Intra-regional disparities and hidden inequalities in the employment of PhD Holders: evidence from Eastern Macedonia and Thrace - one of the EU's poorest regions

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Abstract

This study investigates the employment patterns of PhD holders in Eastern Macedonia and Thrace, among the European Union's less developed regions. Drawing on the 2021 Population and Housing Census conducted by the Hellenic Statistical Authority (ELSTAT), it examines both employment status and forms of employment, emphasising variations across the region's six units. The findings reveal notable gender and territorial disparities, with most PhD holders occupying salaried positions, predominantly in the public sector, while a substantial proportion remains economically inactive, reflecting the underutilisation of highly skilled human capital. By highlighting intra-regional differences within one of Europe's most disadvantaged areas, the study contributes to the discourse on doctoral employability in peripheral labour markets and discusses relevant policy and educational implications, particularly concerning local development and the mitigation of regional inequalities.

Keywords: employability, PhD holders, regional inequalities, gender, regional development, gender equality

Introduction

The employability of PhD holders has emerged as a critical research field, especially in light of rapid global and national labour market transformations. Doctoral graduates exhibit the highest employment rates among all educational levels - 92% across OECD countries (OECD, 2022) - yet their career trajectories are not without challenges. New generations face employment precarity, limited mobility between academic and non-academic sectors, and increasing competition as the number of doctorates rises (Hnátková *et al*., 2022; Pizzolato *et al*., 2023).

In Greece, these dynamics are particularly pronounced due to the combined effects of the economic crisis, digitalisation, and structural changes in production. While Greek PhD holders show

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high overall employment rates (EKT, 2022b), significant inequalities persist, especially in terms of gender and geography (Roupakias, 2018; OECD, 2023).

Eastern Macedonia and Thrace represents an emblematic case. Despite hosting a major academic institution—the Democritus University of Thrace—the region remains one of the least developed in the European Union, with GDP per capita amounting to just 48% of the EU average (Eurostat, 2022). Structural weaknesses such as low productivity, demographic decline, and weak labour absorption hinder the full utilisation of highly skilled human capital (Iammarino, Rodríguez-Pose and Storper, 2022).

According to the OECD (2020), persistent regional imbalances in Greece constrain innovation capacity and the employment of highly qualified workers in the northern and eastern regions. The European Commission (2025) classifies Eastern Macedonia and Thrace among the Emerging Innovators in the Regional Innovation Scoreboard 2025, reflecting low R&D intensity and a fragile innovation ecosystem. Similarly, Ierapetritis (2019) highlights that limited social capital and insufficient networking between universities and local enterprises restrict regional development and innovation potential in northern Greece.

Recent regional labour reports show that employment in Eastern Macedonia and Thrace remains dominated by low- and medium-skill sectors, while opportunities for PhD holders are largely concentrated in the public sector, particularly in education and research (ELSTAT, 2023 Q4). The National Smart Specialisation Strategy 2021-2027 also emphasises the need to strengthen regional innovation ecosystems as a means to improve employment outcomes for highly skilled graduates (GSRI, 2022). These findings confirm that structural weaknesses at the regional level significantly influence the employment prospects of highly educated individuals, including PhD holders.

The purpose of this study is to investigate the employment patterns of PhD holders in Eastern Macedonia and Thrace, one of the least developed regions of the European Union, with particular attention to the intra-regional disparities observed across its six regional units. By examining employment status and forms of employment using census data, the study seeks to highlight gender- and territory-based inequalities in the employability of doctoral graduates. In doing so, it aims to contribute to the broader debate on the integration of highly qualified human capital into peripheral labour markets and to inform policy and educational strategies designed to reduce regional disparities.

The research is guided by the following questions: What is the distribution of PhD holders in terms of employment status across the six regional units of Eastern Macedonia and Thrace? How does employment status differ between male and female PhD holders in each regional unit? What forms of employment (salaried, self-employed, other) prevail in each regional unit? What patterns of

economic inactivity are observed among PhD holders, and how do these vary by gender and regional unit?

1. Literature Review

1.1. Employability of PhD holders at international level

International data indicate that PhD holders enjoy high employment rates, although their career trajectories increasingly diverge from traditional academic paths (OECD, 2022). Limited absorption capacity in education and research sectors has led to diversified career paths, with many PhD holders employed in the private sector, consultancy, or industry (Robinson-Garcia *et al*., 2016). The literature emphasises the importance of interdisciplinarity, adaptability, and transferable skills for professional success (Pizzolato *et al*., 2023; Sala-Bubaré *et al*., 2023).

Significant differences in employment and job satisfaction are observed across academic fields. PhD holders in Engineering and Computer Science predominantly work in industry and services, reporting lower satisfaction in terms of knowledge application compared to those in universities or public research centres (Alfano, 2021). Graduates from social sciences and humanities face difficulties finding employment matching their qualifications and salary expectations (Boulos, 2016). Furthermore, hard science PhDs generally enjoy better career outcomes than graduates in softer fields, such as sociology (Passaretta, 2018; Daouli, 2015). Investigating the link between field of study and career trajectory is crucial for understanding PhD employment patterns.

Specialised research skills are essential for non-academic employment. PhDs working outside R&D often assume demanding roles or positions related to their academic training (Haapakorpi, 2017), with employers placing high value on expertise.

1.2. Gender inequalities in PhD employment

Research consistently shows gender disparities in career progression. Women are less likely to occupy leadership roles, more frequently work in precarious positions, and are underrepresented in STEM entrepreneurship (Van den Brink and Benschop, 2014; ERC, 2021; European Commission, 2024a). She Figures 2021 and 2024 indicate that, despite near parity at graduation, inequalities widen upon entering the labour market (EKT, 2022a; European Commission, 2024b).

