Poverty in the Era of AI: Analysis of Material Deprivation in Europe

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Abstract

Deprivation is a pervasive, ubiquitous, complex and multidimensional issue that perpetuates cycles of poverty and disparity and jeopardises prosperity and development potential for all. The present paper motivated from the increasing wealth disparities worldwide, explores the severe material deprivation in European countries aiming to identify the spatial pattern and its trends influenced by various crises, the degree to which macroeconomic dynamics and inequalities affect deprivation, and the way the determinants of deprivation are differentiated between the welfare systems. Material deprivation is found to be affected to a great degree by cyclical fluctuations presenting a different behaviour across welfare systems. Income and spatial inequalities exert a significant influence on deprivation increase verifying the imperative need for income redistribution and the mitigation of inter-territorial developmental gaps. Overall, deprivation appears resilient and hard to eliminate in both the short and long term. Its association with a broad range of inequalities and adverse conditions highlights the existence of synergies and complex dynamics that reinforce it, calling for more holistic approaches to analysis and policy formulation.

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Keywords: material deprivation, poverty, cyclical fluctuations, welfare system, inequalities, Europe

1. Introduction

Despite the transformative advancements that Artificial Intelligence and Industry 5.0 have brought, inequalities, poverty and deprivation remain major societal challenges that not only persist but have also taken on a new guise (Atkinson et al, 2011), revealing the contextual and systemic complexities of the issues and necessitating a fresh, more holistic and synthetic, approach that would facilitate analysts and policymakers to foster genuine inclusive prosperity.

Poverty, seen as a lack of basic, publicly-agreed, living standards (UN, 1995), proves to be an intricate and persistent state of affairs that brings people to a precarious situation, undermining their livelihood, perpetuating cycles of distress and disparity and compromising

the well-being and development potential for all. As such the elimination of poverty is of crucial significance for all economies independently of their development level. However, poverty is a quite complex issue, multi-dimensional in character, that cannot be affectively addressed through single, traditional intervention methods (Zhou and Liu, 2022). Understanding and dealing with it requires a contextual approach, taking into account the specific (socioeconomic, political and spatial) conditions through which deprivation is shaped and perpetuated as a state (Woodward, 2010).

Yet, conventional approaches stay focused on the financial deprivation (mainly assessed on the basis of incomes below a "poverty threshold"), failing to acknowledge the various other facets (or dimensions) of poverty which households may experience in terms of well-being deprivation, related to limited or lack of access to minimum resources and services essential for social/civic life (Raitano et al, 2021). The employment of such simplistic measures leads to the underestimation of poverty as a chronic complex societal phenomenon, and to failure to capture its true intensity, magnitude and tenaciousness (Baulch and Masset, 2003). In addition, these typical assessments of poverty are subject to a number of concerns related, among others, to the choice of the threshold level and their comparability across space and time. To this end, a number of scholars (*inter alia*, Nolan and Whelan, 2010; Smith et al, 2012; Koczan, 2016) argue that contextual and relativistic measures of poverty can enrich our understanding and provide a more accurate assessment of the multi-dimensional character of deprivation and poverty.

Along these lines it is also important to note that poverty apart from the individual dimension also entails a distinct spatial dimension, which concerns the socioeconomic conditions of an area and its capacity for sustainable, balanced and equitable development (Rodríguez-Pose and Hardy, 2015; Wang et al, 2018). Interestingly, the importance of the territorial environment (the "place") increasingly occupies the discourses about poverty and policy, making clear that effective anti-deprivation strategies require coordinated action for reduction of both personal/individual and spatial/regional poverty (Blank, 2005).

Overall, there is a growing debate on deprivation and poverty analysis that contests the conventional, absolute, individual-centred, single-monetary, measures, as being rather simplistic, if not erroneous, arguing for the need to take under account peoples' experience as well as the contextual-spatial characteristics that determine deprivation outcomes. The present paper aligns with this literature seeking to contribute to this broader perspective and analysis of poverty. It does so by establishing a two-dimensional deprivation index to assess poverty as is experienced by people, which is calculated and visualised at the level of European countries for the period 2005-2021. In addition, it attempts to shed light on the factors that held accountable for poverty's entrenchment and endurance by exploring the determinants of the developed deprivation index.

The contribution of this work is manyfold: First, it focuses on material deprivation to provide a two-dimensional deprivation index that underlines the complexity of the issue. Second, it highlights the spatial character of poverty by exploring how material deprivation is deployed across Europe. Third, it views deprivation from an evolutionary perspective, assessing its dynamics with reference to structural disturbances and changes that occurred, such as the 2008 financial crisis of and the 2020 COVID shock. Last, it sheds light on the underlying determinants with emphasis on specific factors that the literature has not explored to a great extent (e.g. inequalities, income and spatial) and how their influence on the deprivation change is differentiated across welfare regimes.

The paper proceeds as follows. The next section provides a review of the literature discussing the complex concept of poverty and its determinants. Section 3 lays out the methodology we

followed to the development of the material deprivation index which is presented in section 4 outlining its size, intensity and trends. Section 5 investigates econometrically the determinants of deprivation change and how they are differentiated among welfare systems. The last section concludes outlining the main points that emerged.

2. Literature review

2.1 Concept and measurement

Due to the complexity of the issue, the conceptualisation of poverty is absolutely essential and a prerequisite for its understanding and evaluation (Thorbecke, 2007). The literature has approach poverty from two perspectives, defining it in absolute/objective and relative/subjective terms (UN, 1995). Absolute poverty denotes deprivation of basic human needs (i.e. objectively defined absolute necessities) the lack of which endangers human survival. It signifies a minimum of indispensable goods and services (such as food, clothing, drinking water, health, shelter, etc.) that every person in the world must have to avoid hunger, premature death and suffering. Relative conceptions approach poverty as deprivation of standards of living seen as essential by the society in which a person lives. It goes beyond the absolute needs for human existence to signify that poverty is a condition where someone lacks the resources to participate fully in society, and this is judged with reference to what a specific society/place regards as minimum required for a sustainable and decent livelihood. These judgements are spatio-temporal in essence and reflect what the public considers to be an adequate living standard at each given time, based on current conditions and prevailing social values, norms and attitudes towards wellbeing (Forster, 2004).

