		
ROE=ROE_num/100	,00	10169	5280,85	53700913,50
	1,00	473	6195,54	2930489,50
	Total	10642		
Profit_Margin=Profit_margi n_num/100	,00	9832	5202,36	51149651,00
	1,00	489	4329,30	2117030,00
	Total	10321		
Current_Ratio=Current_Ra tio_num / 100	,00	9879	5227,77	51645178,00
	1,00	487	4285,39	2086983,00
	Total	10366		
Solvability=Solvency_Ratio _num/100	,00	11006	5808,93	63933069,00
	1,00	492	4420,09	2174682,00
	Total	11498		
ZScore_Winsor	,00	13980	7290,66	101923410,00
	1,00	502	5872,50	2947993,00
	Total	14482		
ZScoreVE_Winsor	,00	13980	7265,78	101575558,50
	1,00	502	6565,43	3295844,50
	Total	14482		

Table A. 4 - Mean and sum of ranks for financial indicators by group (0 = firms without public contracts, 1 = firms with public contracts).