The literature also shows that specialised skills, prior academic experience, and professional networks influence men and women differently (Herrera, 2015; Pham, 2023), highlighting the need for policies that support both access and career advancement.

At the national level, the Greek context provides further evidence of persistent gendered employment patterns. Gender disparities are particularly visible among PhD holders and researchers. According to the National Documentation Centre (EKT, 2023b), women represent nearly half of new doctoral graduates but remain underrepresented in high-level academic and research positions. They are also more likely to be employed in the public sector, particularly in education and health sciences. Empirical research on the employment of PhD holders in Greece confirms these differences: Daouli and Nikolatou (2015a) found that female doctorate holders are significantly more concentrated in lower-paid public sector occupations, whereas men are more likely to work in research-intensive and higher-remunerated positions. At the international level, the OECD (2024a) report on the state of academic careers highlights that women PhD holders continue to face barriers in securing stable and well-paid research positions, particularly within STEM disciplines. Addressing such gender imbalances is essential to ensure both equality of opportunity and the effective utilisation of highly educated human capital in Greece.

1.3. Regional inequalities and development traps

Regional disparities affect the PhD labour market, with certain areas identified as "development traps," where low productivity and limited job demand hinder convergence despite high educational attainment (Iammarino *et al*., 2022). These regions struggle to retain and utilise high-skilled workers, limiting mobility and human capital utilisation (European Commission, 2022).

Applied to the Greek case, this framework helps interpret the intra-regional variations we observe. Regions such as Attica, with more diversified innovation ecosystems and stronger research–industry–governance linkages, achieve better outcomes for PhD holders (EKT, 2023a; GSRI, 2022). By contrast, peripheral areas such as Eastern Macedonia and Thrace remain constrained by institutional inertia, public-sector reliance and weak private-sector absorption (ELSTAT, 2023; European Commission, 2023). These conditions mirror the characteristics of "development traps", where limited diffusion of innovation and insufficient interaction between academic and productive sectors hinder the full utilisation of highly skilled human capital. From a Regional Innovation Systems perspective, such patterns reflect limited connectivity among universities, firms and regional authorities, which reduces the diffusion of innovation and slows structural transformation (Asheim and Gertler, 2006).

Over-education, international experience, and socio-demographic factors influence employability and study-to-work match. Overseas experience positively affects overcoming mismatches, and positions within universities or research centres increase the likelihood of successful matching (Ermini, 2017; Massimiliano, 2022). Age, marital status, and family ties also influence career trajectories (Daouli, 2015b; Tocchioni, 2021).

1.4. The Greek context

In Greece, PhD holders show high employment rates (97.5%), primarily in the public sector, yet face overrepresentation and skills mismatches (OECD, 2010; EKT, 2022b). The National Documentation Centre records significant international mobility and connections with the diaspora (EKT, 2023). Regional disparities are pronounced: metropolitan areas offer more opportunities, while peripheral regions face structural barriers (Vlados *et al*., 2019; Kosmetatou, 2025).

Research highlights that PhDs in the private sector display varied profiles depending on academic field, type of research, funding sources, and level of study (Herrera, 2015). General skills, such as analytical thinking and problem-solving, along with social capital, are crucial for professional success (Kyvik, 2012; Pham, 2023; Waaijer, 2016).

Finally, the literature emphasises the need for active policies to attract and retain PhDs and enhance their contribution to the economy and higher education. Intermediary organisations, public-private partnerships, and public administration can play a crucial role if adequately supported by resources (Santos, 2016; Alfano, 2021; Boulos, 2016; Fraguas-Sánchez, 2023; Passaretta, 2018).

2. Research methodology

2.1. Research design

This study adopts a quantitative research approach, based on census data. The objective is to investigate employment inequalities among PhD holders in Eastern Macedonia and Thrace, focusing on gender and regional dimensions. The use of secondary, population-wide data ensures stronger validity compared to sample-based studies.

2.2. Dependent and independent variables

To address the research questions, the study employs variables drawn from the 2021 Population and Housing Census of the Hellenic Statistical Authority (ELSTAT). The dependent variables concern labour market outcomes, namely employment status (employed, unemployed, or economically inactive) and form of employment (salaried, self-employed, or other). These measures capture the degree of integration of doctoral graduates into the labour market and allow for the identification of prevailing employment patterns.

The independent variables comprise gender and regional unit. Gender (male or female) enables the analysis of possible inequalities in employment outcomes between men and women. The regional unit variable distinguishes between the six subdivisions of Eastern Macedonia and Thrace—Drama, Kavala, Xanthi, Rodopi, Evros, and Thasos—and makes it possible to examine intra-regional disparities. Taken together, these variables facilitate an in-depth exploration of the interplay between gender, territorial context, and employment outcomes among highly qualified individuals in a less developed European region.

Finally, in line with the definitions provided by ELSTAT (2021), the economically active population comprises those who are employed, formerly employed, or newly unemployed, whereas the economically inactive population includes students, retirees, individuals living on private income, homemakers, and others. Employment position is further classified into six categories: self-employed with employees, self-employed without employees, salaried or wage earners, members of producers' cooperatives, contributing family workers, and other cases.

2.3. Data Source and sample

The data are drawn from the 2021 Population and Housing Census conducted by ELSTAT. For the first time, the census included detailed information on the highest level of education attained, enabling the identification of PhD holders at the regional unit level. The final dataset covers all PhD holders residing in Eastern Macedonia and Thrace, thus ensuring complete population coverage rather than relying on sample surveys.

2.4. Analytical procedure

Data processing was conducted using SPSS. The analysis proceeded in two steps:

- Descriptive statistics: distributions and percentages of employment status and type of employment, disaggregated by gender and regional unit.
- Inferential statistics: chi-square tests were employed to assess associations between gender, region, and employment variables. In cases where expected cell counts were small, alternative methods (e.g., Fisher's Exact test, Monte Carlo simulations) were used to confirm robustness.

