

Combining Statistical and Rule-Based Expert Knowledge to Measure Employment Precarity

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Abstract - The measurement of precarity and the identification of a set of indicators that can be used for its assessment has been established as a key issue in Europe, central to the entire discipline of labour statistics, social policy, and sociology of work. Most recent studies agree upon the basic characteristics that a worker should have to be considered as precarious: insecurity, vulnerability, and no or limited entitlements. The present paper offers an innovative method that combines statistical analysis regarding the measurement of nine key indicators that are linked with precarity to a lesser or greater extent, with a rule-based expert system to rate each worker's precarity. Raw data are drawn from the EU-Labour Force Survey (EU-LFS) for the case of Greece. However, the suggested method can be applied with minor modifications to the remainder thirty-four participating in the EU-LFS countries since a common questionnaire is used for all countries. The estimated indicators refer to three domains that are linked with precarity: labour market conditions and job insecurity, limited entitlements, and insufficient resources. Having estimated a precarious score for each worker, the socio-demographic characteristics of precarious workers are identified, extracting valuable knowledge on their profile.

Keywords: employment precarity, labour market conditions, labour market indicators, job insecurity, rule-based system, expert-knowledge, multi-method approach

1. Introduction

The general objective of this paper is to empirically examine a multi-method approach to measure and explore precarity in an effort to capture its multi-facet nature, making use of raw data drawn from one of the most important cross-national databases regarding labour market participation, the European Union Labour Force Survey (EU-LFS). The development of a set of indicators that will aid the measurement and the identification of precarious workers is currently a central matter at the European level, hindered by the lack of an agreed definition of precarious employment [1]. However, precarity is recognised as a multidimensional construct encompassing dimensions of employment insecurity, integrating both types of contract and perceptions of job insecurity, relations between workers and employers, low earnings, poverty, and deprivation, limited employment rights and social security protection, and incapacity to exercise legally granted employment rights ([2], [3], [4], [5], [6], [7], [8], [9], [10], [11]). The existing literature has revealed that women, young people, and migrants must overcome greater difficulties to find a secure and stable employment, facing higher risk of precariousness and in-work poverty ([12], [13], [14]). In Europe, and particularly in Greece, the prolonged economic recession, and the pandemic crisis has caused an expansion of informal, non-standard forms of employment in private and public sectors ([15], [16], [17], [18]).

This study follows the conceptualisation of precarity presented in [19] and extended in [20] and provides a methodology for rating the degree of each worker's precarity. More specifically, an expert system is developed, that quantifies precarity using a set of expert-rules that describe the significance of each variable and their combination in rating precarity. The variables relate to three domains associated in the literature with precarity: *job insecurity* that include indicators such as part-time employment or temporary employment, *insufficient resources*, where indicators such as low earnings and no supplementary sources of income are measured, and *unsupportive entitlements*, assessing access to social benefits. Data are drawn from the EU-LFS for the case of Greece, but minor modifications are needed to apply the methodology to the

remaining thirty-four participating in the survey countries. The proposed method allows for the examination of the profiles and labour market experiences that render workers precarious, while rating workers in regard with precarity for the first time, examining the distribution of scores among different socio-economic groups and extracting knowledge concerning these categories. Using the appropriate weighting scheme for the indicators, as well as for the domains, results are provided for respondents that are employed, giving insight to the socio-demographic characteristics of precarious workers.

The paper is structured as follows. Section 2 sketches the proposed methodology where we discuss some of the considerations that have informed our choice of domain weights and indicator scores in the context of constructing a set of indicators and rules to measure each worker’s precarity. The next section provides the reader with the results of the study where categories of precarious workers are identified and precarity scores are examined in relation to gender, age, nationality, and educational level. The final section presents the conclusions of the research and addresses the steps that need to be taken towards a set of indicators and rules that can be adopted Europe-wide for measuring precarity with the use of EU-LFS data.

