WORKING paper

BANQUE DE FRANCE
EUROSYSTÈME

Income Smoothing Across EU Regions: a Panel Decomposition of Adjustment Channels[1]

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March 2026, WP #1037

Abstract

Households across European Union regions face diverse economic shocks impacting wage income and welfare. Understanding the channels through which households adjust their income is crucial for assessing regional resilience. Here we analyze regional (NUTS2) data from 2000 to 2020, decomposing income smoothing into public transfers, property income, self-employment and housing income, and demographic changes. We find that approximately 30% of wage shocks are smoothed in the EU, rising to more than 40% in the euro area and 60% in Western Europe, with transfers and self-employment/housing income as the primary adjustment mechanisms. Property income plays a strong role in Western Europe, particularly during recessions, while migration contributes modestly but significantly to smoothing in Southern and Western Europe. Our analysis reveals distinct regional patterns, delineating core, semi-peripheral, and peripheral groups with varying smoothing capacities. These findings highlight substantial regional heterogeneity in income adjustment, underscoring the multi-speed nature of economic integration and the importance of tailored policies to enhance household resilience across Europe.

Keywords: Risk-Sharing, Income Smoothing, Currency Unions, Migration.

JEL classification: E21, F22, F36, F45, G15

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[1] The authors acknowledge useful feedbacks from participants in seminars (Arras, Banque de France, Bayreuth, Montpellier), and conferences. In particular, we would like to thank Pierfederico Asdrubali, Nicolas Bedu, Juan Carluccio, Jérôme Creel, Hartmut Egger, Jan Fidrmuc, Céline Gimet, Katja Kaufmann, Roman Mestre, Gernot Müller, Benoit Mulkay, Stefan Napel, Leandro Navarro, and David Stadelmann for useful comments.

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NON-TECHNICAL SUMMARY

Over the past twenty years, Europe has faced a series of major economic shocks—from the eurozone crisis to the COVID-19 pandemic and energy price surges—that have disrupted economies and household incomes. These shocks have not affected all regions equally. Some areas recovered quickly, while others struggled, exposing deep differences in how regions absorb and adapt through wages and employment. This uneven resilience has fueled growing concerns about regional inequality and "left-behind" areas, as persistent income gaps threaten the fairness and credibility of EU-wide policies.

In this context, this paper examines the resilience of European household income —a more direct indicator of well-being than GDP - to macroeconomic shocks. We investigate to what extent, when considering disposable income, shocks on wages are partially offset in the short run by other types of income. This is known as "income smoothing" in the economic literature (Deaton, 1992). Using detailed regional data from 2000 to 2020, we provide several empirical insights.

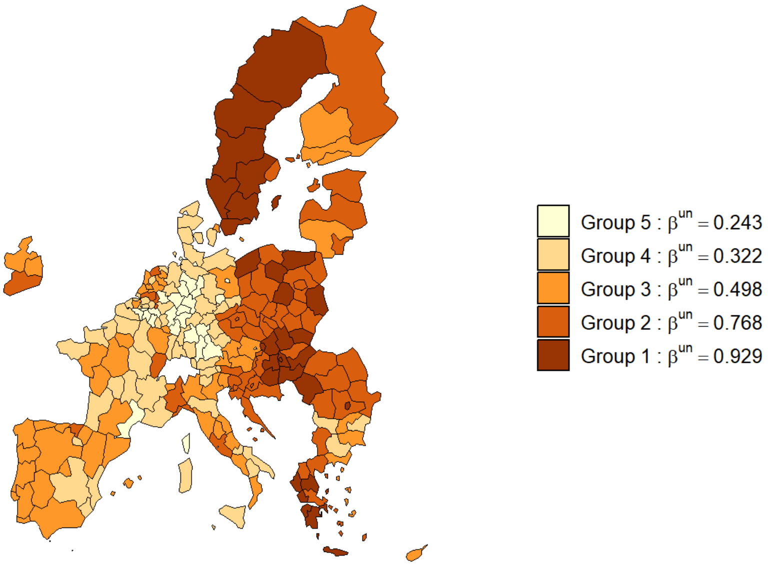
First, only about 30% of wage shocks are smoothed in the EU, rising to nearly 40% in the euro area and 60% in Western Europe. In practical terms, over the last two decades, when a shock affected aggregate wages per head in a European region, decreasing them by €1, disposable income per capita decreased on average by €0.70 in that same region. This decrease was only €0.60 for regions in the euro area. The main mechanisms cushioning these shocks were the higher size of public transfers (social benefits and contributions) and income from real estate and self-employment in the euro area. Migration also played an important role in stabilizing regional incomes, as shown by our distinction between migration and natural population changes.

Second, income smoothing is highly uneven across Europe. Western European regions are better equipped to absorb wage shocks thanks to more diversified mechanisms, including property income (interests, dividends…). In contrast, Central and Eastern Europe and Southern countries such as Greece, Italy, Portugal, and Spain rely on fewer channels, making them more vulnerable. Interestingly, income smoothing does not increase steadily with GDP per capita; it peaks in middle-income regions, suggesting that institutional and structural factors could also matter.

Third, clustering analysis reveals a clear divide between core, semi-peripheral, and peripheral regions. Core regions have stronger and more diversified smoothing mechanisms, while peripheral regions lag behind. Property income and demographic channels are significant only in core regions, indicating that these areas are more attractive and likely have better-functioning capital markets. This creates a "multi-speed" Europe, where some regions recover faster than others. We also show that cluster boundaries do not fully align with national borders, underscoring the value of a regional approach.

In sum, Europe's ability to protect household incomes during shocks remains incomplete and varies widely across regions. To build a more resilient Union, policies must combine public and private mechanisms and target regions lacking effective income-smoothing tools.

Figure. Clustering the European regions by the unsmoothed share of income shocks



Note: The map shows clusters of regions based on their level of smoothing of shocks to aggregate wages on disposable income per capita. A value of 0 for β^{un} means the shock is fully absorbed, while a value of 1 means it is fully transmitted.

Lissage des revenus dans les régions de l'UE : décomposition des canaux d'ajustement

Résumé

Les ménages des régions de l'Union européenne sont confrontés à des chocs économiques divers qui affectent les revenus salariaux et le bien-être. Comprendre comment ces ménages ajustent leurs revenus par différents canaux est essentiel pour évaluer la résilience des régions. Nous analysons ici des données régionales (NUTS2) de 2000 à 2020, en décomposant les mécanismes de lissage des chocs en transferts publics, revenus de la propriété, revenus fonciers et des travailleurs non-salariés, ainsi que les changements démographiques. Nous constatons qu'environ 30 % des chocs salariaux sont lissés dans l'UE, proportion qui atteint près de 40 % dans la zone euro et 60% en Europe de l'Ouest, les transferts publics et les revenus fonciers et non-salariés constituant les principaux mécanismes d'ajustement. Les revenus de la propriété (intérêts, dividendes…) jouent un rôle majeur en Europe de l'Ouest, tandis que la migration contribue de manière modeste mais significative au lissage en Europe méridionale et occidentale. Notre analyse révèle des schémas régionaux distincts, délimitant des groupes « cœur », semi-périphériques et périphériques aux capacités de lissage variables. Ces résultats mettent en évidence une forte hétérogénéité régionale dans l'ajustement des revenus, soulignant la nature à plusieurs vitesses de l'intégration économique et l'importance de politiques ciblées pour renforcer la résilience des ménages en Europe.

Mots-clés : partage du risque, lissage des revenus, union monétaire, migration.

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1. Introduction

In the past two decades, the European Union has experienced a succession of significant economic shocks—including the eurozone crisis, the COVID-19 pandemic and associated lockdowns, energy crises—that have disrupted economic activity and affected household incomes across the continent. Households across European regions have experienced these shocks unevenly, revealing significant disparities in regional capacity to absorb and adjust to adverse conditions via wage and employment channels. Moreover, concerns about spatial inequality and "left-behind" regions have intensified since the global financial crisis (Rodríguez-Pose et al., 2023; MacKinnon et al., 2024) and, as pointed out by recent studies, we observe persistent regional divergences in Europe (Storper, 2018; Iammarino et al., 2019; Rosés and Wolf, 2021). Because convergence in real income per capita is central to the effectiveness and legitimacy of common economic policies, understanding at the regional level how households buffer shocks to income is of first-order importance. Although GDP remains the most commonly employed measure of aggregate economic performance, household income provides a more direct indicator of well-being, as it reflects the means by which individuals maintain their standard of living (Deaton, 1992, Townsend, 1994).

In this paper, we examine the impact of wage fluctuations on regional household incomes per capita. The central question under investigation is how the distinct components of household income per capita respond to variations in the aggregate wage level of a region. Economic shocks—whether technological, macroeconomic, or policy-driven—generate uneven effects across regions, particularly through their impact on wages and employment. For instance, energy price surges and automation can both reduce labor demand, while technological change may disproportionately affect routine jobs. Acemoglu and Restrepo (2022, 2024) attribute much of the recent evolution in the U.S. wage structure to declining relative wages for routine workers. More broadly, automation increases the skill premium and depresses low-skill wages, contributing to rising inequality as productivity growth raises demand for high-skilled labor (Buera and Kaboski, 2012; Hémous and Olsen, 2022). Economic openness also produces asymmetric outcomes: trade liberalization tends to benefit export-oriented regions while exerting downward pressure on import-competing sectors, thereby reinforcing regional disparities (Rodríguez-Pose and Gill, 2006; Ezcura and Rodríguez-Pose, 2013; Lessmann and Seidel, 2017). Recent tariff measures are likely to exacerbate these asymmetries. Broader downturns, such as recessions or financial crises, reduce consumption and investment, weaken labor demand and bargaining power, and trigger persistent wage and employment fluctuations (Blanchard and Katz, 1992). Labor mobility remains a key adjustment mechanism: interstate migration in the U.S. tends to increase during downturns in response to regional job market disparities (Dao et al., 2017; Notowidigdo, 2020). Public policy responses—such as public-sector hiring, wage freezes, or minimum wage regulations—also shape regional wage dynamics, as observed during the European sovereign debt crisis. The COVID-19 pandemic further illustrated the sectoral unevenness of shocks: employment and wages collapsed in hospitality and retail, while remote-compatible sectors were more resilient. These effects were compounded by variation in business support schemes, transfers, and lockdown policies across countries (Coibion et al., 2025; Chetty et al., 2024).

This paper contributes to the literature in four main ways.

First, we shift the focus from GDP-smoothing to *income-smoothing*, emphasizing the impact of shocks on household welfare. Extensive research—beginning with Asdrubali et al. (1996)—has examined how GDP shocks are mitigated through various channels. In the U.S., capital markets absorb 40–50% of GDP shocks, and fiscal transfers account for roughly 10% (Mélitz and Zumer, 1999; Athanasoulis and Wincoop, 2001; Cimadomo et al., 2023; Alcidi et al., 2023). In contrast, Europe exhibits significantly lower and more variable GDP-smoothing, particularly since the Global Financial Crisis, with capital markets and fiscal transfers playing a limited role (Afonso and Furceri, 2008; Furceri and Zdzienicka, 2015; Furceri et al. 2022; Fuentes et al., 2023; Nikolov and Pasimeni, 2023). Our study addresses a gap in the literature by positioning itself at the intersection of macro-level risk-sharing—focused on the economy as a whole—and micro-level analysis at the household level (Asdrubali et al., 2020). This hybrid approach has certain limitations: it does not allow for the construction of cohort-based panels and excludes the savings channel due to the lack of regional consumption data. Nonetheless, it offers two key advantages: (i) the sample includes the entire household population, and (ii) the analysis relies on administrative (hard) data rather than survey data. Consequently, we shift the analytical focus to measure the extent to which fluctuations in aggregate wage are passed through income per capita and investigate how different channels contribute to smoothing the impact of wage shocks on aggregate household income. We focus on the alternative channels, which we detail below, through which households adjust to wage shocks.