While the census data used in this analysis provide a comprehensive and reliable overview of PhD holders' employment patterns, it is important to acknowledge a key limitation. Such data are highly effective for identifying associations and structural trends but cannot establish causality or explain the underlying mechanisms behind observed relationships. Recognising this limitation clarifies the scope of the findings and underscores the value of complementary qualitative research to explore the underlying "why" behind these patterns.

3. Results

3.1. Analysis of the association between regional unit and gender among economically active PhD holders

This study examines the relationship between Regional Unit (Kavala, Drama, Xanthi, Rhodope, Evros, and Thasos) and gender among economically active PhD holders, based on the 2021 population census. The sample comprises 1,498 valid observations.

Overall, males constitute 63.9% and females 36.1% of the economically active PhD population, with variation across regions (The full results are presented in Table A1 (Appendix)). Thasos exhibits exclusively male representation (100%, albeit with a very small sample), while Rhodope demonstrates the highest male predominance (70.4%). Drama and Evros show a relatively balanced gender distribution (61.7% and 60% males, respectively), whereas Kavala and Xanthi approximate the overall average.

A Pearson Chi-Square test (Table 1) indicated a statistically significant association between Regional Unit and gender ($\chi^2 = 11.981$, $p = 0.035$). Given the presence of low expected frequencies in some cells, a Monte Carlo simulation was conducted, which corroborated the significance ($p = 0.032$, 99% confidence interval: 0.028–0.037). These results were further supported by the Likelihood Ratio test ($p = 0.017$) and Fisher's exact test ($p = 0.035$). The Linear-by-Linear Association test did not reveal a significant linear trend ($p = 0.917$), consistent with the categorical nature of the variables.

Table 1. Chi-Square test for the association between regional unit and gender of economically active PhD holders

	Value	df	Asymp. Sig. (2-sided)	Monte Carlo Sig. (2-sided)			Monte Carlo Sig. (1-sided)		
				Sig.	99% Confidence Interval		Sig.	99% Confidence Interval	
					Lower Bound	Upper Bound		Lower Bound	Upper Bound
Pearson Chi-Square	11.981[a]	5	0.035	0.032[b]	0.028	0.037			
Likelihood Ratio	13.729	5	0.017	0.018[b]	0.015	0.022			
Fisher's Exact Test	11.688			0.035[b]	0.030	0.040			
Linear-by-Linear Association	0.011[c]	1	0.917	0.923[b]	0.916	0.929	0.465[b]	0.452	0.478
N of Valid Cases	1498								

Notes: a. 2 cells (16,7%) have expected count less than 5. The minimum expected count is 1,81.
b. Based on 10000 sampled tables with starting seed 2000000.
c. The standardized statistic is -,104.
Source: own processing in SPSS based on data provided by ELSTAT

Symmetrical measures (Table 2) of association (Phi and Cramer's V = 0.089) indicate a weak but statistically significant relationship. In other words, while gender distribution varies across regions, the strength of this variation is limited.

Table 2. Symmetrical measures of association (Phi and Cramer's V) between regional unit and gender of economically active PhD holders

		Value	Approx. Sig.	Monte Carlo Sig.		
				Sig.	99% Confidence Interval	
					Lower Bound	Upper Bound
Nominal by Nominal	Phi	0.089	0.035	0.032[c]	0.028	0,037
	Cramer's V	0.089	0.035	0.032[c]	0.028	0,037
N of Valid Cases		1498				

Notes: a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.
c. Based on 10000 sampled tables with starting seed 2000000.
Source: own processing in SPSS based on data provided by ELSTAT

In conclusion, the geographical distribution of economically active PhD holders is statistically associated with gender, albeit with low intensity. These findings may reflect broader socio-economic, cultural, or institutional factors influencing regional mobility and labour market integration, with a gendered dimension.

3.2. Analysis of the association between regional unit and gender among economically inactive PhD holders

This study investigates the relationship between Regional Unit and gender among economically inactive PhD holders, based on the 2021 population census. The sample comprises 634 valid cases.

Overall, males account for 64.7% and females for 35.3% of the economically inactive PhD population, with relative stability across most regions (The full results are presented in Table A2 (Appendix)). Drama exhibits the highest male predominance (73.7%), whereas Evros displays the lowest (55.2%). Rhodope, Kavala, Xanthi, and Thasos report proportions around 66%, with Thasos reflecting the general trend despite a small sample size (13 individuals).

A Pearson Chi-Square (Table 3) test indicated a statistically significant association between Regional Unit and gender ($\chi^2 = 12.275$, $p = 0.031$). Due to low expected frequencies in one cell, a Monte Carlo simulation was conducted, confirming the significance ($p = 0.030$, 99% CI: 0.025–0.034) and enhancing the robustness of the results. The association was further supported by the Likelihood Ratio test ($p = 0.032$) and Fisher's exact test ($p = 0.033$). The Linear-by-Linear Association test was not significant ($p = 0.377$), as anticipated given the nominal nature of the variables.

Table 3. Chi-Square test of regional unit and gender among economically inactive PhD holders

	Value	df	Asymp. Sig. (2-sided)	Monte Carlo Sig. (2-sided)			Monte Carlo Sig. (1-sided)		
				Sig.	99% Confidence Interval		Sig.	99% Confidence Interval	
					Lower Bound	Upper Bound		Lower Bound	Upper Bound
Pearson Chi-Square	12.275[a]	5	0.031	0.030[b]	0.025	0.034			
Likelihood Ratio	12.175	5	0.032	0.036[b]	0.031	0.040			
Fisher's Exact Test	11.972			0.033[b]	0.028	0.038			
Linear-by-Linear Association	0.779[c]	1	0.377	0.383[b]	0.371	0.396	0.201[b]	0.191	0.212
N of Valid Cases	634								

Notes: a. 1 cells (8,3%) have expected count less than 5. The minimum expected count is 4,59.
b. Based on 10000 sampled tables with starting seed 2000000.
c. The standardized statistic is ,883.
Source: own processing in SPSS based on data provided by ELSTAT

Symmetrical measures (Table 4) (Phi and Cramer's V = 0.139) indicate a weak but statistically significant association, suggesting that gender distribution varies across regions, though the effect is moderate.