2. Methodology

2.1. Survey design

The study makes use of raw data drawn from the EU-LFS for Greece. EU-LFS is a cross-sectional household sample survey and the main source that provides European monthly, quarterly, and annual data on labour market participation, working conditions, and other job characteristics. At the same time, it is the basis for the assessment of unemployment and inactivity rates and other important indicators, such as NEET rates (nor in employment, education, or training) or long-term unemployment in Europe. Therefore, the survey provides a way of measuring significant labour market characteristics, while common classifications and questionnaires ensure the comparability between EU member countries. Almost 240,000 individuals were interviewed in Greece in 2018. Apparently, only employed respondents were considered for this study, which constitute 41.9% of the sample.

2.2. Measures

Based on the information available in the EU-LFS, nine indicators were estimated relating to the three domains of employment precarity that have been described above. In our analysis only wage earners have been included. This condition narrowed the sample to N=47,853 respondents. All estimated indicators are linked with precarity to a lesser or greater extent. A description of the domains and the definitions of the respective indicators are depicted in Table 1. The indicators linked to the insecure employment domain relate to types of employment covering cases of part-time and temporary contracts addressing moreover situations of involuntariness and contacts of very limited duration. Precarity is also linked to limited legal and social protection ([21]). We go beyond the contract-related or job-insecurity dimension and study other objective characteristics such as lack of health insurance and social security. Moreover, income inadequacy, a key dimension to precarity ([22], [21], [20]), is examined here with the aid of two indicators regarding low-income level and lack of supplementary resources.

Table 1: Domains and indicators of precarity

Domain	Indicator	Respective question	Categories
Insecure employment	Part-time employment	Full-time/Part-time distinction	1=Full-time 2-Part-time
	Temporary employment	Permanency of job	1= Person has a permanent job or work contract of unlimited duration 2= Person has a temporary job/work contract of limited duration
	Involuntary part-time	Reasons for the part-time work	1=Person is undergoing school education, or training 2=Of own-illness or disability 3=Looking after children or incapacitated adults 4=Other family or personal reasons 5=Person could not find a full-time job

	Involuntary temporary	Reasons of having a temporary job/work of limited duration	1=Person has a contract covering a period of training (apprentices, trainees, research assistants, etc.) 2=Person could not find a permanent job 3=Person did not want a permanent job 4=It is a contract of probationary period
	Limited contract (less than 3 months)	The duration of the contract	1=less than one month 2=1 to 3 months 3=4 to 6 months 4=7 to 12 months 5=13 to 18 months 6=19 to 24 months 7=25 to 36 months 8=More than 3 years
Unsupportive entitlements	Lack of health insurance	Type of health insurance	1=Social Insurance Institute 2=Agricultural Insurance Organization 3=Public Insurance 4=Social Insurance Organisation of Freelance Professionals 5=Other 6=No health Insurance
	Lack of social security	Types of social security	1=Social Insurance Institute 2=Agricultural Insurance Organization 3=Public Insurance 4= Other 6=No social security
Insufficient resources	Low-paid	Total net monthly income	$< \frac{2}{3} \cdot \text{median of incomes}$
	No supplementary sources of income	Sources of income	1=Work 2=Age pension 3=Death pension 4=Disability pension 5=Income from movable or immovable property 6=From other household members 7=From people that do not belong to the household 8=Benefits and allowances

2.3. Statistical analysis

A first step in measuring precarity would be the estimation of the indicators presented in Table 1. Table 2 presents the estimation of the indicators for the Greek EU-LFS sample.

Table 2: Precarity indicators, EU-LFS, Greek sample, 2018

Indicator	Percentage (%)
Part-time employment (PT)	9.2
Temporary employment (TE)	11.3
Involuntary part-time (IPT)	67.2
Involuntary temporary (ITE)	5.9
Limited contract <3 months (LT<3)	11.6

Lack of health insurance (WHI)	2.3
Lack of social security (WSS)	2.4
Low-paid (LP)	18.3
No supplementary sources of income (WS)	9.6

