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Teacher Salaries in Portugal

A Data-Driven Analysis of Macroeconomic Alignment

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Teacher Salaries in Portugal: A Data-Driven Analysis of Macroeconomic Alignment

by

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Project Work presented as partial requirement for obtaining the Master's degree in Information Management, with a specialization in Business Intelligence

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April, 2026

STATEMENT OF INTEGRITY

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

Lisbon, 24 April 2026

Carolina Ferreira Mateus

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ABSTRACT

Remuneration is widely acknowledged as a key factor influencing the attractiveness, sustainability, and long-term stability of the teaching profession. However, existing research often examines teacher salaries primarily from organizational and policy perspectives, while their relationship with broader macroeconomic dynamics remains relatively underexplored. This study addresses this gap by examining whether the statutory salaries of teachers and school heads in Portugal evolved in alignment with key macroeconomic indicators between 2021 and 2024. The analysis integrates salary data with indicators reflecting economic performance, labor market dynamics, and cost-of-living pressures, including inflation, GDP per capita, national average wages, and housing prices. Methodologically, the research follows a Design Science Research approach and develops a Business Intelligence dashboard as an analytical artifact that enables the integration, visualization, and exploration of heterogeneous datasets within a unified analytical environment. The findings indicate that although statutory salaries increased in nominal terms across all teaching career stages, these adjustments were insufficient to offset inflation and rising living costs, resulting in a decline in real purchasing power. In addition, salary growth remained below the broader labor market's national average wage growth, contributing to a deterioration in the profession's relative economic position. By integrating educational remuneration data with macroeconomic indicators through a Business Intelligence framework, this study proposes a replicable analytical approach that supports more transparent and evidence-based policy analysis in education systems.

KEYWORDS

Teacher Remuneration; Macroeconomic Indicators; Education Policy; Eurydice Data; Design Science Research; Business Intelligence

Sustainable Development Goals (SDG):

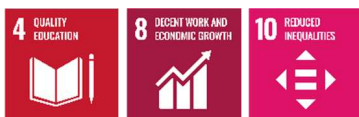


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LIST OF ABBREVIATIONS AND ACRONYMS

BI	Business Intelligence
COFOG	Classification of the Functions of Government
CPI	Consumer Price Index
DSR	Design Science Research
DSRM	Design Science Research Methodology
DW	Data Warehouse
EACEA	European Education and Culture Executive Agency
ETL	Extract, Transform, Load
GDP	Gross Domestic Product
INE	National Institute of Statistics (Statistics Portugal)
ISCED	International Standard Classification of Education
IT	Information Technology
PPP	Purchasing Power Parity
PPS	Purchasing Power Standards
SQL	Structured Query Language



1. INTRODUCTION

Recent research suggests that teachers' salary levels are an important factor associated with motivation, job satisfaction, and turnover intention (Nguyen et al., 2023; Zhou & Ma, 2022). In addition to remuneration, comparative evidence suggests that teacher shortages are shaped by combinations of broader labor-market conditions and school-level working conditions (Gorard et al., 2025). In Portugal, concerns about the future of the teaching profession have intensified due to mass retirement and a decline in candidates, which the literature associates with low professional attractiveness, deteriorating working conditions, and a negative social image of teaching (Flores et al., 2025). While individual incentive reforms in the public sector have been examined in policy-oriented analyses (Martins & Ferreira, 2025), much of the existing literature focuses on the social and organizational consequences of remuneration rather than on its macroeconomic implications. Although some research addresses education spending within macroeconomic models (Amaxhekaj et al., 2024; Coronel & Díaz-Roldán, 2024), the specific alignment of teacher salary trajectories with national macroeconomic dynamics remains an area that warrants further empirical investigation.

Despite the availability of datasets for teacher salary structures and for economic indicators, few studies systematically integrate these two sources to examine whether the evolution of teachers' and school heads' salaries is coherent with national economic dynamics. Current research tends to analyze remuneration in isolation, leaving a clear analytical gap in understanding its relationship with indicators such as inflation, Gross Domestic Product (GDP) per capita, cost of living, and labor market conditions. This study addresses this gap through the following research question: *“To what extent do teachers' and school heads' salaries in Portugal reflect and evolve in relation to key macroeconomic indicators?”* To address this question, the study pursues three main objectives: (i) to analyze the evolution of teachers' and school heads' salaries in Portugal using open data from Eurydice, complemented by macroeconomic indicators from Eurostat and Statistics Portugal (INE - National Institute of Statistics), (ii) to examine the relationships between salary evolution and key national economic indicators, assessing their coherence and (iii) to design and validate a Power BI dashboard as a data-driven artifact that integrates educational and economic data, supporting evidence-based analysis and policymaking in education.

This research follows the Design Science Research Methodology (DSRM) as articulated by Peffers et al. (2007) to guide the design, development, and evaluation of a Power BI dashboard as the central research artifact. The DSRM provides a structured six-phase process that integrates theoretical rigor with practical validation, ensuring the artifact's scientific relevance and applicability. During the design and development phase, the process is complemented by the Kimball Data Warehouse (DW) / Business Intelligence (BI) Lifecycle (Kimball & Ross, 2013), which supports the



technical implementation through robust data modeling, dimensional design, and integration best practices.

In line with the Design Science Research (DSR) framework, the study's main research output corresponds to an instantiation, as defined by March & Smith (1995), representing the realization of a functional analytical artifact within its intended operational environment.

This thesis is organized as follows. Chapter 1 introduces the research context, outlines the problem and motivation, and presents the research question and objectives. Chapter 2 reviews the relevant literature on teacher remuneration, macroeconomic indicators, and the role of BI in education policy analysis, identifying the main gaps addressed by this study. Chapter 3 describes the research methodology, detailing the DSRM adopted, the data sources, the data integration and modeling processes, and the development of the analytical artifact. Chapter 4 presents the empirical results and discussion, including the dashboard implementation, analysis of findings in relation to the research objectives and the existing literature, and a scenario-based evaluation of the artifact. Finally, Chapter 5 concludes the thesis by summarizing the main contributions, discussing limitations, and outlining directions for future research.



2. LITERATURE REVIEW

This chapter reviews the literature relevant to the analysis of teachers' and school heads' remuneration in relation to broader macroeconomic dynamics. It synthesizes research on teacher salary structures, macroeconomic indicators influencing wage evolution, and the use of BI and analytics in education policy analysis.

2.1 UNDERSTANDING TEACHER REMUNERATION

Recent evidence shows that perceptions of salary fairness and higher salary satisfaction are associated with lower turnover intention among teachers (Zhou & Ma, 2022). Moreover, evidence from school finance reforms suggests that increases in district resources, often channeled into teacher pay, are associated with higher salaries and lower turnover, although effects may take several years to materialize (Nguyen et al., 2023). At the same time, insufficient remuneration and prolonged salary stagnation intensify financial strain and contribute to heightened stress, burnout, and diminished professional performance (Rueda et al., 2024; Semel et al., 2025). Research further indicates that competitive remuneration, adjusted to local living and working conditions, is essential not only for attracting new candidates but also for ensuring an equitable distribution of teachers and sustaining the long-term supply of qualified professionals (Berman & DeFeo, 2024).

According to the EACEA/Eurydice (2021), teacher remuneration structures across Europe extend beyond base salary to include career progression models, statutory allowances, and cost-of-living related adjustments. The report highlights substantial cross-country variation: while some European systems offer multi-level career structures with distinct roles, others, such as Portugal, operate within a single-level horizontal structure primarily organized around salary progression steps. Within the European context, the Portuguese system is distinctive in requiring the cumulative fulfillment of years of service, continuous professional development, and performance evaluation as formal conditions for salary progression. This rigidity contrasts with systems allowing more flexible or faster advancement.

Data indicate that Portugal possesses one of the most aged teaching workforces in Europe, with nearly half of its professionals aged 50 or over and a significant cohort approaching retirement age, a trend that coincides with a sharp decline in candidates entering initial teacher education (EACEA/Eurydice, 2021; Flores et al., 2025). Evidence from Eurydice further reveals a striking discrepancy between teachers' relative salary levels and their perceived financial satisfaction. In 2018, only 9.4% of Portuguese teachers reported being satisfied with their salary, one of the lowest levels recorded in Europe. Furthermore, the appeal of the career is undermined by challenging working conditions, characterized by high levels of stress, administrative workload, and limited career prospects (EACEA/Eurydice, 2021; Thomas Dotta et al., 2025). In the Portuguese context, this systemic vulnerability is particularly critical among younger professionals, reflected in a high prevalence of fixed-term contracts



affecting approximately 80% of teachers under the age of 35 (EACEA/Eurydice, 2021). Consequently, the aging demographic profile and insufficient long-term policy responses threaten the sustainability of the teaching profession in Portugal (Flores et al., 2025).

2.2 THE MACROECONOMIC LANDSCAPE SHAPING SALARIES

Comparative analyses emphasize that cross-country salary comparisons should be adjusted using Purchasing Power Parity (PPP), as differences in price levels substantially influence the interpretation of living standards and real income levels (Bilkova, 2020). Within this context, Portugal presents an apparent paradox. In 2018, although teachers' statutory salaries appeared relatively high when measured against national GDP per capita (+46.4%), the growth of teacher salaries has not kept pace with overall economic performance since 2009. In the absence of adjustments that keep pace with inflation and rising living costs, this divergence has progressively eroded teachers' real purchasing power. Consequently, despite seemingly competitive salary levels in relative macroeconomic terms, the effective value of teachers' earnings has declined over time, helping to explain the very low levels of salary satisfaction observed among Portuguese teachers, with only 9.4% reporting satisfaction in 2018, when compared with Northern European education systems (EACEA/Eurydice, 2021).

Beyond the dynamics of purchasing power and macroeconomic performance, government expenditure on education also plays a critical role in shaping remuneration outcomes. Although increased public investment in education is traditionally associated with improved economic performance, evidence from developed and transition economies underscores that its effectiveness critically depends on institutional quality and the strategic allocation of resources (Amahkekaj et al., 2024; Coronel & Díaz-Roldán, 2024). Consequently, macroeconomic indicators provide essential insight into the extent to which compensation aligns with broader economic maturity (Bilkova, 2020) and with the competitive demands of the graduate labor market (See et al., 2020).

Research further indicates that public sector compensation systems are neither fully autonomous nor inflexible, as wage determination is influenced by competitive pressures across sectors, such that, when private or non-profit labor markets offer higher salaries, public wages tend to adjust upward to prevent labor outflows and maintain workforce stability (Langbein & Roberts, 2023). However, teacher salaries in the Portuguese public sector have traditionally been based on seniority and formal qualifications rather than output-based performance, prior to the introduction of individual incentive reforms (Martins & Ferreira, 2025). During periods of economic downturn or fiscal consolidation, public wages often stagnate or freeze, decoupling them from productivity gains and inflation and generating long-term structural dissatisfaction (EACEA/Eurydice, 2021).

Consequently, the absence of an integrated macroeconomic perspective limits the capacity of existing research to determine whether teachers' and school heads'



salaries evolve coherently with national economic conditions. Addressing this limitation requires moving beyond isolated indicators to integrate educational salary data with key macroeconomic variables, enabling a more robust assessment of coherence, divergence, and long-term sustainability.