Initial measures of poverty were drawn on the absolute definition, assessing poverty mainly as lack of financial means needed to secure some minimum human needs defined in absolute terms (time and place invariant) (World Bank, 1990; OECD, 2023). The developed measures adopted, in a rather reductionist spirit, a one-dimensional scale measuring basically the available income of individuals vis-à-vis a minimum limit (Alkire and Foster, 2011; Wang and Qian, 2015). Not only they were oversimplistic, narrow and restricted and, but they also placed too much emphasis on monetary aspects and trust on the market fundamentals, disregarding that some livelihood necessities cannot be achieved through markets, simply because markets do not function as expected, or even do not exist (Thorbecke, 2007). Over time, it has become commonly accepted that although there are certain fundamental needs that apply to all humans, life conditions can vary considerably in space and time, requiring more spatio-temporally tailored assessments of what is essential for decent living (Sen, 1997; Amaghouss, 2020). On the basis of the above, the absolute approach has been considered by many as flawed and misleading (Townsend, 1979), shifting the focus away from income deprivation and monetary aspects and embracing a broader, more multidimensional, measurement perspective (Ashtari, 2020).

The multidimensional poverty measures move beyond the simplistic, unidimensional, absolute approach to poverty, opting to incorporate a wide range of non-monetary attributes that capture different aspects/dimensions of deprivation as experienced and perceived to exist by the people in a locality. These attributes reflect the inter-regional and inter-community diversity of the phenomenon observed across space, but some of them, such as discrimination and social exclusion, are quite difficult to measure in an objective way (Thorbecke, 2007). Overall, the multidimensional poverty indexes include both income and other quantitative and qualitative elements evaluating the fulfilment of typical human needs, such as housing,

food and health, along with subjective assessments of what is deemed essential for decent livelihood.

The assessment of relative poverty through people's perceptions of what meaningfully constitutes deprivation, is certainly a challenging task, as these views can be somewhat biased, influenced by a variety of personal, psychological, ideological, socio-cultural and contextual factors, ranging from socio-economic status, social values, memories, and even weather conditions (Ashtari, 2020). Thus, while the subjective opinion of individuals can capture important qualities of deprivation that cannot be measured otherwise, it raises certain concerns about whether it should be use as a measure of poverty in itself. What is more prudent is for this to be used alongside more objective measures that reflect monetary as well as non-monetary aspects of deprivation, bearing in mind that the range of factors taken into account must be relatively small and manageable, so that the measurement tool developed represents a balance between simplicity and maximum accuracy (Bourguignon, 2006).

2.2. Determinants

Poverty is influenced by a complex interplay of structural, economic, political, institutional and socio-demographic factors. Understanding these determinants and their interconnections is crucial for formulating effective policies to alleviate poverty.

The impact of macroeconomic conditions and dynamics (including business cycles) on poverty is an issue that has occupied the relevant literature to a great extent. It has been argued that a robust economy, grounded upon sound macroeconomic fundamentals, matters more than anything else (Blank, 2000). Since economic growth is an important parameter of a vibrant economy, researchers have argued that it has an impact on reducing absolute poverty (Notten and Neuborg, 2011); although initially growth favours the rich who are more capable of taking advantage of emerging opportunities, the benefits are subsequently diffused downward favouring the poorest strata of the population (Ayla et al, 2017; Dollar and Kraay, 2000; Dollar et al, 2016; Kakwani and Pernia, 2000). Yet, other scholars maintain that unless there are mechanisms (e.g. policies) in place that effectively redistribute the generated wealth downwards to the poor, the initial advantage gained by the rich during growth increases inequality, making existing poverty persist or even increase (Amponsah et al, 2023). In turn, economic recessions are assumed to affect less those in deprivation already, and reduce disparities (as they primarily curtail the dynamism of the rich) bettering the poor, or, as others have argued, to increase them even more compared to economic expansion (Spencer and Ong 2004) giving rise to ratchet effects (de Janvry and Sadoulet 2000), if the state resources allocated to combat poverty are reduced (Jonsson, 2013). On these grounds, scholars tend to conclude that although economic growth certainly plays a role, it is not sufficient for poverty reduction (Aghion et al, 1999; Verme, 2010), and its effect on poverty is rather ambiguous and dependent on contextual or mediating factors (Dollar and Kraay, 2002; Bourguignon, 2003; Enders and Hoover, 2003; Chen and Ravallion, 2012).

The development level of an economy is one factor that has been argued it moderates the effect of growth on poverty. In less developed countries economic growth is associated with increasing inequality and poverty (Salvatore and Campano, 2012), perhaps due to lack of redistributive mechanisms, whereas lower levels of development and higher levels of inequality are found to reduce the growth elasticity of poverty (Bourguignon, 2003). This signifies that less developed territories with significant economic disparities have very low chances to escape from the poverty trap. Generally, inequality proves to be a key, but complex, moderating factor (Anand et al, 2014; Amponsah et al, 2023), which not only can eradicate the effect of growth on poverty (Fosu, 2009), but also to increase poverty under the condition of constant income per capita (Kanbur, 2004; Fosu, 2010).

Income inequality seems to affect poverty in complex ways. Higher inequality may entail that different income groups have different capacity to benefit from the economic conditions (lower to those at the bottom end) to the detriment of the poor (induced-growth argument). But even in the case where economic benefits are equally shared across income strata, higher inequality means that the poor will gain less in absolute terms, while lower inequality may even contribute to the poor gaining more benefits due to growth, while leaving them less exposed to the negative effects of contraction (the growth elasticity argument) (Ravallion, 1997).

Although discussions on poverty and deprivation point to the individual dimension of income inequality, the issue has a distinct spatial aspect that needs to be taken into proper account (Kanbur and Venables, 2005; Pinoncely, 2016; Rodríguez-Pose and Hardy, 2015; Yamada, 2018). Spatial or regional inequality underscores broader spatial disparities in wealth, resources, opportunities and growth potential, associated with agglomeration economies and flows of production factors (labour and capital) which lead to concentration of poverty in certain geographic areas (McKay and Perge, 2015). Various contextual factors are outlined as determinants of spatial disparities leading to a spatially asymmetric pattern of poverty. The notion of the 'spatial poverty trap' articulates these forces and dynamics (Bloom et al, 2003; CPRC, 2004; Barbier and Hochard, 2019), highlighting that areas which are spatially remote and are reliant on unsustainably exploited natural resources or on an outmoded production structure find themselves entrapped into a downward spiral (vicious cycle) of economic, demographic and social decline, consecutive deprivation and chronic poverty (Rodríguez-Pose and Hardy, 2015). As such, lagging regions with an ill-suited economic structure (in terms of adverse economic specialisation, agglomeration (dis-)economies, infrastructure, and resource endowments) are more likely to be and remain poor (Blank, 2005). So do areas with unfavourable geo-environmental characteristics (e.g. geographically isolated, environmentally stressed, disaster-prone regions) and demographic dynamics (Wang et al, 2018). For instance, a large elderly population is likely to be in greater need of specialised services (e.g. health care) and strain resources and social services, weakening the social system and its capacity to combat poverty, while also reflects shortages in the labour force making it difficult or even inhibiting productive transformations and innovations needed for growth.