2.4. Rules

In a rule-based system, much of the knowledge is represented as rules, that is, as logical/conditional sentences linking statements of evidence with one another. A rule-based system is a means of representing a human expert's knowledge in a specific area into an automated system, developed using a set of assertions and a set of rules that specify how to act when a specific input is given. In this regard, to assess each worker's rate of precarity, an expert system was developed, with the aim of representing sociologists' and labour statisticians' expert knowledge as a predetermined set of rules, portraying not only the key indicators linked with precarity, but also the degree with which each indicator contributes to a person's overall objective precarity. To achieve that, a rating ranging from 0 to 100 was assigned to each indicator for each domain, stemmed from its lesser or greater link to precarity, as determined by theory. Criteria for assigning a specific rating to each indicator were as follows: equal ratings were given to the existence of part-time or temporary employment. However, if an individual works part-time or has a temporary contract involuntarily these values are amplified, since involuntariness is a strong criterion for evaluating job quality and by extension precarity. The same goes for having a limited contract of duration less than 3 months, which corresponds to EUROSTAT's definition of precarious employment. Equal ratings are also given to working without health or social insurance. However, being low-paid is given a slight advantage against supplementary resources as poorly paid employment is one of the basic characteristics of precarious work that can lead to long-term in work poverty. Indicator ratings in each domain are added to produce a score for each domain, i.e., $scoreIE$, $scoreUE$, $scoreIR$. For each wage earner, three domain weights are estimated, corresponding to the three precarity domains:

$$w_1 = 1 + \frac{scoreIE}{100}, w_2 = 1 + \frac{scoreUE}{100}, w_3 = 1 + \frac{scoreIR}{100}. \quad (1)$$

To assess each worker's rate of precarity, the three weights were assessed and multiplied to give a final score of precarity, that was transformed to range between 0 and 100. The multiplication was chosen in contrast to simply adding $scoreIE$, $scoreUE$, $scoreIR$, in order to represent the added value of the domains, and on the assumption made on a theoretical basis that scoring on more than one domain further intensifies a person's degree of precarity. That is to say, a worker weighted with a high score in one domain is more likely to be affected in an amplifiable way by an additional high score on another domain, as opposed to a worker weighted with a low score. Figure 1 shows the proposed system's structure.

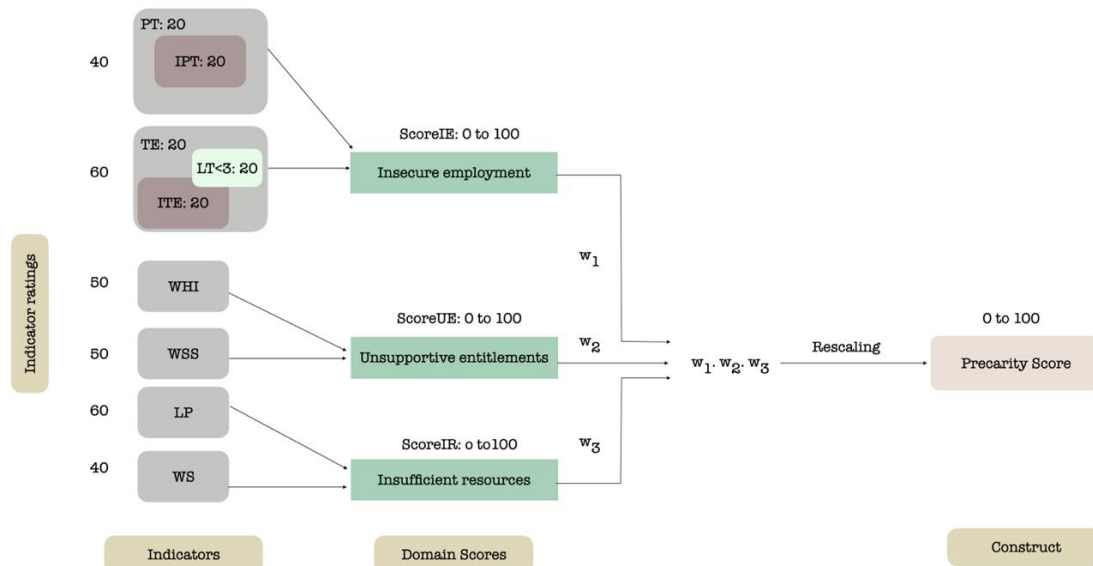


Fig. 1: The structure of the proposed system.

