Regional Financial Distress in Portugal: A Sector-Weighted Approach Using Aggregate Financial Indicators

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Abstract

Keywords: *Financial Distress, Regional Analysis, Sectoral Composition, Regional Vulnerability*

This dissertation develops a regional financial distress index for Portugal by combining sectorlevel financial indicators with regional business structure statistics. While traditional distress prediction models rely on firm-level financial information, publicly available data in Portugal is aggregated at the sectoral level and lacks regional specificity. In order to get over this restriction, the study uses the Banco de Portugal's Sector Tables to modify Ohlson's (1980) OScore to the sector level, producing yearly probabilities of distress for 66 non-financial sectors between 2006 and 2024. These sectoral probabilities are then mapped to the 25 NUTS III regions using weights based on each sector's share of regional turnover and number of firms. The resulting index assesses the extent to which regional economies are vulnerable to financially fragile sectors, producing a balanced panel from 2008 to 2022.

The analysis reveals significant regional heterogeneity, with structurally weaker interior regions consistently exhibiting higher levels of financial distress. Macroeconomic shocks, such as the COVID-19 pandemic, the global financial crisis, and the sovereign debt crisis, cause substantial rises in distress across all regions, demonstrating the index's vulnerability to cyclical conditions. Sector concentration effects are evident, particularly in the Lisbon metropolitan area, where exposure to severely troubled sectors significantly increases regional vulnerability in specific years. The stability of the regional rankings is confirmed by robustness studies using different aggregation techniques.

Overall, the dissertation sheds light on the spatial distribution of corporate vulnerability in Portugal and gives a new, reproducible method to measure regional financial distress.

Dificuldades Financeiras a Nível Regional em Portugal

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Resumo

***Palavras-chave**: Dificuldade Financeira, Análise Regional, Composição Setorial, Vulnerabilidade Regional*

Esta dissertação desenvolve um índice regional de risco financeiro para Portugal, que conjuga indicadores financeiros a nível setorial, com estatísticas da composição empresarial de cada região. Enquanto os modelos tradicionais de previsão de dificuldades financeiras têm por base informação financeira nível empresarial, os dados públicos que estão disponíveis para Portugal encontram-se agregados por setor e carecem de especificidade regional. Para ultrapassar esta limitação, foram utilizadas Tabelas Setoriais do Banco de Portugal para adaptar o Ohlson OScore (1980) ao nível setorial, resultando então probabilidades anuais de insolvência para 66 setores não-financeiros entre 2006 e 2024. Estas probabilidades são depois mapeadas para as 25 regiões NUTS III através de ponderações baseadas na percentagem de volume de negócios e número de empresas para cada setor, em cada região. O índice resultante avalia o grau em que as economias regionais estão expostas a setores financeiramente frágeis, originando um painel equilibrado para o período de 2008 a 2022.

A análise revela uma heterogeneidade regional significativa, com as regiões interiores estruturalmente mais frágeis a apresentarem consistentemente níveis mais elevados de dificuldades financeiras. Choques macroeconómicos, como a crise financeira global, a crise da dívida soberana, e a pandemia de COVID-19, provocam aumentos substanciais de dificuldades em todas as regiões, evidenciando a sensibilidade do índice às condições cíclicas.

Em suma, a dissertação contribui para a compreensão da distribuição espacial da vulnerabilidade empresarial em Portugal e apresenta um método novo e reprodutível para a medição de probabilidade de insolvência a nível regional.

Introduction

Corporate financial distress is a central topic in accounting, finance, and economic policy, as it impacts firms' ability to invest, recruit, and sustain steady operations. At the aggregated level, increases in financial distress are associated with weaker lending conditions, poorer productivity, and slower economic development. Despite distress prediction models traditionally focus on individual firms, financial fragility is not uniformly spread across space. Regions differ in their sectoral composition, firm structure, and susceptibility to economic shocks. Therefore, it is crucial for corporate analysis, the research of regional resilience, and the design of targeted public policies.

In Portugal, the geographical aspect of financial distress is particularly relevant. The country exhibits clear regional disparities: the metropolitan areas of Lisboa and Porto dominate economic activity, while interior regions rely more heavily on traditional, often lower-margin sectors. This uneven distribution suggest that significant localised vulnerabilities may be hidden by national averages. However, little empirical research has been done to quantify financial distress at the regional level in Portugal, despite the significance of regional dynamics. The main limitation lies in data availability. Rich sectoral financial indicators are available from the Banco de Portugal, although they are only released at national level. Conversely, Instítuto Nacional de Estatística provides comprehensive regional data on the number of firms and turnover by sector, but without the underlying financial statements. Consequently, research on financial distress in Portugal has mostly remained firm-level or nationwide, with no tool to evaluate the evolution of vulnerability across regions.

This thesis addresses this gap by developing a regional financial distress index that integrates regional business structure statistics and nationwide sectoral financial indicators. The main contribution lies in adaptation a traditional firm-level distress model, the Ohlson (1980) O-Score, to the sectoral level, and subsequently translating sectoral distress into regional measures using weights based on regional turnover and firm count. This approach enables for the estimation of regional distress levels even in the absence of regionally broken financial data. It extends the application of conventional financial distress models to a new context by offering a method to approximate regional vulnerability using publicly available data.

There are two parts to the technique. First, the Banco de Portugal's Sector Tables, which include financial data for non-financial firms across 66 CAE Rev.3 sectors over the period starting in 2006 and ending in 2024. The sectoral version of the O-Score is computed using

aggregated indicators, resulting in yearly distress probability for each sector. Second, to convert these sectoral probabilities into regional values, the approach uses Instítuto Nacional de Estatística's Business Demography and Regional Accounts to assess the existence of each sector in Portugal's 25 NUTS III regions. Each sector-region combination is assigned a weight based on its percentage of regional turnover and number of enterprises. These weights, which add up to one in each region and year, allow sectoral distress to be aggregated into a regional financial distress index.

The resulting dataset spans 25 regions, 66 sectors, and 15 years (2008-2022), containing almost 23,000 sector-region-year observations. This panel structure enables the analysis of both cross-sectional and temporal trends in regional financial distress. The index depicts how vulnerability evolved in response to significant macroeconomic events such as the global financial crisis, the sovereign debt crisis, the post-2014 recovery, and the shocked associated with the COVID-19 pandemic. It also highlights how financial distress is shaped by structural sectoral factors, such as whether regions with more capital-intensive or volatile sectors have more financial vulnerability on a systematic basis.

Thus, the aim of this dissertation is to provide a standardised and transparent technique for estimating financial distress at the regional level in Portugal, and to assess geographical and temporal patterns of vulnerability across Portuguese regions. The methodology enables for the creation of clear assumptions about geographic heterogeneity, sectoral dependence, the influence of economic cycles, and the consistency of the index under different aggregation models. These hypotheses are tested in the empirical analysis through descriptive trend analysis, sectoral decomposition, correlation patterns, and robustness checks.

Beyond its academic contribution, the index has practical relevance. For policymakers, regional financial distress indicators can supplement existing statistics such as unemployment, GDP, and business creation. While those indicators reflect actual results, the index gives a measure of underlying vulnerability, which might serve as an early warning signal for regions more vulnerable to fragile sectors. Furthermore, since the techniques used are fully based on public data, it may be updated annually and used for future policy assessments or regional diagnostics.

The remainder of the dissertation is structured as follows. The next chapter reviews the literature on financial distress models and regional economic vulnerability, positioning this study within the context of prior research. The subsequent chapter describes the data sources, O-Score variable computation, sectoral distress probability computation, and regional weight creation. The findings chapter discusses the evolution of the regional distress index, the role of sectoral drivers, and the proposed hypotheses. A robustness analysis compares the baseline index with alternative aggregation approaches, such as Z-score-based measures, and assesses the stability of rankings across methods. The thesis concludes with a discussion on findings, limitations, and implications for economic analysis and regional policy.

Literature Review

Theoretical and Conceptual Foundations of Financial Distress

Financial distress is a core concept in corporate finance, which describes a situation in which a firm experiences significant difficulty in meeting its financial obligations and occupies an intermediate position between formal insolvency/bankruptcy and normal financial health (Whitaker, 1999). Early literature on the topic suggests the distinction between cash-flow insolvency, the inability to meet short-term obligations, and balance-sheet insolvency, which occurs when total liabilities exceed total assets (Wruck, 1990). Financial distress is then an economic condition that precedes and sometimes predicts insolvency, and it was initially studied within the traditional ratio analysis.

Beaver (1966) was the first to suggest that simple accounting ratios, like net income over total assets or cash-flow over total debt, could help predicting failure a couple of years in advance. Building on this demonstration, Altman (1968) introduced the Z-Score model, combining five financial ratios through multiple discriminant analysis (MDA), formalising the idea that distress can be identified in more than one dimension. Later studies sought to relax on the usage of discriminant analysis due to required restrictive assumptions.

The subsequent literature integrated financial distress into broader corporate-finance theories. According to trade-off theory of capital structure (Kraus & Litzenberger, 1973), firms weight the tax advantages of having debt against the expected cost of financial distress, making both the likelihood and magnitude of those costs key factors to optimal leverage decisions. The pecking-order theory (Myers & Majluf, 1984) links financial distress to information asymmetry, as financially constrained firms rely more heavily on debt, thereby increasing their vulnerability to shocks. Based on the agency theory (Jensen & Meckling, 1976), that relates financial distress to managerial incentives, suggesting that as the probability of bankruptcy rises, managers may engage in overinvestment in risky projects and underinvestment in value-preserving activities. Taken together these frameworks, one can imply that financial distress is not a random outcome but a predictable consequence of a firm's operational risk, financing choices and external factors.

Current research views financial distress as a process rather than an event, in which firms progressively transition from financially healthy to fragile states as liquidity buffers shrink, debt servicing becomes difficult, and profitability declines (Whitaker, 1999). With the conceptualisation that empirical models aim to estimate the probability of financial distress,

usually using market and accounting indicators as proxies for the financial health of a firm or sector, most subsequent empirical approaches have shifted from ratio-based discrimination methods to logistic regressions and dynamic distress models.

To sum up, the theoretical foundation of financial distress relies on insights from corporate-finance trade-offs, accounting-based predictions, and the economic side of information. These frameworks provide rationale for empirical models, which will be discussed in the following sections, and are typically based on specific variables such as profitability, leverage, liquidity and size.

Empirical Approaches of Financial Distress Prediction

Empirical literature on financial distress has evolved from simple ratio analysis to more comprehensive probabilistic and market-based frameworks. Across successive models, researchers have sought to enhance predictive accuracy and theoretical coherence while adapting to data availability and institutional settings.

Earlier quantitative studies approached financial distress as a classification problem. Altman (1968), applied multiple discriminant analysis to a sample of manufacturing firms, combining five ratios into a single discriminant function. The resulting z-score enabled a successful distinction from healthy to failing firms up to two years before the actual bankruptcy. Although the model became popular due to its simplicity, MDA relied on assumptions such as multivariate normality and equal covariance structures, that limited its robustness.

With subsequent research, probabilistic models were introduced with the goal of overcoming these limitations. Ohlson (1980) proposed a new model, the O-score model, which used logistic regression to estimate the probability of failure as a function of firm/sector characteristics. This model employed variables related to financial structure, size and performance, providing explicit likelihoods of financial distress rather than categorical classifications. Another framework was introduced in following years, by Zmijewski (1984), who adopted a probit framework that allowed for the correction of sample-selection bias in failure prediction. Together, these frameworks established what is known now as the logit-probit tradition that dominates current research.

A significant conceptual advance came with the introduction of time dynamics, by Shumway (2001), who reformulated financial distress prediction using a hazard model that recognized

that firms face a time-varying risk of distress. Furthermore, this approach allowed for the inclusion of both lagged and contemporaneous predictors and made out-of-sample forecasting a more straightforward process.

Market information became an increasingly important in the 2000s. Campbell, Hilscher, and Szilagyi (2008), combined market indicators, such as stock returns, volatility and relative size, with accounting variables, in a dynamic logit framework, and found that firms with high estimated probabilities of financial distress did not earn the excess returns predicted by the "distress-risk premium" hypothesis. This challenged long-standing assumptions in asset-pricing theory. Their highlighted that financial distress is not purely an accounting problem but also reflects market perceptions and macroeconomic expectations.

More recent research has applied non-linear and data-driven approaches have been applied to bankruptcy prediction. Sun, Li, Huang and He (2014) and Altman, Iwanicz-Drozdowska, Laitinen and Suvas (2017) introduced methods capable of capturing complex interactions between variables. However, this comes at the cost of reduced interpretability, making these models less suitable for policy-oriented or sectoral analysis.

Across various methodologies, a consistent set of predictors has emerged as significant profitability, leverage, liquidity, size and cash-flow. The common finding relies on the deteriorating profitability and rising leverage which substantially increases the likelihood of financial distress. Since most empirical models operate at the firm-basis, the question of how distress risk aggregates across sectors and regions remains unanswered, an issue that this thesis addresses by incorporating sectoral and regional indicators.

