Who Bears the Costs of Inflation?
Euro Area Households and the 2021–22 Shock*

Filippo Pallotti[†] Gonzalo Paz-Pardo[‡] Jiri Slacalek[§]
Oreste Tristani[¶] and Giovanni L. Violante[‖]

Abstract

We measure the heterogeneous welfare effects of the recent inflation surge across households in the Euro Area. A simple framework illustrating the numerous channels of the transmission mechanism of surprise inflation to household welfare guides our empirical exercise. By combining micro data and aggregate time series, we conclude that: (i) country-level average welfare costs –expressed as a share of 2021–22 income– were much larger than a typical recession, and heterogeneous, e.g., 3% in France and 9% in Italy; (ii) this inflation episode resembles an age-dependent tax, with the elderly losing up to 20%, and roughly half of the 25–44 year-old winning; (iii) losses were quite uniform across income groups because rigid rents served as a hedge for the poor; (iv) nominal net positions are the key driver of heterogeneity across-households; (v) the rise in energy prices generated vast variation in individual-level inflation rates, but unconventional fiscal policies were critical in shielding the most vulnerable households.

Keywords: Inflation, Redistribution, Household Heterogeneity, Net Nominal Positions, Labor Income, Consumption, Housing, Fiscal Support.

JEL Codes: D12, D14, D31, E21, E52, E58

---

*Preliminary and Incomplete—Please Do Not Quote. This draft: 21st September, 2023. First version: March 2023. We thank Patrik Gorše for excellent research assistance, various seminar participants for helpful comments, and Mai Chi Dao, Kai Foerster, Daniel Leigh, Wolfgang Lemke and Ellen Ryan for sharing their data with us. All opinions expressed are personal and do not necessarily represent the views of the European Central Bank or the European System of Central Banks. This paper uses data from the Eurosystem Household Finance and Consumption Survey.

[†]University College London, filippo.pallotti@ucl.ac.uk
[‡]European Central Bank, Research, gonzalo.paz-pardo@ecb.europa.eu
[§]European Central Bank, Research, jiri.slacalek@ecb.europa.eu
[¶]European Central Bank, Research and CEPR, oreste.tristani@ecb.europa.eu
[‖]Princeton University, CEPR, IFS, IZA and NBER, violante@princeton.edu

1 Introduction

After three decades of low and stable inflation in advanced economies, prices rose sharply after the Covid-19 pandemic. In the euro area, headline inflation reached a peak of 10.6% in October 2022.[1] The increase was marked and unexpected, with energy and food prices being the main drivers of the aggregate price dynamics. Did everyone bear the costs of this surge in the price level equally? Or was the burden uneven across the population?

This same question emerged in past historical episodes of high inflation. John Maynard Keynes and Milton Friedman, whose opinions differed on most core issues, concurred on the inequitable nature of inflation. Keynes considered inflation "unjust".[2] Friedman called it "the cruelest tax of all". Behind this stance there is the commonly held view that inflation is regressive because the nominal share of net worth is larger for the poor (Erosa and Ventura, 2002). This perception of unfairness gets further exacerbated when looking across the age distribution, as done by Doepke and Schneider (2006): elderly households are those hit the hardest, again because of their large nominal savings, but they also happen to be those with the shortest horizon to recover from the negative shock. Inflation, however, operates through a number of other channels besides the dilution of nominal wealth. Thus, assessing its full distributional impact on household welfare is a complex task. For example, the structural origin of the inflation shock matters for the answer, as recently illustrated by Del Canto, Grigsby, Qian, and Walsh (2023).

In this paper, we focus on the most recent inflation episode as an *event study*, and set out to estimate the heterogeneous footprints of surprise inflation across individual households in the four largest euro area countries: Germany, France, Italy and Spain. To do so, we lay out a tractable dynamic framework that illustrates all the various mechanisms through which inflation can have repercussions on household welfare. This simple model provides guidance for our measurement exercise. We then combine several micro and macro data sources that allow

[1] This value refers to year-on-year percentage change in the headline HICP index.