2.3 THE MISSING LINK: INTEGRATING EDUCATIONAL AND ECONOMIC DATA

Much of the literature on teacher remuneration focuses on organizational, social, or demographic dimensions, analyzing salary in relation to factors such as motivation, satisfaction, and turnover intention (Berman & DeFeo, 2024; Flores et al., 2025; Nguyen et al., 2023; Zhou & Ma, 2022). These studies typically examine remuneration at the individual or institutional level, highlighting how salary levels or perceptions of salary fairness influence teachers' professional attitudes, satisfaction, and decisions to remain in the profession. However, this body of research rarely situates institutionally defined salary structures, such as specific career scales and progression rules, within broader macroeconomic dynamics. Conversely, macroeconomic analyses tend to approach education through aggregated expenditure indicators, such as total public spending or investment in human capital, focusing primarily on macro-level outcomes like GDP growth and labor productivity (Amxhekaj et al., 2024; Coronel & Díaz-Roldán, 2024), while rarely engaging explicitly with the evolution of specific, institutionally defined salary structures within the education sector. This fragmentation is particularly evident in European comparative research. While Eurydice provides detailed and standardized data on teacher and school head salary structures, career progression, and statutory frameworks, these data are typically analyzed descriptively or cross-sectionally, often through comparative benchmarking, but rarely integrated into analytical frameworks that systematically model the interaction between salary structures and broader economic indicators such as inflation or cost-of-living (EACEA/Eurydice, 2021).

BI and analytics tools have been identified in the literature as providing a direct methodological response to analytical fragmentation, particularly by enabling the integration and visualization of heterogeneous datasets within a unified analytical environment. Recent research indicates that BI platforms enhance transparency and analytical coherence in public-sector contexts by supporting the integration of multiple data sources, facilitating longitudinal analysis and enabling consistent cross-indicator comparison, capabilities that are essential for policymaking based on evidence (Hilliger et al., 2022; Mandinach & Schildkamp, 2021). The effectiveness of such analytical approaches depends on robust data governance practices and transparent data modeling, which are critical to ensuring reliability, accountability, and interpretability in public-sector analytics. Empirical studies further show that dashboard visual analytics improve policymakers' capacity to identify trends, assess indicator coherence, and communicate complex evidence more effectively, thereby strengthening transparency and institutional accountability in decision-making processes (Córdova Esparza et al., 2025; Stojanov & Daniel, 2024). Therefore, Power BI represents a concrete BI platform



that operationalizes these analytical capabilities, directly addressing the analytical gap identified in the literature.

Overall, the literature reveals a clear analytical gap between institutionally defined teacher salary structures and broader macroeconomic dynamics. While existing research has extensively examined teacher remuneration from organizational, social, and demographic perspectives and macroeconomic studies have focused on aggregated expenditure indicators, few approaches integrate these dimensions within a unified analytical framework. Although detailed data on salary structures and economic indicators are available, they are rarely combined in a way that allows for systematic, longitudinal, and coherent analysis. Addressing this fragmentation requires an integrated methodological approach that links educational salary data with macroeconomic indicators, which motivates the research design and analytical framework adopted in this study.



3. METHODOLOGY

This chapter presents the methodological framework adopted to address the analytical gap previously identified in the literature. It describes the research design, the methodological approach guiding the development of the analytical artifact, the data sources used, and the processes of data integration, modeling, and visualization. This section outlines how the DSRM is operationalized through the construction and evaluation of a BI dashboard that integrates teacher salary data with macroeconomic indicators.

3.1 DESIGN SCIENCE RESEARCH METHODOLOGY

This research addresses the fragmentation between granular data on teacher and school head salary structures and broader macroeconomic indicators. Given the practical and data-driven complexity of this gap, the study adopts a DSRM. DSR is a problem-oriented research paradigm that focuses on the creation and evaluation of Information Technology (IT) artifacts, defined as constructs, models, methods, and instantiations, designed to solve identified organizational problems and provide purposeful solutions that serve human goals rather than solely describing existing phenomena (Hevner et al., 2004; Peffers et al., 2007).

In line with this perspective, the study is guided by the DSRM proposed by Peffers et al. (2007), which structures the research process into six core activities: “problem identification and motivation, definition of the objectives for a solution, design and development, demonstration, evaluation and communication” (Peffers et al., 2007, p. 46). Within this framework, a Power BI dashboard is developed as a concrete instantiation and constitutes the central research artifact through which the integration between educational salary data and macroeconomic indicators is designed, demonstrated, and analytically evaluated.

Figure 3.3.1.1 illustrates the operationalization of the DSRM, based on the framework proposed by Peffers et al. (2007), as applied in this study. The research process begins with the identification of an analytical gap between teachers’ and school heads’ salary data and national macroeconomic indicators. The definition of objectives translates this gap into analytical requirements that guide the dashboard design. The design and development phase corresponds to the construction of the Power BI analytical artifact. Demonstration and evaluation are conducted through the implementation and validation of the dashboard, while the communication phase disseminates the results and research contributions.

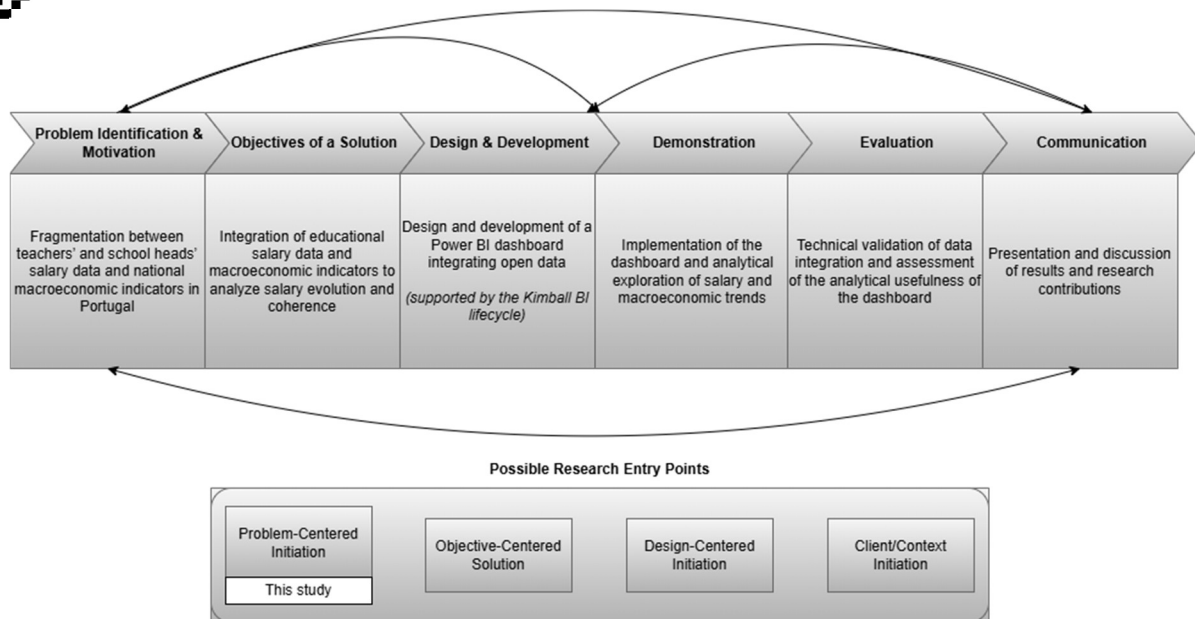


Figure 3.3.1.1 - Operationalization of the DSRM

3.2 KIMBALL BI LIFECYCLE AND ARCHITECTURE

Within the DSR framework, the design and development phase is operationalized through the adoption of the Kimball Business Dimensional Lifecycle. The Kimball approach emphasizes dimensional modeling, incremental development, and a strong alignment between business requirements and data structures (Kimball & Ross, 2013), making it particularly suitable for BI and dashboard-based solutions.

In the context of this study, Kimball BI architecture guides the technical organization of the analytical artifact developed under the DSR framework. It supports the systematic integration of heterogeneous data sources, namely salary data on teachers and school heads obtained from Eurydice and macroeconomic indicators sourced from Eurostat and INE. These data sources differ in structure, granularity, and analytical purpose, requiring a structured modeling approach to ensure semantic consistency, comparability, and analytical coherence across indicators.

Within the Kimball BI lifecycle, the identification of analytical requirements plays a central role in ensuring that the dimensional model and the dashboard outputs are aligned with the research objectives. In this study, analytical requirements are derived from the analytical dimensions defined in section 3.3 and guide the selection of facts, dimensions, and indicators incorporated into the DW and semantic model. This alignment ensures that the technical implementation consistently supports the analytical objectives defined by the research question.

3.3 ANALYTICAL APPROACH AND INDICATORS

This section outlines the analytical approach adopted in this study and the indicators used to operationalize the research question presented in the Introduction. The



analysis is structured around a set of analytical dimensions, which represent complementary perspectives through which the evolution of teachers' and school heads' salaries in Portugal is examined in relation to key macroeconomic indicators.

The analytical dimensions define how the analysis is organized and how the dashboard supports longitudinal and comparative exploration. Each dimension is associated with a specific analytical objective and is operationalized through one or more indicators selected based on relevance, data availability, and methodological consistency. Table 3.3.1.1 summarizes the analytical dimensions adopted in this study, their respective objectives, and the indicators used to support the analysis.

Table 3.3.1.1 - Analytical dimensions, objectives, and indicators

Analytical Dimension	Objective	Indicator(s)
Nominal vs real salary evolution	Assess how salaries evolve over time in nominal terms and in real purchasing power	Statutory gross salary, CPI
Salary evolution vs economic growth	Examine whether salary trends evolve coherently with national economic growth	GDP per capita
Salary position within the domestic labor market	Compare salaries with the general earnings level	Average National Wage
Cost of living and housing affordability	Assess whether salary evolution keeps pace with changes in the cost of living, with a focus on housing	House Price Index
Budgetary context of education policy	Contextualize salary evolution within national education funding priorities	Government expenditure on education (% of GDP)
Structural differences within the education system	Analyze differences in salary levels and evolution across roles, ISCED levels and career stages	Statutory gross salary disaggregated by role, ISCED level and career stage, analyzed in relation to other indicators
European comparative positioning	Position Portuguese teacher salaries within the European salary distribution and assess relative competitiveness	Statutory salaries (PPP adjusted)

3.3.1 INDICATOR DEFINITIONS

The indicators described below provide the empirical basis for the analytical dimensions defined in the previous section and support the operationalization of the research question. Each indicator is briefly defined in terms of its conceptual meaning, data source, and analytical role within the study.

Statutory gross salary refers to the legally defined gross annual remuneration paid to full-time, fully qualified teachers and school heads, as reported by EACEA/Eurydice (n.d.-a). It includes all regular components of the base salary defined by statute, such as holiday and 13th month payments and, in the case of school heads, management



allowances, while excluding discretionary bonuses and employers' social security and pension contributions. These values constitute the base measure of remuneration used throughout the analysis.

The Consumer Price Index (CPI) is an indicator that measures changes over time in the general price level of a basket of goods and services consumed by households (Statistics Portugal, n.d.-a). In this study, the CPI is used to deflate nominal salary values to assess the real evolution of teachers' salaries over time.

GDP per capita expresses GDP on a per-person basis, where per capita indicates the average value per individual within a defined group (Eurostat, n.d.-c). GDP measures the total value of goods and services produced by an economy during a specific period (Eurostat, n.d.-a). When expressed on a per capita basis, GDP represents the average level of economic output per person.

Average monthly earnings measure the regular net amount paid to workers over a given reference period, including payments for paid but non-worked time such as holidays (Statistics Portugal, n.d.-b).