Second, we conduct our analysis at the NUTS2 regional level, enabling us to assess whether smoothing mechanisms more effectively cushion region-specific shocks. This regional lens reveals the importance of economic heterogeneity, reflecting diverse economic structures, and highlights the policy implications of uneven adjustment capacity. Previous studies have examined such dynamics within countries like the UK (Mélitz and Zumer, 2002), Germany (Hepp and von Hagen, 2013), Italy (Petraglia et al., 2018; Gandullia and Leporatti, 2019), Spain (Alberola Ila and Asdrubali, 1997), and Sweden (Andersson, 2008), as well as in federal systems such as Canada (Bayoumi and Masson, 1995; Crucini, 1999; Balli et al., 2012), Russia (Fidrmuc and Degler, 2021), and Switzerland (Feld et al., 2020). Recent findings by Asdrubali et al. (2020) show that Italian households were able to smooth up to 85% of shocks, mainly through private savings. Building on this literature, we adopt a granular approach to the adjustment of shocks at the regional level across Europe, enabling a more nuanced analysis of intra-national dynamics—such as migration flows—that are crucial for effective policy design.

Third, the regional dimension yields a rich dataset that allows for in-depth analysis across development levels and across clusters of regions. We are therefore able to apply regression analysis by development level and conduct cluster analysis to assess whether the EU integration process is proceeding at a single or multiple speeds. This distinction has important policy implications: if income smoothing differs significantly across regions, targeted reforms—such as improved capital market integration (Letta, 2024)—may be required. Defining a one-size-fits-all monetary policy becomes also more difficult in such a fragmented landscape (El-Shagi and Tochkov, 2025).

Fourth, we explicitly incorporate the demographic adjustment channel, distinguishing between natural population change and migration. Our analysis is motivated by the theory of optimum currency areas (Mundell, 1961), which posits that labor mobility across regions constitutes a key mechanism for mitigating the employment effects of asymmetric shocks, particularly in the absence of exchange rate adjustment. Migration affects the denominator of income distribution by altering the population over which income is distributed, thereby influencing regional per capita income. While previous studies use changes in population as a proxy for migration (Asdrubali et al. 1996; Parsley and Popper, 2021), Kohler et al. (2023) are the first to formally integrate migration into a GDP-based framework using survey data and correcting for potential bias arising from natural population change. However, they do not quantify the effect of the latter. In this paper, we explicitly measure both contributions of migration and of natural demographic change at the NUTS 2 level. Although the data do not allow us to distinguish between international and intra-national migration—both influenced by factors such as language, culture, and wage differentials (Kennan and Walker, 2011)—we argue that accounting for both types through regional variables is essential for understanding household income adjustment dynamics, which are often underestimated when intranational flows are excluded.

Beyond demographic adjustment, we explore three main income-smoothing channels:

- **Transfers**: Automatic stabilizers are a central buffer against economic shocks. Dolls et al. (2012) show their effectiveness across OECD countries in adjusting tax revenues and social spending. Their importance was highlighted during the COVID-19 pandemic, although their effectiveness varies due to labour market rigidity and macroeconomic conditions (Kaufman et al., 2023). Moreover, crisis episodes have shown that low-income households are disproportionately affected, necessitating policy measures to mitigate inequality (Almeida et al., 2021). In the euro area, fiscal constraints under the Stability and Growth Pact tend to further limit their potential (Furceri and Zdzienicka, 2015; Dolls, 2024). In contrast, U.S. states benefit from "rainy day funds" and federal transfers, enabling more effective counter-cyclical fiscal responses (Wilson, 2023).
- **Capital income**: Financial returns can buffer income shocks, as suggested in the broader risk-sharing literature (Dufrénot et al., 2021). However, this requires diversified portfolios and well-developed financial systems as well as a degree of regional heterogeneity to facilitate cross-border income-smoothing (Brennan and Solnik, 1989). Krueger et al. (2024) find strong comovement between income shocks and household wealth (a valuation effect) in the case of Italian households. While broad diversification facilitates the distribution of income risk across regions (Kalemli-Ozcan et al., 2004; Kose et al., 2009; Balli et al., 2013), increasing macroeconomic synchronization may weaken the smoothing potential of financial income (Balli et al., 2014).
- **Net operating surplus and mixed income**: Income from real estate and self-employment can, in some cases, amplify the impact of recessions on household income, depending on the structure and resilience of these revenue streams. Yet, as shown by Mian et al. (2013), the impact of housing shocks on households varied substantially across the United States, confirming the interest of a regional approach.

Our analysis is based on Eurostat regional accounts data at the NUTS2 level for the period 2000–2020. This dataset provides the necessary granularity to apply a modified Asdrubali et al. (1996) framework, focusing on income-smoothing rather than GDP shock absorption. This allows us to isolate the effects of demographic dynamics on income adjustment. The regional dimension also enables us to explore variations in smoothing capacity across groups of countries. Using latent class analysis (Su et al, 2016), we identify clusters of regions with similar smoothing characteristics, determining whether observed heterogeneity reflects random dispersion or underlying structural patterns.

Our findings show that, on average, approximately 30% of wage shocks to per capita disposable income were smoothed across the EU between 2000 and 2020, primarily through transfers, self-employment and housing revenues. However, this average conceals substantial variation across time and space. We find that the share of unsmoothed shocks declined after the Global Financial Crisis and that Western European regions are able to offset more than 60% of wage shocks—particularly through property income. This underscores the role of financial development in enhancing income-smoothing. Finally, our regional clustering reveals a clear divide between core, semi-peripheral, and peripheral regions. Core regions benefit more from public transfers and capital income, and these divisions do not align neatly with national borders. This finding highlights the value of regional analysis and suggests that EU integration strategies must account for subnational disparities in adjustment capacity.

The structure of the paper is as follows: Section 2 presents the data and methodology; Section 3 analyzes income-smoothing across EU regions; Section 4 tests the robustness of the findings; and Section 5 concludes.

2. Methodology and data

Data

Our analysis of income smoothing amongst the EU regions relies on the households' accounts of the Regional Accounts data from Eurostat.[1] We use the following variables: compensation of employees (wages, salaries and employers' social insurance contributions), net operating surplus and mixed income (NOSMI), net property income, and net current transfers. The latter is defined as social benefits minus current taxes and social contributions, plus net other transfers, which corresponds to the difference between primary income and disposable income.

The NOSMI variable includes income from self-employment as well as imputed rental value for owner-occupied housing and operating lease (when the user is not the owner). Property income is the sum of investment income and rents on natural resources. Consequently, the real estate rents are recorded as NOSMI rather than net property income. The latter mostly consists of interest on debt, distributed income of corporations (e.g., dividends) and other investment incomes such as income attributable to insurance policyholders or those payable on pension entitlements.

The regional data are classified according to Eurostat's Nomenclature of Territorial Units for Statistics at the second level (NUTS2), which defines regions typically ranging between 800,000 and 3,000,000 inhabitants. These units generally correspond to Provinces, Regions and, in some cases, States.[2] Our sample covers 235 NUTS2 units from 26 EU countries[3] for the period 2000-2020. We use annual data expressed in real terms, using national price indices,[4] and on a per capita basis.[5]

[1] See Table A.1. in appendix for a detailed description of the variables retrieved.

[2] Estonia, Cyprus, Latvia and Luxembourg each have only one region at NUTS level 2. Our results are insensitive to the exclusion of these specific regions.

[3] Data are missing for the 5 French outermost regions (Mayotte, La Réunion, Guyane, Martinique and Guadeloupe), Malta and the Ionian Islands in Greece (EL62).

[4] Price indices are not available at the regional level. We therefore apply national indices as usually done in studies of risk sharing between states in the United States.

[5] See Appendix A for the construction of the population variables.

Table 1 presents some descriptive statistics for the 26 countries, revealing substantial heterogeneity both across and within EU countries in terms of income levels and composition.

Table 1. Descriptive statistics on the income in the EU

Code	Mean disposable income per capita (€)	Coefficient of variation within the country	Breakdown of the disposable income (in %)			
			Compensation of employees	Net operating surplus and mixed income	Net property income	Public transfers
AT	22179	0,035	83%	16%	15%	-14%
BE	19728	0,022	95%	16%	15%	-26%
BG	3293	0,256	66%	28%	5%	1%
CY	14352	0,102	72%	21%	7%	0%
CZ	7599	0,190	82%	27%	6%	-15%
DE	20616	0,028	88%	13%	20%	-21%
DK	19988	0,086	121%	11%	6%	-37%
EE	6935	0,256	94%	10%	6%	-10%
EL	11973	0,176	55%	42%	7%	-4%
ES	14485	0,046	79%	26%	6%	-11%
FI	19212	0,085	96%	15%	7%	-19%
FR	18975	0,028	90%	18%	7%	-15%
HR	6428	0,089	83%	17%	2%	-2%
HU	6333	0,097	84%	22%	7%	-13%
IE	18375	0,098	92%	23%	1%	-16%
IT	18341	0,063	62%	30%	19%	-11%
LT	6656	0,276	68%	14%	23%	-5%
LU	31978	0,027	89%	19%	5%	-12%
LV	6045	0,228	81%	12%	11%	-4%
NL	18863	0,033	104%	16%	13%	-32%
PL	6061	0,165	63%	37%	6%	-6%
PT	11334	0,040	73%	19%	10%	-1%
RO	4451	0,218	62%	29%	2%	7%
SE	19388	0,113	102%	9%	9%	-21%
SI	10752	0,064	89%	19%	3%	-11%
SK	6766	0,284	73%	28%	4%	-4%

Note: The net disposable income is expressed per capita and in real terms (€2015). Compensation of employees, net operating surplus and mixed income, net property income and public transfers are expressed in percent of the disposable income. The coefficient of variation is calculated for the net disposable income per inhabitant and equal to the ratio of the standard deviation to the mean.

Panel-data estimates

To quantify revenue-smoothing channels, our empirical strategy follows Asdrubali et al. (1996), but instead of considering shocks to GDP, it relies on a variance decomposition of shocks on aggregate wages to the per capita disposable income. Our four main adjustment channels are obtained by breaking down aggregate real wages, W, as follows:

$$W = \frac{W}{w}\frac{w}{wtot}\frac{wtot}{pi}\frac{pi}{di}di,$$

where w represents real wages per capita, $wtot$ total wages per capita (including NOSMI), pi the personal income per capita and di the real disposable income per capita.

The first channel is the self-employment and rental income channel: incomes arising from self-employment and rental value of housing owned by households, measured in national account with the net operating surplus and mixed income, may help to smooth total wages perceived (*wtot*). For instance, employees dismissed may choose to start their own business.

The second is the capital channel: property income including both interest, dividends and rents on land, may insulate the personal income (*pi*) from shocks to total wages if households benefit from higher investment income in case of downturn.