[2] A Tract on Monetary Reform (1923).

us to shed light on the relevance of all these mechanisms across the age and income distribution, and quantify them one by one.

Our theoretical framework makes three key assumptions about the nature of this inflation episode: (i) the shock to the aggregate price level is unanticipated, and may lead to a temporary change in relative prices as well; (ii) the inflation surge is transitory and price stability is restored over the 2023–24 period; (iii) once the shock has passed, all nominal variables adjust one-to-one with the aggregate price index, so the shock is neutral in the medium/long-run. Under these conditions, we characterize the money-metric welfare change caused by the inflationary shock, household by household. By exploiting the envelope theorem, we break down the welfare change into easily interpretable components. These components contain sufficient statistics which can be estimated from macro and micro data, without the need of making any additional specific assumption on functional forms or other structural parameters.

Through our analytical expressions, we isolate four separate channels of surprise inflation, all of which are potentially heterogeneous across households. To fully understand this decomposition, it is useful to recognize that during high inflation episodes, governments often intervene to contain price surges in particular goods, and to offer support for certain groups. This last episode was no exception: in particular, interventions on energy markets (electricity, natural gas and liquid fuels), such as subsidies and price controls, were significant.

The first channel, which we label the *direct component*, measures the direct impact of raw pre-government inflation, i.e. abstracting from all these fiscal support measures, and abstracting from the endogenous reaction of wages and prices to the shock. This component captures two key forces. First, households experience different inflation rates due to differences in their consumption baskets. In addition, for a given inflation rate, the structure of household portfolios matters: a larger holding of nominal assets makes households more exposed to surprise inflation, while those households with long-term debt benefit from a higher price level. This effect occurring through the devaluation or revaluation of nominal net positions is the one traditionally emphasized in the literature.

The second channel, which we label *unconventional fiscal policy component*, captures the welfare change associated to the ad-hoc government policies implemented in response to the shock. Some of these policies reduced the actual prices faced by consumers, and others provided transfer payments to vulnerable demographic groups. The heterogeneity of this effect is mostly dictated by the share of heating and gas consumption in households' budgets.

The third channel, labelled *indirect component*, embeds the equilibrium response of all prices to the shock. Households obtain their income from different sources, such as wages, government transfers, rents, interests, dividends and capital gains. All these variables react to a different degree to surprise inflation. For example, nominal labor contracts are much stickier than asset prices. And nominal wage rigidity itself varies substantially, depending on countries' wage setting institutions, and individual occupation and industry.[3] Thus, real income losses may vary even across households experiencing the same inflation rate.

The fourth channel is the *long-run adjustment component*. This residual term descends from our initial assumptions. To account for the disproportionate spike in energy prices, we allow the shock to affect not just the aggregate price level, but also relative prices in the short run. In the long run, though, monetary neutrality dictates that these relative prices return to their old pre-shock values. This realignment of relative prices generates other changes in the real value of nominal net positions across the distribution (although, not on average).

The model-based measurement of all these effects leverages several micro and aggregate time series data. We estimate household-level expenditure shares on different goods and services from the 2015 Household Budget Survey (HBS). The corresponding price changes are available from the disaggregated data underlying the Harmonized Index of Consumer Prices (HICP) –the official euro area price index– in each country. For information on ad-hoc government support, we resort to the Bruegel dataset on national fiscal policy responses to the energy crisis (Sgaravatti, Tagliapietra, and Zachmann, 2021). Counterfactual prices absent government

[3]Heterogeneity in wage stickiness has long been recognised as an institutional feature of labour markets in euro area countries—see for example Eurosystem Wage Dynamics Network (2009).

interventions are based on the IMF methodology (Dao, Dizioli, Jackson, Gourinchas, and Leigh, 2023). Finally, we estimate the response of wages, house prices, stock prices and bond prices over 2021–22 using a combination of event studies and high-frequency identification on days of HICP inflation announcements.