Public expenditure on education (% of GDP) represents total government spending on education, classified under the Classification of the Functions of Government (COFOG) education function, expressed as a percentage of GDP (Eurostat, n.d.-b).

The following section describes the data sources from which these indicators were obtained and outlines the data collection procedures adopted in this study.

3.4 DATA SOURCES AND DATA COLLECTION

This study relies exclusively on secondary open data obtained from publicly available sources. Data collection focused on two complementary domains: (i) detailed information on teachers' and school heads' salaries and (ii) macroeconomic indicators reflecting the national economic context in Portugal.

Data on teachers' and school heads' salaries were obtained from Eurydice through EACEA. Eurydice is a European network covering 43 countries, providing comparative data and analysis on education systems across Europe (EACEA/Eurydice, n.d.). In this study, Eurydice constitutes the primary source of information on statutory salary structures for teachers and school heads for the academic years from 2020/2021 to 2023/2024.

Macroeconomic indicators were collected primarily from Eurostat, complemented by national statistical sources from INE. From Eurostat, the study draws on indicators of economic performance such as GDP per capita and data on general government expenditure by function, including public expenditure on education. National-level data from INE were incorporated to complement Eurostat indicators with detailed information on CPI, as well as average and median earnings, ensuring an accurate representation of the domestic labor market context in Portugal.



All datasets were collected in their most recent available versions at the time of analysis and were selected based on relevance, temporal coverage, and methodological consistency. Together, these data sources provide the empirical foundation for the analytical artifact developed in this study within the DSR framework.

3.5 DATA VOLUME AND STRUCTURE

The datasets used in this study vary in volume, granularity, and structural organization, reflecting the distinct analytical purposes of the educational and macroeconomic data sources.

The Eurydice salary datasets provide structured information at the national level, organized by academic year and by standardized career reference points. For the Portuguese case, the data cover four academic years, from 2020/2021 to 2023/2024, enabling longitudinal analysis of salary developments over time. Salary values are reported in nominal gross terms and correspond to statutory salary levels formally defined within the national career framework for teachers and school heads. These reference points reflect key stages of the professional trajectory, namely starting salaries, salaries after defined periods of service (10 and 15 years), and salaries at the top of the scale (EACEA, n.d.-a).

The Eurydice salary datasets are further disaggregated by education level, classified according to the International Standard Classification of Education (ISCED). Within the scope of this study, the data cover pre-primary (ISCED 02), primary (ISCED 1), lower secondary (ISCED 24), and upper secondary general education (ISCED 34), with teachers assigned to vocational programs excluded from the dataset (EACEA, n.d.-a). The use of ISCED ensures a standardized and internationally comparable classification of education levels, supporting coherent analysis across educational stages.

Macroeconomic datasets obtained from Eurostat and INE differ in structure and level of aggregation from the educational data. These datasets are primarily reported as annual national time series and include indicators such as GDP per capita, CPI-based inflation, average and median earnings, and public expenditure on education. Indicators are expressed in different measurement units, including monetary values, indices, and percentages, reflecting their distinct analytical purposes.

For temporal consistency, statutory salary data reported by Eurydice by academic year (2020/2021-2023/2024) were aligned with their corresponding final calendar year (2021-2024). This adjustment ensures comparability with macroeconomic indicators, which are reported on a calendar-year basis by Eurostat and INE. The alignment assumes that salary conditions in a given academic year are most accurately reflected in the final calendar year of that period.



Based on this data structure, the following section describes the data integration and Extract, Transform, and Load (ETL) pipelines implemented to ensure data consistency, validation, and analytical readiness across all datasets.

3.6 DATA INTEGRATION AND ETL PIPELINES

To support the analytical requirements of the study and ensure a reliable integration of heterogeneous data sources, a structured ETL architecture was implemented. The data integration process was organized into sequential pipelines covering staging area loading, data validation, and DW loading. The following subsections describe each pipeline and its role within the overall data integration workflow.

3.6.1 STAGING AREA LOAD PIPELINE

To ensure a structured and reliable data integration process, a dedicated ETL pipeline was implemented to load the staging area, as illustrated in Figure 3.6.1.1.

The pipeline begins by clearing existing staging tables to prevent data duplication, including removing previous records from both dimension and fact staging tables.

Subsequently, the pipeline orchestrates the loading of all staging dimension tables, including Year, Role, ISCED, Salary Stage, Indicator, Currency, and Country. The loading of fact tables is only triggered after the successful completion of all dimension loads, ensuring referential consistency within the staging area.

Finally, the pipeline loads the staging fact tables related to teacher salaries and macroeconomic indicators, completing the preparation of the staging area for downstream validation and DW loading.

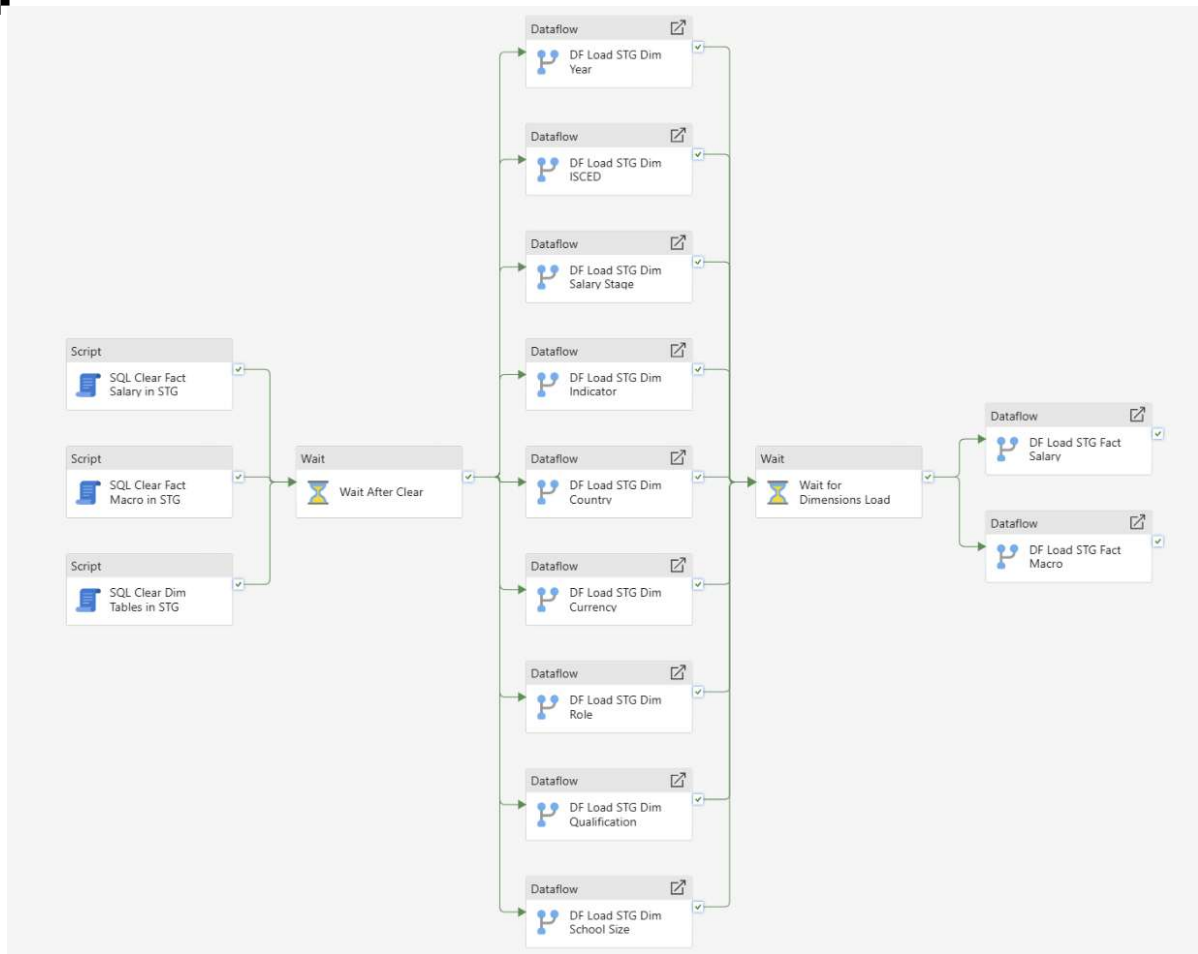


Figure 3.6.1.1 - Staging area load pipeline

3.6.2 STAGING AREA VALIDATION PIPELINE

To ensure data reliability and structural consistency, a dedicated validation pipeline was implemented. The validation process performs a series of data quality checks over the staging area, including business key uniqueness validation in dimension tables and referential integrity checks between fact and dimension tables.

Each validation rule generates a corresponding record in a dedicated logging table, enabling all quality checks to be fully auditable and reproducible. All executed validations were successfully passed, ensuring that only structurally valid and consistent data is propagated to the DW layer.

3.6.3 DATA WAREHOUSE LOAD PIPELINE

After successful validation, data is propagated to the DW through a dedicated loading pipeline, illustrated in Figure 3.6.3.1. A full refresh loading strategy was adopted to ensure consistency and reproducibility of analytical results across execution cycles.

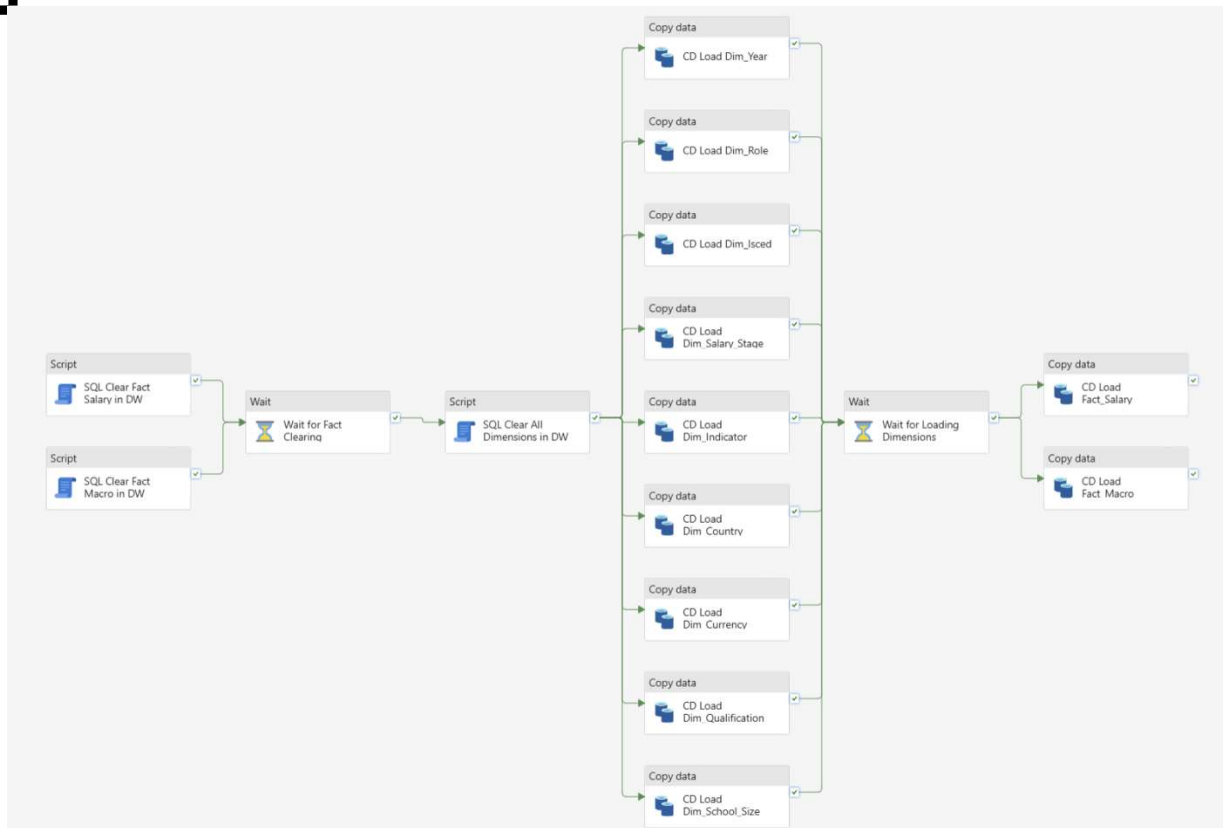


Figure 3.6.3.1 - DW load pipeline

The pipeline starts by clearing existing DW fact tables to ensure a full refresh strategy. Dimension tables are then loaded first, with surrogate keys being generated to replace business keys originating from the staging area. Once all dimension tables are successfully loaded, the pipeline proceeds with the loading of fact tables. During this step, original business keys from the staging area are systematically replaced by their corresponding surrogate keys, ensuring conformance with dimensional modeling best practices.