SMEs and Financial Distress

In the context of most economies, small and medium sized enterprises (SMEs) are the backbone, accounting for the majority of firms and employment in Europe. However, due to their size, financing constraints and reliance on local credit, they are structurally more vulnerable to financial distress than large corporations (Berger & Udell, 1998). Although theoretical foundations suggest that financial distress concepts apply universally, empirical evidence demonstrates that the drivers and dynamics of financial distress in SMEs are distinct and often more severe.

In terms of key differentiating factors regarding financial structure, SMEs typically employ higher leverage and rely more heavily on short-term financing rather than capital markets. This reliance constraints their liquidity buffers and amplifies the impact of earnings shocks (Michaelas, Chittenden and Poutziouris, 1999).

Another major differentiation factor concerns information and governance. SME financial reporting is less transparent and standardised, than that of larger corporations, making external credit assessment more challenging (Altman and Sabato, 2007). The link between informational opacity and financial fragility suggests that financial distress in SMEs tends to cluster geographically and sectoral wise, presenting variations in credit availability and local economic conditions.

To account for these differences, Altman and Sabato (2007) developed an SME-specific z-score model, using European data. Their findings revealed that variables such as retained earnings and cash-flow coverage retained predictive power, while balance-sheet structure played a more significant role than profitability. Subsequent studies by Laitinen (2001) and Calabrese and Zenga (2010), further advanced this line of research, consistently indicating that SME failure risk is more sensitive to short-term solvency and liquidity indicators rather than long-term leverage or market-based variables.

In sum, SME literature emphasises that financial distress is driven not only by firm-specific characteristics but also by structural and contextual factors. These insights motivate the need for models that move beyond the individual firm level to incorporate sectoral and regional aggregation of financial fragility.

Sectoral and regional dimensions of financial distress

Although most empirical models of financial distress are estimated at the firm level, evidence shows that financial distress risk is not randomly assigned across the economy. It is systematically shared by the characteristics of the sectors and regions in which each firms operate. Sectoral factors such as technology intensity and industry structure along with regional economic conditions, influence a firm's exposure to shocks, liquidity constraints and recovery prospects. Consequently, understanding financial fragility at sectoral and regional levels provides valuable insights into how aggregate vulnerabilities emerge.

At sector-level, industries differ primarly in their sensitivity to economic cycles and financing conditions. Empirical studies, such as Altman and Narayanan (1997), have demonstrated that the probability of corporate failure varies across sectors, even when controlling for firm-level financial ratios. This sectoral heterogeneity acts both as a control and as a source of explanatory variation in financial distress models. While many models include industry dummies to absorb such effects, only a few examine how financial distress clusters within sector or how shocks propagate through specific industries.

Looking into regional dimension adds another layer of complexity. Regional economies differ in their industrial composition, business demographics, and financial infrastructure, all of which influence aggregate financial distress outcomes (Fingleton, Garretsen and Martin, 2012). Access to finance is typically uneven across regions, and regional resilience depends on factors such as local specialisation, productivity and innovation capacity. During downturns, these differences often translate into geographical concentrated episodes of financial distress as evidenced in the aftermath of the 2008 financial crisis.

Taken together, the literature suggests that financial distress is not a solely firm-level outcome but a spatially and sectoral structured phenomenon. The uneven distribution of industrial activities, regional resilience mechanisms and credit conditions leads create identifiable patterns of vulnerability, which, when explored, can help policymakers anticipate the propagation of financial fragility, and design targeted support for at-risk sectors and regions.

Hypothesis

The goal of this dissertation is to measure and compare financial distress across Portuguese regions by combining sector-level distress indicators using region-specific economic weighs over time. In order to guide the empirical analysis and ensure a structured interpretation of the results, this section presents a set of testable hypotheses grounded on literature on corporate finance, regional economic structure and spatial heterogeneity in firm performance.

H1 – Persistent Regional Differences in Financial Distress

H1: Portuguese regions exhibit persistent differences in financial distress levels over time due to stable structural and sectoral characteristics

Literature on regional economic structures suggest that structural characteristics, including sectoral specialization patterns and long-standing structural conditions, change gradually and differ across regions. Therefore, regional disparities in financial distress are likely to be persistent rather than transitory. This hypothesis predicts that some regions will consistently experience higher distress levels than others throughout the sample period.

H2 – Sectoral Structure Drives Regional Distress

H2: Regions more exposed to economically vulnerable or cyclically sensitive sectors exhibit higher financial distress

Empirical research on corporate distress indicates that some industries are systematically more fragile than others, due to higher earnings volatility, lower margins, or more limited financing conditions. Since each region has a distinct economic composition, its level of exposure to these vulnerable sectors is expected to influence regional distress outcomes. Regions with large concentration of volatile or low-productivity industries should, therefore, exhibit higher levels of financial distress.

H3 – Regional Distress Responds to Macroeconomic Crises

H3: Financial distress increases sharply during major economic downturns, most notably the 2011-2013 sovereign debt crisis and the 2020-2021 COVID-19 pandemic.

Financial distress is known to be countercyclical, rising when economic activity slows, cash flows weaken, and borrowing conditions tighten. Prior literature has shown that distress levels increase sharply during major recessions, particularly in peripheral European economies. This hypothesis anticipates observable peaks in distress levels during crisis periods, affecting most regions simultaneously, although with varying degrees of severity.

H4 – Metropolitan Regions Exhibit Lower and More Stable Distress

H4: Metropolitan regions, such as Área Metropolitana de Lisboa and Área Metropolitana do Porto, display lower and more stable levels of distress than interior regions

Urban and metropolitan areas tend to benefit from greater economic diversification, easier access to financial and support services, higher productivity and stronger firm networks, all of which promote economic resilience. Interior regions, on the other hand, are more sensitive to shocks due to the dependence on narrower sets of industries and smaller enterprises. As a result, metropolitan regions are expected to exhibit systematically lower distress levels.

Summary

Taken together, these four hypotheses turn theoretical insights from literature into empirically testable predictions. They frame the following methodologic choices and guide the interpretation of the results, particularly regarding:

- The persistence of regional disparities (H1)
- The role of sectoral composition (H2)
- Temporal dynamics linked to economic crises (H3)
- Structural differences between metropolitan and interior areas (H4)

Data & Methodologies

Data Sources

This study relies on two main sources of data that together enable for a sectoral and regional analysis of financial distress in the Portuguese non-financial economy. The first source is the sector tables published by Banco de Portugal (BdP), and regional business statistics from Instituto Nacional de Estatística (INE), at the NUTS III level.

The datasets are based on official, high-quality information and are designed to showcase the economic and financial structure of Portuguese firms in an anonymized and aggregated way. By combining these sources, it becomes possible to conduct a comprehensive analysis that simultaneously considers financial indicators and the geographical distribution of economic activity.

The first dataset, the sector tables, is produced by Banco de Portugal as part of its Central Balance-Sheet Database dissemination program. It is based on data reported through the Simplified Corporate Information system by companies operating in Portugal and compiles standardised accounting and financial information. The database includes all non-financial firms that file annual accounts, ensuring broad coverage of the business population.

The sector tables in use report the aggregated indicators at the CAE Rev.3 level (NACE Rev.2) and at an annual basis. For each sector and year, the tables include income statement and balance sheet variables, financial ratios, and other distribution indicators, such as medians, quartiles and totals.

The final dataset, which compiles all the sector tables, covers 66 sectors, over a period from 2006 to 2024, although not all sectors have data for the full timeframe. On average, each sector provides information for 15.9 years, with a median of 19 years, a maximum of 19 years, and a minimum of 3 years. Conversely, each year includes, on average, 55 sectors, with a maximum of 59 sectors and a minimum of 50. This imbalance reflects the evolving structure of the Portuguese economy and the entry and disappearance of certain activities.

Each sectoral observation represents an aggregation of all firms classified under the corresponding CAE code, with variables reported as medians or averages. This ensures guarantees confidentiality while preserving sectoral comparability and trend consistency. Since the main goal of this study is to assess financial distress at the sectoral level, these aggregated

values are well suited for the analysis, even though they do not capture firm-level heterogeneity.

The second major source of data comes from INE's regional business statistics, at the NUTS III level (2013), which divides the Portuguese territory, including the islands, into 25 regions. This dataset provides the geographical information necessary to link sectoral performance with regional economic structure. For each year, region and sector two key indicators were retrieved, the number of enterprises operating in the sector (available from 2008 until 2023) and sector turnover (covering the period starting in 2008 and ending in 2022).

In terms of summary statistics for this second dataset, the imbalance arises from the turnover variable, which is missing for an average of 18.4 sectors per region between 2008 and 2022, due to confidentiality. To adhere this issue while maintaining representativeness and avoiding bias from excessive omission, missing turnover values were replaced with the annual regional mean turnover.

After cleaning and merging the two datasets, the combined final dataset includes 66 sectors, 25 regions and 15 years (2008-2022). Since not every sector is represented in every region, the theoretical maximum number of 24,750 observations (66x15x25) is reduced to a balance panel of 23,024 observations.

Data Cleaning and Integration

The construction of the final financial dataset required several stages of processing. First, the sector tables were downloaded individually from Banco de Portugal's statistical portal for all available years and sectors, in five-year blocks, with each block exported as a separate Excel file. These files were concatenated into continuous time series for each sector, and only after that there were all sectors merged into a single sector-level dataset.

For the regional dataset, one separate file was exported for each variable, number of enterprises and turnover, using the same CAE Rev.3 classification to ensure alignment with the Banco de Portugal data. The two Excel files were then merged by region and sector. Due to differences in their time spans the common analysis period was restricted to 2008-2022.

Variable Selection and Ratio Construction

From more than 170 indicators that presented in Banco de Portugal's sector tables, a subset of core financial variables was selected to compute ratios consistent with traditional models of financial distress. The chosen variables capture five essential dimensions of financial performance:

1. Liquidity – working capital, current assets and current liabilities
2. Profitability – EBIT and net income
3. Leverage – total assets, total liabilities and equity
4. Efficiency – turnover
5. Cumulative Performance – reserves and retained earnings

From these, it was computed the financial ratios typically used in Altman's and Ohlson's models:

Ratio	**Definition**	**Interpretation**
WC/A	Working Capital / Total Assets	Liquidity and Short-term Solvency
RRE/A	Reserves and Retained Earnings / Total Assets	Cumulative Profitability
EBIT/A	EBIT / Total Assets	Operating Profitability
E/L	Equity / Total Liabilities	Leverage and Solvency
T/A	Turnover / Total Assets	Efficiency in using assets
NI/A	Net Income / Total Assets	Overall Profitability
CL/CA	Current Liabilities / Current Assets	Short-term Liquidity Risk
L/A	Total Liabilities / Total Assets	Overall Leverage
D_E	Dummy = 1 if Equity < 0	Solvency Indicator
C_NI	$\Delta NI / \lvert NIt\rvert+\lvert NIt-1\rvert$	Earnings Momentum
NI2Y	Dummy = 1 if Net Income < 0 in both of previous two years	Persistent Losses
logA	Log(Total Assets)	Firm Size Proxy

These ratios were derived from the aggregated sectoral averages, which means that inter-firm heterogeneity within each sector is not captured. Nevertheless, this approach remains valuable, as it allows for the identification of patterns of financial distress and the evolution of distress risk at the aggregate economy level.

Regional Weight Construction

Since the sector tables are not regionally disaggregated, geographical differentiation was introduced using data retrieved from INE. The regional-sector weights were computed to capture both the economic relevance and business intensity of each sector within each region by weighting each sector's average turnover against the region average turnover.

Formally,

$$w_{s,r,t} = \frac{\frac{T_{s,r,t}}{N_{s,r,t}}}{\frac{T_{r,t}}{N_{r,t}}}$$

where,

$T_{s,r,t}$ = turnover of sector *s* in region *r* at year *t*;

$N_{s,r,t}$ = number of enterprises of sector *s* in region *r* at year *t*;

$T_{r,t}$ = turnover in region r at year t;

$N_{r,t}$ = number of enterprises in region r at year t.

The computed weight balances the two dimensions of regional economic presence, production volume and business presence, assigning them equal importance. The resulting weights add up to one at regional level each year, making the aggregation across sectors and easier process. By using these weights, it is possible to express regional indicators of financial distress as weighted averages of sectoral values, highlighting each sector's contribution to regional economic activity.

The decision to equally weight the two regional variables reflects the intention to avoid overemphasizing either capital-intensive or labour-intensive sectors, making both proportionally represented.

Financial Distress Indicators

To measure sectoral financial vulnerability, three well-established models were implemented using the previously mentioned ratio: Altman's Z'-score, Altman's Z''-score, and Ohlson's O-score.

(1) Altman's Z'-score and Z''-score

The Z'-score model adapts Altman's original formula for private manufacturing firms, excluding market value of equity and focusing on accounting measures:

$$Z' = 0.717X_1 + 0.847X_2 + 3.107X_3 + 0.420X_4 + 0.998X_5$$

where,

X_1 = WC / A

X_2 = RRE / A

X_3 = EBIT / A

X_4 = E / L

X_5 = T / A

The Z''-score model generalizes the previous model to service and non-manufacturing firms:

$$Z'' = 6.56X_1 + 3.26X_2 + 6.72X_3 + 1.05X_4$$

This score excludes the turnover term and is thus more appropriate for intangible-intensive or heterogeneous sectors. In both models, higher z-scores indicate stronger financial health, thus lower values signal financial distress.