The third one is the transfer channel: social benefits and transfers indeed are well-known automatic stabilizers to the disposable income of households (*di*). We here consider transfers net of current taxes and social contributions.[6]

And finally, as in Kohler et al. (2023), we consider a demographic channel. This is made in accordance with the optimum currency area theory, as labor mobility should help to smooth the impact of macroeconomic fluctuations. In case of downturns, we may expect some workers to choose to emigrate, smoothing the per capita disposable income (*di*) of the remaining inhabitants.[7]

From our first accounting equation, we first take logs, first difference, multiply by $\Delta W_{i,t}$ and divide by $var\left(\Delta log W_{i,t}\right)$, to obtain:

$$1=\frac{cov\left(\Delta log\ (W_{i,t}), \Delta log\ (W_{i,t}) - \Delta log\ (w_{i,t})\right)}{var\left(\Delta log\ (W_{i,t})\right)}+\frac{cov\left(\Delta \log\ (W_{i,t}), \Delta log(w_{i,t}) - \Delta \log\ (wtot_{i,t})\right)}{var\left(\Delta \log\ (W_{i,t})\right)}+$$
$$\frac{cov\left(\Delta \log\ (W_{i,t}), \Delta \log(wtot)_{i,t} - \Delta \log\ (p_{i,t})\right)}{var\left(\Delta \log\ (W_{i,t})\right)}+\frac{cov\left(\Delta log\ (W_{i,t}), \Delta log\ (p_{i,t}) - \Delta log\ (di_{i,t})\right)}{var\left(\Delta log\ (W_{i,t})\right)}+\frac{cov\left(\Delta log\ (W_{i,t}), \Delta log\ (di_{i,t})\right)}{var\left(\Delta log\ (W_{i,t})\right)}$$

We then identify β^x for $x \in \{self, cap, trans, mig, un\}$ as:

$$\beta^{self}=\frac{cov\left(\Delta log\ (W_{i,t}), \Delta log(w_{i,t}) - \Delta log\ (wtot_{i,t})\right)}{var\left(\Delta log\ (W_{i,t})\right)}=,$$

$$\beta^{cap}=\frac{cov\left(\Delta log\ (W_{i,t}), \Delta log\ (p_{i,t}) - \Delta log\ (di_{i,t})\right)}{var\left(\Delta log\ (W_{i,t})\right)},$$

$$\beta^{trans}=\frac{cov\left(\Delta log\ (W_{i,t}), \Delta log\ (W_{i,t}) - \Delta log\ (w_{i,t})\right)}{var\left(\Delta log\ (W_{i,t})\right)},$$

$$\beta^{mig}=\frac{cov\left(\Delta log\ (W_{i,t}), \Delta log\ (W_{i,t}) - \Delta log\ (w_{i,t})\right)}{var\left(\Delta log\ (W_{i,t})\right)}=\frac{cov\left(\Delta log\ (W_{i,t}), \Delta log\ (Pop_{i,t})\right)}{var\left(\Delta log\ (W_{i,t})\right)},$$

$$\beta^{un}=\frac{cov\left(\Delta log\ (W_{i,t}), \Delta log\ (di_{i,t})\right)}{var\left(\Delta log\ (W_{i,t})\right)},$$

[6] Transfers in kind are not taken into account. They are typically rigid and non-substitutable offering households little budgetary flexibility or immediate margin for adjustment in response to wage shocks. Moreover, structural differences across countries in the provision and scope of public services introduce substantial heterogeneity, which can confound causal inference in panel settings. Given also that their valuation relies on accounting conventions rather than market behavior–raising concerns about comparability and economic relevance, especially in short-run analyses–we therefore do not include them in the analysis.

[7] At this stage, we make the assumption that the natural balance of population is not influenced in the short run by wage shocks. Only net migration is more likely to vary with economic shocks. This assumption is reasonable insofar as medium- and long-term economic factors are primarily influencing the natural balance. We test this assumption in section 4.3.

β^x for $x \in \{self, cap, trans, mig, un\}$ measures the fraction of shocks to wages absorbed by the corresponding channel. Regarding β^{mig}, a positive value means that a negative shock to aggregate wages will result in a shrinking population: workers choose to emigrate to preserve their income thus preserving the per capita income of the remaining inhabitants. β^{un} represents the fraction of shocks that remaining unsmoothed.

The coefficients are obtained from the following equations, estimated through standard panel regressions, where i denotes each EU region and t indicates the time dimension:

$$\Delta log\ (w_{i,t}) - \Delta log\ (wtot_{i,t}) = \beta^{self} \Delta log\ (W_{i,t}) + \alpha_t^{self} + \varepsilon_{i,t}^{self}$$
$$\Delta log\ (wtot_{i,t}) - \Delta log\ (pi_{i,t}) = \beta^{cap} \Delta log\ (W_{i,t}) + \alpha_t^{cap} + \varepsilon_{i,t}^{cap}$$
$$\Delta log\ (pi_{i,t}) - \Delta log\ (di_{i,t}) = \beta^{trans} \Delta log\ (W_{i,t}) + \alpha_t^{trans} + \varepsilon_{i,t}^{trans}$$
$$\Delta log\ (W_{i,t}) - \Delta log\ (w_{i,t}) = \beta^{pop} \Delta log\ (W_{i,t}) + \alpha_t^{pop} + \varepsilon_{i,t}^{pop}$$
$$\Delta log\ (di_{i,t}) = \beta^{un} \Delta log\ (W_{i,t}) + \alpha_t^{un} + \varepsilon_{i,t}^{un}$$

Time-fixed effects are included to control for common shocks on wages at the EU level. We consider the deviation of each region-specific growth rate with respect to the average growth rate in the EU. Estimations are weighted using the average population over the period to avoid any disproportionate impact of small regions with very high income per capita. Moreover, we report further below robustness checks that test for this specific effect. We do not include individual fixed effects, following the argument of Asdrubali et al. (2025) that this preserves the cross-sectional variation which is central to the identification strategy in the literature (see, e.g., Asdrubali et al., 1996, or Sørensen and Yosha, 1998). Including fixed effects would absorb the time-invariant component of idiosyncratic income, thereby overstating the extent of adjustment, and understating the overall volatility. This would bias our results by artificially dampening the estimated response to idiosyncratic shocks and exaggerating the relative role of common shocks.

Lastly, given the large number of regions (235) compared to the number of years available (20), we correct standard errors using Driscoll and Kraay's (1998) correction, unless otherwise stated, rather than the standard panel corrected standard errors from Beck and Katz (1995). This is due to Hoechle (2007)'s demonstration, that establishes that panel corrected standard errors may be poor when the panel's cross-sectional dimension is large compared to the time dimension.[8]

Heterogeneous smoothing areas

Finally, to analyze (endogenously) if the dynamics of smoothing are different among the European regions, we want to relax the complete slope homogeneity of the classical panel model. We assume that the N regions belong to K_0 clusters of risk-sharing: the degree of unsmoothing is homogeneous within a group and heterogeneous across groups. Such groups are denoted $G = (G_1^{un} \dots . G_{K_0}^{un})$. Individual group membership and the number of groups are ex-ante unknown and have to be determined empirically.[9]

Our equation for the fraction of shocks that goes unsmoothed is now:

$$\Delta log\ (di_{i,t}) = \beta_i^{un} \Delta log\ (W_{i,t}) + \delta_t + \varepsilon_{i,t},$$

[8] We have nevertheless run the same regressions with panel corrected standard errors. The results are qualitatively identical.

[9] We assume that group membership does not vary over time.

where δ_t are the time fixed effects and β^{un}=$(\beta_1^{un}, \dots, \beta_N^{un})$ is the vector of slope parameter such that:

$$\beta_i^{un} = \begin{cases} \alpha_1^{un} if\ i \in G_1^{un} \\ \dots \\ \alpha_{K_0}^{un} if\ i \in G_{K_0}^{un} \end{cases},$$

where $\alpha_j^{un} \neq \alpha_i^{un}$ for any $i \neq j$ and $G_j^{un}\ \cap\ G_i^{un}$=$\emptyset$ for any $i \neq j$.

C-Lasso estimator

To estimate such a model, we rely on the C-Lasso developed by Su, Shi and Phillips (2016) (SSP henceforth).

This penalized-profile-likelihood-based method, building on the classical Lasso, shrinks individual coefficients toward a reduced set of unknown group-specific coefficients, while achieving simultaneously a classification of regions.[10]

SSP (2016) demonstrate that such a method achieves the oracle property: group-specific parameter estimators are asymptotically equivalent to infeasible estimators that use individual group identity information.

In our case, time fixed effects are first eliminated via the following transformation:

$$\Delta\widehat{\log(\mathrm{di}_{\mathrm{i,t}})} = \Delta\log(\mathrm{di}_{\mathrm{i,t}}) - \overline{\mathrm{di}_{\mathrm{i,t}}} = \mathrm{di}_{\mathrm{i,t}} - \frac{1}{\mathrm{N}}\sum_{\mathrm{i=1}}^{\mathrm{N}} \mathrm{di}_{\mathrm{i,t}}$$

$$\Delta\widehat{log(W_{i,t})} = \Delta log(W_{i,t}) - \overline{W_{i,t}} = W_{i,t} - \frac{1}{N}\sum_{i=1}^{N} W_{i,t}$$

Our model then reduces to:

$$\Delta\widehat{log(di_{i,t})} = \beta_i' \Delta\widehat{log(W_{i,t})} + \ddot{\varepsilon}_{i,t}$$

Supposing K_0 fixed, estimators for $\beta^{un} = (\beta_1^{un}, \dots, \beta_N^{un})$ and $\alpha^{un} = (\alpha_1^{un}, \dots, \alpha_{K_0}^{un})$ can obtained through the minimization of the following penalized-profile-likelihood criterion function:

$$Q_{N,T,\lambda}^{K_0}(\beta, \alpha) = Q_{N,T}(\beta) + \frac{\lambda}{N}\sum_{i=1}^{N}\prod_{k=1}^{K_0} ||\beta_i - \alpha_k||,$$

[10] The classical panel model is a specific case of this model with the number of groups being set to one.

where:

$$Q_{N,T}(\beta)=\frac{1}{NT}\sum_{i=1}^{N}\sum_{t=1}^{T}\left(\Delta \widehat{log(di_{i,t})}-\beta_i'\Delta \widehat{log(W_{i,t})}\right)^2$$

The second term of the criterion function is the penalty ensuring that individual-specific parameters shrink toward group-specific parameter, and λ is the regularization parameter. Following SSP (2016), we set $\lambda=c\frac{1}{T^3}Var(\Delta log\ (di))$.

Finally, for a given number of groups K_0, we compute post-Lasso estimates by pooling all observations within each estimated group and then estimating the group-specific parameters for each group. SSP (2016) show that such post-Lasso estimation tend to outperform the C-Lasso estimates in terms of bias and RMSE. It also allows computing standard error for each group-specific estimate.

Following SSP (2016), the optimal number of groups *K* and the regularization parameter *c* is determined using a BIC-type information criterion:

$$IC(K,c)=ln\left(\sigma^2(K,c)\right)+\frac{2K}{3\sqrt{NT}}$$

where $\sigma^2(K,c)$ is the sum of squares of the post-Lasso residuals.

3. Empirical results

It has to be acknowledged that all the variables we consider are, by definition, jointly endogenously related. This is because the analysis relies on a decomposition of accounting identities. Hence, there can be no pretense here to establish any causal relations among the variables. The objective is, as Kohler et al. (2023) phrase it, to “serve as a convenient empirical description of international risk sharing among the set of [units] appearing in the sample used.”

3.1. Simple income smoothing regressions

Diversifying the transmission channels of economic shocks can increase resilience to crises. Thus, the combination of different shock-mitigating mechanisms, such as social transfers and property income, enhances the capacity of economies to absorb shocks and maintain economic stability. The relative importance of each channel still has to be assessed to measure the resilience to crises.
Table 2 presents the results of baseline regressions for the European Union (EU), the euro area (EA) and the EU countries outside the euro area. The total income smoothing effect is calculated as the sum of the coefficient of the four smoothing channels. In case of perfect income smoothing, this sum would be equal to one, indicating that income shocks are completely mitigated, while the unsmoothed coefficient would be zero. Conversely, if the unsmoothed coefficient equals one, it indicates that shocks on wages remain unsmoothed and fully impact disposable income.

The main channels of this mitigating effect are net operating surplus and mixed income (NOSMI) and net current transfers (TRANS) in the EU and the euro area, as well as in the EU without the euro area. The coefficient on NOSMI is rather stable across the three groups of countries ranging from 12% to 14% of smoothing, while net transfers contribute twice more to income smoothing in the euro area, compared to the EU countries outside the euro area. The channel of property income only has a significant mitigating effect in the euro area. Population change has a smoothing property in both the euro area and the EU, but the effect is thrice as large in the former compared to the latter. The total smoothing effect is more pronounced in the EA than in the EU, with up to 43% of the shock on private wages in the euro area which is smoothed against only 21% in EU countries outside the euro area (and 27% in the EU as a whole).

Analysis by Country-groups

To investigate spatial discrepancies in more details, we then estimate the contributions of the smoothing channels for the following groups of countries: Greece, Italy, Portugal and Spain (GIPS); Nordic countries; Central and Eastern European Countries (CEEC); and Western Europe. Coefficients on transfers are significant for all groups of countries but are quite smaller in the CEECs and the GIPS, where net current transfers account for a much smaller share of the disposable income (see Table 2).