3.6.4 SEMANTIC MODEL AND ANALYTICAL LAYER

To support analytical querying and reporting, a semantic model was created on top of the DW, as illustrated in Figure 3.6.4.1. The semantic model follows a star schema design, where fact tables are connected to their respective dimension tables through one-to-many relationships. This structure enables intuitive navigation, efficient aggregation, and consistent analytical results.

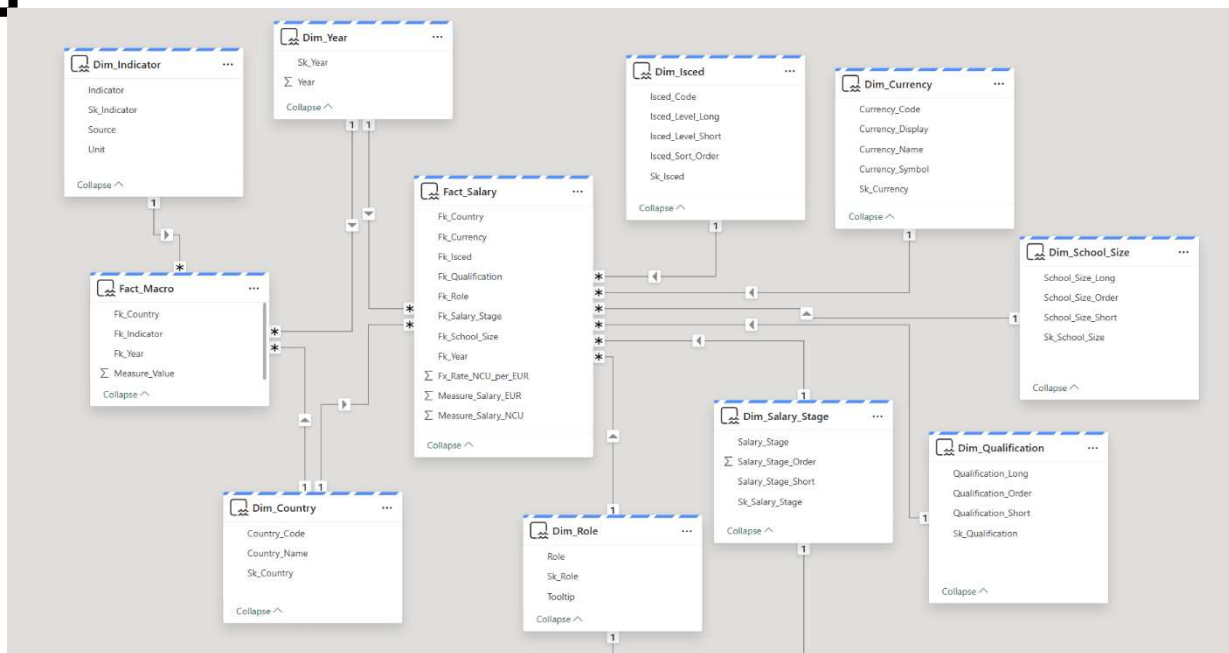


Figure 3.6.4.1 - Semantic model and table relationships

This semantic model serves as the foundation for subsequent analytical exploration and visualization of teacher salary trends and their relationship with macroeconomic indicators.

3.7 TOOLS AND TECHNOLOGIES USED

This section describes the tools and technologies used to implement the analytical artifact developed in this study. The technical implementation relied on a set of integrated BI and data management tools provided within the Microsoft Fabric platform, selected to support the data integration, modeling, and visualization requirements defined by the methodological framework, thereby ensuring consistency between the research design and the technical implementation.

Microsoft Fabric served as the analytics environment, providing a unified architecture for data ingestion, transformation, storage, and analytics. Within this platform, Dataflows Gen2 were employed to perform initial data cleansing and transformation, enabling reusable and centrally managed data preparation logic. Lakehouse components were used to store transformed datasets, while a dedicated Fabric DW implemented a dimensional schema aligned with the Kimball methodology. ETL pipelines were developed using Data Pipelines, enabling controlled data movement between staging and warehouse layers, as well as the execution of validation and load processes. Structured Query Language (SQL) was used extensively to define dimensional and fact tables, generate surrogate keys, enforce referential joins, and populate the DW. Finally, a semantic model was defined to support analytical measures, and Power BI was used for data modeling and visualization through an interactive dashboard.



Together, these components enabled an end-to-end analytical workflow, from raw data ingestion to validated, modeled, and visualized insights, fully aligned with the DSR objectives of this study.

3.8 DASHBOARD DESIGN AND DEMONSTRATION

The dashboard developed in this study constitutes the central instantiation of the DSR artifact. Its design was guided by principles of clarity, analytical coherence, and usability, aiming to support the exploration and comparative analysis of teachers' and school heads' salaries in relation to macroeconomic indicators.

The dashboard operationalizes the research questions and analytical requirements defined in Section 3.3 by translating the selected macroeconomic indicators and salary data into interactive analytical views. Through this design, the dashboard enables the systematic examination of salary evolution over time, comparisons across roles and education levels, and the assessment of coherence between remuneration trends and broader economic conditions.

The dashboard is structured around a star-schema-based semantic model, in which salary and macroeconomic fact tables are connected to shared dimensions such as year, ISCED level, role, indicator, and country. This structure enables flexible slicing and filtering of data across multiple analytical perspectives while maintaining semantic consistency.

3.9 EVALUATION APPROACH

From a technical perspective, the analytical artifact was evaluated through the successful execution of ETL pipelines, data validation procedures, and DW loading processes. The absence of referential integrity violations, the correct resolution of surrogate keys, and the consistency of query results across fact and dimension tables provide evidence of structural correctness and technical robustness.

Beyond technical validation, the artifact was also assessed in terms of its analytical adequacy to support the understanding of the research phenomenon. The dashboard enables the systematic exploration of the evolution of teachers' and school heads' salaries in relation to macroeconomic indicators, supporting longitudinal analysis, cross-indicator comparison, and the identification of patterns of coherence or divergence between remuneration trends and broader economic conditions. In addition, the artifact was evaluated using a scenario-based walkthrough approach, in which representative analytical and policymaking tasks are simulated. This approach provides a structured assessment of the dashboard's functionality, usability, and analytical value, offering further evidence of its effectiveness in supporting decision-making processes.

The transparency of the data model and the explicit documentation of data quality procedures further enhance the artifact's credibility and reproducibility, reinforcing its validity as a research contribution within the DSRM. Taken together, these evaluation



procedures demonstrate that the developed artifact is fit for purpose, not only as a technically robust BI solution, but also as an analytical instrument capable of supporting the empirical analysis presented in the following chapter.

To enhance transparency and facilitate reuse, the Power BI dashboard developed in this study is made publicly available through a GitHub repository containing the dashboard file and documentation of the data sources used (Mateus, 2026).



4. RESULTS AND DISCUSSION

This chapter presents the empirical findings derived from the integrated analysis of statutory salary data and macroeconomic indicators. The analysis is organized around the analytical dimensions defined in Chapter 3 and examines the evolution of teachers' and school heads' salaries in relation to key economic indicators. First, the functional analysis explores salary dynamics across several perspectives, including nominal and real salary evolution, the relative position of teachers' salaries within the national labor market, broader macroeconomic and cost-of-living dynamics, structural differences across career stages, and the European comparative context. These results are presented through the analytical views generated by the Power BI dashboard developed in this study. The chapter then presents a scenario-based functional evaluation of the artifact, demonstrating its usefulness in supporting realistic analytical and policymaking tasks. Finally, the discussion interprets the findings considering the literature reviewed earlier.

4.1 FUNCTIONAL ANALYSIS OF SALARY DYNAMICS

4.1.1 EVOLUTION OF NOMINAL AND REAL SALARIES

Between 2021 and 2024, statutory gross annual salaries for teachers and school heads in Portugal increased in nominal terms across all career stages. The evolution of statutory teachers' salaries in nominal and real terms is summarized in the dashboard page presented in Figure 4.1.1.1.

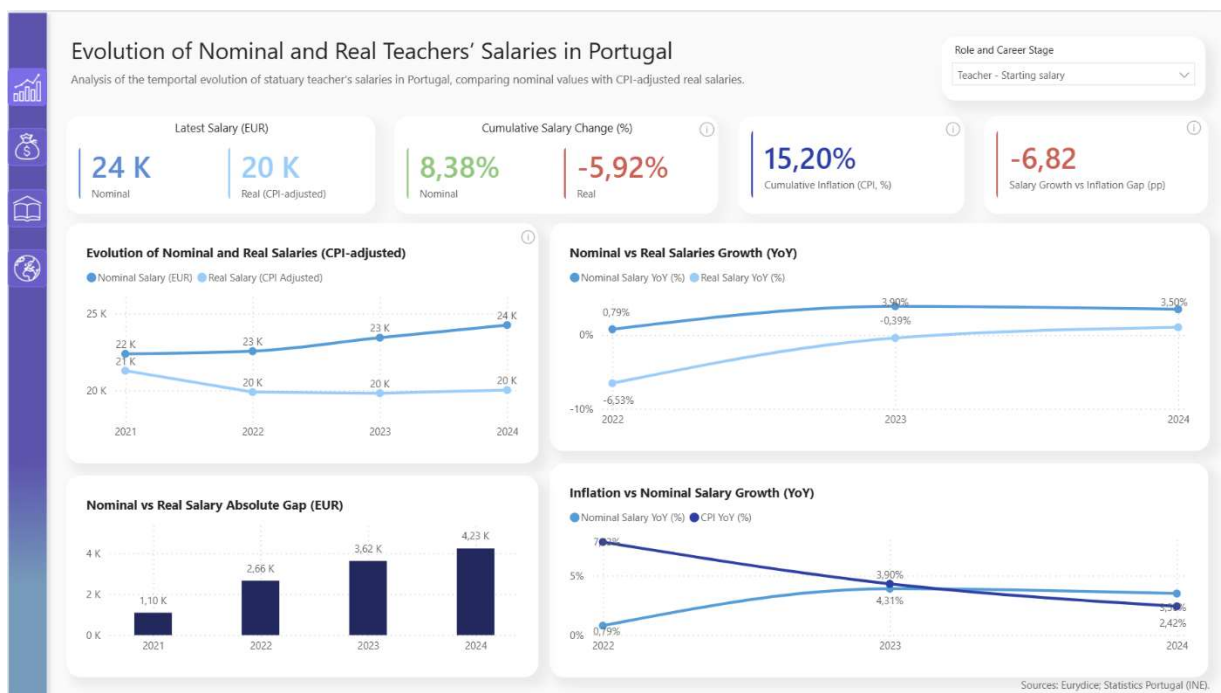


Figure 4.1.1.1 - Evolution of nominal and real statutory teachers' salaries in Portugal



Entry-level teachers experienced nominal salary growth from approximately €22,374 in 2021 to €24,249 in 2024, while salaries at the top of the teacher career scale increased from approximately €48,296 to €51,270 over the same period. Similar upward adjustments were also observed for school leadership positions. Minimum statutory salaries for school heads increased from approximately €27,456 in 2021 to €29,671 in 2024, while maximum school head salaries rose from approximately €50,696 to €54,042 during the same period. Overall, nominal salary increases ranged between approximately 6% and 8% across the different career stages and roles within the education system.