Table 4. Phi and Cramer's V by regional unit among economically inactive PhD holders

		Value	Approx. Sig.	Monte Carlo Sig.		
				Sig.	99% Confidence Interval	
					Lower Bound	Upper Bound
Nominal by Nominal	Phi	0.139	0.031	0.030[c]	0.025	0.034
	Cramer's V	0.139	0.031	0.030[c]	0.025	0.034
N of Valid Cases		634				

Notes: a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on 10000 sampled tables with starting seed 2000000.
Source: own processing in SPSS based on data provided by ELSTAT

In conclusion, the geographical distribution of economically inactive PhD holders differs significantly by Regional Unit. The Monte Carlo approach effectively addresses low-frequency issues, and the observed disparities may reflect broader socio-economic or cultural factors, gender equality concerns, and structural differences in local labour markets and access to postdoctoral opportunities.

3.3. Synthesis of results regarding the association between regional unit and gender among economically active and inactive PhD holders

Analysis of the 2021 census data for PhD holders in Eastern Macedonia and Thrace shows a statistically significant but weak to moderate association between region and gender (Cramer's V = 0.089 for active, 0.139 for inactive). Men predominate among the economically active, reaching 70.4% in Rhodope and approaching parity in Evros (60% male). Gender imbalances are sharper among the inactive, notably in Drama (73.7% male) and Thasos (69.2% male), with Evros again displaying greater balance.

These results mirror broader trends: She Figures 2024 reports that women comprise 50% of PhD graduates but only 39% of researchers, below the EU-27 average (European Commission, 2024a; 2024b). In Greece, 52.2% of 2022 graduates were male (EKT, 2023), confirming that parity at graduation weakens in the transition to employment (García, 2020). International studies also note compounded gender–regional inequalities, with women facing more precarious labour market entry, especially in weaker economies (Auriol *et al*., 2013), while socio-economic norms and spatial dynamics further constrain career paths (Kosmetatou, 2025). She Figures 2021 highlights persistent underrepresentation in STEM and ICT self-employment (EKT, 2022a), consistent with our findings of higher male concentrations in self-employment-oriented regions (e.g., Kavala, Rhodope).

The predominance of male PhD holders in both economically active and inactive groups may be partly explained by gendered patterns in field of study, mobility, and career choices. Men are more frequently concentrated in STEM-related disciplines, which offer greater opportunities for private-sector employment and self-employment (Encinas-Martín, and Cherian, 2023). Women, on the other hand, tend to specialise in education and public-sector–oriented fields, where job security is higher but regional mobility and entrepreneurial options are limited (EKT, 2022a; KEPE, 2022).

Additionally, family-related responsibilities and work–life balance constraints have been found to affect women's career continuity, particularly in peripheral regions with fewer flexible employment options (EIGE, 2025; European Commission, 2024a).

In sum, while the statistical effect of geography is modest, its persistence underscores structural inequalities. Policy must therefore address not only women's participation in research but also the creation of regionally balanced infrastructures for high-skilled employment.

3.4. Analysis of the association between regional unit and employment status of economically active PhD holders in Eastern Macedonia and Thrace

This study examines the relationship between Regional Unit and employment status among economically active PhD holders in Eastern Macedonia and Thrace, based on 2021 census data. The sample comprises 1,547 valid cases. Overall, 96.4% of PhD holders were employed, 2.9% were formerly employed, and 0.7% recently unemployed, indicating a high labour market absorption rate (The full results are presented in Table A3 (Appendix)). Regional variation was minimal: Thasos 100% employed, Drama 98.3%, Xanthi 97.2%, Rhodope 96.5%, Evros 95.9%, and Kavala 95.1% with the highest proportion of formerly employed individuals (4.9%).

Table 5. Chi-Square test by regional unit among economically active PhD holders

	Value	df	Asymp. Sig. (2-sided)	Monte Carlo Sig. (2-sided)			Monte Carlo Sig. (1-sided)		
				Sig.	99% Confidence Interval		Sig.	99% Confidence Interval	
					Lower Bound	Upper Bound		Lower Bound	Upper Bound
Pearson Chi-Square	14.474[a]	10	0.152	0.144[b]	0.135	0.153			
Likelihood Ratio	17.167	10	0.071	0.061[b]	0.055	0.067			
Fisher's Exact Test	14.198			0.140[b]	0.131	0.149			
Linear-by-Linear Association	0.009[c]	1	0.923	0.929[b]	0.922	0.936	0.479[b]	0.466	0.492
N of Valid Cases	1547								

Notes: a. 7 cells (38,9%) have expected count less than 5. The minimum expected count is ,05.
b. Based on 10000 sampled tables with starting seed 2000000.
c. The standardized statistic is -,096.
Source: own processing in SPSS based on data provided by ELSTAT

The Pearson Chi-Square test (Table 5) did not reveal a statistically significant association between Regional Unit and employment status ($p = 0.152$), a finding corroborated by Monte Carlo and Fisher's Exact tests. The Linear-by-Linear Association test was also non-significant ($p = 0.923$), indicating no linear trend. Symmetric measures (Table 6), Phi and Cramer's V (0.097 and 0.068 respectively), were low and non-significant.