Table 2. Income smoothing estimates – Country groups

	EU Nuts2	Euro area Nuts2	EU w/o euro area Nuts2	GIPS Nuts2	Nordic countries Nuts2	CEEC Nuts2	Western Europe Nuts2
Net operating surplus and mixed income	0.1192***	0.132***	0.1432***	0.2427***	0.0009	0.1442***	0.1209***
	(0.0183)	(0.0172)	(0.0426)	(0.0567)	(0.0355)	(0.041)	(0.0335)
Property Income	0.0205	0.0747***	-0.0216	-0.0096	-0.0105	-0.0286	0.1716***
	(0.0265)	(0.0173)	(0.0332)	(0.0206)	(0.0355)	(0.0342)	(0.0208)
Transfers	0.108***	0.1688***	0.0747**	0.1336***	0.1709***	0.097***	0.2324***
	(0.0257)	(0.0261)	(0.0329)	(0.0435)	(0.0579)	(0.034)	(0.0522)
Population variation	0.0184*	0.0547***	0.0173	0.0934***	0.0217	0.0204***	0.1073***
	(0.0084)	(0.0047)	(0.0143)	(0.0202)	(0.0145)	(0.0111)	(0.0391)
Unsmoothed	0.7339***	0.5698***	0.7863***	0.54***	0.817***	0.767***	0.3678***
	(0.0389)	(0.0349)	(0.0741)	(0.0864)	(0.0337)	(0.0774)	(0.0527)
Observations	4700	3500	1200	1260	360	1220	1860

Notes: Time-fixed effects are included but not reported. Standard errors are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

These estimations confirm that income smoothing is mostly driven by euro area countries and especially Western Europe, where 62% of wages shock are compensated and all coefficients are strongly significant. The smoothing of wages shock through the variation of total population is confirmed for the Eastern countries, the GIPS and Western Europe, which include most of the regions where the increase in population over the period was strong. Our results at the regional level thus highlight the role of this channel for smoothing household incomes in (some parts of) the euro area.

Strikingly, the capital markets channel largely contribute to smoothing in Western Europe but is not significant for the rest of the EU, leaving a large share of the shocks unsmoothed despite the fact that the literature usually considers it as an important smoothing factor for GDP shocks (Asdrubali et al., 2023, Dufrénot et al., 2021). Revenue-smoothing channels are more developed within the euro area than outside it. This suggests that further development of capital markets could enhance revenue-smoothing and risk-sharing, thereby strengthening the monetary union (Martinez et al., 2022).

Although our coefficients are not directly comparable to the ones obtained by the literature on risk-sharing, they are smaller than the ones found by Asdrubali et al. (2020) or Fiorelli et al. (2022) for Italian households and regions. They are nevertheless in line with the ones obtained for risk-sharing on the aggregate level for the euro area by, among others, Fuentes et al. (2023) or Cimadomo et al. (2023). We conclude that Western Europe and, to a lesser extent GIPS, exhibit higher estimated income smoothing coefficients than the rest of Europe. However, smoothing channels are more diversified in Western European regions than in the GIPS – where the bulk of adjustment relies on Net operating surplus and mixed income – which enhances their capacity to absorb shocks and maintain the level of income.

Income Smoothing and GDP per capita

The level of GDP per capita may influence the capacity for income smoothing, as higher income levels are often associated with increased household transfers, greater financial development, and the ability to attract population. We thus consider how income level may influence the degree of smoothing, by dividing the sample by quintile of GDP[11] and running regressions on each. The coefficients are significant in nearly all cases (Table 3), underscoring the robustness of the previous findings. Households in the lowest quintile regions generally benefit from less adjustment across most channels, except for the NOSMI, and up to 75% of shocks remain unsmoothed.

Table 3. Income smoothing by quintile of regional GDP per capita in the European Union

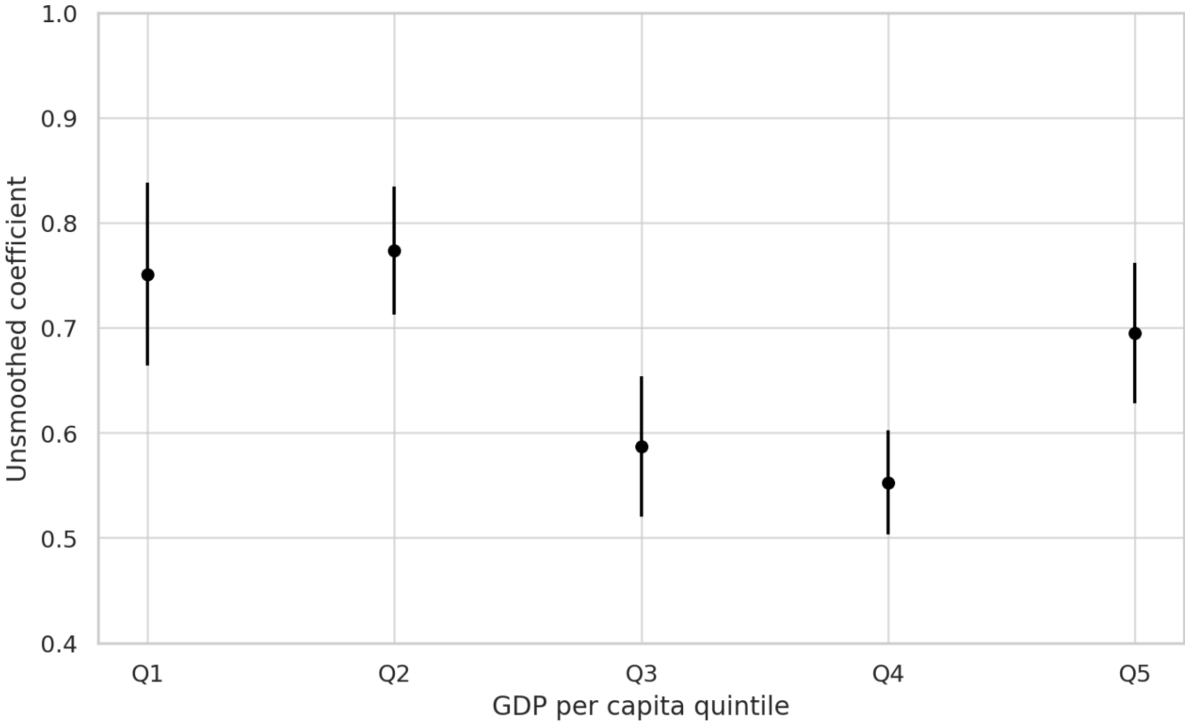
	EU Q1_GDP	EU Q2_GDP	EU Q3_GDP	EU Q4_GDP	EU Q5_GDP
	Nuts2	Nuts2	Nuts2	Nuts2	Nuts2
Net operating surplus and mixed income	0.1723***	0.0604	0.1372***	0.1025***	0.0423***
	(0.0448)	(0.0417)	(0.0273)	(0.0226)	(0.0163)
Property Income	-0.0354	0.015	0.0597***	0.0657***	0.0488
	(0.035)	(0.0247)	(0.0135)	(0 .0312)	(0.041)
Transfers	0.0897***	0.1234***	0.1238***	0.2086***	0.1582***
	(0.0361)	(0.0364)	(0.0323)	(0.0398)	(0.0579)
Population variation	0.0224***	0.028***	0.0924***	0.0706***	0.0557***
	(0.0118)	(0.0095)	(0.023)	(0.0239)	(0.0299)
Unsmoothed	0.751***	0.7733***	0.5868***	0.5527***	0.6951***
	(0.0868)	(0.0611)	(0.0668)	(0.0498)	(0.0668)
Observations	940	940	940	940	940

Notes: See Table 2.

Moreover, these results do not appear to be driven solely by the richest regions. Property income helps to offset around 6% of wage shocks in the third and the fourth quintiles. The population and transfer channels are significant across the five quintiles. For transfers, the lowest quintile benefits from a lower level of smoothing through this channel, while the second and third, and then the fourth and fifth, get higher levels of smoothing from this channel. All in all, the third and fourth quintiles demonstrate higher levels of income smoothing, even compared to the fifth quintile. Hence, we do not identify any linear trend between GDP per capita and smoothing coefficients, but different patterns exist between the middle of the range and the two (lower and superior) other parts, as Figure 1 reveals.

[11] A map of the GDP quintiles can be found in appendix D.

Figure 1. Coefficient of unsmoothed wage-shocks per GDP quintile (EU)



3.2.Income smoothing over time

Income Smoothing and crises

In table 4, we report the estimates of our baseline results for the euro area and the EU which are split in three subperiods covering (i) the early 2000s after the inception of the single currency, (ii) the aftermath of the Global financial crisis and Great recession (2008-10) and the euro area sovereign debt crisis (2010-2013), and (iii) the low inflation phase. Coefficients remain significant for each subperiod, except property income for the EU in the early 2000s. The demographic channel is always significant, but the value of the coefficient is much smaller for the EU than in the euro area. In the late 2010s, the population channel has even a small dismoothing effect in the EU. Net transfers have gained importance over time in both the EU and the euro area, rising from 9.4% and 12.7% respectively in the early 2000s to nearly 19% and 25.2% in the last sub-period. In the euro area, smoothing through the capital income channel was halved during the crisis and has since remained at levels below those observed in the early 2000s. Interestingly also, it appears that the effect of NOSMI has slightly declined in the Euro area, potentially reflecting the increase of public redistribution over time (although the evolution is different in the EU as a whole, as the coefficient increases over time).

Overall, the proportion of unsmoothed shocks in the European Union has decreased from 82.6% to 62.5% at the end of the period. However, the evolution of revenue smoothing in the euro area exhibits a different pattern, with the share of unsmoothed shocks starting at 56.1%, rising to 61.3% during the crisis, and then declining to 50% in the final sub-period.

These results can be compared to others in the literature, established on national data. For instance, Kalemli-Ozcan et al. (2014) examine risk-sharing mechanisms in peripheral euro area countries during the periods 1990–2007, 2008–2009 (financial crisis), and 2010 (sovereign debt crisis), highlighting how fiscal austerity undermined risk-sharing during the sovereign debt crisis. Similarly, Cimadomo et al. (2023) report that while only about 40% of country-specific output shocks were smoothed in the early EMU years, risk-sharing improved post-sovereign debt crisis, reducing consumption growth differentials. Kohler et al. (2023) find that the unsmoothed part of the shock is equal to 45% before the euro crisis, and 67% after, a result that stands in line with ours.

Table 4. Income smoothing estimates - subperiods

	EU 2001-2007 HCC Nuts2	EU 2008-2013 HCC Nuts2	EU 2014-2020 HCC Nuts2	Euro area 2001-2007 HCC Nuts2	Euro area 2008-2013 HCC Nuts2	Euro area 2014-2020 HCC Nuts2
Net operating surplus and mixed income	0.0774***	0.1468***	0.1754***	0.1491***	0.1187***	0.1273***
	(0.0162)	(0.0174)	(0.0147)	(0.0181)	(0.0165)	(0.0188)
Property Income	-0.0125	0.0556***	0.021***	0.1109***	0.0489**	0.0581***
	(0.0154)	(0.0081)	(0.081)	(0.0231)	(0.0161)	(0.0126)
Transfers	0.0934***	0.0959***	0.1898***	0.1274***	0.1691***	0.2517***
	(0.0162)	(0.0127)	(0.015)	(0.0196)	(0.0242)	(0.0222)
Population variation	0.0158***	0.0309***	-0.0111*	0.0516***	0.0505***	0.0627***
	(0.0055)	(0.0061)	(0.0066)	(0.0137)	(0.0071)	(0.0115)
Unsmoothed	0.8259***	0.6708***	0.6249***	0.561***	0.6128***	0.5002***
	(0.0306)	(0.0229)	(0.0201)	(0.0344)	(0.0372)	(0.0316)
Observations	1645	1410	1645	1225	1050	1225

Notes: Time-fixed effects are included but not reported. Given the short time periods, we only report here the heteroscedastic corrected standard errors (in parentheses).[12] * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Income Smoothing and recessions

We now turn to an analysis of income smoothing specifically during recessionary periods, as these are precisely the times when stabilizing household income is most critical. To this end, we adopt the methodology by Asdrubali et al. (2025), which enables us to examine how recessions affect the different channels of income smoothing. Taking the equation related to the first channel (NOSMI) as an illustrative example, we modify the baseline specification as follows:[13]

$$\Delta log\ (w_{i,t}) - \Delta log\ (wtot_{i,t}) = \beta^{self} \Delta log\ (W_{i,t}) + \boldsymbol{\beta}^{\boldsymbol{rec}} \boldsymbol{D}_{\boldsymbol{i,t}} + \boldsymbol{\beta}^{\boldsymbol{inter}} \boldsymbol{D}_{\boldsymbol{i,t}} \boldsymbol{\Delta \log}\ (\boldsymbol{W}_{\boldsymbol{i,t}}) + \alpha_t^{self} + \mu_i^{self} + \varepsilon_{i,t}^{self},$$

where recessions, $D_{i,t}$, (measured through aggregate wages), are identified using the method proposed by Braun and Larrain (2005).