Given the aggregated nature of the data, there was a limitation in getting the market value of equity. This was the reason for the original model was not computed, as the results would not have been accurate.

(2) Ohlson O-score

The Ohlson (1980) model estimates the probability of firm distress using a logistic regression on multiple financial ratios and dummy variables. The model is particularly

suited for heterogeneous datasets and accounts for non-linear relationships between financial indicators and distress risk.

The formula used follows the original model, omitting only the variable "Funds from Operations" due to the absence of depreciation data in the aggregated sector tables.

The O-score is then calculated as:

$$O = -1.32 - 0.407Y_1 + 6.03Y_2 - 1.43Y_3 + 0.076Y_4 - 1.72Y_5 - 2.37Y_6 - 1.83Y_7 + 0.285Y_8$$

where,

Y_1 = logA

Y_2 = L/A

Y_3 = WC/A

Y_4 = CL/CA

Y_5 = D_E

Y_6 = C_NI

Y_7 = NI2Y

Y_8 = NI/A

And the estimated probability of distress:

$$P(Distress) = \frac{e^O}{1 + e^O}$$

Where higher O-scores and probabilities correspond to a higher risk of financial distress.

Descriptive Statistics

The descriptive results confirmed the broad representativeness across sectors and regions over the years. On average, each NUTS III region accommodated around 47,374 firms per year, with a median of 26,407, a minimum of 7,461 and a maximum of 438,046 firms. Regarding

the turnover, the regional average is €13.5 billions, and the median €5.1 billions, highlighting the substantial heterogeneity in regional economic structures.

The core financial ratios exhibit reasonable dispersion, with expected patterns across different sectors:

Variable	Mean	Std. Dev.	Min	Max	Interpretation
WC/A	0.125	0.139	-0.715	0.674	Liquidity
RRE/A	0.033	0.200	-1.895	0.387	Cumulative Profitability
EBIT/A	0.036	0.053	-0.872	0.411	Operating Profitability
E/L	0.541	0.306	-0.218	3.397	Leverage
T/A	0.756	0.398	0.002	2.985	Efficiency
NI/A	0.014	0.052	-0.887	0.395	Profitability

The computed distress scores exhibit the following overall distribution:

Indicator	Mean	Std. Dev.	Min	Max
Z'-score	1.21	0.59	-3.02	3.16
Z''-score	4.99	1.68	-6.39	8.89
O-score	-3.43	1.21	-6.69	3.86
P(Distress)	0.058	0.092	0.001	0.979

The Z'-score and Z''-score results suggest that, on average, Portuguese sectors are financially robust, though with significant variation across sectors and over time. For the O-score results, the median probability of distress is 5.8%, reinforcing the conclusion that Portuguese sectors are predominantly solvent.

Regional Distress Index Construction

Following the computation of the O-Score and the corresponding probability of distress, the next step translates these sectoral indicators into a region-specific measure. Since the original sector tables are not geographically disaggregated, the previous computed regional-sector weights $w_{s,r,t}$ where employed to map sectoral distress into regional outputs.

The probability of financial distress for each sector s in year t is determined from Ohlson model using the logistic transformation:

$$P(Distress_{s,t}) = \frac{e^{O-Score_{s,t}}}{1 + e^{O-Score_{s,t}}}$$

These probabilities capture the likelihood of distress for the representative firm, in each sector-year pair. Then, in order to reach the regional distress index, it was applied a weighted sum of sectoral probabilities, using the previously stated, regional-sector weights.

$$RDI_{r,t} = \sum_{s} w_{s,r,t} * P(Distress_{s,t})$$

Due to the weights add to one within each region and year, the index is directly interpretable as a regional probability of distress. As result, a higher $RDI_{r,t}$ reflects that a region's economic structure is more exposed to financially fragile sectors, while lower values indicate an exposure to more financial resilient sectors.

The resulting panel dataset provides a consistent and comparable indication of regional financial distress for all the 25 NUTS III regions between 2008 and 2022.

Summary

To sum up, this section outlined the data sources, preparation processes, and empirical procedures used to assess financial distress across different Portuguese sectors and regions. The combination of sectoral data with regional statistics provides a multi-dimensional view of sectoral distress, integrating financial performance and regional economic structure. The resulting dataset offers a solid foundation for analysing how sectoral vulnerabilities evolve geographically and over time.

Robustness Checks

To ensure the stability of the Regional Distress Index and verify whether regions are consistently classified across alternative methods, three robustness exercises were conducted. These checks compare the baseline index, the probability of distress obtained from the Ohlson O-Score, with alternative regional indicators derived from the Z'-Score and Z''-Score formulas. As both these scores assess financial health rather than distress, all comparisons were made at the regional average level, using the same weighted aggregation previously described. The robustness analysis examines the correlation between the three methods, rank correlations, and the magnitude of rank changes across regions.

Correlation Between Regional Distress Index and Alternative Z-Score Aggregations

The first robustness exercise assesses the comparability of the baseline regional distress index with the alternative regional values obtained using the Z'-Scores and Z''-Scores. For each region, the average index was computed over the period from 2008 to 2022, and Pearson correlations were estimated between the three regional indicators. Results from this exercise are reported in Table 10.1.

The used Regional Distress Index shows a significant negative correlation with both the Z'-Score and Z''-Score aggregates (-0.63 and -0.84, respectively). These negative signs are expected as higher Z-Scores indicate stronger financial health, the opposite of the what is implied by the probability obtained through O-Score, where higher values indicate a greater chance of financial distress. Regarding the magnitude of the correlations, they suggest a broad alignment between the probability of distress and the Z-Scores methodologies.

Furthermore, Z'-Score and Z''-Score aggregations exhibit a very strong positive correlation of 0.90, indicating that they share a conceptual framework and are computed using similar sector-level ratios. Overall, these results suggest that the baseline distress index is consistent to other established techniques.

Rank Correlations Across Methods

The second robustness test examines whether the relative position of each region remains stable across the three different approaches described. Instead of comparing raw values, each region was first ranked according to its average score for each method. Rank correlations are reported in table 10.2.

Rank correlations between the Regional Distress Index and both the Z-Scores measures range from 0.36 and 0.59, indicating a moderate degree of rank consistency. Although the ordering of some regions shifts from model to model, the correlations obtained are sufficiently positive to suggest that the methods broadly identify similar clusters of more and less susceptible regions.

The rank correlation between Z'-Score and Z''-Score aggregations is substantially higher (0.85), reflecting their methodology similarity. Therefore, the results indicate that the baseline index captures cross-regional patterns also present in Z-Score-based approaches, even if the exact ranking of individual regions differ slightly.

Robustness Rank Changes per Region

To analyse the extent of the ranking variation at the regional level, a final exercise computes the maximum rank change observed across the three approaches for each region. Table 10.3 reports each region's ranking under the three methodologies, as well as the largest rank difference observed.

Some regions, such as Região Autónoma dos Açores, Douro, Médio Tejo and Área Metropolitana de Lisboa, display relatively minor changes, while others exhibit more substantial shifts. The most notable examples include, Terras de Trás-os-Montes (20 positions), Baixo Alentejo (17 positions) and Alto Tâmega (14 positions).

Larger rank changes occur especially in areas with sectoral structures that combine high-volatility manufacturing sectors with low-risk services, making regional averages more sensitive to the underlying distress model. Notably, notwithstanding these differences, the broad classification of structural resilient regions and structural weaker regions remains consistent.

Summary

Throughout all three robustness checks, the evidence indicates that the Regional Distress Index is reasonably stable and broadly aligned with established Z-Score-based approaches. Despite certain regions experience non-trivial rank shifts, the overall pattern of regional vulnerability is robust to alternative aggregation methods. This supports the reliability of the index as a indicator of regional vulnerability to sectoral financial fragility.

Results

This chapter summarises the results of the empirical analysis conducted using the regional financial distress index developed. The index combines sector-level probabilities of distress, derived from Ohlson O-Score, with sector-region-year economic weights based on turnover and number of firms. This approach ensures that each region's financial fragility reflects what sectors it comprises and how financially distressed those sectors tend to be.

The results are shown in three stages:

1. Characterization of the temporal and spatial evolution of regional financial distress
2. Evaluation of the hypotheses previously defined
3. Discussion of patterns, anomalies and structural interpretations

To complement the interpretation of this section, Appendix shows the Regional Distress Index for each region over time; and Maps 1-5 display the index in a spatial and coloured scale.

Temporal and Spatial Evolution of the Regional Financial Distress Index

The 2008 Baseline: Highly uneven regional exposure

The first observation in the dataset is from 2008, a year preceding the full manifestation of the global financial crisis but already marked by economic uncertainty.

The regional map for 2008 (Map 1) reveals a strikingly unequal distribution of financial distress across the Portuguese territory, more heterogeneous than any subsequent year, with exception for 2016.

For this year, distress index values vary significantly:

- Most regions lie between 4% and 10%
- Several interior regions exceed 9-10%
- Some coastal regions fall toward 5-7%
- Área Metropolitana de Lisboa (AML) shows 89% of regional probability of distress, na extreme outlier

The AML value requires detailed explanation, as it does not indicate an actual collapse of all enterprises in the AML region. Rather, it is the mechanical reflection of an exceptionally distressed sector, manufacture of coke and refined petroleum products, with a probability of

distress of 98% in 2008; which accounts for 89% of Área Metropolitana de Lisboa's regional weights, under the used weighting method.

The combined impact is that the regional index becomes almost entirely driven by the sectoral distress of this single sector. This is a legitimate economic aspect (since AML truly hosts this sector), but it also indicates methodological concentration risk. Therefore the observed result should be understood as a sector-driven concentration distortion, not a regional financial collapse.

Besides Área Metropolitana de Lisboa, the 2008 map shows a clearer pattern: ongoing interior fragility and comparatively stronger coastal performance. Regions like Douro, Trás-os-Montes, Alto Alentejo and Beiras e Serra da Estrela have distress levels ranging 8-10%. These regions are fundamentally less diverse and tend to rely the most on older industrial or agricultural sectors, which present weaker financial ratios.

In contrast, regions such as Oeste, Região de Aveiro, Região de Leiria and Algarve have moderate probabilities of distress, ranging between 5% and 7%, consistent with more diversified economic structures.

Thus, 2008 establishes the first key empirical insight: geographic disparities in financial vulnerability are large and strongly correlated with known economic structural weaknesses.

2011: The Sovereign Debt Crisis and Nationwide Increase in Financial Distress

The map for 2011 aligns almost perfectly with what could be macroeconomically expected. Portugal was facing a severe recession with rising corporate insolvencies, credit contraction and tightening lending standards, and the bailout under the Troika programme. The findings show that financial distress uniformly increased across nearly every region, producing a more homogeneous spatial pattern than 2008.

Regarding key observations, most regions fall between the 7% and the 12%, which is a substantial increase to their 2008 values, and higher distress levels can be particularly identified in Douro, Terras de Trás-os-Montes, Tâmega e Sousa and Região Autónoma dos Açores. This increase also affects the stronger coastal regions like Oeste, Área Metropolitana do Porto, Área Metropolitana de Lisboa and Região de Aveiro. This tightening of the distribution demonstrates

that national shocks compress spatial heterogeneity, meaning vulnerable regions still perform worse but the gaps narrow. In 2011, Área Metropolitana de Lisboa records 8% of regional probability of distress, which is commensurate with realistic levels when sector concentration effects are absent.

Overall, 2011 results validate the expectation that systemic macroeconomic shocks spread across regions regardless of their baseline financial strength, elevating distress even where sectoral structures are relatively robust.

2014: The Beginning of Post-Crisis Stabilization

By 2014, Portugal is emerging from the recession and exiting the bailout programme. These positive changes are also translated to the distress index.

For almost all regions, substantial declines in distress were identified, converging towards the 4-7%, joined by a reduction in cross-regional gaps. Although the country is still adapting, regional distress levels are approaching those seen in the mid 2000s across several indicators. Nevertheless, several regions remain systematically more fragile. Douro, Beiras e Serra da Estrela and Terras de Trás-os-Montes keep the values around the 7-10%, while coastal and metropolitan regions cluster around 3-5%.

Highlights from this period indicate persistent structural disparities, consistent with historical patterns of uneven development. Regions that depend on exports, heavy manufacturing or agricultural intensive sectors appear to be more vulnerable to fluctuations in profitability and leverage, as evidenced by the sectoral O-Score components.

2016: Broad National Stabilization with Moderate Regional Variation

The scenario in 2016 changes significantly from both the crisis period and the pre-crisis baseline. At this point, the Portuguese economy is experiencing a moderate GDP growth, along with an expansion in employment and improved financial environment for firms. These macroeconomic improvements are also reflected in the regional distress index.

Most regions consolidate distress index values within a narrow band of 3-6%, reflecting a broad national stability. The dispersion observed in 2008 and 2011 declined sharply, suggesting that reductions in sector financial fragility.

By this stage, Douro, Beiras e Serra da Estrela and Terras de Trás-os-Montes distress indexes got closer to 6-7%, reflecting chronic dependence on weaker or more risky sectors, justifying the tendence to lag during expansions and adjust more slowly to shifting financial conditions.

The coastal regions, such as Oeste, Região de Leiria and Região de Aveiro rely close to 3-4%, showing stronger sectoral compositions.