The impact of unemployment on poverty and deprivation is equally strong (Blank and Blinder, 1985; Saunders and Taylor, 2002), as the lack of stable employment implies a lack of secure income, which is needed for people to fulfil their basic needs and maintain a satisfactory standard of living. Research points out that unemployment has significant and systematic regressive effects on the distribution of wealth and is thus positively associated with deprivation and poverty, while also having other colateral impacts related to social cohesion and demographic stability (Ayala et al, 2017). However, its influence can be differentiated as it is sensitive to the time frame, to the demographic groups (Meyer, 2011), to the labour supply response (Burgess et al, 2001) or the design and regional distribution of social protection benefits (Martínez et al, 2003).

In addition to unemployment, inflation also affects poverty in its own terms (Blank and Blinder 1986). This is because "inflation is the cruellest tax of all" that disproportionally hurts those in the lowest income brackets (Easterly and Fischer, 2001: 160), leading to an increase in both material and social deprivation (Menyhert, 2022). However, studies also suggest that inflation could reduce income inequality if it increases nominal income by raising the income tax paid by the rich (Yue, 2011). In any case, the influence of inflation varies across regions (e.g. between urban and rural or developed and lagging areas), time

periods (Mahua and Puja, 2019) or between cyclical and long-run perspectives (Romer and Romer, 1998).

As argued, public policies and state transfers make a decisive contribution to tackling deprivation and poverty. However, here too there are conflicting views on their role and effectiveness. Some scholars highlight the positive impact of public transfers on poverty reduction, especially in the long-run, on the basis that they raise the income of the poor (Osberg, 2000; Hoynes et al., 2005; Herzer and Klump, 2010; Herzer 2010). Conversely, others argue that beyond a certain threshold, public transfers can exacerbate poverty, as high transfer payments potentially foster dependency among the impoverished and disincentivize efforts to improve and enrich their skills and escape poverty (Peterson and Rom, 1989; Herzer and Klump, 2006). An alternative perspective suggests that the impact of government transfers on poverty is conditional, and positive if the (re-)distribution of income is well adjusted and follows the rate of economic growth (Gottschalk and Danziger, 1984).

The impact of institutions on inequality and poverty constitutes a relatively new but growing field of study by this literature. Credible regimes of democratic and equitable governance have a decisive impact on economic development and facilitate the distribution of wealth across society and space alleviating poverty (North, 1990; Besley and Burgess, 2003; Rodrick et al, 2004; Bastiaensen et al, 2005). In turn, rigid bureaucracies and weak governance structures discourage investment and entrepreneurship, hinder development, exacerbate inequalities and sustain or even increase poverty (World Bank, 2001; Sindzingre, 2005; Tebaldi and Mohan, 2008).

3. Methodology

In order to address the main criticism of the conventional, unidimensional, measurement and to retain, at least part of, its analytical and operational capacity, many scholars have approached poverty by incorporating both monetary and non-monetary aspects (Bourguignon 2006). The former concerns financial deprivation, which has traditionally been used to assess poverty, and the latter material deprivation, a recently added dimension that comes to enrich the relativistic aspect of poverty. Material deprivation has gained importance in conceptualising and assessing poverty at least within the EU; notably it is an element that EU institutions measure regularly, since at least 2004, as part of the AROPE (At Risk of Poverty or Social Exclusion) indicator used for policy-making. Yet, the complexity of the issue provides scope for further development, which the current paper undertakes.

Material deprivation is defined as the severe lack of resources vital to maintaining a basic standard of living; a lack that is imposed and does not result from the preferences, choices and lifestyle of individuals. The first contribution to the measurement of material deprivation comes from Guio (2005) who developed the "standard" *material deprivation index* (MDI). This index defines severely materially deprived households as those lacking at least four out of nine specific items. A revised version was introduced by Guio et al (2012) which expanded the number of items and improved the reliability of the initial index. The revised *index of material and social deprivation* (IMSD) provided refers to those people who cannot afford at least seven of thirteen crucial items (Table 1) and are in a state of severe deprivation.

Table 1. The material deprivation measures

Standard material deprivation index (MDI) (4 of 9 items)	Revised index of material and social deprivation (IMSD) (7 of 13 items)
1. Cannot afford to face unexpected expenses (HS060)	
2. Cannot afford to pay for one-week annual holiday away from home (HS040)	
3. Cannot confront payment arrears (on mortgage or rental payments, utility bills, hire purchase instalments or other loan payments) (HS011, HS021, HS031)	
4. Cannot afford a meal with meat, chicken, fish (or vegetarian equivalent) every second day (HS050)	
5. Cannot afford a car/van for personal use (HS110)	
6. Cannot afford to keep home adequately warm (HH050)	
7. Cannot afford a telephone (HS070)	7. Replacing worn-out furniture (HD080)
8. Cannot afford a TV (HS080)	8. Having internet connection (PD080)
9. Cannot afford a washing machine (HS100)	9. Replacing worn-out clothes by some new ones (PD020)
	10. Having two pairs of properly fitting shoes (PD030)
	11. Spending a small amount of money each week on him/herself (PD070)
	12. Having regular leisure activities (PD060)
	13. Getting together with friends/family for a drink/meal at least once a month (PD050)

Our approach adopts the Alkire-Foster methodology (2011) which assesses material deprivation along two dimensions: the first concerns the breadth, measured by the proportion of deprived people (i.e. those lacking a specific number of MDI and IMSD items covering different aspects of economic strain and lack of durables) and the second the depth, measured by the intensity of deprivation (i.e. the average number of MDI and IMSD items lacked by the deprived people). Therefore, the *composite index of deprivation* (M_0) provided is comprised by two sub-indexes, the *headcount ratio* H, which measures the percentage of people in deprivation, and the *deprivation intensity* A, which measures the average number of items these people are deprived of. This index, by construction, is an absolute and not a relative measure of deprivation.

For the estimation of material deprivation indices (H, A and M_0), we used the EU-SILC database which provides timely and comparable cross-sectional and longitudinal data at the individual level concerning the items of MDI and IMSD outlined in Table 1. The EU-SILC database covers all EU countries plus the UK, Switzerland and Norway, for the period 2005-2021. We adopted a rigorous approach to the compilation of our dataset, excluding countries with unavailable or inconsistent data across periods (Island) as well as respondents with

missing values, while the provided data was weighted by the sampling weight in order to be adjusted for missing observations (Alkire and Apablaza, 2016).