Overall, our results show that the aggregate impact of this inflation episode is large. On average, welfare losses are between 3 and 5 percent of disposable household income in 2021 and 2022 in Germany, France and Spain, but exceed 9% in Italy. These values are at least one order of magnitude bigger than standard estimates of welfare costs of a typical recession. Comparing Italy to France, the country with the lowest welfare cost, reveals three main reasons for this gap: (i) the size of the raw-price shock was much bigger in Italy –a reflection of its energy import dependence and the structure of energy markets; (ii) unconventional fiscal policy measures were generous in both countries, but offset a more modest share of the shock in Italy; (iii) in Italy, middle-age (45–64) and elderly (65+) households hold larger wealth shares in nominal assets, and the young (25–44) borrow less compared to France: as a result, in Italy the nominal net position channel generates mostly losses across the entire distribution.

The most pronounced dimension of household heterogeneity in the welfare effects of inflation is age: this inflation episode resembles an age-dependent tax, with the burden falling disproportionately on the elderly retirees. The key driver of this age profile of welfare costs is the nominal share of financial portfolios which is positive and large for retirees in every country. Inflation differentials also play a role since elderly households, especially low- and middle-income ones, spend a larger share of their pensions on heating and food whose prices increased the most relative to the rest. Somewhat surprisingly, we do not find a significant slope of welfare effects across consumption (our proxy for permanent income) quintiles. If we abstract from rents, we do estimate significantly larger losses for the poor because of the higher inflation rate they suffer due to their more severe exposure to energy and food prices. It turns out, however, that rents are quite sticky in the short run and therefore provide a good inflation hedge for the low-income households, for whom rents represent a sizable share of total spending.

In terms of transmission channels, the key driver of our welfare results is the direct component and, within it, the erosion of labor income due to wage stickiness, and the change in the real value of nominal assets and liabilities. In comparison, the effect of heterogeneous consumption baskets is smaller, with the exception of poor elderly households especially in Italy and Spain. The unconventional fiscal policy component, especially interventions that affected energy prices, played a nontrivial role in shielding households from the shock. This offsetting force is particularly strong for low-income retirees. The indirect component is, instead, small. Nominal wages show some very partial indexation, and housing and stocks do not appear to be good hedges for inflation, at least when the latter has a sizable cost-push component, as in this historical episode.

Quantitatively, the heterogeneity of welfare effects across households in the euro area is quite massive: low-income Italian retirees lost up to 20% of their biennial income over 2021–22, while young households in Spain gained over 5%. Middle-aged households lost roughly 5% of their income across the four countries. Overall, 26% of households in the euro area –and nearly half of the 25–44 year-old– are net winners from the inflation shock.

1.1 Literature

Methodology. Our framework exploits the envelope theorem to analyze the first-order effects of economic shocks, focusing on the notion of 'money metric welfare' (i.e., welfare measured in euros). There have been several recent applications of the envelope theorem to characterize analytically the impact of shocks on the macroeconomy. Notably, Auclert (2019) decomposes analytically the effect of a monetary policy shock on household consumption across the wealth distribution; Fagereng, Gomez, Gouin-Bonenfant, Holm, Moll, and Natvik (2022) analyze the impact of capital gains on welfare; Del Canto et al. (2023) quantify the distributional effects of monetary policy shocks and oil shocks in the US. Instead, we use this approach to measure the effects of the recent inflation outburst in the euro area, and develop a simple framework to

conduct our measurement exercise in a way that is internally consistent.

Empirical channels. Our empirical work is connected to the literature that investigates inflation heterogeneity across different household groups. For the U.S., Michael (1979), Kaplan and Schulhofer-Wohl (2017), and Jaravel (2021) find that even during the period of low inflation prior to the Covid-19 pandemic there were substantial differences in household-specific inflation rates. In general, these studies conclude that lower-income households experience higher inflation, but that these household-specific rates of inflation are not very persistent. Orchard (2022) finds that during U.S. recessions, prices of necessities rise more strongly and hurt low-income households. We contribute to this literature by documenting the extent of heterogeneity in inflation rates during this last episode in the euro area. We identify differences an order of magnitude larger than those estimated by Hobijn and Lagakos (2005) and Argente and Lee (2020) across the US income distribution before the Covid-19 pandemic.