Table 5 presents the results over the period 2003-2017[14] covering both the EU and the euro area. Income smoothing during expansion periods is measured by the coefficient β, while during recessions it is given by the sum of β and the interaction term β^{inter}. The interaction term β^{inter} is not significant for any channel, except the population channel, either in the EU or the euro area. Contrary to Asdrubali et al. (2025), who report a decline in risk-sharing among EU countries during

[12] Driscoll and Kraay (1998), based on Monte Carlo simulation, put the practical minimum at T > 20 for using their correction.

[13] See appendix B for more details on the business cycles determination and the news set of equations.

[14] Following Asdrubali et al. (2025), the first and last three years are used to construct a reliable trend for identifying business cycles. Consequently, these years are excluded from the estimation.

crisis periods, our findings provide no evidence that income smoothing is less effective in recessions.

Table 5. Income smoothing during recessions – EU and euro area

	EU			Euro area		
	Baseline (2003-2017)	β	β^{inter}	Baseline (2003-2017)	β	β^{inter}
Net operating surplus and mixed income	0.1333***	0.15***	-0.053	0.1298***	0.151***	-0.045
Property Income	0.0413**	0.05***	-0.026	0.082***	0.098***	-0.035
Transfers	0.1062***	0.085***	0.065	0.1425***	0.113***	0.063
Population variation	0.0162*	0.006	0.032**	0.0558***	0.047***	0.02*
Unsmoothed	0.703***	0.709***	-0.019	0.5899***	0.591***	-0.002
Observations	3525	3525	3525	2625	2625	2625

Notes: Time-fixed effects are included but not reported. Standard errors are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Column *Baseline* reports the results of the baseline equation over the reduced sample period (2003-2017). Column β^{inter} reports the coefficient for the interaction term in our equations.

Table 6a. Income smoothing during recessions – Western Europe and GIPS

	Western Europe			GIPS		
	Baseline	β	β^{inter}	Baseline	β	β^{inter}
Net operating surplus and mixed income	0.01032***	0.122***	-0.08**	0.2386***	0.335***	-0.196*
Property Income	0.1792***	0.151***	0.122*	0.0011	0.002	-0.003
Transfers	0.1781**	0.147*	0.136**	0.1044**	0.129***	-0.05
Population variation	0.1463***	0.143***	0.013	0.0989***	0.129***	-0.062**
Unsmoothed	0.3932***	0.437***	-0.189	0.557***	0.404***	0.31*
Observations	1395	1395	1395	945	945	945

Notes: See Table 5.

Table 6b. Income smoothing during recessions – CEECs and Nordic countries

	CEECs			Nordic countries		
	Baseline (2003-2017)	β	β^{inter}	Baseline (2003-2017)	β	β^{inter}
Net operating surplus and mixed income	0.1909***	0.208***	-0.072	-0.017	0.042	-0.155***
Property Income	0.0092	0.015	-0.026	0.0132	0.007	0.022
Transfers	0.1246**	0.115***	0.041	0.1466*	0.156	-0.033
Population variation	0.0178	0.018	0	0.0342**	0.053***	-0.067**
Unsmoothed	0.6576***	0.644***	0.056*	0.8078***	0.742***	0.233**
Observations	1260	1260	1260	270	270	270

Notes: See Table 5.

Splitting the sample reveals some heterogeneity in income-smoothing dynamics across EU regions. The coefficient on the NOSMI aggregate is significantly negative for Western Europe, the GIPS and Nordic countries (Table 6). In contrast, for the CEECs, none of the interaction terms are significant across the different channels. This suggests that, in Western Europe, the GIPS and Nordic countries, income smoothing through the NOSMI channel is less effective during recessions than during expansionary periods, resulting in greater loss of income. One possible explanation lies in the negative externalities associated with wage declines in a given region: lower purchasing power among employees can lead to downward adjustments in rents and housing prices and reduced demand for products and services provided by the self-employed — the two components of NOSMI.

In Western Europe, this negative effect appears largely mitigated by robust countercyclical public transfers during recessions. Indeed, although the interacted term is not highly statistically significant, the overall evidence points to relatively stronger income smoothing during downturns. In contrast, for the GIPS countries, the interaction term for property income is significantly negative (although at 10% only). This likely reflects the severe financial losses incurred during the financial and sovereign debt crises, combined with a strong domestic investment bias, which undermined the stabilizing role of property income. Consequently, while approximately 40% of wage shocks is left unsmoothed during expansionary periods—as much as in Western Europe—this figure increases to 70% during recessions.

3.3. Zooming on the migration channel

To investigate the role of population dynamics at the regional level, we analyze the impact of the population channel to determine whether it is more pronounced in regions characterized by higher population growth rates. Tables 7a and 7b presents results where the sample is split with regard to the demographic dynamism of the regions: we run a regression for each quintile, using population growth as the separating variable (similarly as we did above with GDP).[15]

Table 7a presents the results for the EU, which reveal that the property income and the population channels are not always significant, and quite often at low levels of significance. The NOSMI channel is strongly significant, and operating importantly in the less dynamic regions (in terms of population growth), to a level (16%) even superior to what it reaches for the most dynamic regions (at 12.85%). Interestingly, our results also reveal that transfers are significant channels of income smoothing in all types of regions, but they act more strongly at the two extremes of the distribution. Moreover, it is in the middle of the distribution (third quintile) that the degree of unsmoothing is the highest, at 80%.

The results in Table 7b indicate, for the euro area, that all the coefficients are statistically significant, suggesting a robust relationship between wage shocks and the variables of interest for each level of demographic dynamism. In the second and third quintiles, population coefficients are the lowest, while population smooths up to 13.27% in the upper quintile. Regions within the fourth and the fifth quintile, which exhibit the fastest population growth, demonstrate the highest levels of income smoothing (respectively, almost 57% and 61% of smoothing), and they are the regions where population also has the strongest impact. This suggests that the population channel operates with particular strength in areas experiencing rapid demographic expansion. Furthermore, our analysis shows that the population channel significantly contributes to the adjustment of shocks, although not within the lowest quintile, although this group contains regions experiencing lower growth (or even a decline) in their population.

Our analysis further investigates the mechanisms of income smoothing via the population channel by distinguishing between the effects of natural balance (the difference between births and deaths)

[15] A map of the population growth quintiles can be found in appendix D.

and net migration. This distinction enables us to differentiate the respective contribution of each sub-channel to overall income stabilization within European regions. Due to limitations in data availability, we re-estimated an unbalanced panel for the total population channel using a reduced sample of 3888 observations (as opposed to the full sample of 4700 observations for the EU).

The results obtained from the reduced sample are robust and consistent with those derived from the full sample, indicating that the key findings are not sensitive to the size of the sample (Table 8). We then estimate the effects of the two sub-channels using the reduced sample. As can be seen from the third row of Table 8, the population channel's influence on income smoothing is predominantly driven by migrations within the Euro area, as well as in the EU. Coefficients are statistically insignificant for natural balance across the two sample of EU regions: this result is reassuring as we expect natural balance to be mostly influenced by medium- and long-term economic factors.

Considering the evolution of this channel over time, we observe a smoothing effect of demographic changes that increases over time (Figure 2). This is true for both the European Union and the euro area, although the coefficients associated with natural balance sub-channel remain very small, and inferior to the coefficients for migration. The substantial contribution of migration to smoothing over a seven-year period thus confirms the role of population movements in adjusting to wage shocks, with positive (negative) shocks prompting an influx (exodus) of workers into (from) the region. Moreover, the impact of these movements is larger in the euro area than in the European Union.

Table 7a. Income smoothing and population variation - European Union (by population growth quintile)

	EU Q1_ΔPop Nuts2	EU Q2_ΔPop Nuts2	EU Q3_ΔPop Nuts2	EU Q4_ΔPop Nuts2	EU Q5_ΔPop Nuts2
Net operating surplus and mixed income	0.1598***	0.0884***	0.0698***	0.0993***	0.1285***
	(0.0322)	(0.0143)	(0.0274)	(0.0161)	(0.0237)
Property Income	-0.0175	0.0451**	0.0334*	0.0742***	0.0146
	(0.0452)	(0.012)	(0.0143)	(0.0089)	(0.025)
Transfers	0.112***	0.0813***	0.0827***	0.1521***	0.1627***
	(0.0375)	(0.0265)	(0.0263)	(0.0315)	(0.0216)
Population variation	0.0157	0.0074	0.0139*	0.0321***	0.0763***
	(0.0096)	(0.0062)	(0.0054)	(0.0107)	(0.0147)
Unsmoothed	0.73***	0.778***	0.8002***	0.6423***	0.6179***
	(0.08)	(0.0377)	(0.0384)	(0.0388)	(0.0434)
Observations	940	940	940	940	940

Notes: See Table 2.

Table 7b. Income smoothing and population variation - euro area (by population growth quintile)

	Euro area Q1_ΔPop Nuts2	Euro area Q2_ΔPop Nuts2	Euro area Q3_ΔPop Nuts2	Euro area Q4_ΔPop Nuts2	Euro area Q5_ΔPop Nuts2
Net operating surplus and mixed income	0.1013***	0.1127***	0.1771***	0.1101***	0.1705***
	(0.0239)	(0.0453)	(0.0451)	(0.0146)	(0.0358)
Property Income	0.0895***	0.0653***	0.0336	0.1178***	0.0696***
	(0.025)	(0.0168)	(0.0285)	(0.0155)	(0.0291)

Transfers	0.1297***	0.1487***	0.118***	0.2339***	0.2294***
	(0.0194)	(0.0234)	(0.034)	(0.0347)	(0.0318)
Population variation	0.001	0.0243**	0.0389***	0.1097***	0.1327***
	(0.0106)	(0.0102)	(0.0166)	(0.022)	(0.0349)
Unsmoothed	0.6695***	0.649***	0.6323***	0.4286***	0.3978***
	(0.0248)	(0.0756)	(0.0872)	(0.0329)	(0.0436)
Observations	700	700	700	700	700

Notes: See Table 2.

Table 8. Decomposing population growth: natural balance & migration

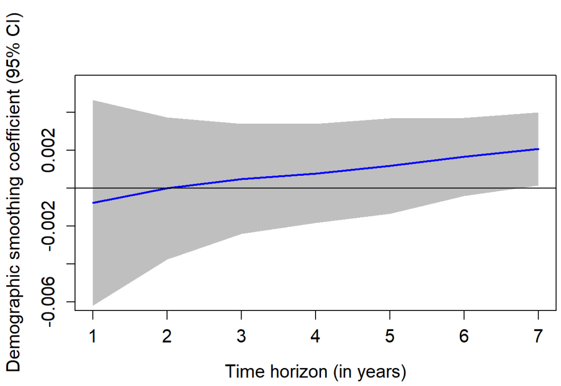
	EU	Euro area
	Nuts2	Nuts2
Full sample	0.01838***	0.05473***
	(0.0837)	(0.0047)
Reduced sample	0.01655	0.05333***
	(0.0105)	(0.00479)
Migrations	0.01715*	0.05137***
	(0.00896)	(0.00567)
Natural balance	-0.00078	0.00226
	(0.00277)	(0.00189)
Observations (reduced sample)	3888	3042

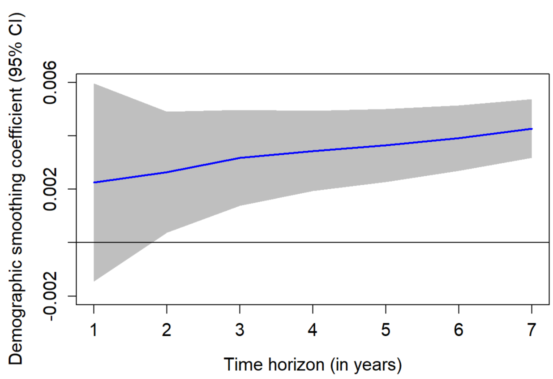
Notes: See Table 2.