4. Mapping analysis

The spatial pattern of material deprivation and its characteristics are presented in this section in order to provide a first insight into its spatial behaviour and its evolution over time. According to Figure 1, two areas present higher levels of poverty for the year 2021, the south-east and south-west. These areas are characterised by a significant number of deprived people, as is reflected in the high values of the H index. However, the A index shows a somewhat different picture concerning the intensity of deprivation, with higher values in the countries of south-eastern and central Europe. Germany constitutes a quite interesting case as is the country with the greatest contrast, having relatively lower H but relatively higher A, indicating that there is a low number of deprived people who nevertheless experience serious degree of deprivation.

Figure 1. Material deprivation across European countries, 2021

Material deprivation index (M_0)

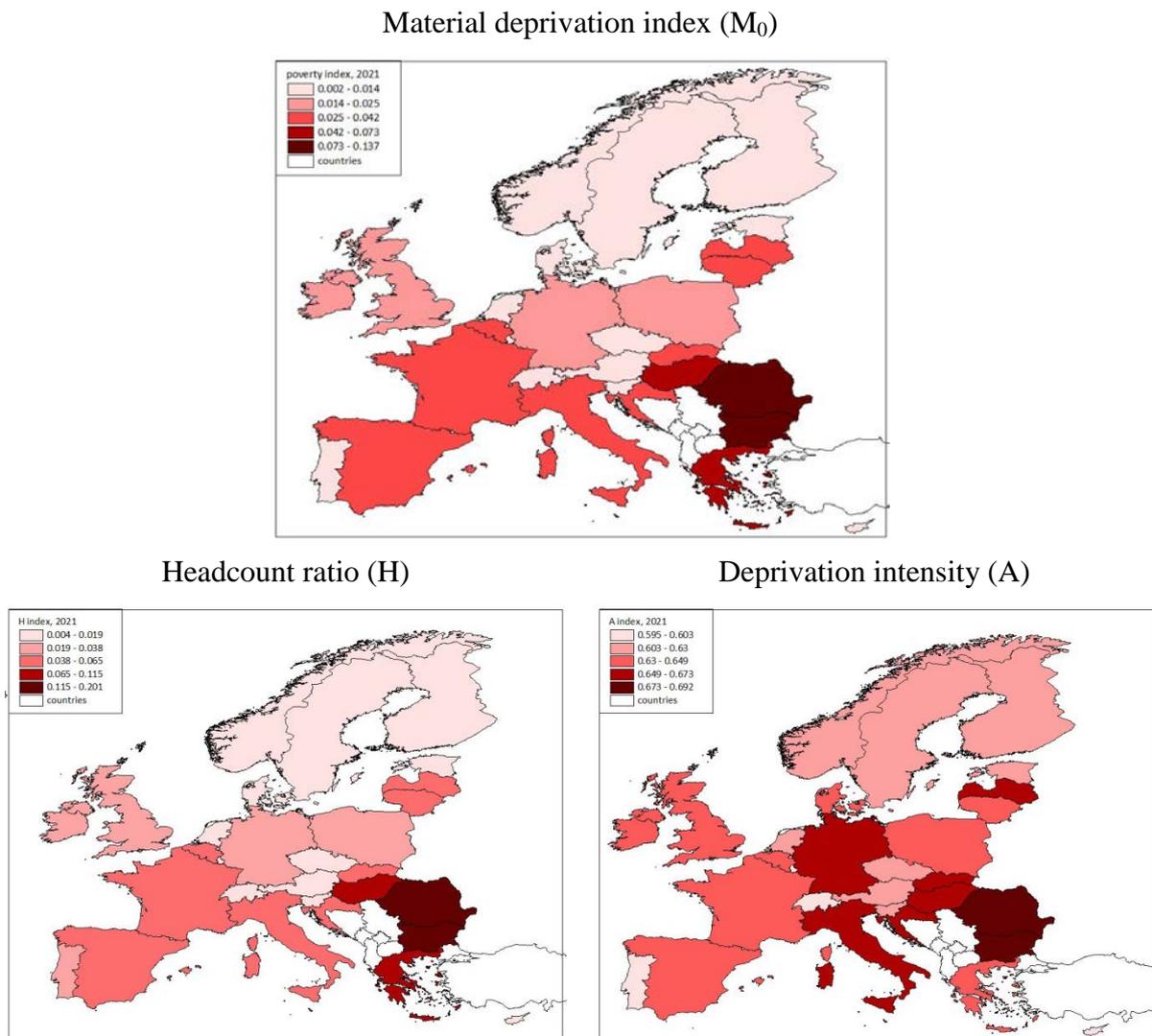Headcount ratio (H)   Deprivation intensity (A)

Figure 2 depicts changes in the material deprivation index M_0 between 2005 and 2021 (top), 2008 and 2013 (bottom left) and 2019-2020 (bottom right). The last two periods correspond

to the two major chocks, the financial crisis and the COVID19 crisis, which have asymmetrically affected the European economies and presumably the overall pattern and trend of deprivation, two elements that this study attempts to explore and assess. As is observed, material deprivation was reduced in most European countries, apart from those in South-West Europe. Moreover, the financial crisis increased deprivation in all countries apart from Scandinavian and some central-eastern ones, while the COVID19 crisis raised deprivation in Scandinavia (two countries) and central-south Europe (five countries). Overall, the impact of the financial crisis on material deprivation appears to be greater than this of COVID19, as it affected almost all of Europe, albeit more heavily the south-western countries.
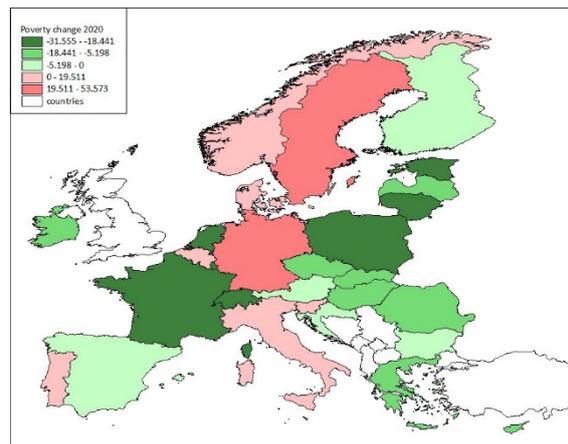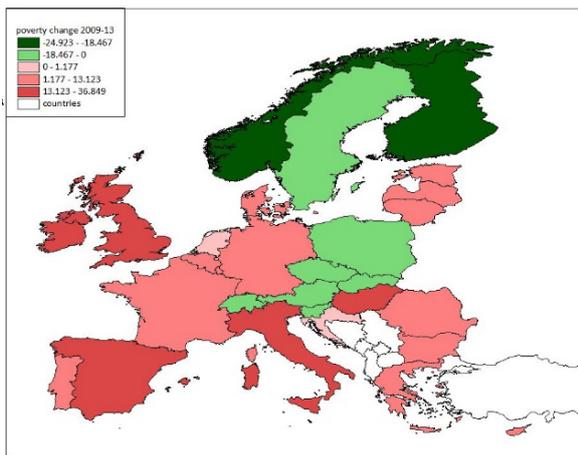
Figure 2. Change of material deprivation index (M_0) in the European countries