Table 6. Symmetric measures (Phi and Cramér's V) by regional unit among economically active PhD holders

		Value	Approx. Sig.	Monte Carlo Sig.		
				Sig.	99% Confidence Interval	
					Lower Bound	Upper Bound
Nominal by Nominal	Phi	0.097	0.152	0.144[c]	0.135	0.153
	Cramer's V	0.068	0.152	0.144[c]	0.135	0.153
N of Valid Cases		1547				

Notes: a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.
c. Based on 10000 sampled tables with starting seed 2000000.
Source: own processing in SPSS based on data provided by ELSTAT

In conclusion, PhD holders in the region exhibit generally high and homogeneous employment, with minor local differences lacking statistical significance. Their strong labour market presence is likely linked to the existence of academic institutions, research centres, and the gradual decentralisation of knowledge-based activities.

3.5. Correlation analysis between regional unit and employment status of economically inactive PhD holders in Eastern Macedonia and Thrace

Analysis of the 2021 census data on economically inactive PhD holders in Eastern Macedonia and Thrace reveals notable differences in types of inactivity across Regional Units. The dataset comprises 555 valid cases, with retirees forming the vast majority (88.1%), followed by students (5%), other forms of inactivity (4.7%), and homemakers (2.2%).

At the regional level (The full results are presented in Table A4 (Appendix)), Thasos has the highest share of retirees (100%), followed by Evros (90.9%) and Xanthi (90.7%). Kavala (81.7%) and Drama (81.1%) show lower retirement rates and a modest presence of other inactivity forms, including homemakers and unspecified categories. The “students” and “others” categories indicate ongoing studies or transitional employment phases, with Kavala reporting 8.5% students, Xanthi 6.5%, and Rhodope and Drama showing higher proportions in “others” (7.6% and 10.8%, respectively).

Pearson’s Chi-Square test (Table 7) indicated a statistically significant association between Regional Unit and type of inactivity ($p = 0.014$), supported by Monte Carlo, Likelihood Ratio, and Fisher’s Exact tests. The Linear-by-Linear Association test was also significant ($p = 0.008$), suggesting a negative linear trend for certain variables. The strength of the association (Table 8), as measured by Cramer’s V (0.133), indicates a weak but statistically significant relationship.

Table 7. Chi-Square test for employment status by regional unit among economically inactive PhD holders

	Value	df	Asymp. Sig. (2-sided)	Monte Carlo Sig. (2-sided)			Monte Carlo Sig. (1-sided)		
				Sig.	99% Confidence Interval		Sig.	99% Confidence Interval	
					Lower Bound	Upper Bound		Lower Bound	Upper Bound
Pearson Chi-Square	29.454[a]	15	0.014	0.021[b]	0.017	0.025			
Likelihood Ratio	37.695	15	0.001	0.002[b]	0.001	0.002			
Fisher's Exact Test	30.013			0.005[b]	0.003	0.006			
Linear-by-Linear Association	7.116[c]	1	0.008	0.007[b]	0.004	0.009	0.004[b]	0.002	0.005
N of Valid Cases	555								

Notes: a. 12 cells (50,0%) have expected count less than 5. The minimum expected count is ,26.
b. Based on 10000 sampled tables with starting seed 2000000.
c. The standardized statistic is -2,667.
Source: own processing in SPSS based on data provided by ELSTAT

Table 8. Phi and Cramer's V for employment status by regional unit among economically inactive PhD holders

		Value	Approx. Sig.	Monte Carlo Sig.		
				Sig.	99% Confidence Interval	
					Lower Bound	Upper Bound
Nominal by Nominal	Phi	0.230	0.014	0.021[c]	0.017	0.025
	Cramer's V	0.133	0.014	0.021[c]	0.017	0.025
N of Valid Cases		555				

Notes: a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.
c. Based on 10000 sampled tables with starting seed 2000000.
Source: own processing in SPSS based on data provided by ELSTAT

In summary, while most inactive PhD holders in the region are retirees, there are regional variations in other forms of economic inactivity, such as study, household duties, or other reasons. Geographical distribution has a statistically significant effect on the type of inactivity, though the overall strength of this association remains limited.

3.6. Synthesis of findings on the correlation between regional unit and employment status of economically active and inactive PhD holders in Eastern Macedonia and Thrace

The 2021 census highlights exceptionally high employment rates among economically active PhD holders in Eastern Macedonia and Thrace: 96.4% were employed, with only 2.9% formerly employed and 0.7% newly unemployed. Employment exceeded 96% across all regional units, with no statistically significant differences, indicating a uniform integration into the labour market.

By contrast, regional disparities emerge among the economically inactive (n = 555). The vast majority (88.1%) were retirees, concentrated in Evros, Xanthi, Rhodope, and exclusively in Thasos. In Drama and Kavala, additional categories such as students and homemakers appeared. Statistical tests ($\chi^2 = 29.454$, $p = 0.014$; Monte Carlo $p = 0.021$) confirmed a significant association between region and type of inactivity, with Cramer's V (0.133) indicating a weak to moderate relationship.

These results mirror national and international trends. According to the National Documentation Centre, 97.5% of PhD holders are employed, 31.3% have international experience, and 14.8% work abroad (EKT, 2022b), while 82.3% enter the labour market immediately after graduation, mainly in research institutions (EKT, 2023). EU and OECD data also show PhD employment rates above 90%, though issues of overqualification and skill mismatches persist (OECD, 2010; 2013).

Policy research emphasises the need to support PhD holders during career transitions. The OECD recommends upskilling and reintegration programmes, particularly for older workers (OECD, 2024b), while career counselling, intersectoral mobility, and alternative career paths are seen as essential given the increasing number of PhDs pursuing careers outside academia (OECD, 2023).

Accordingly, regional policies should focus on harnessing doctoral skills both before and after retirement, thus extending professional participation and contributing to broader European and national objectives of optimising highly skilled human capital (OECD, 2014; EKT, 2023).