Figure 2. Evolution of the population channel over time, European Union (EU) and euro area (EA)

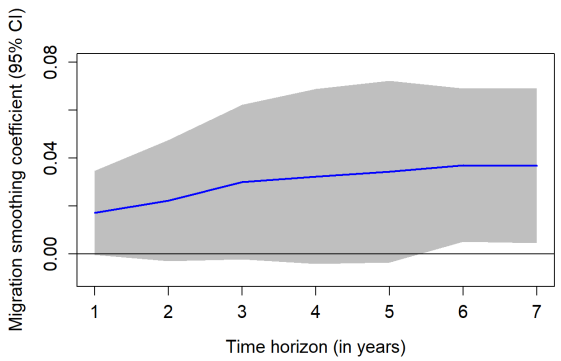
EU EA

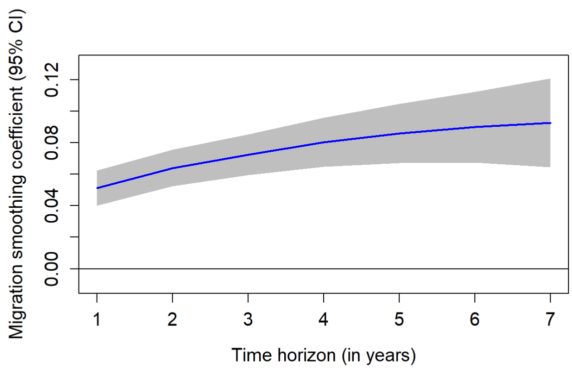
Natural balance





Migration





3.4. Clustering of income smoothing

The heterogeneity that our results highlight across European regions allows us to wonder if there are regular geographical patterns. In other words, is the smoothing degree similar in clusters of regions, or is it randomly spread across the area? To answer this question, we rely on the methodology defined by SSP (2016). The method allows estimating latent grouped patterns in dynamic panel data models with interactive fixed effects. Assuming that the individual slope coefficients are homogeneous within a group and heterogeneous across groups (with each individual's group membership being unknown to the researcher), a penalized principal component (PPC) estimation is run (see Section 2).

We consider the share of the unsmoothed part of the shock as our criterion. In essence, the unsmoothed part is the difference between 1 and the sum of the shares of each channel of smoothing. It thus summarizes the information delivered by the other channels in a single number that we use to assess the heterogeneity inside the area.

In our case, we consider a number of groups K up to 8 and a regularization parameter c between 0.5 and 2. We obtain that K=5 and c=1.2. [16]

As can be seen in Figure 3, the picture that emerges delivers information along two dimensions. At first sight, it appears that there is a core (groups 4 and 5) / semi-periphery (group 3) / periphery

[16] The values of the information criterion and a list of the NUTS belonging to each cluster can be found in appendix C.

(groups 1 and 2) division among euro area regions. The arc going from Sweden[17] to Greece, characterized by a large degree of non-smoothing of income shocks, would constitute the periphery of the area, while the Iberian Peninsula, Ireland, Austria and regions of Italy would constitute the semi-periphery. The core would then be constituted by France, Germany, Denmark, and Belgium. However, there is a second dimension of the information revealed by the analysis. Although the periphery and semi-periphery are characterized by a large degree of unsmoothing which is homogeneous per country (Poland being a typical example of this, as all the regions of the country have a large degree of unsmoothing), the core is not homogeneous (France is a case in point, with regions in the North and South having a higher degree of smoothing than its Center).

Interestingly, looking at the importance of each channel of income-smoothing unveils important differences between the clusters, as can be seen from Table 9. First, for Cluster 1 (the one with the largest share of unsmoothing), there is almost no smoothing mechanism and a shock on wages is nearly transmitted. Second, the importance of transfers is a second major difference between the clusters: they play an increasing role when moving from Cluster 1 to Cluster 5. In other words, the role of transfers in income-smoothing is fundamental, and even predominant in Clusters 4 and 5. Finally, the channels of property income and population are significant only in the core, revealing that the regions belonging to these clusters are more attractive and that their capital markets are probably functioning better than in their counterparts.

Hence, this result underscores both the importance of looking at the issue from a regional perspective and at investigating the different channels of smoothing at this level.

Figure 3. Clustering the euro area regions by the unsmoothed share of income shocks

[17] The limited smoothing observed for Swedish regions may appear surprising at first glance but can be explained by two factors: the predominance of the variable compensation of employees in household disposable income and the relatively small share of NOSMI (see Table 1). In Sweden, compensation of employees accounts for more than 100% of household disposable income (compared with an average of 83% in other European countries), while NOSMI represents only 9% of income (versus 21% on average elsewhere in Europe). The large share of wages can be attributed to the inclusion of employers' social contributions (e.g., payments to pension funds under collective agreements) in the *Compensation of employees* variable. These contributions represented 27.5% of labor costs in Sweden in 2020, compared with an average of 16.5% in other EU countries. The small size of NOSMI, in turn, is linked to two structural features. First, only 6.5% of Swedish workers were self-employed on average between 2000 and 2020, compared with more than 16.5% at the European level. Second, the share of owner-occupiers and private landlords is relatively low (55% of the housing stock in 2023, compared with 83% in France and 90% in Spain, for example) according to *The State of Housing in Europe 2023*. As a result, a large proportion of actual and imputed rents is not included in household accounts.
A shock to the *Compensation of employees* is therefore more difficult to smooth through other components–particularly NOSMI–given their relatively small weight. A comparable pattern can be observed in Denmark and the Netherlands (where wages account for 121% and 106% of disposable income, respectively, and NOSMI for 11% and 16%), although in these cases the effect is partially offset by larger transfers.

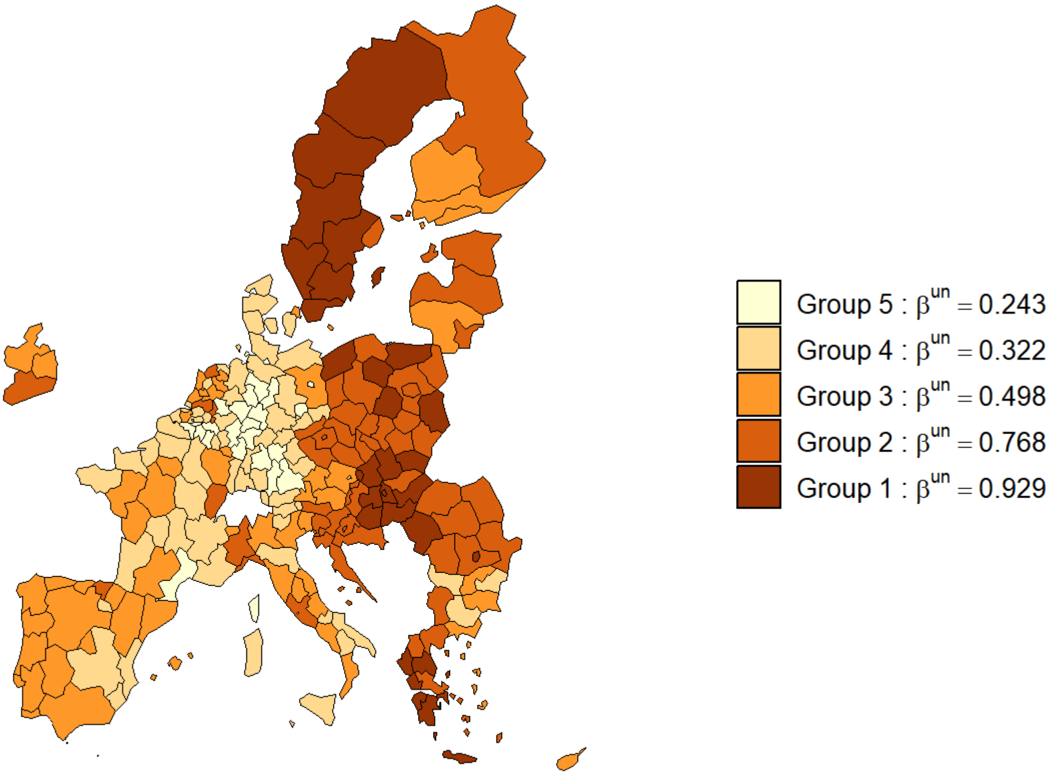


Table 9. Income smoothing and population variation in the euro area (per cluster)

	Cluster 1 Nuts2	Cluster 2 Nuts2	Cluster 3 Nuts2	Cluster 4 Nuts2	Cluster 5 Nuts2
Net operating surplus and mixed income	0.0186	0.117***	0.2372***	0.3436***	0.1254***
Property Income	0.0012	-0.0073	0.0711**	0.0389*	0.1895***
Transfers	0.0446**	0.1079***	0.1736***	0.2576***	0.2878***
Population variation	0.0069	0.0145	0.0203	0.0384*	0.1547***
Unsmoothed	0.9287***	0.7679***	0.4977***	0.3216***	0.2425***
Observations	600	1160	1200	1220	520

Notes: See Table 2.

Table 10. Robustness check: using national data or excluding some regions

	EU	Euro area	EU	Euro area	Euro area w/o richest regions	Euro area w/o DE	Euro area w/o FR	Euro area w/o IT	Euro area w/o ES	Euro area w/o NL
	(Nuts2)	(Nuts2)	(national)	(national)	(Nuts2)	(Nuts2)	(Nuts2)	(Nuts2)	(Nuts2)	(Nuts2)
Net operating surplus	0.1192***	0.132***	0.0807***	0.0732***	0.1512***	0.1515***	0.1212***	0.127***	0.114***	0.132***
and mixed income	(0.0183)	(0.0172)	(0.0178)	(0.0136)	(0.0175)	(0.0214)	(0.0209)	(0.0201)	(0.0269)	(0.0176)
Property Income	0.0205	0.0747***	0.0274	0.0989***	0.0772***	0.0425***	0.0756***	0.0817***	0.0844***	0.0766***
	(0.0265)	(0.0173)	(0.0326)	(0.0297)	(0.0187)	(0.0187)	(0.0188)	(0.0168)	(0.0163)	(0.0179)
Transfers	0.108***	0.1688***	0.1***	0.1433***	0.1922***	0.1582***	0.1623***	0.1591***	0.1518***	0.1634***
	(0.0257)	(0.0261)	(0.0245)	(0.0354)	(0.0334)	(0.0213)	(0.0269)	(0.0214)	(0.0263)	(0.0264)
Population variation	0.0184*	0.0547***	0.076	0.0286***	0.0625***	0.0392***	0.0549***	0.0518***	0.0388***	0.0543***
	(0.0084)	(0.0047)	(0.0117)	(0.0076)	(0.0109)	(0.0134)	(0.0062)	(0.0059)	(0.0083)	(0.0049)
Unsmoothed	0.7339***	0.5698***	0.7842***	0.6559***	0.5168***	0.6126***	0.5861***	0.5804***	0.6111***	0.5737***
	(0.0389)	(0.0349)	(0.0346)	(0.0304)	(0.0385)	(0.0309)	(0.0326)	(0.0335)	(0.0446)	(0.0356)
Observations	4700	3500	500	380	3120	2740	3060	3080	3120	3260

Notes: See Table 2. The first two columns reproduce results from Table 2 for ease of comparison with robustness analysis.