2005-2021
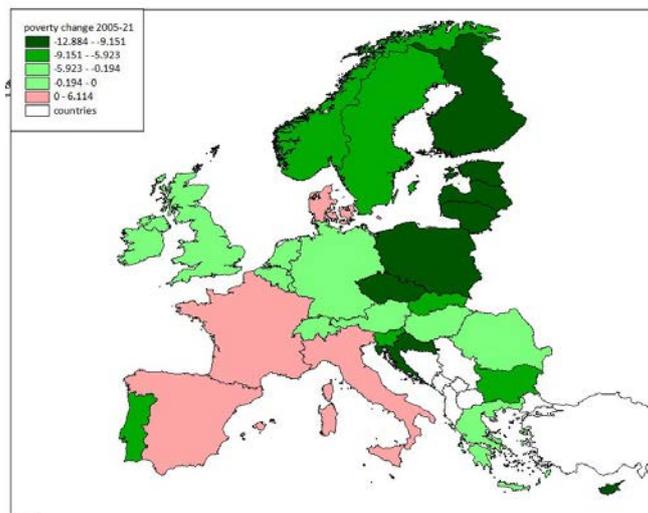
2008-2013 (financial crisis)   2019-2020 (COVID19)

The next two figures depict the changes in the H and A indexes, for the same time periods. As regards the headcount ratio (Figure 3), the percentage of deprived people has been reduced in all European countries apart from Spain. The index presents a different spatial footprint over the two crises. During the financial crisis H increased in Europe apart from Scandinavian and some central-east countries, while the COVID19 crisis heavily increased the deprived people in Germany and Sweden.

Figure 3. Change of headcount ratio (H) in the European countries
2005-2021

2008-2013 (financial crisis)   2019-2020 (COVID19)
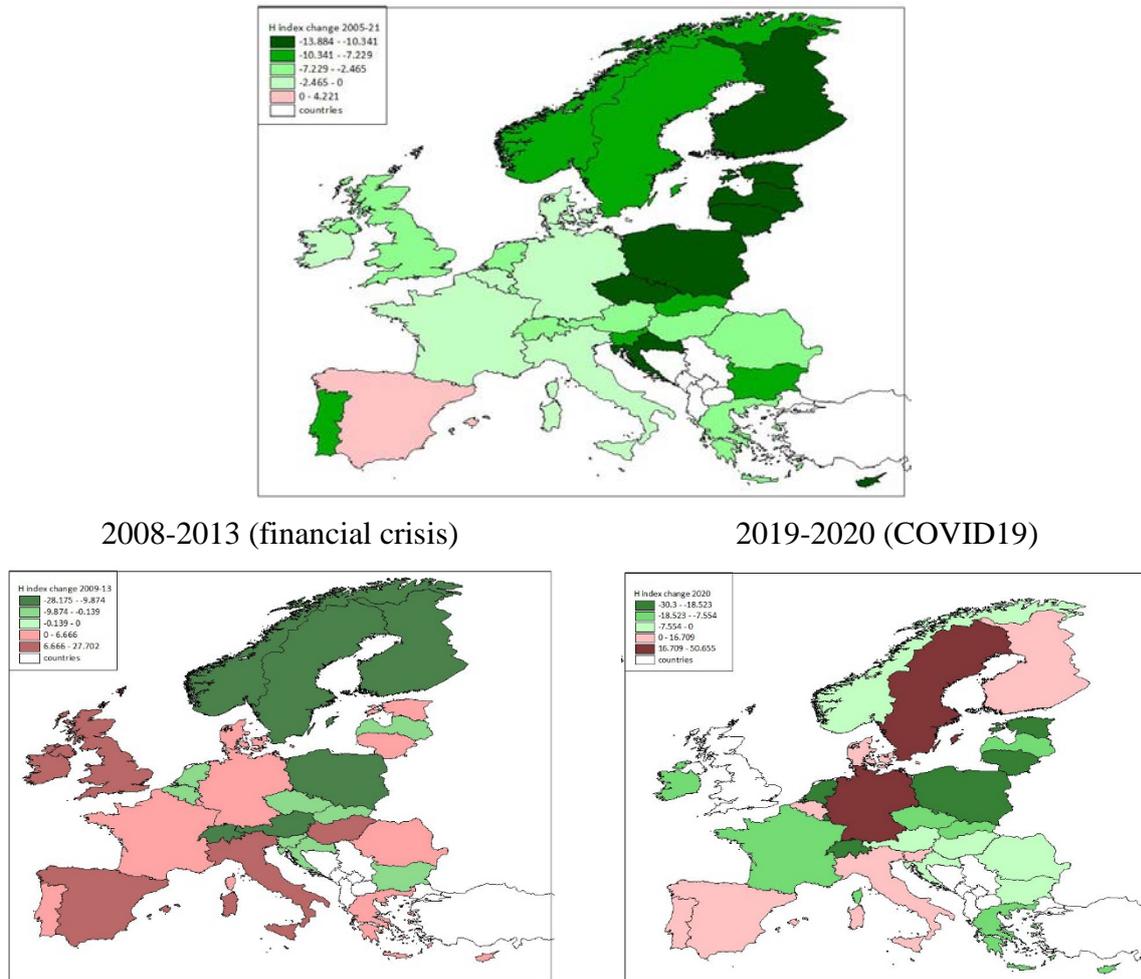
As regards the deprivation intensity (Figure 4), it was increased in several countries in the European periphery but much more so in central Europe. The financial crisis had a negative imprint in Scandinavia, the UK and parts of central Europe, while COVID19 increased deprivation in north-eastern Europe (plus Italy and Ireland).