To contextualize the 24% regional distress probability obtained for Área Metropolitana de Lisboa, it reflects again a sectoral composition distortion, not an actual macroeconomic shock.

2022: Post-Pandemic Coverage and Widespread Improvement

In 2022, right after the disruptions of the COVID-19 pandemic and subsequent recovery, the regional distress index exhibits its lowest dispersion in the entire panel, with many regions recording distress levels between the 1% and 3%, and no single region having more than 5%. The absence of the extreme petroleum-sector effect, and the normalisation of sectoral weights made Área Metropolitana de Lisboa reaching a level of 0%.

These results suggest an effective adaptation to post-2020 conditions, due to stabilisation of supply chains, recovery in tourism and government support programmes.

Hypotheses Evaluation

H1: Persistence of Regional Distress

The first hypothesis argues that regions with high levels of financial distress at the beginning of the sample should tend to remain among the most susceptible regions throughout the sample. The empirical evidence from the regional distress index supports this idea, but only partially. Several interior regions, such as Douro, Beiras e Serra da Estrela, Terras de Trás-os-Montes and Alto Alentejo, consistently appear among the highest distressed regions across most of the years. Their paths exhibit a degree of structural inertia – places with less diverse economic structures, older industrial profiles, or lower levels of investment tend to keep higher risk levels, independent of the overall macroeconomic environment.

However, persistence is not absolute. Regions with above-average distress levels, such as Oeste, Região de Leiria, and Região de Aveiro, improve significantly throughout national recovery, especially after 2014. Their distress levels fall closer to the national mean, indicating that regional trajectories are not set and that structural improvements or positive sectoral shifts can significantly change a region's position over time. On the other hand, the two outlier observations for Área Metropolitana de Lisboa, in 2008 and 2016, do not indicate actual regional persistence, but rather the brief dominance of a particularly very distressed sector in the region's economic composition. After accounting for these biases, Área Metropolitana de Lisboa behaves very similarly to other coastal regions.

Overall, the findings show that, while considerable persistence occurs, especially in structurally weaker interior regions, the pattern is not inflexible, as regional distress reflects both long-term structural characteristics and short-term macroeconomic dynamics, leading to a partial validation of the first hypothesis.

H2: Impact of Macroeconomic Crises

The second hypothesis holds that financial distress should increase across all regions during major macroeconomic downturns. The evidence strongly supports this expectation. The year 2011, during the height of the Portuguese sovereign-debt crisis and the implementation of the Troika adjustment programme, exhibits a clear and widespread increase in financial distress across virtually every NUTS III region. Regardless of structural characteristics or baseline

levels, all regions report increased levels of distress compared to 2008. This uniform deterioration illustrates the shock's systemic nature – credit limits tightened nationwide, profitability declined across industries, and financial pressure rose – all of which feed directly into the O-score model.

What stands out in 2011 is the compression of regional variance. Differences between interior and coastal regions diminish dramatically, revealing that macroeconomic crises tend to override local differences. Regions that had been reasonably stable in the previous years – coastal manufacturing zones – saw large increases in risk, while already vulnerable interior regions deteriorated further, but not in proportion to the others. This widespread deterioration indicates that macroeconomic stress is transmitted through financial ratios across all sectors and regions, giving strong empirical support for the second hypothesis.

H3: Structural Vulnerability of Interior Regions

The third hypothesis suggests that Portuguese interior regions, which tend to be characterised for having lower sector diversification, and more traditionally economic structures, should experience higher average distress over time. The data strongly supports this expectation. Across every snapshot year analysed – 2008, 2011, 2014, 2016 and 2022 – interior regions had consistently greater financial distress levels than coastal or urban areas, with the only partial exception being 2022, when distress values converge to historical lows across the country.

Even when there is no crisis, regions like Beiras e Serra da Estrela, Terras de Trás-os-Montes, Alto Alentejo, and sections of the Douro tend to be at the top of the distribution. Their sectoral composition, including agriculture, food industries, textiles, and basic manufacturing, correlate to industries that, when aggregated in sector tables, exhibit lower profitability, higher leverage, or more cyclical instability. This structural fragility is observable both before the crisis of 2008 and after the initial recovery of 2014, indicating how regional economic composition plays a major role in shaping financial risk.

Thus, the findings lend significant and consistent support to the third hypothesis, indicating a continuous inland-coastal divide in financial fragility.

H4: Metropolitan Stability and Diversification

The fourth hypothesis contends that the metropolitan areas of Lisboa and Porto should experience lower and more steady financial distress levels, reflecting their higher economic diversity and bigger, more resilient firm populations. The findings broadly support this idea, though with a significant qualification. Área Metropolitana do Porto behaves exactly as predicted since it shows low distress values throughout the sample and responds proportionally to national shocks, avoiding excessive swings. Its diverse industrial and service base ensures reasonably consistent performance even during crisis years.

Área Metropolitana de Lisboa also aligns with expectations in most years, displaying distress levels that are comparable or lower than national averages. However, two years – 2008 and 2016 – stand out as outliers. In both years, Área Metropolitana de Lisboa's index is dominated by the sector manufacture of coke and refined petroleum products, which has a very large weight in the region's economic structure and exhibits significant distress at the sectoral level.

These examples demonstrate a methodological and economic truth – when a region has a high-turnover industry that is struggling, the regional index is dominated by its performance. This does not refute the premise but rather emphasises the relevance of sector concentration in evaluating metropolitan results.

After adjusting for sector-driven diversifications, urban regions consistently have lower and more stable distress levels than interior regions. Thus, the fourth hypothesis is endorsed, with the caveat that sector dominance may briefly overshadow diversification benefits.

H5: Sector-Driven Regional Distress

The fifth hypothesis argues than regional distress levels should be heavily impacted by industries with significant economic weight within each area. This hypothesis is very clearly confirmed by the data. The most compelling evidence comes from the two Área Metropolitana de Lisboa anomalies. In both 2008 and 2016, Área Metropolitana de Lisboa's regional index reflects almost solely the distress of a single sector – one than experienced particularly high financial pressure in the early years of the sample and has a disproportionately large regional weighting. These events show that regional financial vulnerability is influenced not just by region but also by economic specialisation.

Aside from Área Metropolitana de Lisboa, many cases support this hypothesis. Regions with higher proportion of structurally weaker industries, such as traditional manufacturing, agriculture, or some export sectors, show persistently higher distress across the entire period. Conversely, regions with strong service sectors or diversified industrial bases exhibit more stable values.

This dynamic demonstrates that the regional distress index works exactly as intended – it reflects the financial state of the sectors that dominate each local economy. Thus, the fifth hypothesis receives unambiguous empirical support.

Discussion

This section interprets the empirical findings in list of the exiting literature on financial distress, regional inequality, and sectoral specialisation. The objective is not to repeat the findings, but rather to examine the mechanisms that underlie the observed trends, assess their consistency with prior research, and elucidate the economic drivers of regional financial fragility in Portugal.

Sectoral Composition as a Determinant of Regional Distress

One of the most important conclusions of this dissertation is the extent to which sectoral specialisation influences regional financial crisis. The weighting system scheme used in this study, which is based on turnover and the number of firms, implicitly incorporates each sector's economic prominence within a region. As a result, the regional distress index reflects not only local economic performance, but also the financial condition of the dominant industries.

This approach is consistent with the literature on regional economic vulnerability. Regions that are strongly concentrated in industries with a high risk of bankruptcy, cyclical volatility, or structurally poor financial indicators tend to exhibit greater instability (Glaeser et al., 11992; Henderson et al., 1995). The Portuguese case supports this overall expectation. Interior regions that rely heavily on conventional industry, agriculture, or low-value-added activities display higher distress levels throughout the period. In contrast, regions with more diverse service-based economies demonstrate better resilience.

The episodes involving the Manufacture of Coke and Refined Petroleum Products sector in Área Metropolitana de Lisboa further illustrate this point. In 2008 and 2016, the sector's unusual combination of very high distress and overwhelming regional weight resulted in remarkable regional outcomes. These instances are not statistical artefacts, but rather manifestations of the theoretical principle that regional financial fragility is heavily influenced by economic structure factors. They demonstrate that any region, regardless of geography, can experience increased hardship when dominated by a highly vulnerable industry. In this respect, the results align closely with the findings of Delgado et al. (2014) and Martin et al. (2016), who highlight the relevance of sectoral composition for regional resilience.

Regional Inequality and Structural Persistence

The observed inland-coastal asymmetry in financial distress levels resonates with long-standing arguments in the literature on Portuguese regional disparities. Interior areas have historically exhibited weaker economic performance, less diverse industrial bases, and slower productivity development (Lopes & Santos, 2012). Higher distress levels exist in locations such as Beiras e Serra da Estrela, Terras de Trás-os-Montes, and Alto Alentejo, supporting this idea that financial vulnerability is another dimension of broader structural disadvantage.

However, the data indicates that regional positions are not fixed, several regions – including Oeste, Região de Leiria and Região de Aveiro – experience noteworthy improvements during the recovery phase following the sovereign debt crisis. This dynamic adjustment implies some level of economic flexibility and adaptation. Such findings lend credence to the concept that resilience is controlled not only by static structural characteristics but also by the capacity of regional economies to adjust to macroeconomic and sectoral shocks (Brakman et al., 2015).

Thus, the findings depict a picture of partial persistence – regional vulnerabilities exist and matter, but they do not completely dictate long-term trends.

The Dominance of National Business Cycles

The 2011 sovereign debt crisis demonstrates the powerful effect of national macroeconomic shocks on regional financial outcomes. During this period, distress levels rose across all regions, with the cross-regional distribution becoming increasingly narrow. This pattern is consistent with the traditional idea that financial distress is heavily procyclical and responds strongly to recessions, liquidity shortages, and credit contraction (Bernanke & Gertler, 1989).

During crises, firm-level financial ratios tend to worsen concurrently, regardless of geographical differences. The findings show that even locations with relatively robust economic bases experience significant distress during severe downturns. This is consistent with the work of Altman (1983), Ohlson (1980), and Campbel et al. (2008), who emphasise the sensitivity of distress models to macroeconomic situations.

Portugal's 2011 findings therefore illustrate a central principle – systemic shocks dominate regional differentiation, at least in the short to medium term. This explains why the geographical distribution of distress becomes more uniform during crisis years.

Post-Pandemic Convergence and the Role of Policy Intervention

The 2022 findings show the lowest and most homogeneous distress levels across the entire period. This convergence is likely due to a mix of factors: the quick recovery of tourism, expansionary fiscal and monetary policies, liquidity support during the pandemic, recovery of export-oriented manufacturing, and adjustment and consolidation among surviving firms.

The literature on post-crisis recovery emphasises the need of targeted support measures and the resilience of larger firms in achieving quick improvements in financial conditions (Farinha & Félix, 2021). The results from 2022 are consistent with this body of work. Regions that were fundamentally more vulnerable, particularly in the interior, saw the largest reductions in distress, reducing the spatial inequality that characterised previous years.

While caution should be used when attributing too much to short-term stabilisation measures, findings indicate that economic policy had a significant role in preventing a broad deterioration in the corporate sector, thereby enabling regional convergence.

Interpreting the Financial Distress Index as a Sector-Weighted Measure

It is important to note that the regional distress index is a sector-weighted average of distress probability at the sectoral level. It is not a direct observation of firm-level financial ratios in each region. As a result, the index should be seen as a measure of regional exposure to sectoral financial risk, rather than a direct reflection of regional accounting data.

This methodological characteristic affects interpretation in three ways:

- Sector dominance: A region with a high-weight disturbed sector will experience significant distress even if most other sectors are stable.
- Aggregation smoothing: Because sector data provides averages, intra-regional variability is nor reflected.
- Comparability: Despite these limitations, the index remains a reliable and economically significant indication of relative regional financial distress.

This view aligns with approaches to regional risk mapping and sectoral stress modelling, in which composite indicators reflect economic structures rather than individual firm dynamics.

Synthesis

Overall, the debate focusses on three major insights:

1. Sectoral specialisation is the primary driving force shaping regional financial distress – regions absorb risk from their dominant industries.
2. Macroeconomic factors cause simultaneous swings in suffering across the country – national shocks outweigh local variances
3. Structural regional disparities persist but can be reduced during periods of national recovery – long-term structural variables contribute to resilience but are also influenced by short-term changes.

The analysis shows that the Portuguese regional economy's performance between 2008 and 2022 is highly consistent with established theoretical and empirical literature on financial distress, regional development and economic resilience.

Policy Implications

The findings of this dissertation carry several implications for Portugal's regional development policy, financial stability monitoring, and sector-sensitive economic planning. Since the regional distress index reflects both structural and cyclical forces, the policy recommendations resulting from this study must address short-term vulnerability, medium-term sectoral composition, and long-term regional development objectives. The primary policy lessons for national authorities, regional policymakers and financial supervisory institutions are outlined in this section.

Strengthening Regional Economic Diversification

One of the analysis' most consistent conclusions is the higher and more persistent financial distress observed in interior regions with little sector diversification. Financial indicators are weaker and more vulnerable to macroeconomic shocks in areas that rely primarily on agriculture, traditional manufacturing, or low-value-added sectors. This implies that diversification strategies, long supported in the research on regional development, remain crucial.