However, the period analyzed coincided with significant inflationary pressures. Cumulative inflation reached approximately 15% between 2021 and 2024, with the most pronounced increase occurring in 2022. When salary values are adjusted using CPI data, the real evolution of salaries reveals a consistent decline in purchasing power. For entry-level teachers, although nominal salaries increased by roughly 8% over the four-year period, real salary values declined by approximately 6%. This indicates that statutory salary adjustments were insufficient to fully compensate for the increase in consumer prices. The most significant real contraction occurred in 2022, when inflation peaked while salary updates remained comparatively limited.

This dynamic can also be observed when comparing cumulative salary growth with cumulative inflation over the period analyzed. Across all career stages, salary growth remained below inflation, with the gap ranging from approximately -6.8 percentage points for starting teachers to around -9.0 percentage points for teachers at the top of the salary scale, indicating that inflation consistently outpaced salary growth.

Although nominal salary growth accelerated slightly in 2023 and 2024, these increases were not sufficient to restore the purchasing power observed in 2021. As a result, real salary levels remained below their initial benchmark across the entire salary structure.

4.1.2 SALARY POSITION IN THE NATIONAL LABOR MARKET

To better understand the economic positioning of salaries within the Portuguese education sector, statutory salaries for teachers and school heads were compared with the national average wage between 2021 and 2024. This comparison enables the assessment of whether remuneration in the education sector evolved in line with broader wage dynamics in the Portuguese labor market.

During this period, the national average wage rose steadily from approximately €19,230 in 2021 to around €23,177 in 2024. Similarly, salaries for teachers and school heads increased across all roles and career stages. However, these increases occurred at a slower pace than the growth observed in the national average wage.

Despite this difference in growth rates, teachers' salaries remained consistently above the national average wage throughout the period analyzed. Entry-level teachers earned approximately 116% of the national average wage in 2021, indicating that starting salaries in the teaching profession were moderately higher than the average



wage in the Portuguese labor market. By 2024, however, this ratio had declined to approximately 104%, reflecting a gradual reduction in the relative wage advantage.

Similar trends are observed across other career stages. Teachers with ten years of experience earned around 142% of the national average wage in 2021, declining to approximately 126% by 2024. For teachers with fifteen years of experience, the ratio decreased from roughly 150% to around 134% during the same period. At the top of the teacher salary scale, salaries corresponded to approximately 251% of the national average wage in 2021, falling to around 221% in 2024. A comparable pattern is also evident among school leadership positions. Minimum statutory salaries for school heads corresponded to approximately 143% of the national average wage in 2021, decreasing to around 128% by 2024. For school heads at the maximum salary level, the ratio declined from approximately 264% to around 233% over the same period.

These results indicate that although teachers and school heads continue to earn salaries above the national average wage, the relative advantage of the profession within the broader wage distribution has gradually weakened. The decline in these ratios reflects the fact that wage growth in the overall economy has outpaced salary adjustments within the education sector.

Overall, the analysis suggests that although teaching remains a comparatively well-paid profession relative to the national average wage, its relative economic attractiveness within the Portuguese labor market has diminished over the period analyzed.

The broader macroeconomic environment in which teacher salaries evolved is summarized in Figure 4.1.2.1, which integrates indicators related to GDP growth, national wage dynamics, housing prices, and public expenditure on education.

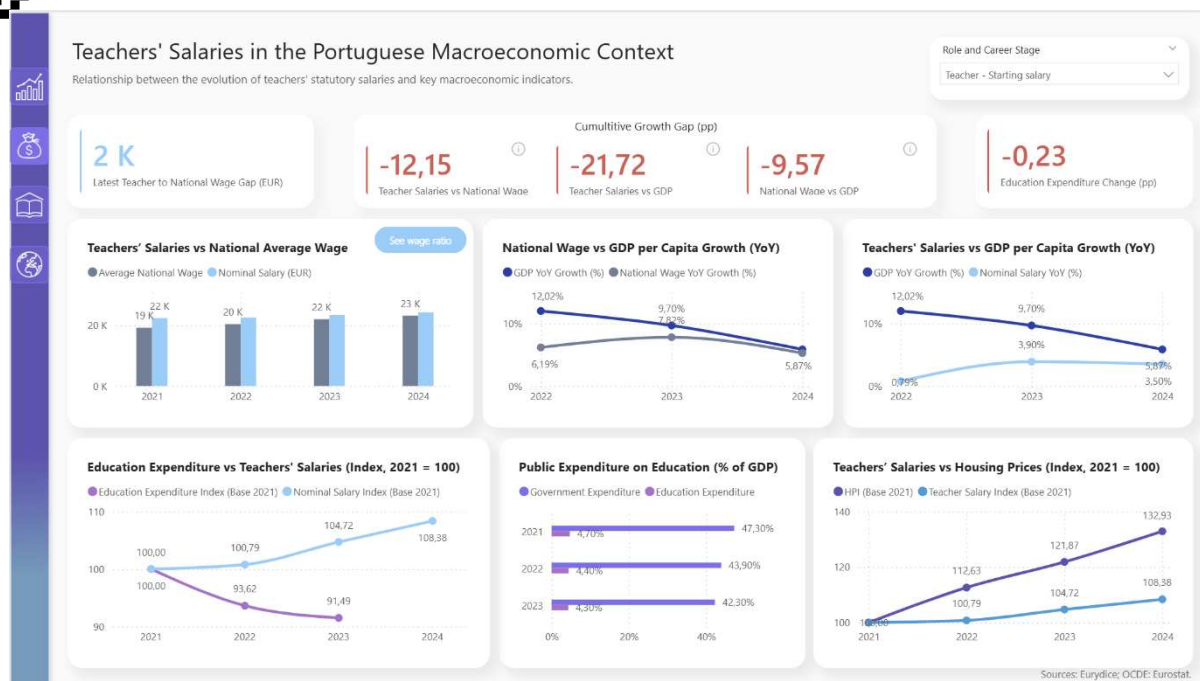


Figure 4.1.2.1 - Macroeconomic indicators related to teacher salary dynamics in Portugal

4.1.3 MACROECONOMIC CONTEXT AND COST-OF-LIVING DYNAMICS

Beyond comparisons with the national average wage, the evolution of teachers' salaries must also be interpreted within the broader macroeconomic context. During the period between 2021 and 2024, Portugal experienced significant economic adjustments characterized by strong GDP growth, rising wages across the labor market, and increasing cost-of-living pressures, particularly in the housing sector.

GDP per capita increased from approximately €20,800 in 2021 to around €27,060 in 2024, reflecting the overall expansion of economic activity during the period analyzed. Year-on-year growth reached approximately 12.0% in 2022, before moderating to 9.7% in 2023 and 5.9% in 2024. These dynamics contributed to improvements in labor market conditions and were accompanied by a steady increase in the national average wage.

Despite these favorable macroeconomic developments, salary adjustments within the education sector remained comparatively moderate. While teachers' statutory salaries increased gradually across all career stages, the growth observed in national wages was stronger in several years. As a result, the relative wage position of teachers declined, as discussed in the previous section.

Cost-of-living dynamics provide an additional perspective on the evolution of teachers' purchasing power. Housing prices increased substantially between 2021 and 2024. Based on the housing price index (base year 2021 = 100), housing prices rose to approximately 113 in 2022, 122 in 2023, and nearly 133 in 2024. In contrast, the index



for teachers' starting salaries increased more moderately, reaching approximately 101 in 2022, 104 in 2023, and around 108 in 2024.

This divergence indicates that housing costs increased considerably faster than teachers' salaries during the period analyzed. Given that housing expenditure represents a major component of household budgets, the rapid increase in property prices suggests that teachers' effective purchasing power may have been further constrained by rising living costs.

Public expenditure patterns provide additional context. Government expenditure on education represented approximately 4.7% of GDP in 2021, declining slightly to 4.4% in 2022 and 4.3% in 2023. Although these variations are relatively modest, they indicate that public investment in education did not increase significantly during the period analyzed, which may have limited the space for larger salary adjustments within the sector.

Overall, the macroeconomic indicators suggest that although the Portuguese economy experienced economic growth and rising wages in the broader labor market, teachers' salaries did not evolve at the same pace as broader economic and cost-of-living dynamics. The combination of faster wage growth in the general labor market and rising housing prices increased economic pressures on education professionals and reinforced the gradual decline in their relative economic position.

4.1.4 STRUCTURAL DIFFERENCES ACROSS CAREER STAGES

In addition to the temporal evolution of salaries, the analysis also highlights important structural differences across career stages within the Portuguese education salary system. The statutory salary structure is characterized by a progressive scale in which salaries increase substantially with experience and career advancement. The structural differences between career stages within the Portuguese salary system are illustrated in Figure 4.1.4.1, which presents the distribution of statutory salaries across different career stages and leadership positions.