As Doepke and Schneider (2006), we conclude that the key dimension of heterogeneity in the costs of inflation is age, more than income, due to the strong life-cycle profile in net nominal positions. See also, Pallotti (2022) and Adam and Zhu (2016) for more recent assessments of this specific channel in the US after the pandemic, and in the euro area before the pandemic, respectively.

Our finding that the size of the indirect channel is small is related to a vast literature on nominal wage rigidity in the euro area (see, e.g., Babecký, Du Caju, Kosma, Lawless, Messina, and Rõõm, 2010, for survey-based evidence), and to the finding that stocks assets are not great hedges against core inflation (Fang, Liu, and Roussanov, 2022).

Recent inflation episode in the euro area. There exist several contemporaneous papers to ours which address the impact of the recent inflation shock across euro area households. They all virtually stop at measuring differential inflation rates and the role of government interventions to mitigate effective inflation faced by consumers (Curci, Savegnago, Zevi, and Zizza,

2022; Battistini, Di Nino, Dossche, and Kolndrekaj, 2022; Menyhert, 2022). A notable exception is Cardoso, Ferreira, Leiva, Nuño, Ortiz, Rodrigo, and Vazquez (2022) who use Spanish bank account and household survey data to quantify the relative contribution of consumption basket heterogeneity, net nominal positions, and labor income channels of the current inflationary shock. Our analysis is more extensive in several directions. First, we offer a theoretical framework to guide the empirics. Second, we our measurement covers also the role of variations in prices of real assets, and explicitly accounts for the role of government interventions. Third, we analyze the inflation shock in the four largest euro area economies, which have different wealth and income distributions, have been impacted differently by the energy shock, and whose governments have intervened in different ways through taxes, transfers and regulation to shield the household sector from the shock.[4] Finally, the fact that we study a longer time period (2021–2022, which we plan to expand further) allows us to gauge the extent to which nominal wages, rent, stock and house prices might have adjusted over time.

The rest of the paper is organized as follows. Section 2 outlines the model and the welfare decomposition. Section 3 describes the data and some key measurement inputs. Section 4 presents the results. Section 5 concludes. The Appendix contains more details on the model, the various data sources, and the welfare calculations.

2 Framework

We organize our empirical analysis around a simple reference framework. This framework is aimed at analyzing the effects of an unanticipated (or 'MIT') aggregate inflationary shock across a distribution of heterogeneous households. The impact of the shock is unequal across the distribution because households: (i) consume different bundles, and the shock changes relative prices; (ii) have different compositions of their balance sheet, including the share of nominal assets and liabilities; (iii) have different sources of nominal income (e.g., labor, capital,

[4]In fact, our results for Spain are quite different from those of the other countries we study, so Spain is not representative of the euro area experience.

government transfers) which adjust differently to the shock; (iv) are differentially affected by the government response to the shock.

In this section, we describe the model environment, the household problem, define our measure of welfare, and present our analytical welfare expressions that will guide the empirical analysis. In all that follows we use the convention that small letters denote quantities or real variables and capital letters denote nominal variables. All detailed derivations are in Appendix A.

2.1 Preliminaries

Time, uncertainty, and demographics. Time is discrete and indexed by t. The economy is populated by overlapping-generations of households who live for two periods. There is no aggregate uncertainty. We denote the initial period of interest (period zero) as $t = 0$. Before period 0 the economy rests in a steady state (denoted by the subscript ss) with inflation normalized to zero wihout loss of generality.

Shock. The unanticipated inflationary shock occurs at the start of $t = 0$ and lasts for one period only, which we label the *short run.* By $t = 1$, the shock has subsumed and its effects are reabsorbed within period $t = 1$, which we label the *long run.* The expressions "short-run" and "long-run" refer to the perspective of the cohorts who are hit by the shock. The young cohort lives through the long-run adjustment, while the old cohort does not.