Policy measures that could address this structural vulnerability include:

- Using targeted incentives to support high-productivity industries, such as digital services, renewable energy, and technology-intensive manufacturing.
- Encouraging groups of related sectors, which can reduce reliance on a single industry and provide spillover benefits.
- Improving transport, digital and logistics infrastructure to lessen geographical disparities and increase regional attractiveness to diversified investment.
- Encouraging entrepreneurship and SME capability improvement to enable interior regions to grow into higher-value segments of global value chains.

Diversification does not imply replacing existing sectors. Instead, it entails enhancing them with activities that provide more stable financial profiles and greater resilience to economic shocks.

Monitoring Sector Concentration Risks

The severe consequences of sector concentration, particularly in Área Metropolitana de Lisboa due to the petroleum products sector, emphasise the necessity of closely monitoring regions where a single sector accounts for a sizable portion of employment or turnover. While such concentration can generate strong economic performance during expansionary periods, it can also increase regional risk when the dominant sector experiences financial distress.

Financial supervisors and regional authorities should:

- Determine which regions have a high sectoral concentration, especially in capital-intensive or volatile industries.
- Develop early warning systems to flag sector-specific financial distress that may have a disproportionate impact on local economies.
- Conduct region-specific stress-testing exercises that are calibrated to sector-weighted regional structures and resemble those conducted at the national level.
- Encourage diversification withing dominating sectors by promoting innovation or upstream/downstream integration, to reduce vulnerability.

This approach ensures that sector-level effects are more accurately predicted by coordinating regional economic planning with contemporary frameworks for financial stability.

Enhancing Crisis Preparedness and Countercyclical Support

Systemic shocks increase financial misery concurrently in all regions, as the 2011 sovereign-debt crisis shows. Therefore, in order to ensure that sectors in all regions can continue to operate during revenue disruptions, policymakers should design response mechanisms that:

- Quickly implement liquidity support programmes during turndowns.
- Preserve credit availability, especially for SMEs in interior economies that are structurally weaker and typically suffer the most during credit tightening.
- Use automatic stabilizers and targeted subsidies, like tax deferrals or wage support, to ease short-term financial strains.
- Take regional vulnerabilities into account by including regional indicators into macroprudential monitoring, when establishing national policies.

The convergence seen in 2022 indicates that the pandemic countercyclical measures, including as credit moratoria, liquidity lines, and fiscal support, were successful in halting regional decline. Institutionalising comparable tools would help protect regional economies during upcoming crises.

Supporting Firm-Level Financial Resilience

The findings suggest that sectoral averages of firm-level financial measures account for many regional variations. Thus, improving these underlying indicators should be a priority.

Policies could target:

- Strengthening of the capital structure, through incentives for equity financing or retained earnings accumulation.
- Management training courses to enhance operational efficiency, risk assessment, and financial planning.
- Digitalisation and technological advancements, which have been demonstrated to boost output and sustain firm performance.
- SME financing instruments, such as loan guarantees, venture capital initiatives, and simplified access to EU structural funding.

By improving firm-level resilience, particularly in areas where smaller firms represent a substantial portion of economic activity, should boost regional resilience.

Tailoring Regional Development Strategies

The results of this research highlight the need for regional policy initiatives as opposed to standard national approaches. For instance:

- Targeted support for infrastructure investment, SME upgrading, and structural diversification may be needed in interior regions.
- Coastal regions may benefit from policies promoting export competitiveness, innovation, and integration into higher-value supply chains.

- Regions that rely heavily on tourism, such as Algarve and Região Autónoma da Madeira, may require stabilising tools that might lessen hardship when demand declines.
- Metropolitan regions require sectoral concentration monitoring, despite the typical higher resilience.

Differentiated strategies like those previously described acknowledge the diversity of regional economies and align with the EU's "place-based" approach to regional development.

Improving Data Infrastructure and Regional Analytical Capacity

The process of constructing the regional distress index revealed limitations regarding availability and granularity of regional sector-level financial data. Improving data systems would support better policy design. Key improvements include:

- Greater regional disaggregation of sector-level financial information, building on the Central Balance Sheet Database.
- The release of financial indicators for each region, which makes it possible to monitor weaknesses more closely.
- Integration of Instítuto Nacional de Estatística and Banco de Portugal datasets, allowing for more in-depth regional studies regional studies.
- Regular updates to regional economic risk dashboards that include distress indicators like those used in this dissertation.

Thus, enhancing analytical capacity at the national and regional levels would support forward-looking and evidence-based policies.

In conclusion, the findings suggest that policy interventions should consider the dual nature of regional financial distress – the influence of structural characteristics, such as structural composition and regional economic development, and cyclical macroeconomic shocks. Therefore, long-term structural strategies and short-run stabilisation tools must be combined in effective policymaking. The regional distress index developed in this dissertation offers a useful tool for tracking these vulnerabilities and incorporating it into regular policymaking could enhance the supervision of financial stability and regional planning.

Limitations

Besides the methodological rigor and the contribution of developing a regional financial distress index for Portugal, this dissertation faces several limitations that should be noted. They arise from the availability of data, methodological limits of sector-level aggregation, and the nature of econometric tools employed. Understanding these constraints is crucial for correctly interpreting the findings and guiding future research.

Limitations Related to Data Sources

The lack of sector-level financial data broken down at the regional level is the main drawback. The Sector Tables from Banco de Portugal provide aggregated financial data by CAE Rev.3 sector, however, these figures are not region-specific but represent sector-wide averages across the entire national economy. Consequently, the financial ratios used to compute the O-Score reflect national sectoral behaviour rather than the financial structure of firms operating in each region.

This limitation is especially important since regional variations in local costs, productivity or market circumstances might affect a sector's financial performance. Despite the weighting scheme partially mitigate this by accounting for regional turnover and firm counts, the inability to observe regional financial statements directly acts as a restriction for the precision of the index.

Furthermore, the Sector Tables for some sectors only provide partial coverage. Although the average number of available years is high, several sectors have shorter time spans, leading to lower number of observations for the distress estimation.

Limitations Arising from Sector-Level Aggregation

A second limitation arises from the usage of sector-level aggregated indicators instead of firm-level data. Given the availability of data, such aggregation is inevitable, but it implies:

- Intra-sector heterogeneity is lost – variation amongst companies in the same CAE Sector is hidden by sectoral averages. Some firms may be financially healthy while others are distressed, but the index merely shows the average condition.

- Possible sectoral non-linearity – since the O-Score is not always linear in sector size or financial ratios, having financial indicators aggregated before calculating the score may provide different outcomes than computing the score at firm-level and then proceeding with the aggregation.
- The presume of representativeness – the methodology implicitly assumes that the combined sectoral ratios approximate the "typical" financial structure of firms within that sector. This presumption may hold for large sectors but be less accurate for narrowly defined or extremely diverse industries.

These limitations must be considered when evaluating the findings, even if sector-level analysis is still often used in regional economic evaluations.

Limitations in Regional Weight Construction

Sectoral distress is converted into regional values using weights based on the number of firms and regional turnover, both of which are derived from Instítuto Nacional de Estatística. This approach has a number of constraints even if it offers a coherent way to reflect a sector's presence in each region:

- Some region-sector pairs, missing turnover numbers must be replaced by regional averages, potentially smoothing true variation.
- Financial exposure is not always captured by sector size. A region might have many small firms in a sector but low total turnover, or vice versa, affecting the resulting weights in a different way.
- Weights reflect economic structure, not financial structure. In other words, sectoral distress is inherited by regions in proportion to the sector's importance, but not always in proportion to the local financial circumstances of firms in that sector.

Although the weighting system is sound and internally consistent, it is important to acknowledge these conceptual limitations.

Limitations Related to the Distress Models Used

The distress analysis relies primarily on the O-Score, with the Z' and Z''-Scores only used for robustness check. Although the O-Score is widely used and capable of capturing several aspects of financial distress, it also has some constraints:

- Since it was developed using data from the United States between 1962 and 1975, there may be issues with its external validation.
- Some variables are imperfect proxies in aggregated data, such as change in net income calculated from sector averages rather than individual firm dynamics.
- The functional relationship assumed by the logistic form of probability estimation might not accurately represent the sector-level data environment.

Nevertheless, the O-Score continues to be the most suitable and empirically sound option given the constraints of available information.

Geographical and Structural Limitations

The NUTS III level is the most granular territory division for which consistent data are available over time. However, it implies certain constraints:

- Within-region heterogeneity cannot be captured. Large regions, such as the metropolitans, contain highly diversified sub-regions whose economic compositions vary substantially.
- The index reflects economic exposure, not actual sector-level distress, and therefore it should not be interpreted as a direct measure of solvency rates.
- Structural shocks in dominant sectors can disproportionately affect results, as was seen in Área Metropolitana de Lisboa in 2008 and 2016.

These restrictions suggests that the index does not directly evaluate firm-level financial health, but rather regional exposure to sectoral financial distress.

Methodological Scope

This dissertation deliberately avoids predictive modelling or causal inferences. Its descriptive goal is to map, measure and analyse the dynamics of regional financial distress. As a result:

- Regression analysis is not employed to separate causal effects.
- No forecasting is attempted.
- No structural model is estimated to quantify the contribution of specific variables.

These methodological decisions restrict the range of inference but ensures the analysis remains transparent and consistent with the available data.

While the dissertation faces meaningful constraints, primarily due to data availability and aggregation, none of these limitations compromises its central objective of constructing and analysing a sector-weighted measure of regional financial distress. Rather, they draw attention to areas where future research would benefit from better data availability or methodological improvements. The index remains a valuable descriptive tool and provides a basis for understanding how sectoral vulnerabilities translates into regional financial risk patterns throughout Portugal.

Conclusion

This dissertation sought to quantify and assess financial distress across Portuguese regions between 2008 and 2022 by integrating sector-level probability of distress indicators with regional economic weights. A regional distress index was created for all 25 NUTS III regions by combining aggregated sectoral financial ratios from Banco de Portugal's Central Balance Sheet Database with regional turnover and enterprise counts from Instítuto Nacional de Estatística. This concept enabled financial distress to be seen not just as a firm- or sector- level occurrence, but also as a geographically dispersed result dictated by economic structure, macroeconomic shocks, and regional specialisation.

The empirical findings shed light on the growth of regional financial risk in Portugal over the past decade and a half. First, the results shows significant geographical variation, notably between coastal and inland locations. Douro, Terras de Trás-os-Montes, Alto Alentejo, and Beiras e Serra da Estrela continuously exhibited higher distress levels, reflecting a structural reliance on industries with weaker financial indicators or greater cyclical volatility. Conversely, many coastal regions with more diverse economies and stronger service sectors have maintained lower distress levels throughout the period.

Second, the study shows significant evidence that systemic shocks cause simultaneous increases in distress across all regions. The 2011 sovereign-debt crisis serves as a clear example – distress levels grow dramatically in every NUTS III area, indicating that macroeconomic conditions have a significant impact on corporate financial stability. This behaviour aligns with the previous research on financial distress and credit cycles, suggesting that regional disparities narrow during crises because all areas are adversely impacted.

Third, the research emphasises the critical relevance of sectoral makeup in explaining regional results. The weighting technique used to create the index ensures that areas inherit the financial fragility of their dominating sectors. This dynamic is especially visible in Área Metropolitana de Lisboa, where two years – 2008 and 2016 – display exceptionally high distress indexes. These periods are driven not by broad regional degradation, but by the significant regional weight of a single ailing sector: Manufacture of Coke and Refined Petroleum Products. This demonstrates the broader principle that sectoral concentration may exacerbate regional financial risk, particularly when significant industries face severe financial difficulties.

Fourth, the findings indicate a significant post-pandemic convergence in 2022, with distress reaching historically low and very uniform levels across the country. This suggests that firms benefited from recovery measures, demand rebounds, and improved financial conditions. Importantly, even structurally weaker interior regions record some of their lowest levels of financial distress, showing that national support mechanisms and broad-based economy recovery significantly stabilised the corporate sector.

Fifth, the analytical framework developed in this research provides methodological support for the analysis of regional economic vulnerability. The technique combines sectoral financial distress metrics with region-specific economic weights to bridge the gap between firm-level risk assessment and regional resilience analysis. The resultant index provides a consistent and reproductible method to evaluate how regions are exposed to financial fragility based on their economic structure. This is a new contribution to Portuguese regional research, as firm-level financial data are typically unavailable at a granular geographic scale.

Overall, the data indicate that regional financial distress in Portugal is influenced by structural, sectoral, and cyclical factors. Long-term distress patterns are shaped by structural variables such as sectoral specialisation and geographic location, whereas national macroeconomic shocks apply broad and simultaneous stresses on all regions. Meanwhile, sector concentration allows individual industries to have a disproportionate impact on regional vulnerability.

Several broader implications emerge from the study. Regions with weaker or less diverse economic systems are consistently more susceptible, emphasising the necessity of policies focused on regional growth, diversification, and modernisation. Crisis experiences demonstrate the need for countercyclical financial support to alleviate widespread distress. Finally, the concentration effects reported in Área Metropolitana de Lisboa highlight the significance of monitoring sectoral clusters that might offer systemic risks.