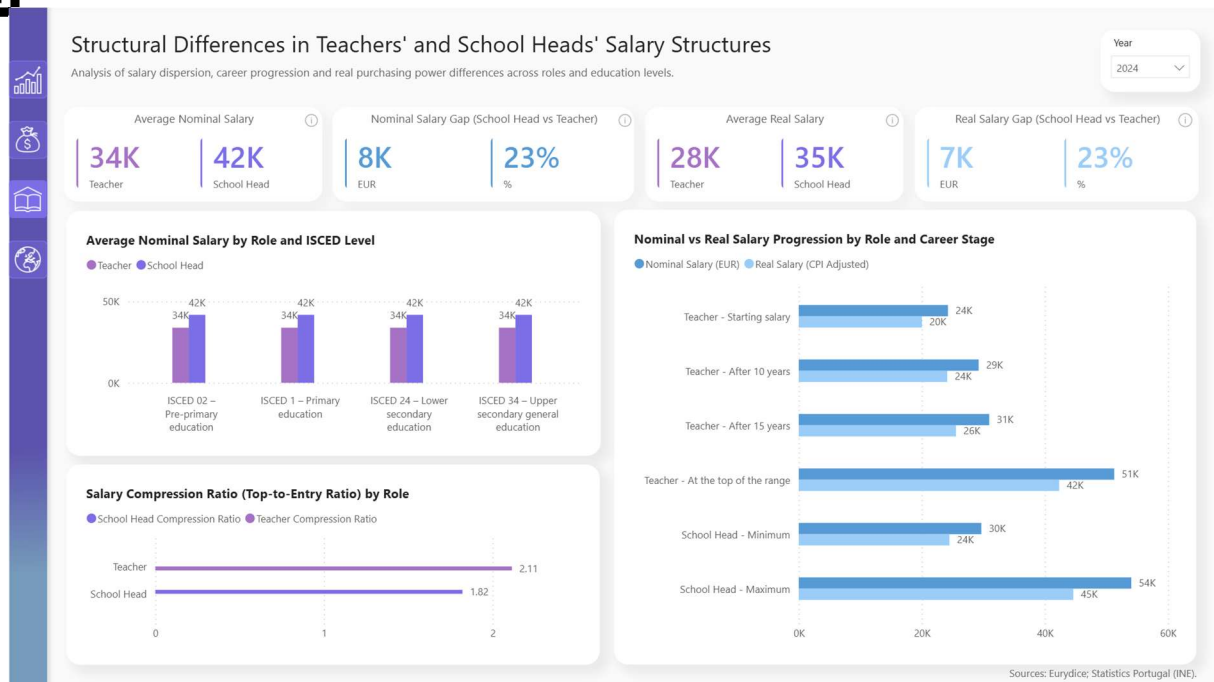


Figure 4.1.4.1 - Salary differences across career stages in the Portuguese education system

Entry-level teachers receive the lowest salaries within the system, with statutory annual earnings of approximately €22,374 in 2021, increasing to around €24,249 by 2024. In contrast, teachers at the top of the salary scale earned approximately €48,296 in 2021 and €51,270 in 2024. This difference reflects the strong vertical progression embedded in the salary framework, where experienced teachers earn more than double the salary of entry-level professionals. The compression ratio for teachers, defined as the relationship between top-of-scale and starting salaries, remained relatively stable during the period analyzed at slightly above 2,1, indicating that maximum salaries are approximately twice the level of entry salaries.

Intermediate career stages also illustrate this progressive structure. Teachers with ten years of experience earned approximately €27,226 in 2021, rising to around €29,231 in 2024, while teachers with fifteen years of experience received approximately €29,886 in 2021 and around €30,950 in 2024. These values confirm that salary increases occur gradually across the career trajectory, reflecting accumulated experience and professional seniority.

School leadership positions occupy a distinct level within the salary hierarchy. Minimum statutory salaries for school heads increased from approximately €27,456 in 2021 to around €29,671 in 2024, while maximum salaries rose from approximately €50,696 to €54,042 during the same period. These values place school heads above most teaching career stages, reflecting the managerial and administrative responsibilities associated with these roles. The compression ratio for school heads remained slightly lower than that observed for teachers, reflecting a somewhat narrower salary range within leadership positions.



Another notable characteristic of the Portuguese salary structure is the absence of significant differences between education levels. Unlike in many European education systems where salaries vary across ISCED levels, statutory salaries in Portugal remain largely identical for teachers across pre-primary, primary, lower secondary and upper secondary education. As a result, salary progression depends primarily on career stage and years of experience rather than on the level of education taught.

Despite these structural differences, the erosion of purchasing power observed in earlier sections affected all career stages in a broadly equivalent way. Salary adjustments were applied relatively uniformly across the salary scale, preserving proportional differences between career levels but failing to generate real salary gains. Consequently, both early-career teachers and more experienced professionals experienced declines in real purchasing power during the period analyzed.

4.1.5 EUROPEAN COMPARATIVE PERSPECTIVE

In addition to national and macroeconomic dynamics, it is also important to situate Portuguese teachers' salaries within the broader European context. Cross-country comparisons provide insight into the relative competitiveness of teacher remuneration and allow for a better understanding of how the Portuguese salary structure compares with other education systems. To ensure comparability across countries with different price levels, salaries are analyzed using Purchasing Power Standards (PPS), which adjust nominal salaries for differences in the cost of living.

Portugal's position within the European distribution of teachers' salaries is illustrated in Figure 4.1.5.1, which presents a cross-country comparison of statutory starting salaries adjusted for PPS.

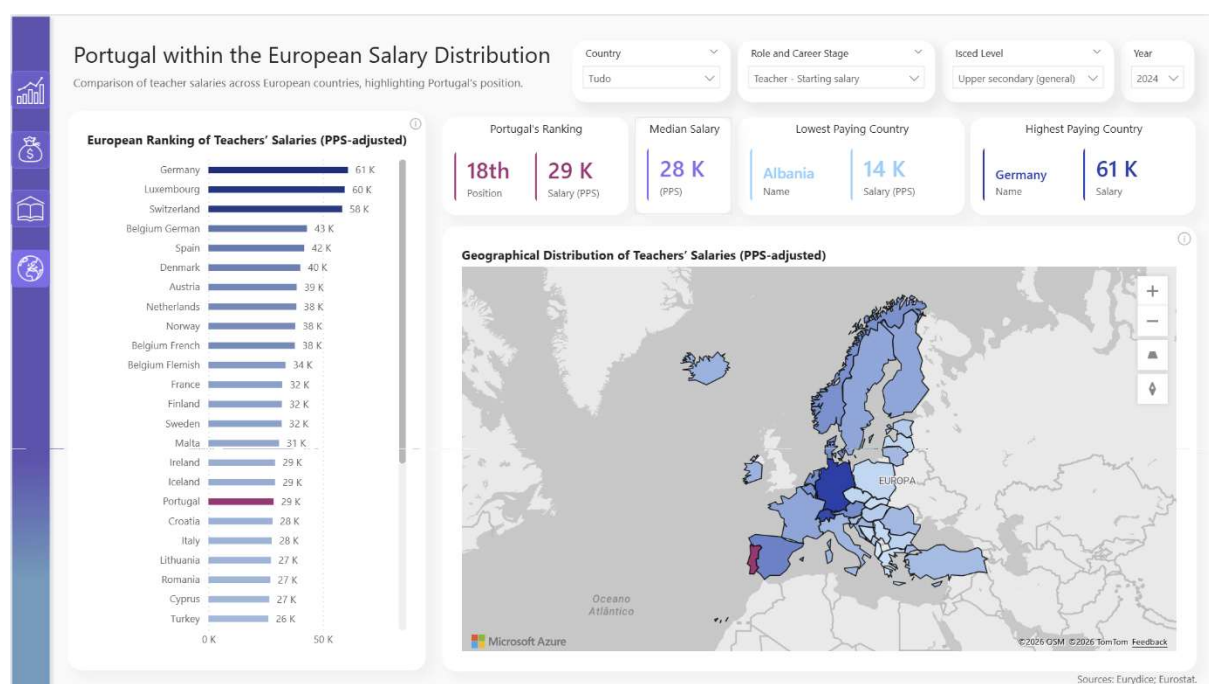


Figure 4.1.5.1 - European distribution of teachers' starting salaries adjusted for PPS



Across Europe, statutory teacher salaries vary substantially depending on national economic conditions, education policies, and levels of public investment in education. Some Western and Northern European countries consistently report the highest salary levels. For example, starting salaries for upper secondary teachers reach approximately €61,009 PPS in Germany, €59,580 PPS in Luxembourg, and around €58,445 PPS in Switzerland, placing these countries at the top of the European salary distribution.

When salaries are compared using PPS, Portugal typically occupies an intermediate position within the European salary distribution. Starting salaries for upper secondary teachers in Portugal reached approximately €28,516 PPS in 2024, placing the country below Northern and Western European education systems but above several Central and Eastern European countries. A similar pattern can be observed across other career stages, where Portuguese salaries remain moderate when compared with the broader European distribution.

The analysis also shows that the structure of salary progression in Portugal is relatively steep when compared with many European countries. The difference between entry-level and top-of-scale salaries is significant, meaning that career progression plays an important role in determining long-term earnings within the profession. However, this also implies that early-career teachers may face comparatively lower salary levels when compared with their counterparts in higher-income European education systems.

Overall, the European comparison indicates that Portugal does not occupy either the highest or lowest positions in the European salary distribution. Instead, the country maintains a relatively intermediate position. While statutory salaries increased during the period analyzed, similar adjustments occurred across several European education systems, meaning that Portugal's relative position within the European salary landscape remained broadly stable.

However, when these findings are considered alongside the national analysis presented in previous sections, an important distinction emerges: although Portugal occupies a middle position within the European salary distribution, teachers' salaries have experienced declining purchasing power and a weakening relative position within the domestic labor market. This suggests that the challenges associated with teacher remuneration in Portugal are less related to its European ranking and more connected to internal macroeconomic dynamics, including inflation, wage growth in the broader economy, and rising living costs.

4.1.6 SUMMARY OF EMPIRICAL FINDINGS

Table 4.1.6.1 summarizes the main empirical findings derived from the functional analysis of salary dynamics presented in this chapter. The table synthesizes the key results identified across the different analytical dimensions explored in the dashboard.



Table 4.1.6.1 - Summary of Empirical Findings

Analytical Dimension	Main Finding	Evidence
Nominal vs real salary evolution	Salaries increased across all career stages; however, teachers experienced a decline in purchasing power.	Nominal growth of approximately 6-8% between 2021 and 2024. Inflation (~15%) exceeded salary growth.
Salary evolution vs economic growth	Economic growth outpaced salary adjustments in the education sector.	GDP per capita increased from ~€20,800 in 2021 to ~€27,060 in 2024, with growth rates of 12.0% (2022), 9.7% (2023) and 5.9% (2024).
Salary position within the domestic labor market	Teachers remain above the national average wage but lost relative advantage.	Starting salaries declined from ~116% to ~104% of the national average wage.
Cost of living and housing affordability	Housing prices increased substantially faster than salaries.	Housing price index rose to ~133 vs salary index ~108.
Budgetary context of education policy	Education spending remained relatively stable.	Decline from ~4.7% to ~4.3% of GDP.
Structural differences within the education system	Strong career progression within the salary system.	Top-of-scale salaries exceed entry salaries by more than two times.
European comparative positioning	Portugal occupies an intermediate position within Europe.	Starting salaries around 29K PPS, ranking approximately 18 th .

Overall, the empirical results indicate that while statutory teacher salaries increased in nominal terms during the period analyzed, these adjustments were insufficient to offset broader macroeconomic dynamics. As a result, teachers experienced declining purchasing power and a gradual weakening of their relative economic position within the Portuguese labor market, despite maintaining a mid-range position within the European salary distribution.

4.2 SCENARIO-BASED FUNCTIONAL EVALUATION

In line with the DSRM, the evaluation of the developed analytical artifact was conducted through a scenario-based walkthrough approach. This method was selected as an evaluation strategy to demonstrate the artifact's usefulness in supporting analytical and policymaking tasks.

This approach simulates realistic policymaking and analytical questions, enabling the systematic assessment of the dashboard's functionality, usability, and analytical value. Each scenario represents a typical decision-support task in the context of education policy analysis.

For each scenario, the following dimensions are evaluated: (i) objective of analysis, (ii) dashboard components used, (iii) navigation and filtering steps performed, (iv) insights generated, and (v) assessment of dashboard usefulness.



First, the objective of analysis defines the analytical question being explored within the scenario. Second, the dashboard components used identify the relevant visualizations, filters, and interface elements required to perform the analysis. Third, the navigation and filtering steps describe the sequence of user interactions when exploring the dashboard. Fourth, the insights generated summarize the main findings obtained from the analysis. Finally, the assessment of dashboard usefulness evaluates the extent to which the dashboard effectively supports the task, considering aspects such as clarity, usability, and analytical relevance.

The following scenarios illustrate the application of the proposed evaluation, demonstrating how the dashboard supports different analytical and policymaking tasks in practice.