The functionality of the system is explained in Figure 2. Input is provided from the EU-LFS database for the Greek sample converted into a comma separated value file. The respective indicators are identified, and the necessary transformations are performed, separating for example involuntary part-time workers from workers that work part-time for other reasons. Input is imported to the rule-based system, programmed in the way earlier defined to yield precarity scores for each employee.

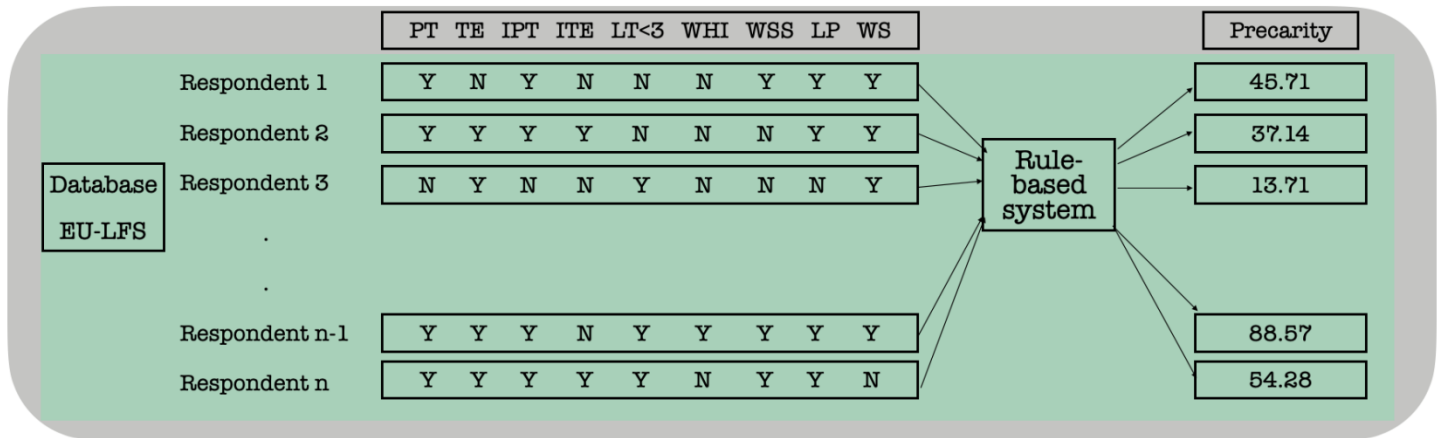


Fig. 2: The functionality of the rule-based system.

3. Results

Having estimated the precarity scores for each worker, the scores were divided into five categories that reflect different levels of precarity. Observed precarity scores range from 0 to 88, in a scale from 0 to 100, where lower values correspond to no or low precarity and increased values to high levels of precarity. The characteristics of each category are now provided, in order to identify which groups are more vulnerable to precarious forms of employment in Greece. Educational level in the EU-LFS is based on the completed level of education, according to the latest version of International Standard Classification of Education (ISCED-11). The educational attainment of respondents has been recoded into three educational categories: low (ISCED level= ≤ 3 , which means that they achieved no more than secondary education), medium ($4 < \text{ISCED level} < 5$, which indicates that respondents have broader education than secondary and/or they have attended short first tertiary programmes that are typically practically-based, occupationally-specific and prepare for labour market entry) and high (ISCED level ≥ 6 , meaning respondents have completed tertiary education, having either a Bachelor, Master or PhD degree). Data was analysed using IBM SPSS v. 28.0 and Python v. 3.6.

From the analysis, in Table 3 it is evident that the first category i.e., the one that corresponds to the lowest levels of precarity consists of mainly men (55.7%), and Greek workers (93.8%), with medium or high level of education, while the mean age of individuals is 43 years old. Moving to the higher levels of precarity the picture seems to change, since more women and greater percentage of lower educated people are detected at those categories. Interestingly, the non-EU nationals are also showing an increasing percentage analogously to the precarity level, while the age does not seem to affect the labour market situation of the employed individuals in this survey. The sample size of the last category (scores 81-100) is too small to allow us to derive reliable conclusions for the highest precarity level.