Figure 4. Change of deprivation intensity (A) in the European countries
2005-2021

2008-2013 (financial crisis)   2019-2020 (COVID19)
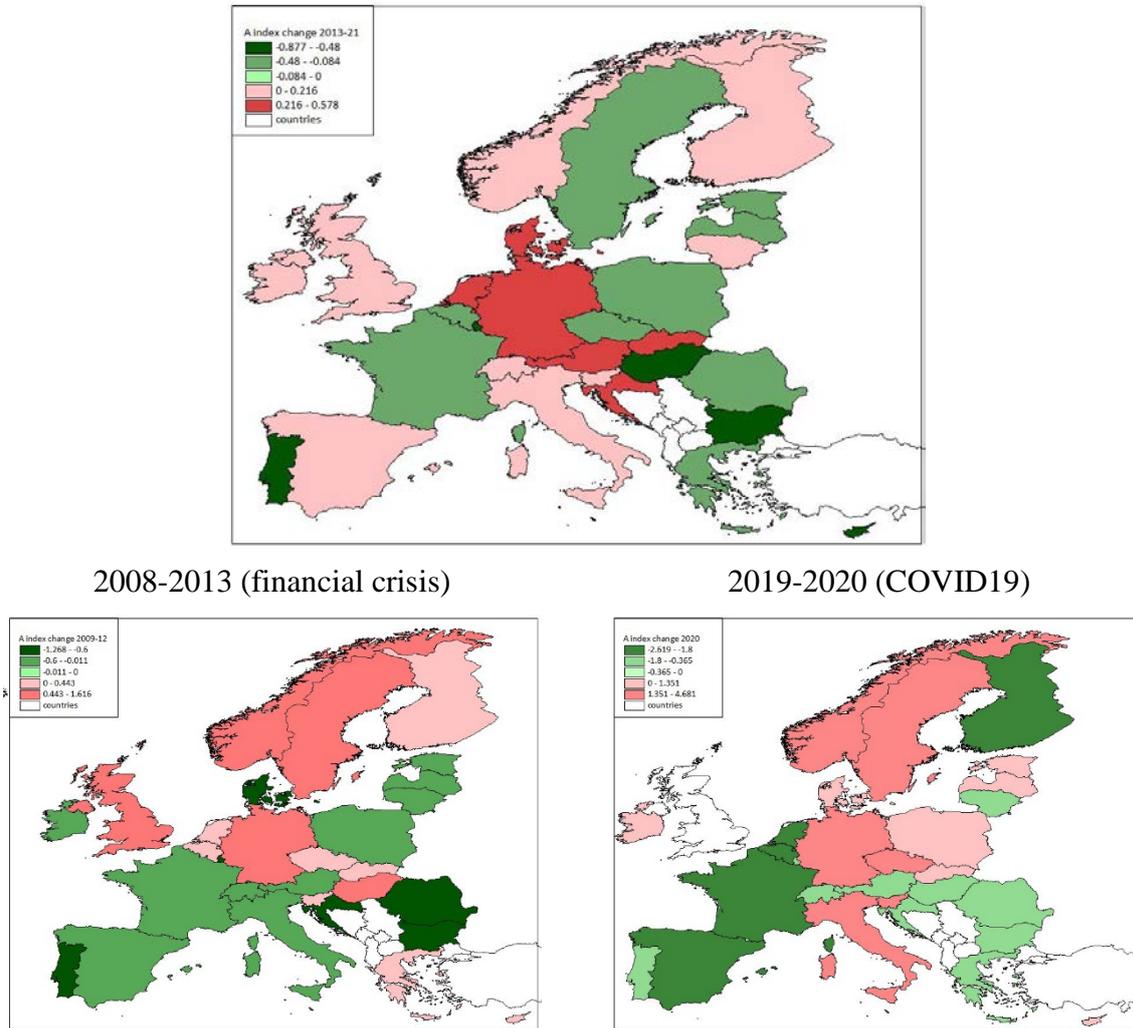
5. Econometric analysis

Following the graphical documentation of the dynamics of material deprivation, the current section sets out to explore what determines it. In particular, the econometric analysis carried out aims to indicate which factors have a significant impact (negative or positive) on deprivation change and to assess their magnitude. The factors reflect the socio-economic, demographic and institutional environment at country level. The econometric model we deployed has the following form:

$$\Delta POV_{i,t} = c + b_1 \Delta POV_{i,t-1} + b_2 CYCLE_{i,t} + b_3 \Delta ININEQ_{i,t-1} + b_4 SPINEQ_{i,t-1} \\ + b_5 UNEM_{i,t-1} + b_6 INF_{i,t-1} + b_7 \Delta SOCEXP_{i,t-1} + b_8 \Delta AGEING_{i,t} + \varepsilon_{i,t}$$

where i denotes the country, t the year and ε is the disturbance term, which follows the normal probability distribution with zero mean and constant variance (i.e. $\varepsilon_{i,t} \sim N(0, \sigma_t^2)$).

The analysis uses an unbalanced panel data consisting of the EU27 countries plus the UK, Switzerland and Norway over the time span of 2005-2021 (527 observations). Table 2 outlines the variables used and their descriptive statistics.

Table 2. Description of variables

Variable	Name	Definition	Obs	Mean	Std. Dev.	Min	Max
ΔPOV	Material deprivation change	Change of material deprivation index developed	463	-0.003	0.015	-0.069	0.131
CYCLE	Business cycle	Cyclical component of GDP/cap (HP filter)	527	0.000	0.015	-0.080	0.111
ΔININEQ	Income inequalities change	Change of GINI index	496	-0.079	0.972	-6.400	2.800
SPINEQ	Spatial inequalities	Weighted coefficient of variation of GDP/cap in NUTS2 regions	425	0.252	0.156	0.021	0.631
UNEM	Unemployment	Unemployment rate	527	7.946	4.208	2.020	27.690
INF	Inflation	Inflation rate	527	2.058	2.076	-4.478	15.402
ΔSOCEXP	Social expenditure change	Change of total public gross social expenditure (% of GDP)	416	0.179	1.330	-4.896	6.537
ΔAGEING	Population over 65 yrs old change	Change of the population over 65 years old	496	0.264	0.146	-0.177	0.667

The dependent variable is change of the material deprivation index (M_0) we developed, which reflects a relativistic, non-monetary, aspect of poverty concerning lack of essentials for a decent living with social participation. All independent variables (except CYCLE and AGEING) are with one-year time lag, which helps to avoid endogeneity problems. We included the time lag of the material deprivation change in order to check if there is persistence in deprivation change. Persistence is a frequently cited feature of poverty (Whelan et al, 2003), with profound, long lasting and detrimental effects on well-being (Alkire et al, 2017).

Deprivation is affected by wider (macro)economic conditions and dynamics but in a rather complex way. In economic expansion deprivation is usually reduced, and in economic recessions usually increases, but this depends on whether wealth allocation/redistribution mechanisms (either structural market-based, or public policy related) work affectively (Ayala et al, 2017). Whatever the case, the business cycle is found to exert an influence on poverty (Meyer and Sullivan, 2011). The effect of cyclical fluctuations on deprivation change is examined in the present analysis by including the cyclical component of GDP per capita (CYCLE) through the use of the Hodrick-Prescott (1997) HP filter.