4.2.1 SCENARIO 1

Objective of analysis: Evaluate whether statutory teacher salaries evolved in line with inflation, preserving purchasing power over time.

Dashboard components used: Role and career stage filter; KPI cards (latest salary, cumulative salary change, cumulative inflation and salary growth vs inflation gap); “Evolution of Nominal and Real Salaries (CPI-adjusted)” line chart; “Nominal vs Real Salaries Growth (YoY)”; “Inflation vs Nominal Salary Growth (YoY)”; and “Nominal vs Real Salary Absolute Gap” visual.

Navigation/filtering steps performed: The user begins the analysis on the main dashboard page, where the temporal scope is predefined for the period between 2021 and 2024. Using the role and career stage filter, the user navigates across different categories (e.g., starting salary, after 10 and 15 years, top of the scale, and school heads) to identify patterns across career stages. The analysis starts with the “Evolution of Nominal and Real Salaries (CPI-adjusted)” line chart, where nominal salary trends are compared with CPI-adjusted real values. The user then examines the KPI cards to assess cumulative salary growth (nominal and real), cumulative inflation, and the salary growth versus inflation gap. To further explore the dynamics, the user analyzes the “Nominal vs Real Salary Absolute Gap” chart to evaluate the magnitude and evolution of the divergence over time. Finally, the “Nominal vs Real Salaries Growth (YoY)” and “Inflation vs Nominal Salary Growth” visualizations are used to assess annual changes and compare salary adjustments with inflation trends.

Insights generated: The analysis reveals consistent patterns across all roles and career stages. Nominal salaries increased over the period, as reflected in the positive cumulative nominal growth values across all categories. However, when adjusted for inflation, real salaries declined, indicating a loss of purchasing power. Cumulative inflation reached approximately 15%, exceeding salary growth in all cases. This is further confirmed by the negative values observed in the “Salary Growth vs Inflation Gap (pp)” card, showing that inflation consistently outpaced salary increases. The line chart comparing nominal and real salaries shows a widening divergence over time,



with real salaries remaining below nominal values and the gap increasing steadily. This pattern is reinforced by the “Nominal vs Real Salary Absolute Gap” visualization, which highlights a growing difference between nominal and real salary levels. Year-on-year analysis provides additional insight into this dynamic. Between 2021 and 2022, inflation increased sharply while salary growth remained limited, resulting in a significant decline in real salary values. In subsequent years, although nominal salary growth accelerated and inflation slowed down, these adjustments were insufficient to recover the purchasing power lost in earlier periods.

Assessment of dashboard usefulness: The dashboard effectively supports this analysis by enabling integrated exploration of salary and inflation dynamics across multiple dimensions. The combination of KPI indicators and complementary visualizations allows users to quickly identify trends, quantify divergences, and validate findings through cross-analysis. Interactive filtering enhances usability by allowing comparison across different roles and career stages, while the structured layout supports a logical, analytical flow from high-level indicators to detailed trend analysis. This facilitates a clear and comprehensive assessment of purchasing power dynamics.

4.2.2 SCENARIO 2

Objective of analysis: Assess whether the evolution of school head remuneration has kept pace with overall economic growth, measured by GDP per capita, between 2021 and 2024.

Dashboard components used: Role and career stage filter; KPI card for cumulative gap between teacher salaries and GDP; “Teachers’ Salaries vs GDP per Capita Growth (YoY)” line chart; and “National Wage vs GDP per Capita Growth (YoY)” chart (used as contextual benchmark).

Navigation/filtering steps performed: The user navigates to the second dashboard page through the left-hand menu, where the period is predefined between 2021 and 2024. Using the role and career stage filter, the analysis focuses specifically on “School Head – Minimum” and “School Head – Maximum” to compare leadership remuneration with GDP per capita growth at both ends of the salary scale. The analysis begins with the KPI card representing the cumulative gap between salary growth and GDP per capita growth, which provides an overall measure of divergence across the period. Next, the “Teachers’ Salaries vs GDP per Capita Growth (YoY)” chart is examined to compare annual salary growth rates with GDP growth rates and identify periods of divergence between the two series. Finally, the “National Wage vs GDP per Capita Growth (YoY)” chart is used as a benchmark to assess whether the observed pattern is specific to school head remuneration or reflects broader wage dynamics in the economy.

Insights generated: The analysis indicates that the evolution of school head remuneration did not keep pace with GDP per capita growth between 2021 and 2024. This pattern is observed for both minimum and maximum school head salary levels.



The KPI card shows a strongly negative cumulative gap between salary growth and GDP growth, with values of approximately -22.03 pp for School Head – Minimum and -23.50 pp for School Head – Maximum. This indicates that, over the period analyzed, the economy expanded substantially faster than school head remuneration. The year-on-year comparison further reinforces this pattern. In 2022 and 2023, GDP per capita growth was notably higher than salary growth, generating a widening divergence. Although GDP growth slowed in 2024 and the gap narrowed slightly, this was not sufficient to offset the cumulative difference accumulated over the full period. When compared with national wage dynamics, a similar trend is observed, although less pronounced. While national wages also grew more slowly than GDP, the gap between school head remuneration and GDP remains substantially larger, suggesting that salary adjustments in school leadership positions lagged more strongly behind broader economic growth.

Assessment of dashboard usefulness: The dashboard effectively supports this analysis by providing a focused comparison between school head remuneration and GDP per capita growth. The role and career stage filter makes it possible to isolate school leadership positions and compare minimum and maximum salary levels in a clear and intuitive way. The combination of a cumulative KPI indicator and year-on-year visualizations allows users to assess both the overall magnitude of the divergence and its development over time. The inclusion of the national wage benchmark further strengthens the analysis by situating school head remuneration within the broader macroeconomic context.

4.2.3 SCENARIO 3

Objective of analysis: Analyze differences in salary progression across ISCED levels, while also considering variations across roles and career stages, to identify the main structural drivers of remuneration within the education system.

Dashboard components used: Year filter; KPI cards (average nominal salary, nominal salary gap, average real salary, real salary gap); “Average Nominal Salary by Role and ISCED Level” chart; “Nominal vs Real Salary Progression by Role and Career Stage” chart; and “Salary Compression Ratio (Top-to-Entry Ratio) by Role” visual.

Navigation/filtering steps performed: The user navigates to the “Structural Differences” page through the navigation menu, where salary structures can be analyzed across multiple dimensions. The analysis begins by using the year filter to observe how structural differences evolve over time between 2021 and 2024. First, the user examines the KPI cards to compare average nominal and real salaries between teachers and school heads, as well as the corresponding salary gaps in both absolute (EUR) and relative (%) terms. Next, the “Average Nominal Salary by Role and ISCED Level” chart is analyzed to assess whether salary levels differ across education levels. The user then explores the “Nominal vs Real Salary Progression by Role and Career Stage” chart to understand how salaries evolve along the career path for both roles, comparing nominal and inflation-adjusted values. Finally, the “Salary Compression



Ratio (Top-to-Entry Ratio)” visual is used to evaluate differences in career progression structures, specifically the relative increase from entry-level to top-level salaries within each role.

Insights generated: The analysis reveals clear structural differences in salary levels and progression patterns between teachers and school heads, while showing limited variation across ISCED levels. Firstly, school heads systematically earn higher salaries than teachers in both nominal and real terms. The KPI indicators show a stable gap of approximately €7K-€8K (around 23%), indicating a persistent remuneration premium associated with leadership roles. Across ISCED levels, salary differences remain broadly consistent for both teachers and school heads. This suggests that the level of education taught does not significantly influence salary structures and that remuneration disparities are primarily driven by role and career stage rather than ISCED classification. Career progression analysis highlights important differences in salary growth dynamics. While both roles exhibit increasing salaries over time, school heads consistently present higher salary levels across comparable points in the career structure, particularly when considering minimum and maximum positions. However, teachers display a steeper progression curve, particularly from starting salary to the top of the scale. This pattern is confirmed by the salary compression ratio, which is higher for teachers (approximately 2.1) than for school heads (approximately 1.8). This indicates that teachers experience greater relative salary growth throughout their careers, whereas school heads have a more compressed structure with less variation between entry and top salaries. Furthermore, the consistency of salary levels across ISCED categories suggests that career progression patterns are structurally defined and remain stable regardless of the education level taught, reinforcing the interpretation that ISCED plays a limited role in shaping salary progression.

Assessment of dashboard usefulness: The dashboard effectively supports the analysis of structural salary differences by enabling simultaneous comparison across roles, career stages, and ISCED levels. KPI cards provide a clear and immediate overview of salary levels and gaps, while the visualizations allow deeper exploration of how these differences manifest across dimensions. The integration of nominal and real values enhances analytical depth by incorporating purchasing power considerations. The year filter further strengthens the analysis by enabling temporal comparison, allowing users to assess the stability of structural patterns over time.

4.2.4 SCENARIO 4

Objective of analysis: Evaluate whether changes in public expenditure on education evolved in line with teacher salary increases between 2021 and 2024, assessing the alignment between funding effort and remuneration policies.

Dashboard components used: Role and career stage filter; KPI card for education expenditure change (pp); “Education Expenditure vs Teachers’ Salaries (Index, 2021 = 100)” line chart; “Public Expenditure on Education (% of GDP)” bar chart; and “Teachers’ Salaries vs GDP per Capita Growth (YoY)” chart (as contextual reference).



Navigation/filtering steps performed: The user navigates to the “Macroeconomic Context” page through the navigation menu, where the relationship between salaries and key public expenditure indicators is analyzed within a broader macroeconomic context. The period is predefined between 2021 and 2024. The analysis begins by examining the KPI card for education expenditure change, which provides a summary of how public investment in education evolved over the period. Next, the “Education Expenditure vs Teachers’ Salaries (Index, 2021 = 100)” chart is analyzed to compare the evolution of salary growth and education expenditure in indexed terms, allowing a comparative assessment of their relative trends over time. The user then examines the “Public Expenditure on Education (% of GDP)” chart to understand how education spending has evolved relative to total economic output. Finally, the “Teachers’ Salaries vs GDP per Capita Growth (YoY)” chart is used as contextual support to assess whether salary increases are consistent with broader macroeconomic conditions.

Insights generated: The analysis indicates that public expenditure on education did not keep pace with teacher salary increases over the period. The KPI indicator reveals a slight decline in education expenditure (approximately -0.23 pp), indicating that, relative to GDP, investment in education decreased rather than increased. This pattern is clearly reflected in the indexed comparison chart. While teacher salaries exhibit a steady upward trajectory, increasing consistently from the 2021 base year, education expenditure follows a downward trend, diverging from salary growth over time. The “Public Expenditure on Education (% of GDP)” chart reinforces this finding, showing a gradual decline in education spending as a share of GDP, despite increases in nominal salary levels. Taken together, these results highlight a structural misalignment between salary policy and public funding dynamics. While remuneration increased over time, public investment in education did not expand accordingly. This suggests that salary growth was not supported by proportional increases in funding effort, potentially raising concerns regarding the sustainability of expenditure allocation within the education sector.

Assessment of dashboard usefulness: The dashboard effectively supports this analysis by enabling a clear comparison between salary evolution and public expenditure dynamics. The use of indexed visualizations facilitates intuitive interpretation of relative trends, while KPI indicators provide immediate insight into overall changes. The combination of absolute and relative measures enhances analytical depth, allowing users to assess both levels and structural relationships. Additionally, the integration of contextual indicators, such as GDP growth, strengthens the analysis by situating education expenditure and salary dynamics within the broader economic environment.