We think of this inflationary shock as an aggregate disturbance that induces a *permanent jump in the aggregate price level* at $t = 0$, and then a (higher) constant price level from $t = 1$ on. Thus above trend inflation only occurs in period $t = 0$. We also allow the shock to affect relative prices in the short-run. For example, over the period of interest, the prices of food and energy rose disproportionately relative to the price of other items, and we want to capture these dynamics.

In the model, the nominal shock has heterogeneous real effects in the short-run for two

reasons. First, households consume different bundles as a result of heterogeneous preferences. Because of relative price changes, different individuals experience different effective inflation rates for their own basket of goods. Second, households are allowed to hold different positions in nominal assets, and receive heterogeneous nominal income from different sources (e.g., wages, pensions and other fiscal transfers, dividends, interests, rents, etc...). Because of nominal rigidities, all these contractual arrangements may not be not fully indexed to inflation.

We assume that these nominal rigidities vanish in the long run. In the long run, thus, we let all nominal variables fully adjust to the new *aggregate* price level. We also assume that relative prices gets realigned to their pre-shock values in the long run. All these assumptions will be stated explicitly in what follows.

2.2 Household problem

Preferences. We index individual households by i to model their heterogeneity in a general form. Household i derives utility $u_i(c_{it})$ from a consumption aggregator c_{it} and discounts the future at factor β_i. For all individuals i, the function u_i is strictly increasing, concave and twice differentiable.

Price Indexes Let P_{it} be the individual-level price index faced by households, i.e. the deflator for basket c_{it} which satisfies the relation

$$c_{it}P_{it} = \sum_{j=1}^{J} c_{i,jt}\mathcal{P}_{jt}, \tag{1}$$

where $j = 1, ..., J$ denotes a specific consumption category (e.g., food, housing services, energy, clothing, entertainment, etc.) and $\mathcal{P}_{jt}$ its price. Let $\bar{P}_t$ be the average price index of the economy, i.e. the official consumption expenditure deflator, defined as in (1) with quantities of each j goods ($\bar{c}_{jt}$) evaluated at the nationwide average. This average consumption bundle is the numeraire of the economy, and its deflator $\bar{P}_t$ is normalized to one in the initial steady

state, i.e. before the shock hits at $t = 0$.

We also explicitly take into account that good prices $\mathcal{P}_{jt}$ paid by consumers are inclusive of good-specific taxes and subsidies (e.g., sales and excise taxes which raise effective prices, or subsidies and price control measures which lowers it). Let

$$\mathcal{P}_{jt} = \mathcal{P}^*_{jt} \left(1 + \tau_{jt}\right), \tag{2}$$

where $\mathcal{P}^*_{jt}$ is the pre-tax or raw price, and τ_{jt} is a wedge capturing good-specific taxes (if positive) or subsidies (if negative).[5] Consistently with the definitions of after-tax price indexes above, we can also define pre-tax individual and aggregate price indexes, respectively P^*_{it} and $\bar{P}^*_t$.

Let $d \log X_t$ denote the change in a variable X from its pre-shock steady state value to its value at time t (i.e., log deviation from steady-state). Up to the first order, the change in the household specific price index (1) realized at $t = 0$ is

$$d \log P_{i0} = \sum\nolimits_{j=1}^{J} xsh_{ij,ss} \cdot d \log \mathcal{P}_{j0}, \tag{3}$$

where $xsh_{ij,ss} = \frac{c_{ij,ss}\mathcal{P}_{j,ss}}{\sum_{j=1}^{J} c_{ij,ss}\mathcal{P}_{j,ss}}$ is the nominal expenditure share on good j at the point of the expansion, i.e. in steady-state (denoted by the subscript ss) before the inflation shock. Using (2) evaluated at $t = 0$ into (3), we obtain

$$\begin{aligned} d \log P_{i0} &\simeq \sum\nolimits_{j=1}^{J} xsh_{ij,ss} \cdot \left(d \log \mathcal{P}^*_{j0} + d\tau_{jt}\right) \\ &= d \log P^*_{i0} + d \log \mathcal{T}_{i0} \end{aligned} \tag{4}$$

where the approximately equal sign comes from the log-approximation $\log\left(1 + \tau_{j0}\right) \simeq \tau_{j0}$. In