To conclude, this research presents a thorough and empirically informed account of the geography of financial distress in Portugal throughout a period distinguished by economic crises, recovery phases, and structural transformation. By tying sectoral distress to regional structures, it provides a significant tool for understanding the spatial dimension of business susceptibility and for informing the design of policies aimed at strengthening regional economic resilience.

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Appendixes

Appendix 1: Sector Names

Sector Number	Sector Name
01	Crop and animal production, hunting and related service activities
07	Mining of metal ores
09	Mining support service activities
10	Manufacture of food product
11	Manufacture of beverages
12	Manufacture of tobacco products
13	Manufacture of textiles
14	Manufacture of wearing apparel
15	Manufacture of leather and related products
16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
17	Manufacture of paper and paper products
18	Printing and reproduction of recorded media
19	Manufacture of coke and refined petroleum products
20	Manufacture of chemicals and chemical products
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
22	Manufacture of rubber and plastic products
23	Manufacture of other non-metallic mineral products
24	Manufacture of basic metals
25	Manufacture of fabricated metal products, except machinery and equipment
26	Manufacture of computer, electronic and optical products
27	Manufacture of electrical equipment
28	Manufacture of machinery and equipment n.e.c.
29	Manufacture of motor vehicles, trailers and semi-trailers
30	Manufacture of other transport equipment
31	Manufacture of furniture
32	Other manufacturing
33	Repair and installation of machinery and equipment
35	Electricity, gas, steam and air conditioning supply
36	Water collection, treatment and supply
38	Waste collection, treatment and disposal activities; material recovery
41	Construction of buildings
42	Civil engineering
43	Specialised construction activities
45	Wholesale and retail trade and repair of motor vehicles and motorcycles
46	Wholesale trade, except of motor vehicles and motorcycles
47	Retail trade, except of motor vehicles and motorcycles
49	Land transport and transport via pipelines
50	Water transport
51	Air transport
52	Warehousing and support activities for transportation
53	Postal and courier activities
55	Accommodation
56	Food and beverages service activities
58	Publishing activities

59	Motion picture, video and television programme production, sound recording and music publishing activities
60	Programming and broadcasting activities
61	Telecommunications
62	Computer programming, consultancy and related activities
63	Information service activities
68	Real estate activities
69	Legal and accounting activities
70	Activities of head offices; management consultancy activities
71	Architectural and engineering activities; technical testing and analysis
73	Advertising and market research
74	Other professional, scientific and technical activities
77	Rental and leasing activities
78	Employment activities
79	Travel agency, tour operator and other reservation service and related activities
80	Security and investigation activities
81	Services to buildings and landscape activities
82	Office administrative, office support and other business support activities
85	Education
86	Human health activities
92	Gambling and betting activities
93	Sports activities and amusement and recreation activities
96	Other personal service activities

Appendix 2: Sectoral Coverage

Sector Number	**Years Available**	**Number of Regions with Data**	**Notes**
01	17	25	Missing 2 Years
07	6	14	Missing 13 Years & 11 Regions
09	6	21	Missing 13 Years & 4 Regions
10	18	25	Missing 1 Year
11	19	25	Full Coverage
12	4	5	Missing 15 Years & 20 Regions
13	19	25	Full Coverage
14	19	25	Full Coverage
15	19	25	Full Coverage
16	19	25	Full Coverage
17	19	25	Full Coverage
18	7	25	Missing 12 Years
19	5	20	Missing 14 Years & 5 Regions
20	19	25	Full Coverage
21	19	22	Missing 3 Regions
22	19	25	Full Coverage
23	19	25	Full Coverage
24	19	25	Full Coverage
25	19	25	Full Coverage
26	19	24	Missing 1 Region

27	19	25	Full Coverage
28	19	25	Full Coverage
29	19	25	Full Coverage
30	12	25	Missing 7 Years
31	19	25	Full Coverage
32	19	25	Full Coverage
33	19	25	Full Coverage
35	19	25	Full Coverage
36	19	25	Full Coverage
38	19	25	Full Coverage
41	19	25	Full Coverage
42	19	25	Full Coverage
43	19	25	Full Coverage
45	19	25	Full Coverage
46	19	25	Full Coverage
47	19	25	Full Coverage
49	19	25	Full Coverage
50	8	25	Missing 11 Years
51	19	19	Missing 6 Regions
52	19	25	Full Coverage
53	8	25	Missing 11 Years
55	19	25	Full Coverage
56	19	25	Full Coverage
58	19	25	Full Coverage
59	3	25	Missing 16 Years
60	8	25	Missing 11 Years
61	19	25	Full Coverage
62	19	25	Full Coverage
63	12	25	Missing 7 Years
68	15	25	Missing 4 Years
69	19	25	Full Coverage
70	19	25	Full Coverage
71	17	25	Missing 2 Years
73	7	25	Missing 12 Years
74	7	25	Missing 12 Years
77	7	25	Missing 12 Years
78	19	25	Full Coverage
79	7	25	Missing 12 Years
80	19	25	Full Coverage
81	19	25	Full Coverage
82	19	25	Full Coverage
85	19	25	Full Coverage
86	19	25	Full Coverage
92	14	25	Missing 5 Years
93	16	25	Missing 3 Years
96	7	25	Missing 12 Years
Average	15.9	24.2	
Median	19	25	
Maximum	19	25	
Minimum	3	5	

Appendix 3: Regional Coverage

Region	Average Number of Firms	Maximum Number of Firms	Average Sector Turnover	Average Missing Sectors per Year - Turnover
Alto Minho	3 485.19	5 526	€ 35 543 269.13	12.13
Cávado	2 646.75	6 576	€ 114 279 232.38	11.93
Ave	1 712.25	6 390	€ 62 316 563.38	10.93
Área Metropolitana do Porto	5 063.06	41 539	€ 242 144 654.00	9.53
Alto Tâmega	3 604.38	5 364	€ 26 778 960.38	16.27
Tâmega e Sousa	3 088.50	6 685	€ 45 444 358.38	10.93
Douro	1 0628.13	15 687	€ 162 317 079.25	15.20
Terras de Trás-os-Montes	7 179.31	10 531	€ 67 364 551.25	19.00
Oeste	5 366.38	6 993	€ 724 959 382.85	18.47
Região de Aveiro	2 321.44	7 190	€ 80 325 218.23	17.40
Região de Coimbra	3 223.25	8 547	€ 121 369 922.00	19.40
Região de Leiria	1 357.25	5 419	€ 259 552 016.62	19.87
Viseu Dão Lafões	3 232.44	4 759	€ 182 873 828.46	21.20
Beira Baixa	970.13	1 506	€ 36 056 099.00	21.27
Médio Tejo	1 028.13	4 275	€ 134 068 207.08	17.13
Beiras e Serra da Estrela	4 065.31	5 625	€ 70 084 632.85	20.27
Área Metropolitana de Lisboa	5 489.75	92 564	€ 521 387 110.87	4.53
Alentejo Litoral	1 854.69	1 994	€ 322 385 818.07	23.73
Baixo Alentejo	4 258.25	5 097	€ 437 054 669.27	26.60
Lezíria do Tejo	3 297.13	4 007	€ 565 439 192.13	21.20
Alto Alentejo	2 537.06	3 094	€ 166 518 353.00	22.47
Alentejo Central	3 450.56	3 957	€ 287 858 214.93	24.00
Algarve	3 756.25	13 183	€ 179 810 657.57	21.33
Região Autónoma dos Açores	6 242.63	6 907	€ 262 560 813.36	27.00
Região Autónoma da Madeira	3 243.00	4 711	€ 45 065 411.86	27.93

Appendix 5: Variable Statistics

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
WC_A	1 047	0.1254	0.1389	- 0.7148	0.6736
RRE_A	1 047	0.0335	0.1995	- 1.8951	0.3874
EBIT_A	1 047	0.0359	0.0526	- 0.8720	0.4111
E_L	1 047	0.5412	0.3059	- 0.2182	3.3972
T_A	1 047	0.7562	0.3982	0.0017	2.9852
L_A	1 047	0.6712	0.1201	0.2274	1.2791
NI_A	1 047	0.1393	0.0516	- 0.8871	0.3953
CL_CA	1 047	0.8240	0.3225	0.1356	3.5365
D_E	1 047	0.0067	0.0815	0	1
C_NI	981	0.0503	0.5052	- 1	1
NI2Y	1 047	0.1710	0.3767	0	1
logA	1 047	14.7049	1.4275	9.1470	18.3877

Score	Observations	Mean	Standard Deviation	Minimum	Maximum
Z'-score	1 047	1.2119	0.5903	- 3.0183	3.1644
Z''-score	1 047	4.9917	1.6797	- 6.3904	8.8877
O-score	981	- 3.4324	1.2127	- 6.6912	3.8580
P(Distress)	981	0.0576	0.0924	0.0012	0.9793

Appendix 6: Panel Structure

Reason For Removal	Number of Observations
Missing Financial Ratio in Sector-Year	284
Missing Turnover in Region-Year	672
Sectors Not Present in Region	770
Final Dataset	23 024 (= 66 Sectors * 15 Years * 25 Regions – Missing Observations)

Appendix 7: Weights Computation

Region	Year	Sector	Sector Turnover	Sector Number of Firms	Sector Average Turnover (SAT) (= ST / SNF)	Sector Average Turnover Applied* (SATA)	Region Average Turnover (RAT) (= Σ SAT + Σ SATA)	Weight (= SAT / RAT)
Douro	2008	01	€ 124 049 485	2 127	€ 58 321.34		€ 25 780 563.37	0.23%
Douro	2008	07		1		€ 107 849.00	€ 25 780 563.37	0.42%
Douro	2008	09		1		€ 107 849.00	€ 25 780 563.37	0.42%
Douro	2008	10	€ 77 446 092	261	€ 296 728.32		€ 25 780 563.37	1.15%
Douro	2008	11	€ 200 447 511	177	€ 1 132 471.81		€ 25 780 563.37	4.39%
Douro	2008	12	€ -	0	€ -	€ -	€ -	-
Douro	2008	13	€ 201 035	12	€ 16 752.92		€ 25 780 563.37	0.06%
Douro	2008	14	€ 450 313	56	€ 8 041.30		€ 25 780 563.37	0.03%
Douro	2008	15		2		€ 107 849.00	€ 25 780 563.37	0.42%
Douro	2008	16	€ 9 692 301	121	€ 80 101.66		€ 25 780 563.37	0.31%
Douro	2008	17		2		€ 107 849.00	€ 25 780 563.37	0.42%
Douro	2008	18	€ 2 761 588	21	€ 131 504.19		€ 25 780 563.37	0.51%
Douro	2008	19	€ -	0	€ -	€ -	€ -	-
Douro	2008	20	€ 4 827 926	9	€ 536 436.22		€ 25 780 563.37	2.08%
Douro	2008	21	€ -	0	€ -	€ -	€ -	-
Douro	2008	22		6		€ 107 849.00	€ 25 780 563.37	0.42%
Douro	2008	23		66		€ 107 849.00	€ 25 780 563.37	0.42%
Douro	2008	24	€ 92 761	5	€ 18 552.2		€ 25 780 563.37	0.07%
Douro	2008	25	€ 26 875 782	244	€ 110 146.65		€ 25 780 563.37	0.43%
Douro	2008	26	€ 16 195 766	3	€ 5 398 588.67		€ 25 780 563.37	20.94%
Douro	2008	27		3		€ 107 849.00	€ 25 780 563.37	0.42%
Douro	2008	28	€ 761 698	9	€ 84 633.11		€ 25 780 563.37	0.33%
Douro	2008	29	€ 1 111 309	6	€ 185 218.17		€ 25 780 563.37	0.72%
Douro	2008	30	€ -	0	€ -	€ -	€ -	-
Douro	2008	31	€ 2 910 254	44	€ 66 142.14		€ 25 780 563.37	0.26%