3.7. Correlation analysis between regional unit and employment position of economically active PhD holders

This analysis examines the relationship between Regional Unit (Kavala, Drama, Xanthi, Rhodope, Evros, and Thasos) and the employment position of economically active PhD holders, based on 2021 Census data. The dataset includes 1,502 valid cases, ensuring analytical reliability.

Employment position varies substantially across Regional Units (The full results are presented in Table A5 (Appendix)), reflecting differences in labour market integration. Evros reports the highest share of salaried employees (31.8%), followed by Xanthi (21.2%), whereas Thasos shows minimal representation in this category, likely due to the small number of PhD holders (n=9).

Kavala stands out with the highest proportion of self-employed PhD holders with employees (30.6%) and a considerable share without employees (22.8%), indicating a local entrepreneurial orientation. Kavala's relatively higher share of self-employed PhD holders may reflect its more diversified and business-oriented local economy. According to OECD. (2024c), Kavala and Evros

together account for almost 53% of the region's GDP. The regional unit also benefits from a strong agri-food base (around 20% of its land under cultivation; Black Sea CBC, 2022) and infrastructure connecting it to trans-European transport axes and oil-related activities (Municipality of Kavala). Recent analysis by the Kavala Chamber of Commerce and Industry (KCCI, 2021) highlights the strong presence of SMEs in tourism, agri-food and services, underscoring the local economy's entrepreneurial orientation. Together these features likely contribute to the region's more pronounced business dynamism compared to other parts of Eastern Macedonia and Thrace. Rhodope exhibits a balanced distribution, with notable rates of both self-employment without employees (22.8%) and salaried work (16.1%). In contrast, Drama shows lower representation across all categories, including only 11.5% in salaried employment.

Pearson's Chi-Square test (Table 9) demonstrated a statistically significant association between Regional Unit and employment position ($\chi^2 = 45.482$, df = 15, $p < 0.001$). Given that 8 cells had expected frequencies below 5, the Monte Carlo method (10,000 iterations) was applied, confirming significance (p = 0.003; 99% CI: 0.002–0.005). Likelihood Ratio and Fisher's Exact tests corroborated this association, while Linear-by-Linear Association showed no trend (p = 0.494), as expected due to the nominal nature of the variables.

Table 9. Chi-Square test of employment position by regional unit among economically active PhD holders

	Value	df	Asymp. Sig. (2-sided)	Monte Carlo Sig. (2-sided)			Monte Carlo Sig. (1-sided)		
				Sig.	99% Confidence Interval		Sig.	99% Confidence Interval	
					Lower Bound	Upper Bound		Lower Bound	Upper Bound
Pearson Chi-Square	45.482[a]	15	0.000	0.003[b]	0.002	0.005			
Likelihood Ratio	41.913	15	0.000	0.000[b]	0.000	0.001			
Fisher's Exact Test	40.001			0.000[b]	0.000	0.001			
Linear-by-Linear Association	0.469[c]	1	0.494	0.501[b]	0.488	0.514	0.250[b]	0.239	0.262
N of Valid Cases	1502								

Note: a. 8 cells (33,3%) have expected count less than 5. The minimum expected count is ,09.
b. Based on 10000 sampled tables with starting seed 2000000.
c. The standardized statistic is -,685.
Source: own processing in SPSS based on data provided by ELSTAT

The Phi coefficient (0.174) and Cramer's V (0.100) indicate (Table 10) a weak to moderate association, suggesting that the region has a measurable influence on employment type, likely reflecting local demographic or socio-economic conditions.

Table 10. Symmetric measures of association (Phi and Cramer's V) between regional unit and employment position of economically active PhD holders

		Value	Approx. Sig.	Monte Carlo Sig.		
				Sig.	99% Confidence Interval	
					Lower Bound	Upper Bound
Nominal by Nominal	Phi	0.174	0.000	0.003[c]	0.002	0.005
	Cramer's V	0.100	0.000	0.003[c]	0.002	0.005
N of Valid Cases		1502				

Notes: a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.
c. Based on 10000 sampled tables with starting seed 2000000.
Source: own processing in SPSS based on data provided by ELSTAT

In summary, the employment position of PhD holders differs significantly across Regional Units. Although the strength of the association is not high, the findings reveal spatial differences in professional opportunities and types of employment, warranting further investigation within the context of regional development policy and employment strategies for highly educated human capital.

Conclusions

The analysis of the 2021 census confirms the exceptionally high employment rates of PhD holders in Eastern Macedonia and Thrace, indicating a generally successful labour market integration. Yet, beneath this stability, regional and demographic variations persist. Men remain predominant among the economically active, while gender, age and local institutional structures continue to influence employment outcomes. The persistence of such patterns reflects the broader context of public-sector dependence, demographic ageing and uneven private-sector development across the region.

At the same time, differences in employment type and inactivity highlight the varying capacity of local economies to absorb high-skilled labour. Regions such as Kavala, characterised by a more diversified and business-oriented economy, display stronger self-employment and entrepreneurial activity, whereas others remain dominated by public-sector positions. These findings underscore the need for geographically sensitive employment policies that link research capacity with regional innovation potential.

The results are consistent with national and international evidence. According to the National Documentation Centre (EKT, 2022b; 2023), the vast majority of Greek PhD holders are employed, yet many face overqualification and limited mobility beyond academia. OECD studies (2010; 2013; 2016; 2023; 2024a; 2024b) emphasise the importance of reskilling, cross-sectoral mobility and career diversification for doctoral graduates. Especially in ageing regions such as Eastern Macedonia and

Thrace, initiatives supporting career transitions, lifelong learning and the re-engagement of retirees in mentoring or innovation activities can strengthen the utilisation of doctoral skills and extend employability.

