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Graduate Business School

MIS41130 Statistical Methods

Statistical Analysis of Unemployment across Europe

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1. Abstract

This report analyses unemployment trends in EU countries, from 2013 to 2023, at the combined unemployment rate level, and by gender, age groups (15–24, 25–39, 40–64 years) and citizenship status (EU or non-EU). The report also provides insights on job vacancy levels across various EU countries over the past decade. The study aims to understand long-term trends, gender gaps, age factor and citizenship status to explore their impacts on employment and highlight country-specific patterns using descriptive and inferential statistics.

The analysis summarizes the data with measures such as means, medians, standard deviations and hypotheses to summarize central trends and variation within the data. Annual averages assist in portraying trends over time, while indices for individual nations can unveil which countries continuously boast high or low unemployment rates. Additionally gender breakdown is useful to understand male-female unemployment rates, while age and citizenship status give a picture of wider social and economic divides. Furthermore, the job vacancy trend promotes understanding of unemployment in a broader perspective.

This report highlights the vital need to shape labour and economic policy through an understanding of the unemployment experience. These findings highlight how targeted measures are needed to aid economic recovery and promote inclusive opportunities for all groups to access employment.

2. Introduction

Unemployment is a critical economic and social indicator that reflects the health of labor markets and broader economic conditions. It directly impacts the well-being of individuals and households, influencing income stability, social mobility, and economic growth. Analyzing unemployment data is essential for understanding labor market trends, identifying disparities, and shaping effective policies to address employment challenges.

By examining various dimensions, the study aims to uncover patterns that highlight age-specific vulnerabilities, gender inequalities, job availability, and the unique challenges faced by non-EU citizens in European labor markets. The analysis is particularly timely, considering long-term economic disruptions, including the COVID-19 pandemic, and ongoing efforts to promote inclusivity in employment.

This analysis addresses the following questions:

- a. How have unemployment rates changed in the studied countries from 2013-2023?*
- b. Are there unemployment differences by gender and citizenship status, and how do such inequalities differ over time?*
- c. Which nations have uniformly high or low unemployment rates, across time, and what trends can be observed among these nations?*
- d. How have significant events, such as the COVID-19 pandemic, affected unemployment rates?*

By exploring these queries, the report aims to provide meaningful insights on unemployment trends across Europe, helping to pave the way for recommendations that enable equal and sustainable labor markets.

3. Statistical Analysis

The statistical analysis provides a comprehensive understanding of unemployment across Europe. The descriptive statistics reveal regional disparities, inferential statistics confirm significant differences between unemployment based on factors like gender, citizenship status and age.