Income inequality also affects the effectiveness of redistribution mechanisms; it can prevent the benefits of growth from being spread to the poorer sections of the population and, as a result, deprivation is maintained. To Gini index (ΔININEQ), which measures the degree of income inequality, is used to explore this effect. Spatial inequalities reflect development imbalances and asymmetries that arise due to unfavourable spatial and locational

characteristics, and similar to income inequalities might retain or deteriorate deprivation. The analysis explores whether spatial inequalities within countries affect deprivation using as explanatory variable the weighted coefficient variation of GDP per capita (SPINEQ) between regions in each country.

Macroeconomic conditions are also critical factors related to poverty. Unemployment is associated with the lack of economic means required for a decent life (Blank and Blinder, 1985), it weighs more heavily on the poor than other macroeconomic indicators (Ayala et al, 2017) and is thus an important cause of deprivation. The unemployment rate (UNEM) is used to assess the effect of unemployment on deprivation. Inflation also diminishes people's ability to acquire the essentials for living. High inflation not only erodes real wages, savings and hence the purchasing power of households, disproportionally burdening the poorer strata of the population (a phenomenon dubbed "inflation inequality"), but also the effectiveness of public policy since the real value of public funds provided is also reduced (Chee-Hong and Siew-Voon, 2020, Heer and Sussmuth, 2003). The effect of inflation on material deprivation is investigated with the use of the variable inflation rate (INFL).

As underlined, public policy is a key parameter of deprivation. It concerns the amount of public money devoted to fighting poverty as well as the effectiveness in policy formulation. The econometric analysis investigates this examining whether changes in social expenditures (ΔSOCEXP) have an impact on the deprivation reduction. Finally, socio-demographic conditions can also influence deprivation dynamics. An ageing population is likely to have greater needs for health and social services and place a strain on public resources, weakening state's capacity to address poverty. Furthermore, a large elderly population reflects an imbalance in the labour market (smaller pool of workers), in the fiscal sector (reduced tax base) and in the national finances (increased pension payments), which affect development prospects and impairs public policy. The effect of the demographic structure on deprivation is investigated with the variable ΔAGEING which is the change of elderly's share in the national population.

In order to achieve a robust econometric model and avoid spurious results, the Im-Pesaran-Shin test for stationarity was used. According to Table 3, the low p-values of the variables indicate that data in the deployed model are stationary. The appropriateness of the model is checked by the Hausman test. The null hypothesis that the random effects model might be related to inconsistent coefficients and biased standard errors was rejected, signifying that the fixed effects model is the most appropriate.

The results of the fixed effects panel model used are presented in Table 4. Material deprivation is found to deteriorate in periods of economic recession (CYCLE) and to diminish during economic expansion. This counter-cyclical behaviour of deprivation is in line with other studies (*inter alia*, Ayala et al, 2017) which argue that in times of economic prosperity more resources and means become available enabling states to combat poverty. As expected, both spatial (SPINEQ) and income (ΔININEQ) inequalities aggravate poverty. The polarization of space leads to developmental imbalances which prevent the flow of resources, increasing deprivation. Similarly, the increase in income inequalities mainly afflicts the poorest part of the population depriving them of the essentials for a decent living. As regards the macroeconomic conditions, both unemployment (UNEM) and inflation (INF) appear to exacerbate deprivation. The increase of unemployment leads to income loss increasing the number of people who cannot afford the necessities of livelihood, while rising inflation erodes households' purchasing power at the detriment of the poorest people.

Table 3. Im-Pesaran-Shin unit root test results

Variables	t-statistics
CYCLE	-13.62***
ΔINEQU	-7.98***
SPINEQ	-1.27*
UNEM	-3.74***
INF	-4.56***
ΔSOCEXP	-10.11***
ΔAGEING	-6.50***

Note: *** significant at the 1% level; ** significant at the 5% level; *significant at the 10% level

Table 4. Factors affecting deprivation change in the European countries, 2005-2021

Explanatory variables	Dependent: material deprivation change
ΔPOV_{t-1}	-0.09
$CYCLE_t$	-0.12**
$\Delta ININEQ_{t-1}$	0.001*
$SPINEQ_{t-1}$	0.09***
$UNEM_{t-1}$	0.001***
INF_{t-1}	0.002***
$\Delta SOCEXP_{t-1}$	-0.001
$\Delta AGEING_t$	0.004
c	-0.03***
N	305
Hausman test	24.85***

Note: *** significant at the 1% level; ** significant at the 5% level; *significant at the 10% level

Three of the factors examined were found to be statistically not significant in explaining material deprivation (see Table 4). The first is the time-lagged material deprivation change (ΔPOV), revealing that there is no persistence in the pattern of deprivation change, that means, the change is not determined by the course of previous changes. The variable of population ageing (ΔAGEING) is also not statistically significant, suggesting that demographic imbalances is not a key driver of deprivation at the national level. Surprisingly, social transfers (ΔSOCEXP) as well, were not found to have a (statistically) significant role in reducing deprivation, perhaps because they might be distributed to other sectors, have a more indirect and subtle contribution or work through other channels. This gives rise to a question whether the institutional framework of each country play some role.

In an attempt to shed light into the question just posed, the paper has explored whether different welfare regimes enable or hinder certain factors from operating as prescribed. The literature (Esping-Andersen, 1990; Watson, 2018; Bambra, 2005) identifies five types of

welfare regime grouping European countries (as displayed in Table 5) in accordance to specific characteristics as follows:

- Liberal, where the market is the main mechanism of welfare provision and the state only comes in to support the market.

- Social-democratic, where there is a strong social policy of equitable welfare provision, in favour of redistribution through social welfare and unemployment benefits.

- Corporatist (or conservative), where welfare entitlements are linked to lifelong employment and the state acts as a guarantor of this provision giving less emphasis on redistribution through direct intervention.

- Southern, where the family is seen as the main provider of welfare facilities supported to a lesser degree by state (labour-market) policies which remain underdeveloped and selective.

- Eastern (or post-communist), where the system retains certain socialist values and practices of the previous regime, mixing elements from corporatist, and, to a lesser extent, social-democratic models.

Table 5. Categorisation of welfare regimes

Welfare system	*Countries*
Liberal	United Kingdom, Ireland
Social-democratic	Sweden, Finland, Norway, Netherlands, Denmark, Island
Corporatist	Austria, Belgium, France, Switzerland, Luxembourg, Germany
Southern	Italy, Spain, Greece, Portugal, Malta, Romania, Bulgaria, Cyprus
Eastern	Estonia, Latvia, Lithuania, Poland, Hungary, Czech, Slovakia, Slovenia, Croatia

The econometric results of the model for each welfare system are displayed in Table 6. We observe that the southern and eastern regimes present a counter-cyclical behaviour (CYCLE). This indicates that during recession deprivation increases (and during expansion it declines), signifying the weakness of the system to address the issue when the economy is underperforming. In contrast, deprivation in socio-democratic welfare systems displays a pro-cyclical behaviour; during recessions, when people become more vulnerable, the system steps in to provide a safety net for those in need.