Integrating doctoral talent into national and regional development strategies is therefore essential for enhancing innovation capacity and reducing territorial disparities. Strengthening the linkages between education and labour markets, improving institutional tools, and promoting regional innovation policies would enhance knowledge diffusion and support sustainable economic growth. These findings support international calls for mobility schemes and advisory services (Pizzolato *et al*., 2023; Hnátková *et al*., 2022), particularly in regions with limited professional opportunities.

These regional disparities can also be interpreted through the lens of development traps, where persistent structural rigidities prevent regions from converting educational achievement into economic competitiveness. The persistence of disparities between dynamic regions such as Attica and peripheral areas like Eastern Macedonia and Thrace illustrates the mechanisms of the regional development trap, where public-sector dependence, weak private-sector absorption and institutional rigidity constrain the full use of highly skilled human capital (European Commission, 2023; Iammarino, Rodríguez-Pose and Storper, 2017). From a Regional Innovation Systems perspective, these conditions demonstrate the limited interaction between universities, industry, and governance, reducing knowledge diffusion and innovation potential (Asheim and Gertler, 2006). Addressing these structural barriers requires targeted regional innovation policies, incentives for research–industry collaboration, and measures to enhance the mobility and employability of PhD holders. Strengthening regional ecosystems of innovation could help Greece not only retain its highly educated workforce but also transform regional disparities into opportunities for sustainable, knowledge-driven growth.

Policy and Educational Implications

The findings of this study underline the importance of targeted policy interventions in less developed regions such as Eastern Macedonia and Thrace. While the presence of PhD holders can be a driver of regional innovation and growth, yet their potential often remains underutilised in the absence of adequate policy support.

First, EU Cohesion Policy can act as a catalyst for mobilising highly skilled human capital if investments are strategically directed towards high value-added sectors capable of absorbing doctoral graduates (Christou *et al*., 2024; European Commission, 2022). Strengthening university–industry linkages is particularly crucial for transforming research into regional economic benefits.

Second, doctoral graduates need stronger transversal skills, such as entrepreneurship, project management, and communication, which are increasingly important for employability in uncertain labour markets (Iškrova, 2023). Embedding such training in doctoral programmes could enhance career opportunities beyond academia.

Third, professional networking mechanisms—including academic associations, mobility schemes, and collaborations with industry—should be reinforced. Evidence from Greece indicates that a considerable share of PhD holders have international work experience, highlighting the need to capitalise on scientific diaspora networks (EKT, 2022b).

Finally, gender inequalities persist in doctoral employment outcomes both in Greece and across Europe. Targeted initiatives, such as mentoring programmes and incentives for hiring female researchers, could contribute to narrowing these gaps (European Commission, 2022).

In addition, the implementation of targeted regional policies is crucial for the effective utilisation of human capital at the sub-regional level. Within the framework of the Operational Programme of Eastern Macedonia and Thrace (2021–2027), a substantial share of ERDF and ESF resources was allocated to innovation, SME support, and skills development, thereby opening opportunities for tailored employment and mobility programmes for PhD holders (European Commission, 2021).

Moreover, under the post-2020 regional policy framework, the OECD emphasises the importance of talent retention and the development of local skills through targeted policies. Improving accessibility, digital infrastructure, and the linkages between universities and the labour market are identified as critical tools to address intra-regional inequalities in Eastern Macedonia and Thrace and to avoid so-called “development traps” (OECD, 2020; OECD, 2025).

Limitations of the Study

The study is based exclusively on census data, which limits access to dynamic variables such as career characteristics, job satisfaction levels, or participation in research and innovation networks. The absence of primary qualitative information prevents a deeper exploration of the causes behind differentiated professional behaviour, particularly among inactive or underemployed doctoral holders.

Recommendations for Future Research

It is recommended to conduct mixed-method research combining quantitative and qualitative analyses to explore in depth the factors influencing doctoral career development in regional contexts.

Special emphasis could be placed on local innovation strategies, forms of support for postdoctoral employment, and comparative gender studies. Moreover, longitudinal monitoring of changes in doctoral employability in relation to regional and national policies would also be valuable.

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Appendix

Table A1. Crosstabulation results between regional unit and gender of economically active PhD holders

			Gender		Total
			Male	Female	
Region	Regional Unit of Rhodope	Count	145	61	206
		Expected Count	131.6	74.4	206.0
		% within Region	70.4%	29.6%	100.0%
	Regional Unit of Drama	Count	108	67	175
		Expected Count	111.8	63.2	175.0
		% within Region	61.7%	38.3%	100.0%
	Regional Unit of Evros	Count	279	186	465
		Expected Count	297.1	167.9	465.0
		% within Region	60.0%	40.0%	100.0%
	Regional Unit of Thasos	Count	5	0	5
		Expected Count	3.2	1.8	5.0
		% within Region	100.0%	0.0%	100.0%
	Regional Unit of Kavala	Count	205	123	328
		Expected Count	209.5	118.5	328.0
		% within Region	62.5%	37.5%	100.0%
	Regional Unit of Xanthi	Count	215	104	319
		Expected Count	203.8	115.2	319.0
		% within Region	67.4%	32.6%	100.0%
Total		Count	957	541	1498
		Expected Count	957.0	541.0	1498.0
		% within Region	63.9%	36.1%	100.0%

Source: authors' representation

Table A2. Crosstabulation of gender and regional unit among economically inactive PhD holders