Table 11. Robustness check: excluding 2020 or using alternative confidence intervals for subperiods

	EU (Nuts2) *(reminder)*	**Euro area (Nuts2)** *(reminder)*	**EU (Nuts2) w/o 2020**	**Euro area (Nuts2) w/o 2020**	**EU (Nuts2) 2001-2007 SCC**	**EU (Nuts2) 2008-2013 SCC**	**EU (Nuts2) 2014-2020 SCC**	**Euro area (Nuts2) 2001-2007 SCC**	**Euro area (Nuts2) 2008-2013 SCC**	**Euro area (Nuts2) 2014-2020 SCC**
Net operating surplus and mixed income	0.1192***	0.132***	0.1212***	0.1373***	0.0774***	0.1468***	0.1754***	0.1491***	0.1187***	0.1273***
	(0.0183)	(0.0172)	(0.0189)	(0.0183)	(0.0222)	(0.0057)	(0.0247)	(0.0201)	(0.0333)	(0.028)
Property Income	0.0205	0.0747***	0.0199	0.0782***	-0.0125	0.0556***	0.021	0.1109***	0.0489**	0.0581**
	(0.0265)	(0.0173)	(0.0272)	(0.0181)	(0.0393)	(0.0187)	(0.0144)	(0.0229)	(0.0213)	(0.0234)
Transfers	0.108***	0.1688***	0.1026***	0.1522***	0.0934***	0.0959**	0.1898***	0.1274***	0.1691***	0.2517***
	(0.0257)	(0.0261)	(0.0245)	(0.0198)	(0.0357)	(0.0377)	(0.0429)	(0.0226)	(0.0319)	(0.0602)
Population variation	0.0184*	0.0547***	0.0178***	0.0555***	0.0158	0.0309**	-0.0111	0.0516***	0.0505***	0.0627***
	(0.0084)	(0.0047)	(0.086)	(0.005)	(0.0099)	(0.013)	(0.016)	(0.0055)	(0.0077)	(0.0073)
Unsmoothed	0.7339***	0.5698***	0.7384***	0.5768***	0.8259***	0.6708***	0.6249***	0.561***	0.6128***	0.5002***
	(0.0389)	(0.0349)	(0.0388)	(0.035)	(0.0444)	(0.0408)	(0.0515)	(0.0288)	(0.0648)	(0.0293)
Observations	4700	3500	4465	3325	1645	1410	1645	1225	1050	1225

Notes: See Table 2.

4. Robustness checks

In this section, we test the robustness of our findings using various specifications and estimation assumptions. First, we estimate income smoothing at the national level for both the euro area (EA) and the European Union (EU) to ensure the validity of our results at a less granular scale and to facilitate comparisons with previous studies based on national-level data. As a benchmark, we report the regional-level results in the first two columns of Table 10.

Our findings for both the EA and the EU are generally consistent when using national data but reveal a more pronounced smoothing effect at the regional level, with varying degrees of smoothing depending on channels, thereby underscoring the interest of a more granular approach. Notably, the property income channel exhibits a smaller effect at the regional level, while the population channel is more important, potentially reflecting the role of intra-national migration between regions within the same country.

Second, to determine whether our results are influenced by regions that may benefit from stronger integration into the global economy, we exclude the region with the highest GDP per capita in each euro area country (Table 10, column 5). The coefficients remain largely unchanged, confirming the robustness of our findings, particularly with respect to the property income and population channels. However, overall smoothing is more pronounced when the richest regions are excluded, primarily due to the contribution of NOSMI and transfers' channels.

Third, to further verify that our euro area results are not driven by the largest economies, we re-estimate the main model for the EA while sequentially excluding Germany, France, Italy, Spain, and the Netherlands (see Table 10, six final columns). The results remain remarkably consistent across all channels for the latter four countries. However, when Germany—accounting for the largest share of our sample—is excluded, the property income channel is significantly impacted, with its smoothing effect decreasing from 8.8% to 4.2%. This finding highlights Germany's substantial influence in determining the magnitude of this channel among Western countries. Nevertheless, even without Germany, the contribution of this channel remains significantly higher than for the broader EU and remains statistically significant at the 99% confidence level.

Fourth, given the potential outlier effect of the COVID-19 crisis, we re-estimate the smoothing equations excluding the year 2020, the last year in our sample. During this period, households might have received substantial transfers to counter the negative economic shock, while financial income was likely affected by the crisis. Additionally, population movement was severely restricted due to lockdown measures.

Notably, when 2020 is excluded, the main change observed is a reduction in the role of transfers, likely due to the extensive assistance provided to households during the pandemic (see Table 11). We also apply unadjusted confidence intervals to assess the significance of our results across the three sub-periods previously analyzed (in the last columns of Table 11). The results remain significant for the euro area in all cases.

Fifth, we examine whether our results are robust to the inclusion of individual fixed effects. All the explorations indicate that their inclusion does not alter the main findings – a feature also noted by

Kohler et al. (2023), as can be seen in Table 12. However, the estimated smoothing coefficients exhibit a greater volatility (i.e., they are less stable) when estimated over sub-periods with individual fixed effects, a feature consistent with the argument of Asdrubali et al. (2025) and presented in the methodological section above.* As a further robustness check for the clustering section, we apply the Lu and Su (2017) fixed-effects methodology, identifying five groups. Overall, the results are reassuring: 50% of regions remain in the same cluster, with an additional 45% shifting by only one rank (the only notable distinction in fact concerns the group with the highest degree of smoothing).

Sixth, we have also checked the robustness of our results to outliers. Table 13 provides the results of our estimates for the euro area, when we trim and winsorize the sample (at the 2 and 5% levels). As can be observed, our results are not sensitive to this type of potential bias.

Table 12. Impact of the inclusion of individual fixed effects

	Without individual fixed effects		*With individual fixed effects*	
	EU Nuts2	Euro area Nuts2	EU Nuts2	Euro area Nuts2
Net operating surplus and mixed income	0.1192***	0.132***	0.1205***	0.147***
	(0.0183)	(0.0172)	(0.0251)	(0.0227)
Property Income	0.0205	0.0747***	0.0244	0.088***
	(0.0265)	(0.0173)	(0.0281)	(0.0155)
Transfers	0.108***	0.1688***	0.1088***	0.179***
	(0.0257)	(0.0261)	(0.0244)	(0.0217)
Population variation	0.0184*	0.0547***	0.023***	0.0572***
	(0.0084)	(0.0047)	(0.0081)	(0.0101)
Unsmoothed	0.7339***	0.5698***	0.7233***	0.5288***
	(0.0389)	(0.0349)	(0.0453)	(0.0447)
Observations	4700	3500	4700	3500

Notes: See Table 2 (from which the first two columns are repeated).

Table 13. Robustness on trimming and winsorizing – The EA case

	EA Full sample	EA Trimmed 5%	EA Trimmed 2%	EA Winsorized 5%	EA Winsorized 2%
Net operating surplus and mixed income	0.132 ***	0.1484 ***	0.1660 ***	0.1332 ***	0.1412 ***
	(00172)	(0.0130)	(0.0837)	(0.0162)	(0.0145)
Property Income	0.0747 ***	0.0702 ***	0.0837 ***	0.0722 ***	0.0678 ***
	(0.0173)	(0.0165)	(0.0233)	(0.0174)	(0.0173)
Transfers	0.1688 ***	0.1864 ***	0.2112 ***	0.1727 ***	0.1815 ***
	(0.0261)	(0.0375)	(0.0381)	(0.0288)	(0.0317)
Population variation	0.0547 ***	0.0704 ***	0.0920 ***	0.0570 ***	0.0615 ***
	(0.0047)	(0.0107)	(0.0039)	(0.0064)	(0.0085)
Unsmoothed	0.5698 ***	0.5294 ***	0.4472 ***	0.5516 ***	0.5208 ***
	(0.0349)	(0.0475)	(0.0382)	(0.0343)	(0.0389)
Observations	3500	3420	3300	3500	3500

Notes: See Table 2.

* The full set of results is omitted for brevity but is available from the authors upon request.

5. Conclusion

This paper contributes to the literature on the adjustment of regional shocks by offering a comprehensive, empirically grounded analysis of income smoothing mechanisms across EU regions. It provides novel insights into how different channels—transfers, property income, NOSMI, and population movements—contribute to economic stabilization, distinguishing their relative importance across space, time, income levels, and demographic trends.

Income smoothing across European regions is uneven and primarily driven by euro area countries, especially in Western Europe. Although the euro area exhibits greater consistency in income smoothing than the broader EU, it remains heterogeneous. Variation in regional income-smoothing channels suggests that some areas benefit from more effective mechanisms, while others lag behind, potentially exacerbating regional disparities in response to wage shocks.

Key channels for absorbing wage shocks include net operating surplus and mixed income (NOSMI) and net public transfers. Western Europe displays the most diversified and effective use of these mechanisms including through property income and migration channels. Income smoothing is significantly weaker in Central and Eastern European countries and in GIPS countries (Greece, Italy, Portugal, Spain), where reliance on a narrow set of channels limits their resilience. Importantly, regional income smoothing does not follow a simple linear relationship with GDP per capita but instead peaks in middle-income regions, suggesting that other factors such as institutional or structural ones also play a significant role.

Over time, smoothing dynamics exhibit substantial variation, and migration, rather than natural population changes, increasingly contributes to a part of income adjustment. A key contribution of this study is also to consider the regional-level of demographic variations. Distinguishing natural population balance from migration, we find that migration is associated with a stronger smoothing effect at the regional level.

Moreover, the effect of smoothing appears relatively stable during recessions for many regions, although GIPS countries experience a marked drop in the effectiveness of NOSMI smoothing during downturns. Clustering analysis reveals geographic heterogeneity, with a core/semi-periphery/periphery structure, and highlights the critical importance of regional heterogeneity and diversification in risk-sharing capacity. Core regions show both stronger smoothing and more diversified mechanisms, while periphery regions exhibit lower smoothing coefficients. The findings underscore a multi-speed process, challenging the traditional focus on national aggregates and underscoring the need for regionally targeted economic policies within the EU.

Our broader perspective on income-smoothing channels therefore suggests an incomplete and heterogeneous integration process, pointing to the need for policy measures that enhance regional cohesion by targeting specific smoothing mechanisms. With stricter fiscal constraints resulting from high debt levels in some countries and the recent reform of the EU economic governance framework aimed at controlling government deficits, future public transfers to households may be impacted, limiting the extent of fiscal transfers as a smoothing channel. Combining public and private mechanisms at the EU level may be associated with more robust income-smoothing solutions.

First, it appears essential to strengthen income smoothing through the private sector. Our results indicate that the capital channel remains limited—except in Western Europe—as highlighted by Letta (2024) and Draghi (2024). This would require increasing household participation in financial markets, thereby increasing the share of capital income in total income. It also necessitates further developing Savings and Investments Union to reduce home bias and enable more risk-sharing via the financial income channels by reducing the share of domestic investments in household portfolios. Moreover, such EU-level diversification could boost household incomes by improving portfolio performance (Gossé and Jehle, 2024).

Second, the development of transfers at the EU level could help compensate the lack of fiscal space at the national level. One policy implication of our study is the potential benefit of common insurance systems—such as an integrated unemployment insurance scheme (Dolls, 2024)—to bolster smoothing. Beetsma et al. (2021) highlight the eurozone's limited ability to respond to asymmetric shocks due to the absence of a centralized fiscal transfer mechanism, advocating for enhanced fiscal coordination and instruments like the European Unemployment Insurance System (EUIS). Recent studies, including Ábrahám et al. (2023) and Beetsma et al. (2024), underscore the EUIS's potential to stabilize fiscal policy by smoothing revenues and bolstering counter-cyclical responses, particularly in more vulnerable member states.

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Appendix

Appendix A: Data and variables used

Table A.1. Detailed description of the variables retrieved from Eurostat

Variable	Name in Eurostat	Description	Source
Wages (W)	Compensation of employees	Wages, salaries and employer's actual and imputed social contributions	Regional Accounts, D.1
Net operating surplus and mixed income (NOSMI)	Net operating surplus	Self-employment income	Regional Accounts, B.2n
	Net mixed income	Rental value of housing owned by households, whether it is owner-occupied or rented to other households	Regional Accounts, B.3n
Property income (PROP)	Property income paid	Income paid including both interest, dividends and rents on land	Regional Accounts, D4
	Property income received	Income received including both interest, dividends and rents on land	Regional Accounts, D4
Personal income (PI)	Net primary income	Gross total income perceived by households	Regional Accounts, B.5n
Disposable income (DI)	Net disposable income	Total amount of money available for spending and saving after including social benefits and transfers received and subtracting current taxes	Regional Accounts, B.6n
Population (pop_avg)	Average annual population	Average annual population to calculate regional GDP data	Regional Accounts, nama_10r_3popgdp
Population (pop)	Total population on 1 January	Annual population on 31 December	Population (regional level), demo_r_d2jan
Price indices	HICP	National harmonised index of consumer prices – index 100 2015	HICP, prc_hicp_aind

We have the following accounting equations:

$WTOT = W + NOSMI$

$PI = W + NOSMI +$

$Transfers = PI - DI$

where Transfers are net current transfers.