3.1. Descriptive Statistics

3.1.1. Based on Total Population

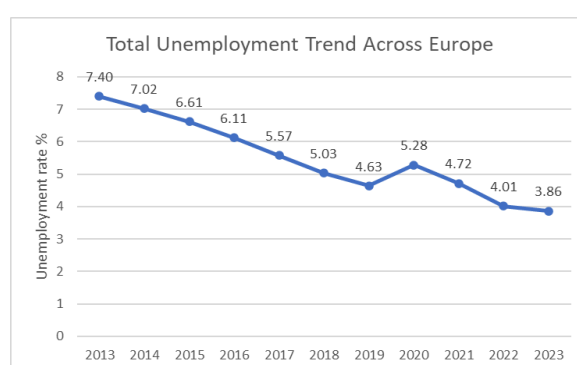


Fig 3.1.1.a

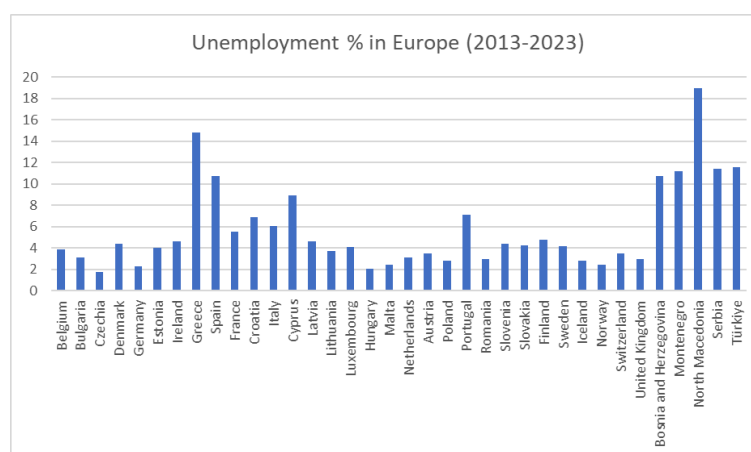


Fig 3.1.1.b

1. The unemployment rate in Europe declined from 7.4% to an average of 3.86% over a decade, with a 0.65% spike in 2020 due to the COVID-19 pandemic (Fig 3.1.1.a).
2. Czechia (1.72%), Hungary (2.07%), and Germany (2.25%) reported the lowest average rates, reflecting stable and robust labor markets, while North Macedonia (18.91%) and Greece (14.78%) had the highest, indicating persistent challenges in the labour market (Fig 3.1.1.b).

- Western nations like Belgium (3.87%), Germany (2.25%), and Ireland (4.63%) showed stable averages, contrasting with Southern and Eastern Europe, where countries like Greece, Spain, and Serbia exhibited high variability (standard deviation > 2.5), likely due to economic disparities and regional dynamics.

3.1.2. Based on Citizenship

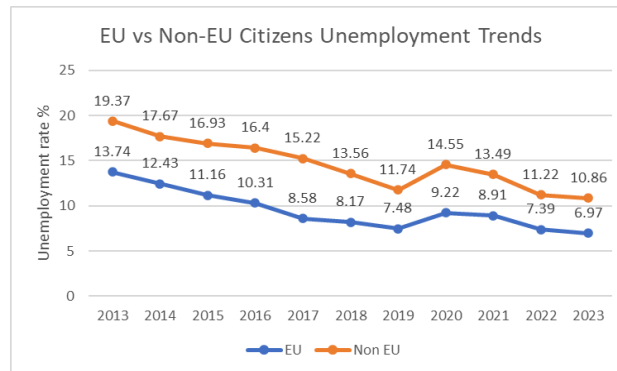


Fig 3.1.2.a

- Over the past decade, unemployment rates decreased significantly for both EU citizens (from 13.74% to 6.97%) and non-EU citizens (from 19.37% to 10.86%), though non-EU citizens continue to face higher unemployment than native EU citizens. (Fig 3.1.2.a)
- Variability in unemployment is greater for non-EU citizens, with consistently higher IQR values compared to EU citizens. Non-EU citizens experienced peak disparities in 2013 (IQR 13.2%) and 2016 (11.85%), while EU citizens recorded their highest IQR in 2016 (7.2%), reflecting more uniform unemployment across EU countries.(Fig 3.1.2.a)

3.1.3. Based on Job Vacancy

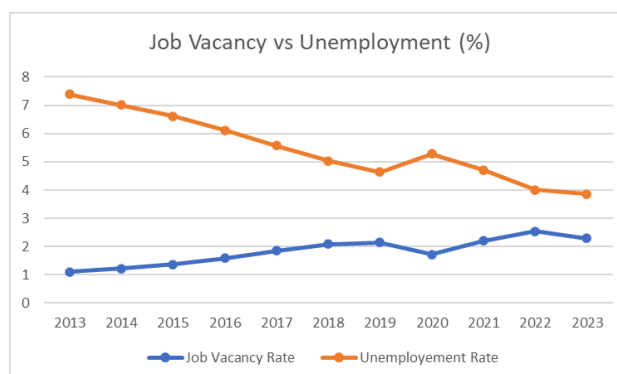


Fig 3.1.3.a

	Job Vacancy	Unemployment
Job Vacancy	1	
Unemployment	-0.98	1

Fig 3.1.3.b

The strong negative correlation (-0.98) between the Job Vacancy Rate and Unemployment Rate (Fig 3.1.3.b) suggests that these two variables are inversely related, higher job vacancies are associated with lower unemployment, and vice versa. This makes sense intuitively, as more job openings indicate greater demand for labor, which typically leads to lower unemployment rates. Refer to Fig 3.1.3.a to visualize the trend and better understand the correlation.

3.2. Inferential Statistics

3.2.1. Hypothesis on Male and Female Unemployment Rates

The following hypothesis test uses a paired t-test to determine the relationship between male and female unemployment rates for the 36 European countries in the past decade (2013-2023).

Null Hypothesis (H_0): There is no significant difference between male and female unemployment rates.

Alternative Hypothesis (H_a): There is a significant difference between male and female unemployment rates.