[5] Changes in the parameter τ_{jt} can capture, for example, government interventions in the energy sector aimed at mitigating the hike in unit prices paid by consumers in the aftermath of the shock. This type of government actions were significant over this period in the countries we analyze.

addition,

$$d\log P^*_{i0} = \sum_{j=1}^{J} xsh_{ij,ss} \cdot d\log \mathcal{P}^*_{j0}$$

measures the change in the pre-tax "raw" individual price index, and

$$d\log \mathcal{T}_{i0} = \sum_{j=1}^{J} xsh_{ij,ss} \cdot d\tau_{jt}$$

measures the change in the post-tax individual price index caused by the good-specific government interventions.

Similarly, $d\log \bar{P}_0$ is the change in the aggregate price index

$$d\log \bar{P}_0 = \sum_{j=1}^{J} \overline{xsh}_{j,ss} \cdot d\log \mathcal{P}_{j0}, \tag{5}$$

where $\overline{xsh}_{j,ss}$ is the *aggregate* share spent on good j in the period before the shock hits. In the same vein, we can define the changes in the pre-tax aggregate price index

$$d\log \bar{P}^*_0 = \sum_{j=1}^{J} \overline{xsh}_{j,ss} \cdot d\log \mathcal{P}^*_{j0}$$

All these different concepts allow us to decompose the first-order impact of the shock on individual-level prices P_{it} in two ways. First, we can separate the average effect and individual deviations from the average in order to highlight the heterogeneous consequences of the shock (e.g., $d\log P_{it} - d\log \bar{P}_t$). Second, we can separate pre-tax and post-tax prices in order to identify the role of ad-hoc government interventions (e.g., $d\log P_{it} - d\log P^*_{it}$). Appendix A derives these expressions step by step.

Budget constraint. Households earn nominal labor income W_{it} and pay nominal net tax liability (nominal taxes net of transfers, or net taxes) T_{it} to the government.[6] It is useful

[6]The dependence of labor income on i can be interpreted as households belonging to different labor markets or supplying different efficiency units to the same labor market. Also the dependence of net taxes on i is general,

to split net household transfers T_{it} as the sum of two components, T_{it}^{AUT} and T_{it}^{HOC}. The first component represents the "automatic stabilizers" already in place at the time of the shock. The second one represents the ad-hoc measures newly put in place only at $t = 0$ by the government as a fiscal response to the shock.

Households can hold real and nominal assets. Real assets (e.g., stocks, housing) are denoted as $a_{i,kt}$, $k = 1, ..., K$. Real assets trade at price Q_{kt} and pay a nominal dividend D_{kt}.[7] Households can hold both one-period (short-term) nominal bonds $B_{i,St}$ with price Q_{St} and long-term nominal bonds. To model long-term bonds (which also capture mortgage debt when they are held in negative amounts), we follow the conventional approach in the sovereign default literature (Arellano and Ramanarayanan, 2012) and assume that they are a perpetuity contract with nominal coupon payments that decay geometrically at rate $\delta < 1$. Thus a long-term nominal bond issued in period t entails a promise to pay δ^{s-1} units of currency (i.e., euros) in period $t + s$, for all $s \geqslant 1$. $B_{i,Lt}$ represents the nominal face value of the long-term bond portfolio held by household i, and Q_{Lt} the bond price of new issuances at t.[8]

Combining all these components, we can write the household budget constraint in period t as:

$$\begin{aligned} c_{it}P_{it} &= W_{it} - T_{it} + B_{i,St} + B_{i,Lt} + \sum_{k=1}^{K} (Q_{kt} + D_{kt})\, a_{i,kt} \\ &\quad - Q_{St}B_{i,St+1} - Q_{Lt}\left(B_{i,Lt+1} - \delta B_{i,Lt}\right) - \sum_{k=1}^{K} Q_{kt}a_{i,kt+1}. \end{aligned} \tag{6}$$

and as such it encompasses progressive taxes on income, consumption, wealth, separate taxation of different forms of income, age- and location-specific taxes and transfers (e.g., pensions), etc...