4.2.5 SUMMARY OF SCENARIO-BASED EVALUATION

To synthesize the findings obtained across the different analytical scenarios, a summary of the key objectives, insights, and contributions of the dashboard is presented in Table 4.2.5.1. The summary also facilitates a consolidated evaluation of



the dashboard's analytical value, enabling a clearer understanding of its strengths in supporting evidence-based decision-making within the context of education policy.

Table 4.2.5.1 - Evaluation Summary Table

Scenario	Objective	Key Insight	Dashboard Contribution
1	Assess whether salaries kept pace with inflation	Real salaries declined despite nominal salary growth, indicating a loss of purchasing power	Enables clear comparison between nominal and CPI-adjusted salaries through integrated indicators and trend visualizations
2	Compare salary evolution with GDP per capita growth	Salary growth remained consistently below economic growth, leading to a deterioration in the relative position of salaries	Supports direct comparison between salary dynamics and macroeconomic indicators through cumulative and year-on-year analysis
3	Identify structural differences in salary progression	Persistent salary gap between roles, with teachers showing stronger relative progression, while school heads maintain higher overall salary levels	Provides multi-dimensional analysis across roles, career stages and education levels
4	Evaluate alignment between expenditure and salaries	Public expenditure on education declined relative to GDP and did not evolve in line with salary growth	Facilitates alignment analysis between funding trends and salary evolution using indexed and relative indicators

The walkthrough demonstrated that the artifact effectively supports multidimensional analytical exploration of salary and macroeconomic data, enabling intuitive filtering, coherent cross-indicator comparison, and meaningful insight generation for evidence-based educational analysis.

4.3 DISCUSSION

The results presented in the previous sections indicate that statutory salaries for teachers and school heads in Portugal consistently fell behind key macroeconomic indicators between 2021 and 2024. While nominal increases were implemented across all career stages, integrating salary data with inflation, GDP per capita, national average earnings, and housing indicators reveals patterns of consistent divergence from macroeconomic dynamics rather than alignment.

First, the real erosion of purchasing power observed across all career stages confirms that statutory salary updates were insufficient to offset cumulative inflation. This finding aligns with the Eurydice report, which notes that slow or modest salary progression and prolonged periods of wage stagnation, particularly in contexts of constrained public investment, contribute to higher levels of teacher dissatisfaction (EACEA/Eurydice, 2021). The report further emphasizes that salary attractiveness and progression pace are key factors influencing professional satisfaction and career choice decisions.



Second, the comparison between statutory salaries and GDP per capita provides additional insight into the profession's relative economic positioning. Although GDP per capita grew strongly during the period analyzed, particularly in 2022, statutory salary adjustments followed a more moderate trajectory and did not fully reflect broader economic expansion. This divergence suggests that improvements in national economic output did not translate proportionally into adjustments within the statutory education salary framework. Eurydice (2021) further highlights that in countries where teachers' salaries remain below or only marginally aligned with national economic indicators, levels of salary satisfaction tend to be lower. While Portuguese statutory salaries may appear competitive in certain relative measures, the absence of proportional adjustment during a period of macroeconomic expansion may weaken perceptions of fairness and alignment with broader economic progress.

Third, the decline in the teacher-to-national wage ratio indicates that salary growth within the education sector remained below the pace observed in average earnings across the broader labor market. Although teachers and school heads continued to earn above the national average wage in absolute terms, the narrowing relative premium suggests a gradual weakening of the profession's competitive positioning within the broader labor market. Existing research emphasizes that competitive remuneration is essential not only for retention but also for attracting new entrants into the profession (Berman & DeFeo, 2024). When teachers' salaries lose their relative advantage compared to national earnings, the profession may become less attractive over time. This concern is particularly salient in the Portuguese context. Flores et al. (2025) document the transition from teacher surplus to teacher shortage in Portugal, driven largely by mass retirements and a sustained decline in the number of candidates entering initial teacher education programmes. The authors emphasize that the aging profile of the teaching workforce, combined with insufficient long-term policy responses, has intensified recruitment pressures. In this context, the relative weakening of teachers' economic positioning identified in the present study may further compound structural challenges already documented in the literature.

The analysis of housing affordability further reinforces this interpretation. The faster growth of the housing price index relative to the teacher salary index indicates that cost-of-living pressures intensified during the period under review. As housing costs represent a significant component of household expenditure, the divergence between salary growth and housing prices may intensify financial pressure on teachers' households. In the Portuguese context, housing affordability has already been identified as a structural constraint affecting teacher recruitment in high-cost regions such as the metropolitan area of Lisbon and the Algarve (Flores et al., 2025). The authors note that difficulties in accessing affordable accommodation have contributed to teacher shortages in these regions, prompting the introduction of government rental subsidies for displaced teachers. In this context, the widening gap between salary growth and housing prices identified in the present study may further undermine the attractiveness and geographic mobility of the profession.



Furthermore, empirical evidence indicates that inadequate remuneration is associated with lower psychological well-being and higher levels of occupational stress among teachers (Rueda et al., 2024). In parallel, empirical evidence indicates that lower salary satisfaction and perceived unfairness in compensation structures are significantly associated with higher turnover intention among teachers (Zhou & Ma, 2022). Although the present study does not directly measure individual well-being or turnover behavior, the macroeconomic patterns identified provide a contextual basis for understanding potential pressures on professional stability within the Portuguese education system.

At the structural level, the stability of salary differentials across career stages suggests that adjustments were applied relatively uniformly throughout the salary scale. While this uniformity preserved internal proportionality between entry-level and senior positions, it also meant that no specific stage experienced compensatory real gains. Consequently, purchasing power erosion was distributed across the entire career structure, affecting both early-career and experienced professionals. In systems characterized by rigid progression frameworks, such as the Portuguese model described by EACEA/Eurydice (2021), limited flexibility in adjusting salary steps may reduce the capacity to respond dynamically to macroeconomic shocks.

Finally, within the European comparative perspective, Portugal maintained a stable intermediate position throughout the period analyzed. Although statutory salaries increased in nominal terms, similar upward adjustments occurred across most European systems, resulting in limited variation in Portugal's relative ranking. The absence of significant convergence toward higher-paying European systems suggests structural continuity rather than upward realignment. Comparative literature on wage levels in OECD countries shows that cross-country differences in remuneration are closely associated with macroeconomic indicators such as GDP per capita, employment ratios, and labor productivity (Bilkova, 2020). In this context, Portugal's stable positioning indicates that domestic salary adjustments did not fundamentally alter its relative standing within the European landscape.

Overall, the findings suggest that teachers' and school heads' salaries in Portugal consistently fell behind macroeconomic dynamics between 2021 and 2024. As a result, the profession experienced declining real purchasing power and a gradual weakening of its relative labor market position. The integration of educational and macroeconomic indicators through the analytical artifact developed in this study provides a comprehensive perspective on salary evolution, revealing patterns of real constraint, relative adjustment, and structural stability.

These results contribute to the literature by empirically operationalizing the integration between statutory remuneration structures and macroeconomic indicators through a unified BI framework. By bridging educational salary data with macroeconomic context, the study addresses the analytical gap identified in Chapter 2 and provides a replicable analytical model for evidence-based policy analysis in education systems.



5. CONCLUSIONS

This study examined the extent to which teachers' and school heads' statutory salaries in Portugal evolved in alignment with key macroeconomic indicators between 2021 and 2024. By integrating salary data from Eurydice with macroeconomic indicators obtained from Eurostat and INE, the research addressed an analytical gap identified in the literature regarding the limited integration between educational remuneration structures and broader economic dynamics. The study further developed a Power BI dashboard as an analytical artifact that supports the systematic exploration of these relationships within a BI framework.

The empirical findings indicate that statutory salaries for teachers and school heads increased in nominal terms across all career stages during the period analyzed. However, these increases were insufficient to offset cumulative inflation, resulting in a decline in real purchasing power. At the same time, the growth of salaries in the education sector remained below the pace observed in national average wages and in broader macroeconomic indicators such as GDP per capita. Consequently, the relative economic position of teachers within the Portuguese labor market weakened over the period analyzed.

The analysis also highlighted the influence of cost-of-living dynamics, particularly the rapid increase in housing prices. The housing price index grew considerably faster than teachers' salaries, suggesting that economic pressures on teachers' households intensified during this period. In addition, the structural analysis of the Portuguese salary system revealed a strongly progressive career structure, with salaries at the top of the scale exceeding entry-level salaries by more than two times. While this structure preserves internal proportionality across career stages, the uniform application of salary adjustments resulted in purchasing power erosion affecting both early-career and experienced professionals.

From a European perspective, Portugal maintained a relatively intermediate position within the distribution of teachers' salaries adjusted for PPS. Although nominal salaries increased during the period analyzed, similar adjustments occurred across other European education systems, resulting in only a slight change in Portugal's relative ranking.

In addressing the research question, to what extent teachers' and school heads' salaries in Portugal reflect and evolve in relation to key macroeconomic indicators, the results suggest that salary evolution followed a pattern of consistent misalignment with macroeconomic dynamics. While salaries increased in nominal terms, these adjustments were insufficient to keep pace with inflationary pressures, broader wage growth, and rising living costs.

This study contributes to the literature in two main ways. First, it provides an empirical analysis that integrates statutory teacher remuneration with macroeconomic indicators



within a unified analytical framework, addressing the fragmentation identified in previous research. Second, it demonstrates the value of BI tools for policy-relevant analysis in the education sector. The Power BI dashboard developed in this study constitutes a practical analytical artifact that enables the integration, visualization, and exploration of heterogeneous data sources, supporting evidence-based analysis and decision-making.

Despite these contributions, some limitations should be acknowledged. The analysis focuses on a relatively short time horizon (2021-2024), which may limit the ability to capture longer-term structural dynamics in salary evolution. In addition, the study relies exclusively on secondary aggregated data, which does not allow for direct analysis of individual-level outcomes such as teacher satisfaction, mobility, or turnover. Furthermore, the European comparison is limited to statutory salary levels and does not incorporate broader institutional or contractual differences across education systems. Finally, the evaluation of the analytical artifact was conducted through a scenario-based walkthrough approach, which, although suitable for demonstrating functional capabilities and analytical usefulness, does not include empirical validation with end-users or real-world decision-making contexts.

Future research could extend this analysis in several directions. First, expanding the temporal scope would allow for a more comprehensive assessment of long-term salary dynamics and their relationship with macroeconomic cycles. Second, integrating micro-level data on teachers' perceptions, working conditions, or career decisions could provide deeper insight into the behavioral consequences of remuneration dynamics. Third, the analytical framework developed in this study could be applied comparatively across multiple countries to examine cross-national differences in the relationship between teacher remuneration and macroeconomic conditions.

Overall, this study demonstrates that integrating educational salary data with macroeconomic indicators through BI tools can provide a more comprehensive understanding of remuneration dynamics within education systems. By combining data integration, analytical modeling, and visual analytics, the research offers a replicable approach for supporting evidence-based policy analysis and contributes to a more informed discussion on economic sustainability and the attractiveness of the teaching profession.

In this context, the analytical approach developed in this study highlights the importance of evaluating teacher remuneration not only as an isolated policy variable but as a component embedded within broader economic dynamics. Strengthening this integration between educational policy analysis and macroeconomic context is essential for ensuring that remuneration systems remain economically sustainable and capable of supporting the long-term attractiveness and stability of the teaching profession.



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Data with Purpose.