Sample Information	Sample Size	36
	Difference in sample values Mean	-1.04
	Difference in sample values Std Deviation	2.02
Decided/Obtained by the researcher before test	Significance Level (α)	0.05
	Hypothesized value for difference in means	0
Defining the test	Null Hypothesis	$H_0: \mu_1 - \mu_2 = 0$
	Alternative Hypothesis	$H_a: \mu_1 - \mu_2 \neq 0$
	Type of Test	Two-tailed test
Computation of the test	Standard Error	0.34
	Test Statistic	-3.11
	Critical Value	-2.03
	p-value	0.003720
	Significance Level (α)	0.05
Decision	Reject H_0	

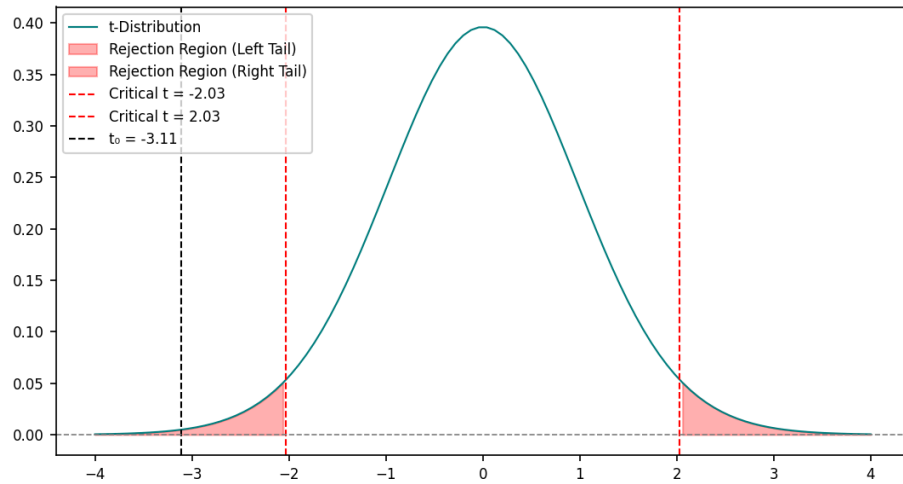


Fig 3.2.1.a

The test result implies that the p-value(0.003720) is less than the significance level(0.05). Therefore, at the 5% significance level, the paired t-test results provide sufficient evidence to conclude that the mean unemployment rate of males and females are not equal(see Fig 3.2.1.a). Hence, the Null Hypothesis is **rejected**.

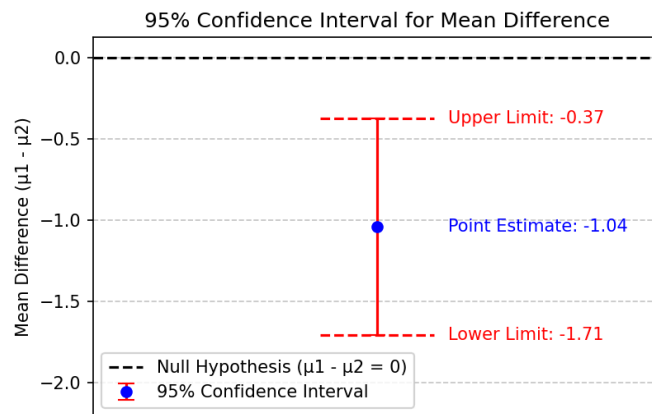


Fig 3.2.1.b

The confidence interval suggests that the true mean difference lies between -1.73 and -0.36 at 95% confidence level (see Fig 3.2.1.b). Since the interval does not include 0, there is sufficient evidence to reject the null hypothesis (H_0).

3.2.2. Hypothesis on Employment Variation in different Age Groups

In this analysis, we are utilizing the Analysis of Variance (ANOVA) test to examine the unemployment rate across different age groups for the decade 2013 to 2023. The population is categorized into three age groups (years): 15 to 24, 25 to 39, and 40 to 64. To assess the trend in unemployment rates across these age groups, the following hypotheses has been formulated:

Null Hypothesis (H_0): The unemployment rate is the same across all age groups in Europe.

Alternate Hypothesis (H_a): The unemployment rate differs significantly across all age groups in Europe.