Douro	2008	32	€ 3 456 550	19	€ 181 923.68		€ 25 780 563.37	0.71%
Douro	2008	33	€ 1 058 306	18	€ 58 794.78		€ 25 780 563.37	0.23%
Douro	2008	35	€ 28 553 528	9	€ 3 172 614.22		€ 25 780 563.37	12.31%
Douro	2008	36	€ 22 151 960	3	€ 7 383 986.67		€ 25 780 563.37	28.64%
Douro	2008	38	€ 16 735 129	13	€ 1 287 317.62		€ 25 780 563.37	4.99%
Douro	2008	41	€ 148 355 864	1 090	€ 136 106.30		€ 25 780 563.37	0.53%
Douro	2008	42	€ 62 637 098	93	€ 673 517.18		€ 25 780 563.37	2.61%
Douro	2008	43	€ 49 025 071	810	€ 60 524.78		€ 25 780 563.37	0.23%
Douro	2008	45	€ 168 427 176	653	€ 257 928.29		€ 25 780 563.37	1.00%
Douro	2008	46	€ 277 637 736	764	€ 363 400.18		€ 25 780 563.37	1.41%
Douro	2008	47	€ 529 912 911	3 610	€ 146 790.28		€ 25 780 563.37	0.57%
Douro	2008	49		557		€ 107 849.00	€ 25 780 563.37	0.42%
Douro	2008	50		1		€ 107 849.00	€ 25 780 563.37	0.42%
Douro	2008	51	€ -	0	€ -	€ -	€ -	-
Douro	2008	52		18		€ 107 849.00	€ 25 780 563.37	0.42%
Douro	2008	53		2		€ 107 849.00	€ 25 780 563.37	0.42%
Douro	2008	55	€ 13 461 188	162	€ 83 093.75		€ 25 780 563.37	0.32%
Douro	2008	56	€ 82 117 216	1 694	€ 48 475.33		€ 25 780 563.37	0.19%
Douro	2008	58	€ 1 184 522	16	€ 74 032.63		€ 25 780 563.37	0.29%
Douro	2008	59	€ 384 735	20	€ 19 236.75		€ 25 780 563.37	0.07%
Douro	2008	60	€ 487 865	7	€ 69 695.00		€ 25 780 563.37	0.27%
Douro	2008	61	€ 464 299	8	€ 58 037.38		€ 25 780 563.37	0.23%
Douro	2008	62	€ 2 488 552	48	€ 51 844.83		€ 25 780 563.37	0.20%
Douro	2008	63	€ 123 435	4	€ 30 858.75		€ 25 780 563.37	0.12%
Douro	2008	68	€ 15 182 597	197	€ 77 069.02		€ 25 780 563.37	0.30%
Douro	2008	69	€ 15 730 004	655	€ 25 541.99		€ 25 780 563.37	0.10%
Douro	2008	70	€ 4 266 478	124	€ 34 407.08		€ 25 780 563.37	0.13%
Douro	2008	71	€ 18 141 664	514	€ 35 295.07		€ 25 780 563.37	0.14%
Douro	2008	73	€ 1 627 714	34	€ 47 873.94		€ 25 780 563.37	0.19%
Douro	2008	74	€ 4 429 052	86	€ 51 500.60		€ 25 780 563.37	0.20%
Douro	2008	77	€ 8 014 518	96	€ 83 484.56		€ 25 780 563.37	0.32%

Douro	2008	78	€ 8 035 014	7	€ 1 147 859.14		€ 25 780 563.37	4.45%
Douro	2008	79	€ 15 353 070	39	€ 393 668.46		€ 25 780 563.37	1.53%
Douro	2008	80		5		€ 107 849.00	€ 25 780 563.37	0.42%
Douro	2008	81		58		€ 107 849.00	€ 25 780 563.37	0.42%
Douro	2008	82	€ 12 593 847	1 315	€ 9 577.07		€ 25 780 563.37	0.04%
Douro	2008	85	€ 10 538 225	1 217	€ 8 659.18		€ 25 780 563.37	0.03%
Douro	2008	86	€ 37 504 557	873	€ 42 960.55		€ 25 780 563.37	0.17%
Douro	2008	92		7		€ 107 849.00	€ 25 780 563.37	0.42%
Douro	2008	93	€ 2 317 063	143	€ 16 203.24		€ 25 780 563.37	0.06%
Douro	2008	96	€ 11 439 289	775	€ 14 760.37		€ 25 780 563.37	0.06%

Appendix 8: Regional Distress Index

Region	Y2008	Y2009	Y2010	Y2011	Y2012	Y2013	Y2014	Y2015	Y2016	Y2017	Y2018	Y2019	Y2020	Y2021	Y2022
Alentejo Central	6,17%	6,29%	3,14%	6,56%	3,75%	3,50%	3,49%	3,61%	15,14%	3,40%	6,81%	2,80%	2,50%	1,73%	2,25%
Alentejo Litoral	3,30%	6,37%	3,18%	3,92%	3,32%	6,62%	5,81%	6,45%	4,36%	4,79%	5,22%	5,11%	1,39%	3,45%	2,41%
Algarve	11,31%	7,88%	10,38%	13,58%	7,65%	8,56%	8,43%	6,25%	6,00%	5,63%	5,13%	3,37%	3,59%	2,40%	2,51%
Alto Alentejo	6,87%	6,08%	4,45%	5,30%	3,41%	6,25%	2,29%	2,75%	3,23%	2,95%	1,97%	1,72%	1,26%	1,27%	1,37%
Alto Minho	6,31%	5,30%	4,41%	5,32%	5,65%	3,82%	3,46%	3,08%	3,53%	3,93%	3,94%	3,37%	1,62%	1,56%	1,81%
Alto Tâmega	5,82%	5,56%	5,30%	8,34%	8,69%	4,02%	3,94%	3,36%	3,66%	2,56%	2,82%	1,90%	1,94%	1,37%	1,34%
Ave	8,13%	7,96%	6,41%	6,03%	7,01%	4,72%	5,41%	4,19%	5,42%	3,12%	4,13%	2,83%	2,05%	1,79%	1,87%
Baixo Alentejo	6,51%	5,45%	4,75%	8,03%	4,75%	4,49%	4,85%	3,90%	4,28%	3,82%	3,22%	0,19%	1,88%	1,65%	0,09%
Beira Baixa	3,75%	6,64%	2,94%	6,47%	8,41%	2,90%	3,50%	2,49%	3,77%	2,48%	3,43%	2,53%	2,74%	1,33%	1,67%
Beiras e Serra da Estrela	6,79%	7,16%	4,49%	6,90%	4,82%	4,37%	7,01%	2,82%	3,68%	2,62%	3,17%	1,94%	1,50%	1,62%	1,92%
Cávado	8,44%	8,38%	6,27%	5,73%	6,06%	3,67%	6,43%	5,07%	3,54%	3,36%	3,82%	2,39%	2,34%	1,90%	1,94%
Douro	10,33%	9,24%	7,96%	8,52%	8,24%	8,28%	4,43%	3,70%	3,36%	2,98%	3,38%	2,12%	2,28%	1,86%	1,39%
Lezíria do Tejo	6,71%	5,37%	4,38%	6,79%	5,24%	3,66%	6,84%	3,57%	4,55%	2,96%	2,91%	2,53%	1,90%	1,58%	1,78%
Médio Tejo	4,91%	5,06%	5,01%	7,11%	6,74%	4,10%	4,39%	3,46%	4,10%	4,44%	3,72%	2,78%	2,49%	1,75%	1,97%
Oeste	6,69%	7,60%	6,81%	7,95%	6,65%	5,34%	4,85%	3,60%	3,87%	3,71%	3,70%	2,17%	2,04%	1,88%	2,02%
Região Autónoma da Madeira	8,81%	7,94%	6,40%	8,98%	5,78%	5,80%	4,15%	3,82%	5,02%	5,79%	4,60%	3,38%	3,20%	2,62%	1,91%
Região Autónoma dos Açores	7,08%	3,70%	6,29%	9,47%	5,23%	5,69%	4,56%	4,30%	5,14%	12,36%	4,67%	3,48%	3,02%	2,44%	4,47%
Região de Aveiro	6,13%	6,22%	5,41%	7,14%	5,90%	5,03%	5,55%	3,31%	3,46%	3,71%	4,37%	3,00%	3,10%	2,30%	2,36%
Região de Coimbra	4,09%	6,32%	2,99%	5,97%	7,50%	2,33%	3,79%	2,29%	3,62%	4,72%	3,99%	2,70%	2,79%	1,72%	1,91%
Região de Leiria	7,49%	7,07%	5,50%	8,19%	5,29%	4,44%	6,55%	3,53%	3,80%	3,94%	3,86%	2,69%	2,54%	2,09%	1,54%
Terras de Trás-os-Montes	10,22%	5,70%	9,38%	6,58%	10,42%	5,92%	4,30%	5,44%	4,44%	5,29%	4,69%	2,21%	3,36%	1,95%	1,34%
Tâmega e Sousa	8,43%	8,10%	5,60%	7,36%	7,52%	5,81%	7,00%	4,06%	5,13%	3,07%	4,23%	2,84%	2,30%	1,69%	1,78%
Viseu Dão Lafões	8,16%	7,00%	5,96%	6,06%	7,58%	4,82%	4,54%	4,08%	5,12%	3,73%	3,48%	3,67%	1,83%	1,46%	3,84%
Área Metropolitana de Lisboa	88,57%	5,98%	6,67%	7,78%	3,95%	3,16%	3,04%	4,17%	23,79%	1,11%	1,57%	1,40%	3,19%	0,88%	0,41%
Área Metropolitana do Porto	9,00%	11,61%	6,09%	8,35%	5,96%	4,98%	6,11%	3,90%	5,08%	4,20%	4,71%	3,18%	3,58%	2,49%	2,02%
Average	10,40%	6,80%	5,61%	7,30%	6,22%	4,89%	4,99%	3,89%	5,48%	4,03%	3,90%	2,65%	2,42%	1,87%	1,92%

Appendix 9: Robustness Checks

Table 9.1 – Correlation Between Regional Distress Index and Alternative Z-Score Aggregations

Correlation Matrix	P_Distress_reg	Z'_Score_reg	Z''_Score_reg
P_Distress_reg	1.000	-0.630	-0.837
Z'_Score_reg	-0.630	1.000	0.896
Z''_Score_reg	-0.837	0.896	1.000

Notes:

- Correlation shown for 25 NUTS III regions, averaged across years
- Negative correlations with Z-Scores are expected, as higher Z-Scores values indicate lower distress
- Higher correlation between Z'_Score_reg and Z''_Score_reg reflects similar methodology

Table 9.2 – Rank Correlations Across Methods

Correlation Matrix	Rank_P_Distress	Rank_Z'_Score	Rank_Z''_Score
Rank_P_Distress	1.000	0.362	0.594
Rank_Z'_Score	0.362	1.000	0.851
Rank_Z''_Score	0.594	0.851	1.000

Notes:

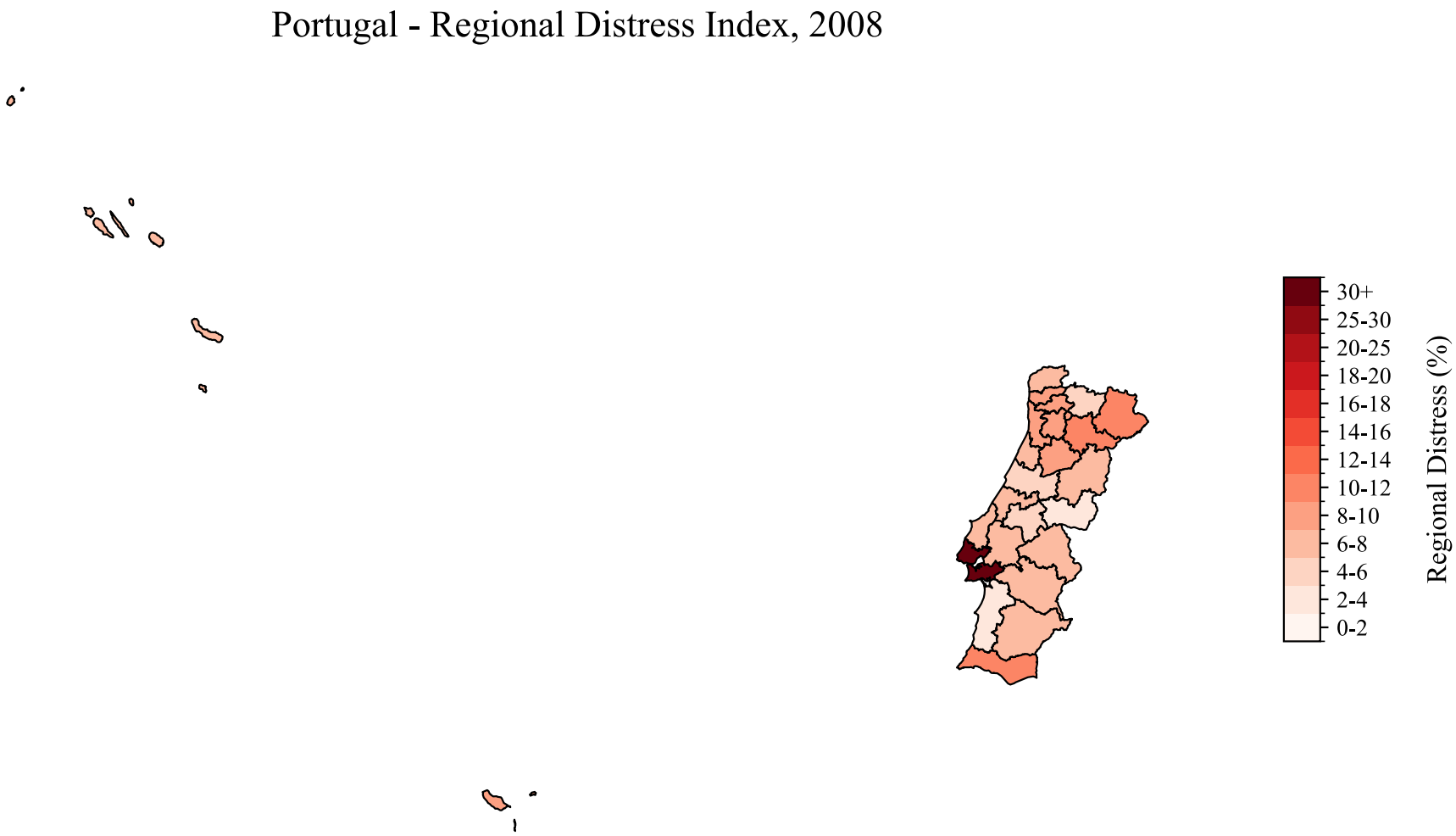
- Ranks computed for each region's average score between 2008-2022
- A moderate rank correlation (0.36-0.59) concludes that regions' positions change depending on the distress metric