Table 3: Precarity level one: low or no precarity (scores 0-20), EU-LFS, Greek sample, 2018

Precarity Levels	Socio-demographic characteristics	Percentage (%)
Precarity Level 1 (scores 0-20), n=44,728	Gender	
	Male	55.71
	Female	44.29
	Mean age	43.00
	Nationality	
	Greek	93.79
	EU	1.07

	Other	5.14
	Educational level	
	Low	14.20
	Medium	44.95
	High	40.85
Precarity Level 2 (scores 21-40), n=2,710	Gender	
	Male	40.33
	Female	59.67
	Mean age	38.00
	Nationality	
	Greek	88.07
	EU	3.47
	Other	14.46
	Educational level	
	Low	25.76
	Medium	50.92
	High	23.32
Precarity Level 3 (scores 41-60), n=302	Gender	
	Male	43.38
	Female	56.62
	Mean age	40.00
	Nationality	
	Greek	88.07
	EU	10.60
	Other	32.78
	Educational level	
	Low	53.97
	Medium	32.45
	High	13.58
Precarity Level 4 (scores 61-80), n=96	Gender	
	Male	51.04
	Female	48.96
	Mean age	39.00
	Nationality	
	Greek	64.58
	EU	5.21
	Other	30.21
	Educational level	
	Low	59.37
	Medium	36.46
	High	4.17
Precarity Level 5 (scores 81-100), n=17	Gender	Count
	Male	6
	Female	11
	Mean age	42.00
	Nationality	
	Greek	1
	EU	12
	Other	4

	Educational level	
	Low	13
	Medium	4
	High	0

Figure 3 depicts precarity scores in relation to educational level and age. An increase in precarity scores is clearly related with a respective decrease of the educational level, whereas this is not as evident in respect to age.

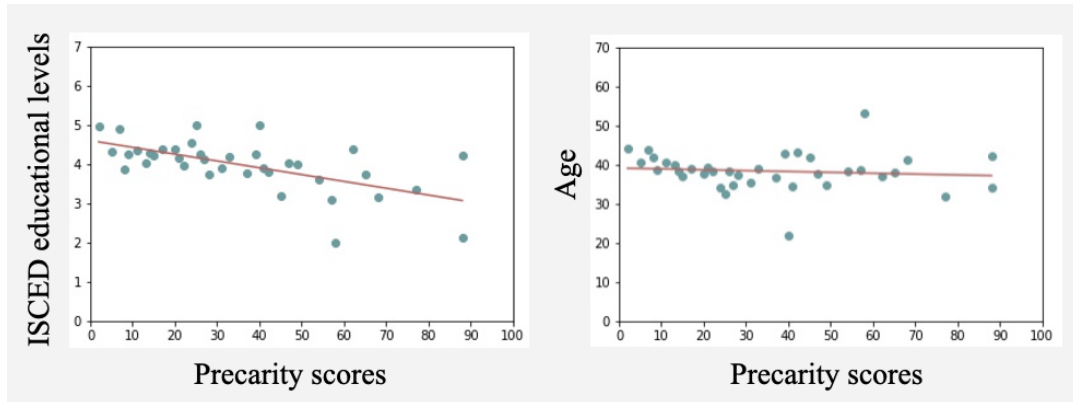


Fig. 3: Precarity scores by educational level and age.

4. Conclusions

This study presents the first rule-based expert system for measuring workers' precarity. It provides a way of quantifying each wage earner's precarity, offering a way to study the social distribution of precarity in Greece with the use of the EU-LFS data. The results of the current study have significant theoretical and practical implications. The proposed method delivers a way to quantify precarity, whereby different levels of precarious workers can be identified. This evidently adds to the present discourse on precarity and its conceptualisation. To our knowledge, this is the first time that precarity is actually measured using specific, and well-defined rules. Another asset of the suggested method is the provision of a way to select employees that belong to different levels of precarity and systematically examine their socio-demographic characteristics to extract knowledge concerning these categories. Other variables can be used, such as occupational sectors, marital status, degree of urbanisation, shifts, etc., to gain more insight on the characteristics of precarious workers.

Common definitions, questions and variables used in the EU-LFS make the proposed methodology replicable to the remaining European countries. Moreover, due to the usage of probabilistic sample design in the EU-LFS, reliable inferencing about the entire population is allowed.

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