[7] The dividend for housing is the rental rate.

[8] As we show in Appendix A, the law of motion for long term bonds is $B_{i,Lt+1} = \delta B_{i,Lt} + \ell_{it}$, where ℓ_{it} are new bond purchases if positive, and new bond sales if negative. When $B_{i,Lt}$ is negative (and captures, e.g., mortgage debt), ℓ_{it} denotes new borrowing if negative and debt repayments if positive. Similarly, the term $\delta B_{i,Lt}$ denotes the residual bond holdings after all coupon payments at t if positive, and the residual outstanding debt after the scheduled proportional repayments of size $(1 - \delta) B_{i,Lt}$ if negative. It is easy to generalize the model so that each individual i holds portfolios of different durations δ_i. While the notation would be heavier, nothing of substance would change in the formulas because the model already allows for different holdings B_{iLt} of long-term bonds.

It follows from this description that both unsecured and secured borrowing are allowed, i.e. $B_{i,St}$ and $B_{i,Lt}$ are allowed to take negative values. We assume, however, that households only face natural credit limits, i.e. liquidity constraint do not bind.[9]

Household maximization. The problem of a household born at $t = 0$ is to maximize lifetime utility

$$V_i = u_i(c_{i0}) + \beta_i u_i(c_{i1})$$

subject to the budget constraints (6) at $t = 0, 1$. The choice variables at $t = 0, 1$ are the J consumption goods $\{c_{i,jt}\}_{j=1}^{J}$, and holdings of real and nominal assets $\{a_{i,kt+1}\}_{k=1}^{K}$, $B_{i,St+1}$ and $B_{i,Lt+1}$. At every t, the household takes as given good prices $\{\mathcal{P}_{jt}\}_{j=1}^{J}$, wages W_{it}, net taxes T_{it}, dividend policies $\{D_{kt}\}_{k=1}^{K}$, and asset prices $\{Q_{kt}\}_{k=1}^{K}$, Q_{St} and Q_{Lt}. Appendix A lays out the sequential formulation to the household problem in the form of a Lagrangean.

2.3 Nature of the shock

We are interested in the impact on households' welfare of an exogenous shock, denoted as dz_0, which occurs at the beginning of period $t = 0$ and causes an increase in the price level equal to $d \log \bar{P}_0$ (recall that before the shock the aggregate price level is normalized to one and inflation to zero). As anticipated, we adopt three assumptions which we state formally here:

Assumption 1: The shock is unanticipated. The burst of inflation is a surprise, and thus not already incorporated in prices and nominal variables at time $t = 0$. We leave all changes in nominal variables at time $t = 0$ unrestricted to capture the different degrees of frictions and partial adjustment that occurs in the short-run in labor markets, housing markets, and asset markets. We also allow the shock to affect relative prices in the short-run. As a result, the

[9] In this simple finite-life two-period model without uncertainty, the natural credit constraints specify that holdings of all assets must be non-negative at the end of the second period of life. For the theoretical analysis, incorporating the effect of the shock on credit constraints is straighforward. The challenge is its empirical measurement, thus for now we abstract from it.

individual inflation rates $d \log P_{i0}$ can differ from the aggregate one $d \log \bar{P}_0$.

Assumption 2: The inflation shock is temporary. After the initial unexpected jump in the price level $d \log \bar{P}_0$, in the long run, i.e. from $t = 1$ onward, the aggregate price index remains constant at its new, higher level:

$$\frac{d \log \bar{P}_1}{dz_0} = \frac{d \log \bar{P}_0}{dz_0}, \tag{7}$$

and thus inflation returns to its steady-state value (normalized to zero).