Table 9.3 – Robustness Rank Changes per Region

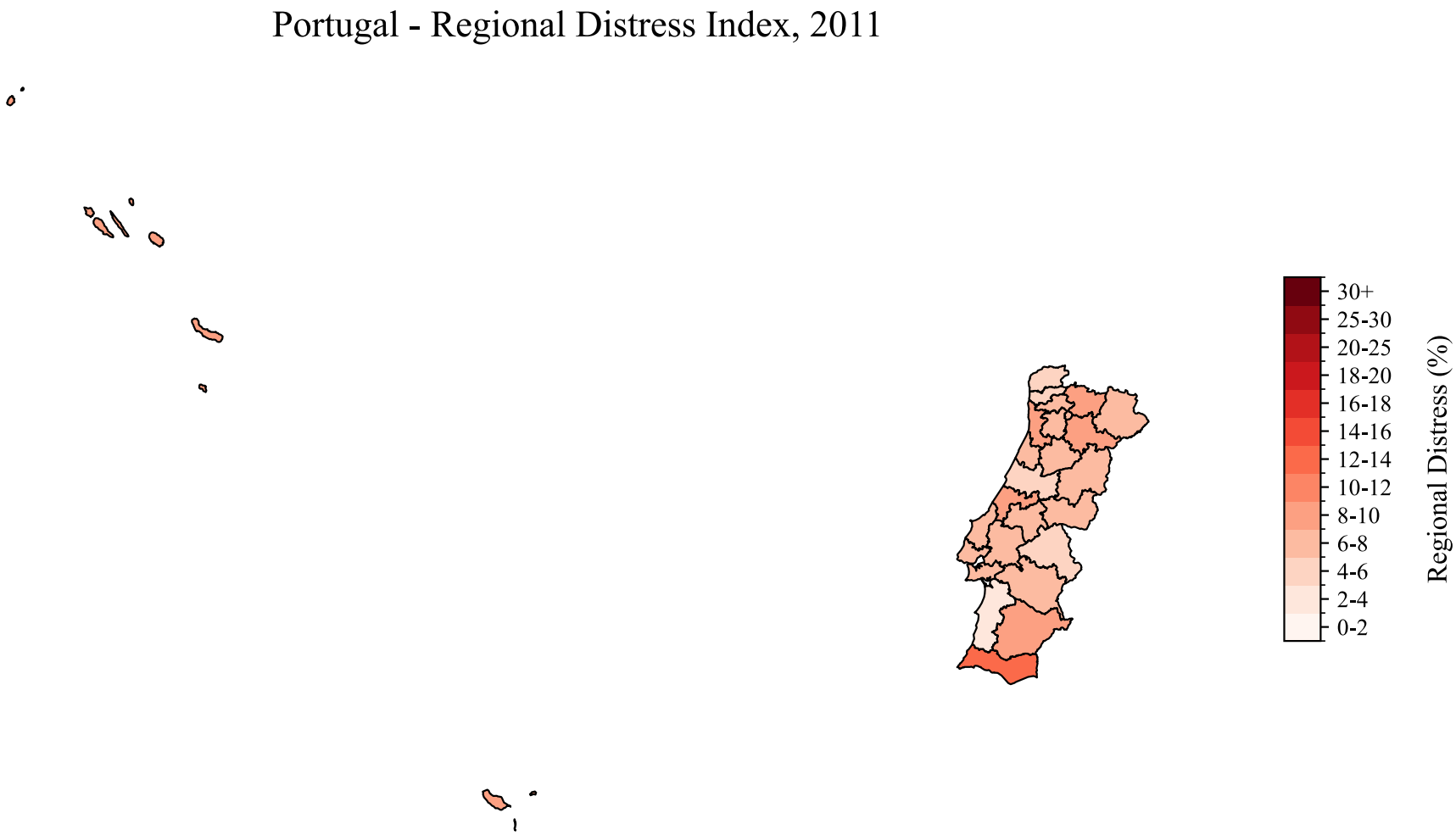
Region	Rank P-Distress	Rank_Z'-Score	Rank Z''-Score	Max Change
Alentejo Central	10	10	7	3
Alentejo Litoral	16	9	10	7
Algarve	2	7	5	5
Alto Alentejo	25	20	21	5
Alto Minho	22	24	25	3
Alto Tâmega	20	6	16	14
Ave	11	23	23	12
Baixo Alentejo	21	4	4	17
Beira Baixa	24	17	20	7
Beiras e Serra da Estrela	18	13	17	5
Cávado	12	18	24	12
Douro	7	5	6	2
Lezíria do Tejo	19	14	11	8
Médio Tejo	17	16	15	2
Oeste	13	8	9	5
Região Autónoma da Madeira	6	3	3	3
Região Autónoma dos Açores	3	2	2	1
Região de Aveiro	15	12	13	3
Região de Coimbra	23	21	22	2
Região de Leiria	14	15	14	1
Terras de Trás-os-Montes	5	25	12	20
Tâmega e Sousa	8	19	19	11
Viseu Dão Lafões	9	22	18	13
Área Metropolitana de Lisboa	1	1	1	0
Área Metropolitana do Porto	4	11	8	7

Appendix 10: Regional Distress Index – Maps

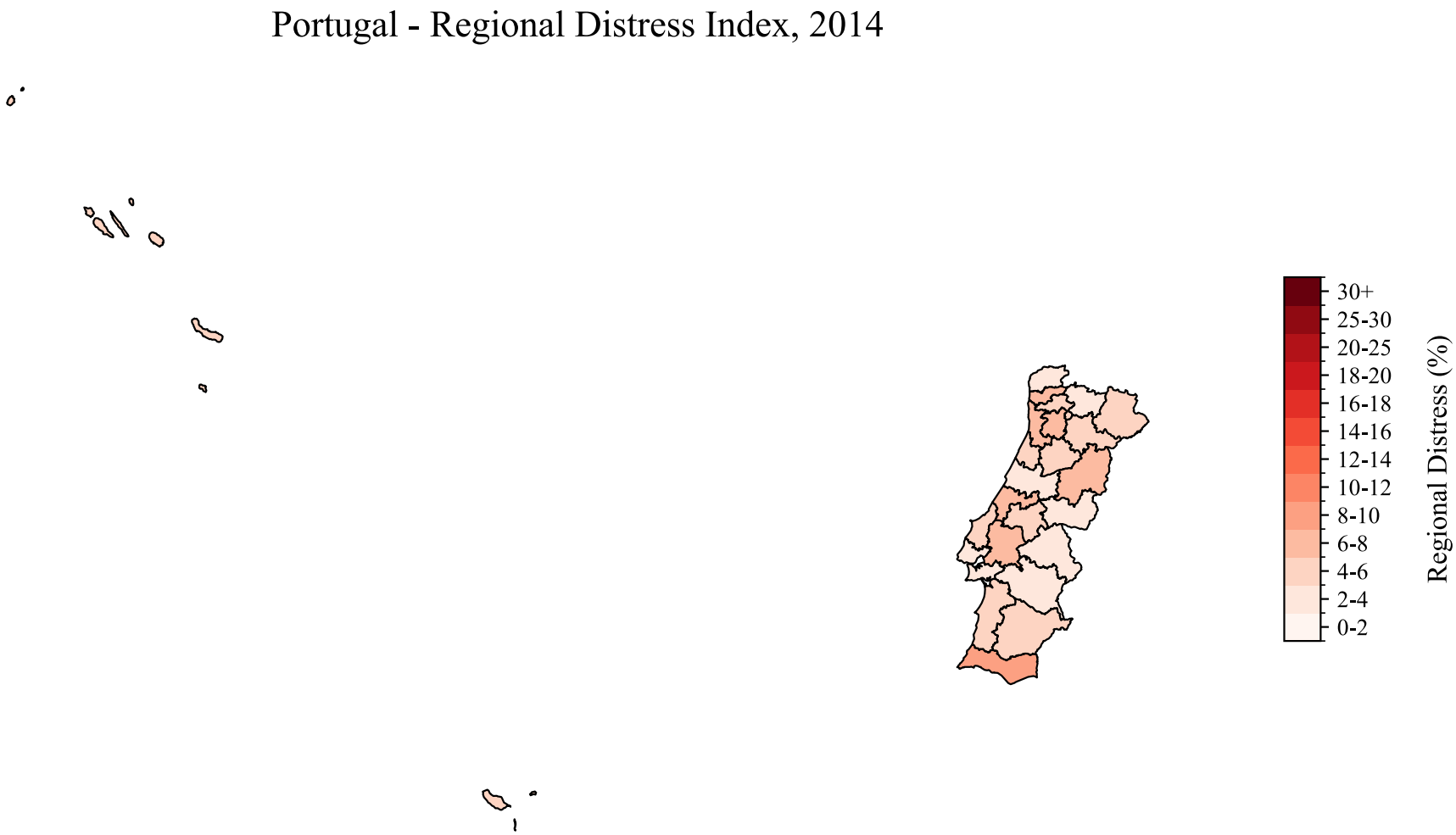
Map 10.1: Regional Distress Index Map – 2008



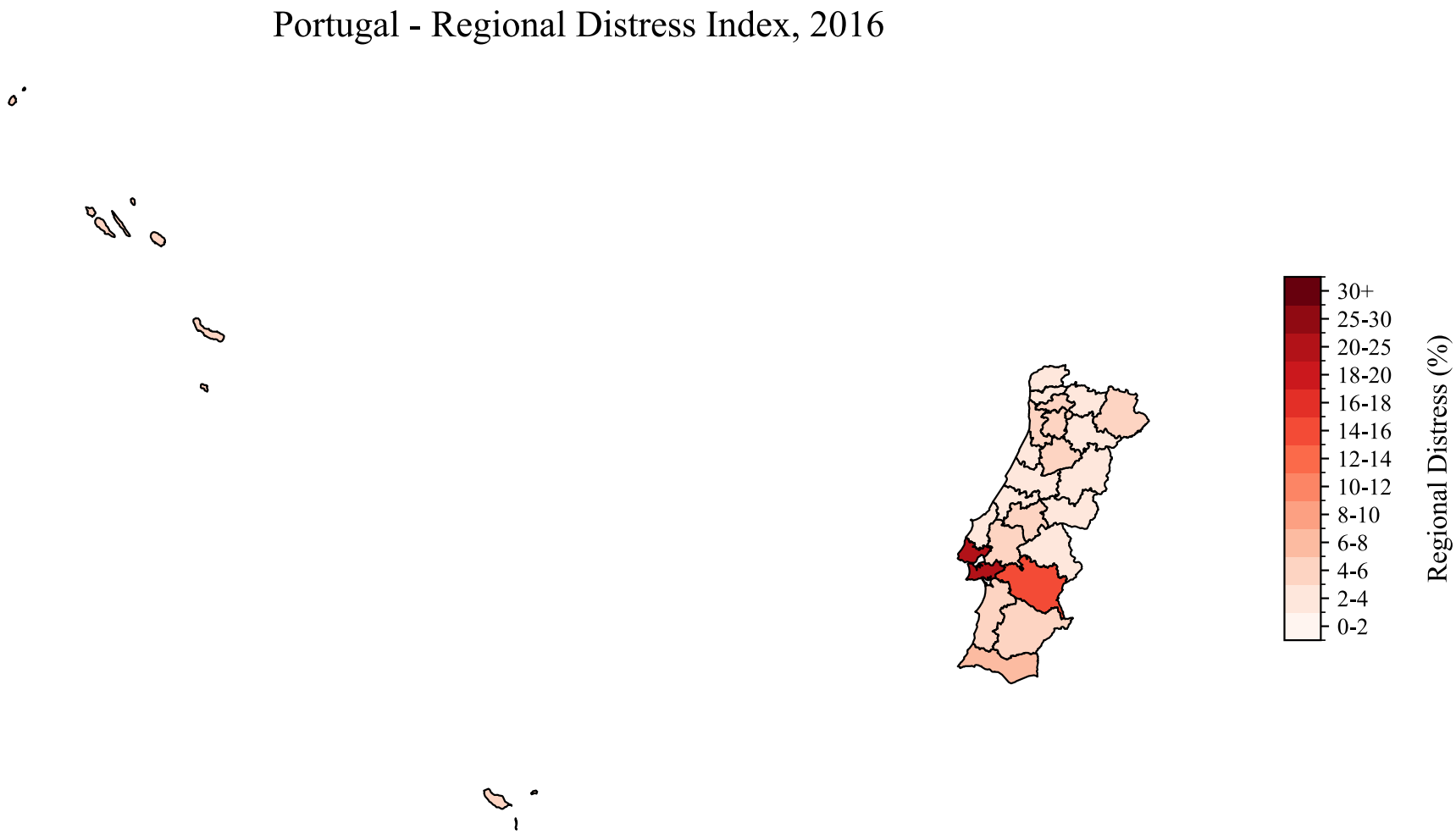
Map 10.2: Regional Distress Map – 2011



Map 10.3: Regional Distress Map – 2014



Map 10.4: Regional Distress Map – 2016



Map 10.5: Regional Distress Map – 2022