Income (ΔININEQ) and spatial inequalities (SPINEQ) increase deprivation change in most of the welfare systems[1] following the same pattern of the overall model. This highlights the existence of synergies between different forms of disparities and the need to approach them in tandem deploying policies that address both, something which applies to all welfare regimes. Unemployment (UNEM) remains a statistically significant factor that leads to increase of deprivation in almost all welfare systems. Inflation (INF), however, seems to be an issue in the southern and eastern welfare systems, and concerns countries with weaker economies and less credible institutions and governance structures (Menyhert, 2022).

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[1] The negative correlation of spatial inequalities with deprivation in the socio-democratic welfare system is largely attributed to the particular morphological topography of the Nordic countries.

The effect of social expenditures (ΔSOCEXP) in the reduction of deprivation is proved to be significant in three welfare systems apart from the southern and the liberal. It implies that in these two regimes social transfers are either low (less than the critical mass required to make a difference) or their benefits might be offset by other unfavourable conditions or counteractive policies, e.g. high direct or indirect taxation (southern system) or labour market deregulation (liberal system). The problem of ageing population (ΔAGEING) appears to encumber deprivation in the southern, eastern and liberal welfare systems, which are either more vulnerable or have a smaller social footprint by their policies.

Table 6. Factors affecting deprivation change in welfare systems, 2005-2021

Variables	liberal	social-democratic	corporatist	southern	eastern
ΔPOV$_{t-1}$	0.42	-0.24**	-0.24*	-0.08	-0.14
CYCLE$_t$	0.11	0.02*	-0.02	-0.24**	-0.27**
UNEM$_{t-1}$	-0.0005	0.0002*	0.001**	0.0003**	0.002*
INF$_{t-1}$	-0.0001	-0.0002	0.0004	0.003**	0.002**
ΔINEQU$_{t-1}$	0.004***	0.0005***	0.001*	-0.0006	0.001***
SPINEQ$_{t-1}$	0.11**	-0.01***	0.006**	0.04**	0.42***
ΔSOCEXP$_{t-1}$	0.001	-0.0006**	-0.0001**	-0.0006	-0.002**
ΔAGEING$_t$	0.04*	$-1.62 \cdot 10^{-6}$	0.0001	0.02***	0.003*
c	-0.01***	-0.01***	-0.0001	-0.02***	-0.24**
N	25	56	88	60	90
Hausman test	1.94	4.22	0.53	0.72	22.52***

Notes: *** significant at the 1% level; ** significant at the 5% level; *significant at the 10% level. Models with Hausman value less than 0.1 are regressed with fixed effects, while models with Hausman value greater than 0.1 with random effects.

6. Conclusions

In the era of rapid technological advancement and artificial intelligence, poverty and deprivation persist, but their manifestations have evolved, demanding a re-evaluation of traditional income-based metrics and a fresh approach to measurement and analysis. While wealth remains a crucial factor for assessing poverty, contemporary forms of deprivation extend beyond mere financial scarcity. To comprehensively understand and address poverty within this new context, holistic approaches that encompass a broader spectrum of indicators capturing the multifaceted nature of deprivation are required. Such an inclusive framework will empower policymakers to implement effective strategies aimed at ensuring the well-being of all members of society.

The current paper has aligned with this perspective to provide a two-dimensional deprivation index that assesses poverty as is experienced by people, which has been calculated and visualised at the level of European countries for the period 2005-2021. This mapping analysis enabled also to shed light on the impact of the 2008 financial crisis and the 2020 COVID shock on deprivation. In addition, the paper has explored econometrically the factors that the literature holds accountable for poverty's entrenchment and endurance by examining whether

and to what extent various socio-economic, demographic and institutional factors have an impact on deprivation change. A number of findings have emerged which are summarised next.

People at risk of poverty are a significant part of the population in the EU, though their numbers vary across countries (Eurostat, 2023). The mapping of the material deprivation index we developed revealed this spatial asymmetry in Europe with the southern and south-eastern countries (particularly Romania, Bulgaria, Greece and Hungary) exhibiting quite high levels of deprivation. Moreover, it became apparent that the intensity of deprivation is a serious issue not only for the southeast but also for the central European states. Most countries succeeded in reducing their deprivation levels during the period 2005-2021 apart from the large southwest economies (Spain, Italy, France) and Denmark. The 2008 financial crisis, compared to the 2020 COVID shock, undoubtedly affected a greater number of countries by increasing the number of poor people, however, the latter appeared to exacerbate the intensity of deprivation.

The econometric analysis verified that material deprivation follows a counter-cyclical behaviour as countries during recessionary periods experience economic and fiscal distress leading to inability to reduce rising poverty. In fact, cyclical fluctuations exert a greater impact on deprivation change in terms of magnitude than all the determinants. On the contrary, in countries with a social-democratic welfare system where strong welfare programs are in place, deprivation exhibits a pro-cyclical trend in which deprivation decreases in times of recession.

Disparities appear to play a significant role in poverty dynamics as both income and spatial inequalities were also found to increase material deprivation. Income inequalities seem to inhibit the benefits of growth from trickling down to the poor, or even prevent the economy from fully exploiting the growth potential. Spatial inequalities reflect regional imbalances and asymmetries arising from adverse structural, spatial and locational characteristics, which also exacerbate material deprivation, confirming the claim that where one lives matters.

Macroeconomic factors, such as high unemployment and inflation, reveal possible distortions and inefficiencies an economy encounters, which come to deteriorate the deprivation conditions that people experience. Similarly, demographic ageing increase deprivation especially in countries that lack strong social anti-poverty policies.

Undoubtedly, the socio-economic changes and transformations taking place at all spatial levels require the implementation of national policies to mitigate any negative impacts and balance any asymmetries. The contribution of public transfers to reducing deprivation was found to be significant but in specific countries and welfare systems with a tradition in social care. The weak partial effect of these policies in a number of countries illustrates their inadequacy in term of the magnitude or, in turn, the depth and persistence of poverty that eventually offsets deployed policies, especially under adverse macroeconomic conditions.

Overall, deprivation appears resilient and hard to eliminate in both the short and long term. Its association with a broad range of inequalities and adverse conditions highlights the existence of synergies and complex dynamics that reinforce it. We believe that approaches that go beyond conventional income-based assessments and embrace a holistic perspective in analysis and policy have a greater chance of success.

Acknowledgements

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