			Gender		Total
			Male	Female	
Region	Regional Unit of Rhodope	Count	145	61	206
		Expected Count	133.2	72.8	206.0
		% within Region	70.4%	29.6%	100.0%
	Regional Unit of Drama	Count	28	10	38
		Expected Count	24.6	13.4	38.0
		% within Region	73.7%	26.3%	100.0%
	Regional Unit of Evros	Count	107	87	194
		Expected Count	125.5	68.5	194.0
		% within Region	55.2%	44.8%	100.0%
	Regional Unit of Thasos	Count	9	4	13
		Expected Count	8.4	4.6	13.0
		% within Region	69.2%	30.8%	100.0%
	Regional Unit of Kavala	Count	49	25	74
		Expected Count	47.9	26.1	74.0
		% within Region	66.2%	33.8%	100.0%
	Regional Unit of Xanthi	Count	72	37	109
		Expected Count	70.5	38.5	109.0

		Gender		Total
		Male	Female	
	% within Region	66.1%	33.9%	100.0%
Total	Count	410	224	634
	Expected Count	410.0	224.0	634.0
	% within Region	64.7%	35.3%	100.0%

Source: own processing in SPSS based on data provided by ELSTAT

Table A3. crosstabulation by regional unit among economically active PhD holders

			Employment Status			Total
			Employed	Formerly Employed	Recently Unemployed.	
Region	Regional Unit of Rhodope	Count	247	5	4	256
		Expected Count	246.7	7.4	1.8	256.0
		% within Region	96.5%	2.0%	1.6%	100.0%
	Regional Unit of Drama	Count	169	3	0	172
		Expected Count	165.8	5.0	1.2	172.0
		% within Region	98.3%	1.7%	0.0%	100.0%
	Regional Unit of Evros	Count	447	15	4	466
		Expected Count	449.1	13.6	3.3	466.0
		% within Region	95.9%	3.2%	0.9%	100.0%
	Regional Unit of Thasos	Count	7	0	0	7
		Expected Count	6.7	.2	.0	7.0
		% within Region	100.0%	0.0%	0.0%	100.0%
	Regional Unit of Kavala	Count	308	16	0	324
		Expected Count	312.3	9.4	2.3	324.0
		% within Region	95.1%	4.9%	0.0%	100.0%
	Regional Unit of Xanthi	Count	313	6	3	322
		Expected Count	310.3	9.4	2.3	322.0
		% within Region	97.2%	1.9%	0.9%	100.0%
Total		Count	1491	45	11	1547
		Expected Count	1491.0	45.0	11.0	1547.0
		% within Region	96.4%	2.9%	0.7%	100.0%

Source: own processing in SPSS based on data provided by ELSTAT

Table A4. crosstabulation of employment status by regional unit among economically inactive PhD holders

			Employment Status				Total
			Students	Retirees	Homemakers	Others	
Region	Regional Unit of Rhodope	Count	5	113	3	10	131
		Expected Count	6.6	115.4	2.8	6.1	131.0
		% within Region	3.8%	86.3%	2.3%	7.6%	100.0%
	Regional Unit of Drama	Count	0	30	3	4	37
		Expected Count	1.9	32.6	.8	1.7	37.0
		% within Region	0.0%	81.1%	8.1%	10.8%	100.0%
	Regional Unit of Evros	Count	10	179	0	8	197
		Expected Count	9.9	173.6	4.3	9.2	197.0
		% within Region	5.1%	90.9%	0.0%	4.1%	100.0%
	Regional Unit of Thasos	Count	0	12	0	0	12
		Expected Count	0.6	10.6	0.3	0.6	12.0

			Employment Status				Total
			Students	Retirees	Homemakers	Others	
		% within Region	0.0%	100.0%	0.0%	0.0%	100.0%
	Regional Unit of Kavala	Count	6	58	3	4	71
		Expected Count	3.6	62.6	1.5	3.3	71.0
		% within Region	8.5%	81.7%	4.2%	5.6%	100.0%
	Regional Unit of Xanthi	Count	7	97	3	0	107
		Expected Count	5.4	94.3	2.3	5.0	107.0
		% within Region	6.5%	90.7%	2.8%	0.0%	100.0%
Total		Count	28	489	12	26	555
		Expected Count	28.0	489.0	12.0	26.0	555.0
		% within Region	5.0%	88.1%	2.2%	4.7%	100.0%

Source: own processing in SPSS based on data provided by ELSTAT

Table A5. crosstabulation of employment position by regional unit among economically active PhD holders

			Work_position				Total
			Self-employed with employees	Self-employed without employees	Salaried employees or wage earners	Other cases	
Region	Regional Unit of Rhodope	Count	20	50	184	3	257
		Expected Count	21.2	37.5	195.7	2.6	257.0
		% within Region	7.8%	19.5%	71.6%	1.2%	100.0%
	Regional Unit of Drama	Count	17	21	131	3	172
		Expected Count	14.2	25.1	131.0	1.7	172.0
		% within Region	9.9%	12.2%	76.2%	1.7%	100.0%
	Regional Unit of Evros	Count	26	51	364	4	445
		Expected Count	36.7	64.9	338.9	4.4	445.0
		% within Region	5.8%	11.5%	81.8%	0.9%	100.0%
	Regional Unit of Thasos	Count	4	0	5	0	9
		Expected Count	0.7	1.3	6.9	0.1	9.0
		% within Region	44.4%	0.0%	55.6%	0.0%	100.0%
	Regional Unit of Kavala	Count	38	50	218	5	311
		Expected Count	25.7	45.3	236.9	3.1	311.0
		% within Region	12.2%	16.1%	70.1%	1.6%	100.0%
	Regional Unit of Xanthi	Count	19	47	242	0	308
		Expected Count	25.4	44.9	234.6	3.1	308.0
		% within Region	6.2%	15.3%	78.6%	0.0%	100.0%
Total		Count	124	219	1144	15	1502
		Expected Count	124.0	219.0	1144.0	15.0	1502.0
		% within Region	8.3%	14.6%	76.2%	1.0%	100.0%

Source: own processing in SPSS based on data provided by ELSTAT