Sample Information			
Population No.	1	2	3
Sample Size (n_j)	11	11	11
Degrees of freedom ($n_j - 1$)	10	10	10
Sample Mean (\bar{x}_j)	18.21	6.55	3.53
Sample Variance (s_j^2)	14.03	1.99	0.43
$(\bar{x}_j - \bar{x})^2$	77.10	8.31	34.78
Overall Sample Mean (\bar{x})	9.43		
Total no. of Observations (n)	33		
No. of Populations (k)	3		
df_n	2		
df_d	30		

Significance Level (α)	0.05
Null Hypothesis	$H_0: \mu_1 = \mu_2 = \mu_3$
Alternative Hypothesis	$H_a: \text{Not all population means are equal}$
Type of Test	Right-tailed test
SSTR	1322.16
SSE	164.51
MSTR	661.08
MSE	5.48
Test Statistic	120.55
Critical Value	3.32

p-value	4.56851E-15
Significance Level (α)	0.05
Decision	Reject H_0

Since the p-value is less than the significance level(0.05) and the test statistic exceeds the critical value, we have strong evidence to **reject** the null hypothesis. This suggests that the unemployment rate significantly varies across the different age groups. Thus, at the 5% significance level, the alternative hypothesis is accepted.

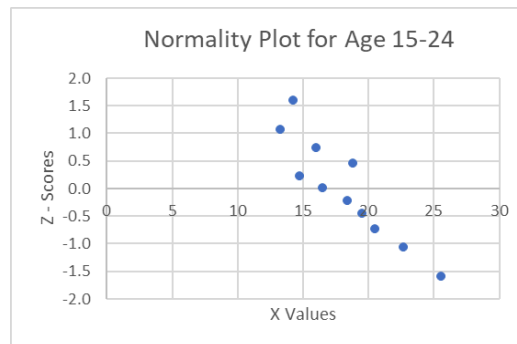


Fig 3.2.2.a

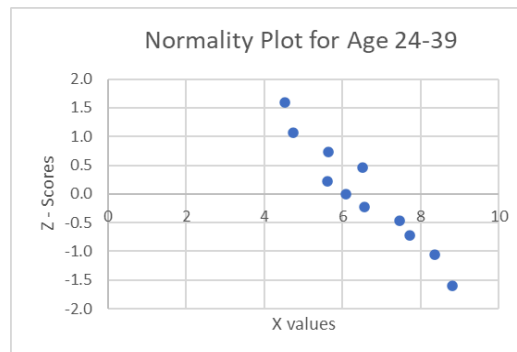


Fig 3.2.2.b

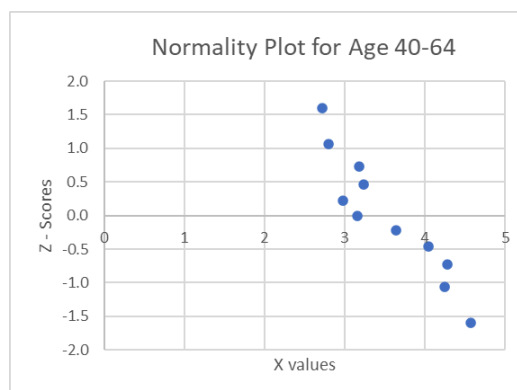


Fig 3.2.2.c

The normality plot for the age group 15 to 24 (Fig 3.2.2.a) shows some deviation from a straight line, particularly at the tails. While the middle points are closer to the line, suggesting partial adherence to normality. Similar

trends are observed for other age groups(refer Fig 3.2.2.b, 3.2.2.c). However, the unemployment percentages differ significantly for these age groups.

4. Conclusion

The statistical analysis provides significant insights into unemployment trends across Europe from 2013 to 2023. Here are the key takeaways:

1. General Trends
 - a. Unemployment rates have significantly declined over the decade, highlighting improvements in the European labor market.
 - b. The COVID-19 pandemic caused a notable spike in unemployment in 2020, showing the vulnerability of labor markets to global disruptions.
2. Regional Disparities
 - a. Countries like Czechia, Hungary, and Germany consistently maintained low unemployment rates due to robust labor market policies and economic stability.
 - b. Conversely, North Macedonia and Greece faced persistently high unemployment rates, reflecting structural challenges in their economies.
3. Gender and Age Disparities
 - a. A significant difference is observed between male and female employment rates, highlighting ongoing gender disparities in the labour market.
 - b. Unemployment significantly varies across age groups, with the youngest cohort (15–24 years) often the most vulnerable, reflecting difficulties in transitioning into the workforce.
4. Citizenship-Based Disparities
 - a. Non-EU citizens consistently experienced higher unemployment rates than EU citizens, underlying systemic barriers in accessing labor markets for immigrants.
5. Job Vacancy Trends
 - a. The strong negative correlation between job vacancies and unemployment underscores the importance of economic demand in stabilizing labor markets.