We use the population on 31 December of each year to deflate our variables. Some series of population present breaks due to methodological data processing changes or revisions.[*] To correct, we use, when

[*] Countries with data breaks: BE, CZ, CY, DE, DK, EE, HR, HU, IE, IT, LU, PL, RO and SI.

available, the average annual population estimated by Eurostat as a proxy.[†] The corrected series of population are available upon request.
Net migration is derived through the difference between the overall population growth and the rate of natural increase (the difference between the birth rate and the death rate) during the same period.

[†] Such a correction is used for BE, SI, CZ, DE, IT, IE, DK and HR and uses the calculation's method of the average population (arithmetic mean of the population on 1st January of two consecutive years). Average annual population estimated by Eurostat for EE, CY, LU, HU, PL and RO also present data breaks and we therefore prefer to retain raw series.

Appendix B: Asymmetric smoothing – business cycles determination and country groups results

Business cycles determination

Following Asdrubali et al. (2025), we adopt the methodology of Braun and Larrain (2005) to identify business cycles over real aggregate wages.

We begin by extracting the cyclical component of the wage series using the two-sided HP filter with a smoothing parameter of 6.25. Recession troughs are identified as years in which the cyclical component falls more than one standard deviation below zero. For each identified through, we trace backward to locate the preceding local peak, defined as the year in which the cyclical component exceeds the values in both the preceding and following years. A recession is then defined as the period spanning from the year following the peak to the year of the trough.

The first and last three years are used to construct a reliable trend for identifying business cycles. Consequently, these years are further excluded from the estimation.

Measuring for cyclicality in income smoothing

The recession indicator $\boldsymbol{D_{i,t}}$ is then incorporated into our baseline specification as follows:

$$\Delta log\ (w_{i,t}) - \Delta log\ (wtot_{i,t}) = \beta^{self} \Delta log\ (W_{i,t}) + \boldsymbol{\beta}^{\boldsymbol{inter,self}} \boldsymbol{D_{i,t}} \boldsymbol{\Delta \log\ (W_{i,t})} + \boldsymbol{\beta}^{\boldsymbol{rec,self}} \boldsymbol{D_{i,t}} + \alpha_t^{self} + \varepsilon_{i,t}^{self}$$
$$\Delta log\ (wtot_{i,t}) - \Delta log\ (pi_{i,t}) = \beta^{cap} \Delta log\ (W_{i,t}) + \boldsymbol{\beta}^{\boldsymbol{inter,cap}} \boldsymbol{D_{i,t}} \boldsymbol{\Delta \log\ (W_{i,t})} + \boldsymbol{\beta}^{\boldsymbol{rec,cap}} \boldsymbol{D_{i,t}} + \alpha_t^{cap} + \varepsilon_{i,t}^{cap}$$
$$\Delta log\ (pi_{i,t}) - \Delta log\ (di_{i,t}) = \beta^{trans} \Delta log\ (W_{i,t}) + \boldsymbol{\beta}^{\boldsymbol{inter,trans}} \boldsymbol{D_{i,t}} \boldsymbol{\Delta \log\ (W_{i,t})} + \boldsymbol{\beta}^{\boldsymbol{rec,trans}} \boldsymbol{D_{i,t}} + \alpha_t^{trans} + \varepsilon_{i,t}^{trans}$$
$$\Delta log\ (W_{i,t}) - \Delta log\ (w_{i,t}) = \beta^{pop} \Delta log\ (W_{i,t}) + \boldsymbol{\beta}^{\boldsymbol{inter,pop}} \boldsymbol{D_{i,t}} \boldsymbol{\Delta \log\ (W_{i,t})} + \boldsymbol{\beta}^{\boldsymbol{rec,pop}} \boldsymbol{D_{i,t}} + \alpha_t^{pop} + \varepsilon_{i,t}^{pop}$$
$$\Delta log\ (di_{i,t}) = \beta^{un} \Delta log\ (W_{i,t}) + \boldsymbol{\beta}^{\boldsymbol{inter,un}} \boldsymbol{D_{i,t}} \boldsymbol{\Delta \log\ (W_{i,t})} + \boldsymbol{\beta}^{\boldsymbol{rec,un}} \boldsymbol{D_{i,t}} + \alpha_t^{un} + \varepsilon_{i,t}^{un}$$

Appendix C: Clusters of income smoothing

In line with SSP (2016), the optimal number of groups *K* and the smoothing parameter *c* are chosen by minimizing the following BIC-type information criterion:

$$IC(K,c)=ln\big(\sigma^2(K,c)\big)+\frac{2K}{3\sqrt{NT}}$$

where $\sigma^2(K,c)$ is the sum of squares of the post-Lasso residuals.

Table C.1. Information criterion values

	K=1	K=2	K=3	K=4	K=5	K=6	K=7	K=8
c=0.5	-7.292	-7.394	-7.407	-7.411	-7.427	-7.414	-7.383	-7.365
c=0.6	-7.292	-7.394	-7.405	-7.412	-7.427	-7.416	-7.405	-7.368
c=0.7	-7.292	-7.394	-7.405	-7.412	-7.426	-7.416	-7.409	-7.364
c=0.8	-7.292	-7.395	-7.405	-7.415	-7.428	-7.419	-7.408	-7.364
c=0.9	-7.292	-7.395	-7.408	-7.415	-7.428	-7.419	-7.408	-7.364
c=1	-7.292	-7.395	-7.409	-7.415	-7.431	-7.419	-7.413	-7.367
c=1.1	-7.292	-7.395	-7.408	-7.411	-7.431	-7.419	-7.419	-7.397
c=1.2	-7.292	-7.394	-7.409	-7.411	**-7.432**	-7.416	-7.418	-7.392
c=1.3	-7.292	-7.395	-7.408	-7.411	-7.427	-7.416	-7.418	-7.390
c=1.4	-7.292	-7.395	-7.41	-7.414	-7.247	-7.147	-7.423	-7.399
c=1.5	-7.292	-7.395	-7.413	-7.414	-7.42	-7.416	-7.422	-7.394
c=1.6	-7.292	-7.393	-7.413	-7.413	-7.419	-7.416	-7.422	-7.39
c=1.7	-7.292	-7.393	-7.413	-7.413	-7.419	-7.417	-7.422	-7.395
c=1.8	-7.292	-7.393	-7.413	-7.412	-7.419	-7.417	-7.423	-7.401
c=1.9	-7.292	-7.392	-7.413	-7.412	-7.418	-7.417	-7.423	-7.393
c=2	-7.292	-7.392	-7.412	-7.412	-7.417	-7.416	-7.422	-7.395

Table C.2. Classification of regions for K=5 and c=1.2

Group n°1: *30 regions,* β^{un}=0.929
EL30, EL43, EL54, EL61, EL63, EL65, HU11, HU12, HU21, HU23, HU32, HU33, PL42, PL61, PL62, PL71, PL81, RO32, RO42, SE12, SE21, SE22, SE23, SE31, SE32, SE33, SK01, SK02, SK03, SK04.

Group n°2: *58 regions,* β^{un}=0.768
AT11, AT21, BG41, CZ01, CZ02, CZ03, CZ04, CZ05, CZ06, CZ07, CZ08, EE00, EL42, EL52, EL53, EL64, ES21, ES63, ES64, FI1D, FI20, FRC2, HR02, HR03, HR05, HR06, HU22, HU31, IE05, ITC1, ITC3, ITI4, LT01, LV00, NL12, NL41, NL42, PL21, PL22, PL41, PL43, PL51, PL52, PL63, PL72, PL82, PL84, PL91, PL92, RO11, RO12, RO21, RO22, RO31, RO41, SE11, SI03, SI04.

Group n°3: *60 regions,* β^{un}=0.498
AT12, AT22, AT31, AT32, BE23, BG32, BG34, CY00, DE40, DEC0, DK01, EL41, EL51, ES11, ES12, ES13, ES22, ES24, ES30, ES41, ES43, ES51, ES53, ES61, ES70, FI19, FI1B, FI1C, FR10, FRB0, FRF3, FRG0, FRI3, FRJ2, IE04, IE06, ITC2, ITC4, ITH3, ITH4, ITI1, ITI2, ITI3, ITF1, ITF3, ITF6, LT02, NL13, NL21, NL22, NL31, NL32, NL33, PT11, PT15, PT16, PT17, PT18, PT20, PT30.

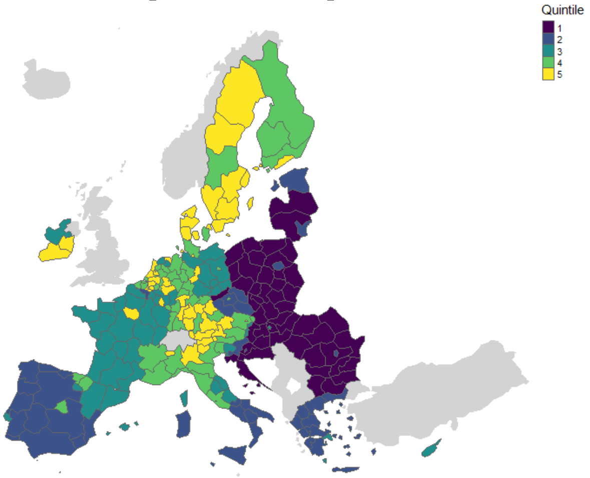
Group n°4: *61 regions,* β^{un}=0.322
AT13, AT33, AT34, BE21, BE22, BE24, BE25, BG31, BG33, BG42, DE12, DE13, DE14, DE22, DE23, DE24, DE26, DE80, DE93, DE94, DEA2, DEA3, DEB2, DED2, DED4, DEE0, DEF0, DEG0, DK02, DK03, DK04, DK05, ES23, ES42, ES52, ES62, FRC1, FRD1, FRD2, FRE1, FRE2, FRF1, FRF2, FRH0, FRI1, FRI2, FRK1, FRK2, FRL0, ITH1, ITH2, ITH5, ITF2, ITF4, ITF5, ITG1, ITG2, LU00, NL11, NL23, NL34.

Group n°5: *26 regions,* β^{un}=0.243
BE10, BE31, BE32, BE33, BE34, BE35, DE11, DE21, DE25, DE27, DE30, DE50, DE60, DE71, DE72, DE73, DE91, DE92, DEA1, DEA4, DEA5, DEB1, DEB3, DED5, FRJ1, FRM0.

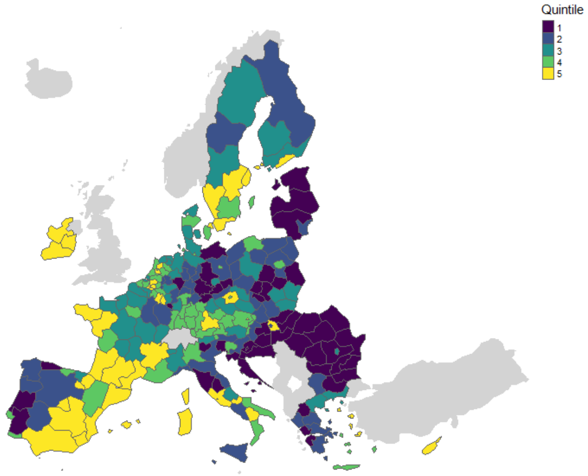
Note: Classification and estimates for different values of *c* are similar and are available upon request.

Appendix D: GDP and population growth quintiles

Period-average real GDP
per inhabitant quintiles



Population growth quintiles



Note: we mean values over the period 2000-2020 for the real GDP per inhabitant and population growth to compute the quintiles.