In conclusion, while overall unemployment trends are improving, disparities based on region, age, and citizenship status highlight the need for targeted interventions to create equitable labor market opportunities.

5. Recommendations

Based on the findings, here are actionable recommendations to address unemployment disparities and promote inclusive labor markets:

1. Policy Interventions in High-Unemployment Regions:
 - a. Southern and Eastern European countries should focus on structural reforms, including investment in education, workforce training, and business-friendly policies, to boost employment opportunities.
2. Support for Youth Employment:
 - a. Governments and organizations should implement targeted programs like internships, apprenticeships, and vocational training to support young individuals in transitioning into the workforce.
 - b. Tailored policies addressing industries with high youth engagement can help alleviate unemployment in the youngest cohort.
3. Integrate Non-EU Citizens into the Workforce:
 - a. Address barriers for non-EU citizens through language training, skills recognition programs, and anti-discrimination policies.
 - b. Encourage partnerships between governments and employers to promote the hiring of immigrants and create culturally inclusive workplaces.
4. Responsive Measures for Economic Disruptions:
 - a. To mitigate future shocks like the COVID-19 pandemic, governments should create adaptive unemployment insurance schemes and develop policies that support rapid economic recovery.
5. Increase Labor Demand:
 - a. Policies promoting entrepreneurship, start-ups, and investment in emerging sectors can create new jobs, addressing both regional and sectoral unemployment disparities.
 - b. Enhance job-matching services to reduce the gap between job seekers and vacancies, leveraging technology to connect labor supply with demand.
6. Gender Equality in Labor Markets:
 - a. With significant gaps in male and female unemployment rates, efforts should focus on addressing unique challenges faced by each gender. This includes creating equal opportunities, supporting skill development, ensuring fair pay, and breaking barriers in male or female-dominated industries to promote balanced workforce participation.
7. Enhance Labor Market Data Collection:
 - a. Regular monitoring and granular data collection by age, gender, region, and citizenship status are essential to design and implement effective policies.

By addressing these recommendations, policymakers and organizations can facilitate inclusive labor markets that support sustainable economic growth and social equity.

6. References

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7. Individual Summary

7.1. Gourish Deshpande

In this assignment, I was responsible for dataset selection and contributed significantly to the descriptive statistics analysis. The results from the descriptive statistics enabled me to identify the key factors contributing to unemployment. While numerous factors could have been included, we selectively focused on those with the most significant impact on the problem statement, streamlining the report to avoid unnecessary complexity. Additionally, I contributed to the inferential statistics analysis by working on the ANOVA test, hypothesis testing and normality plots. The book *An Introduction to Statistical Learning with Applications in R* provided me with a deeper understanding of statistical analysis techniques. Overall, this experience not only strengthened my knowledge of statistical concepts but also offered practical insights into applying these techniques to real-world problems.

7.2. Jaee Jain

My contributions included dataset selection, analysis, and interpretation using descriptive and inferential statistical techniques. In the descriptive statistical analysis, I calculated key measures such as mean, median, standard deviation, range, interquartile range (IQR), etc to summarize the dataset effectively. In the inferential analysis, I conducted hypothesis testing to examine significant differences in unemployment rates across years and between genders. This involved formulating and testing statistical hypotheses to identify meaningful patterns and variations. I relied heavily on Neil Weiss's *Introductory Statistics* to understand and apply statistical concepts, particularly those related to inferential analysis. Excel served as a primary tool for data processing, performing calculations, and creating visualizations to present insights effectively. This assignment enhanced my statistical skills, providing practical experience in data analysis, visualization, and deriving meaningful insights from real-world unemployment data.

7.3. Nidhi Sharma

In this project, I actively contributed by selecting the dataset, performing thorough analysis, and applying both descriptive and inferential statistical methods, including hypothesis testing. This process deepened my understanding of statistical techniques and their real-world applications as I have read some research papers which helped me to understand my topic well. This project not only strengthened my understanding of statistical methods but also sparked a deeper appreciation for how data can address pressing issues. In the future, I hope to apply these skills to analyze trends, solve problems, and contribute to meaningful policies in areas like labor markets or economic development.

Note - [Code](#) for graph generation(Fig 3.2.1.a, 3.2.1.b) for Hypothesis and Confidence Interval.