Assumption 3: The shock is neutral in the long-run in the aggregate and across the distribution In the long-run, none of the real variables are affected by the shock. Wages, net taxes, dividends, and prices of real asset (e.g., stocks and housing) adjust one-to-one with the new aggregate price level:

$$\frac{d \log W_{i1}}{dz_0} = \frac{d \log T_{i1}}{dz_0} = \frac{d \log D_{k1}}{dz_0} = \frac{d \log Q_{k1}}{dz_0} = \frac{d \log \bar{P}_1}{dz_0}. \tag{8}$$

In addition, we assume that this long-run realignment occurs also with respect to individual price levels, or

$$\frac{d \log P_{i1}}{dz_0} = \frac{d \log \bar{P}_1}{dz_0}. \tag{9}$$

This assumption requires relative prices return to their initial pre-shock values. Thus, all good prices in the long run increase by the same amount. As a result, in the long-run, individual inflation equals aggregate inflation.[10]

Finally, because expected inflation returns to its steady-state level, from $t = 1$ onward

[10]For example, the supply chain disruptions due to Covid led to a rise in the relative price of manufacturing goods relative to non-tradable services. Once that shock subsumed in 2023, relative prices moved in the opposite direction, offsetting the initial shift, even though the aggregate price level remained permanently elevated compared to the pre-shock period.

nominal bond prices return to their initial value,

$$\frac{d\log Q_{L1}}{dz_0} = \frac{d\log Q_{S1}}{dz_0} = 0 \tag{10}$$

Assumption 4: The adjustment in the government budget constraint either occurs through the price level, or through higher real surpluses at $t > 1$. Let B_{Gt} be government debt (a component of households' portfolio of long-term bonds) and assume, without loss of generality, that δ_G is the parameter governing average duration of government debt. Let Q_{Gt} denote its price. Let G_t denote real government spending and $\mathcal{S}_t$ denote the real budget surplus (deficit if negative) at date t, or $\bar{P}_t\mathcal{S}_t = T_t - \bar{P}_t G_t$. The intertemporal government budget constraint at date $t = 0$ is

$$Q_{G0}\delta_G B_{G0} = \bar{P}_0\mathcal{S}_0 + Q_{S0}\left[\bar{P}_1\mathcal{S}_1 + Q_{G1}B_{G2}\right]. \tag{11}$$

As explained, the shock dz_0 has an impact on bond prices Q_{G0}, real surpluses $\mathcal{S}_0$, and the aggregate price level $\bar{P}_0$. Potentially, it also affects the stock of nominal debt B_{G0} to the extent that the government issues new debt to finance temporary deficits. For the sake of generality, we opted to leave all these changes entirely unrestricted at date $t = 0$. Equation (11), however, has to hold which requires a corresponding adjustment. *Assumption 4* states that this accommodation can occur in two ways. First, through inflation itself, which reduces appropriately the value of real debt to equate the present value of all future real surpluses. This type of adjustment takes place under "active fiscal policy", and is often labeled as fiscal theory of the price level (Cochrane, 2023). Second, under "passive fiscal policy", the adjustment will take place through future real surpluses, i.e. either via lower real spending G_t or via a higher automatic component of future net taxes T_t^{AUT}, at $t > 1$.

2.4 Welfare analysis

Welfare metric. Let $\mathcal{L}_i$ denote the Lagrangean for household i belonging to the cohort who enters the economy at $t = 0$, and λ_{it} be the shadow value of a unit of account (i.e., a euro) at date t. Because of the envelope theorem, the first-order impact of the shock on a household's welfare can be computed from the Lagrangean abstracting from any change in choice variables (consumption goods, and shares of assets and liabilities in the household balance sheet):

$$\frac{dV_i}{dz_0} = \frac{d\mathcal{L}_i}{dz_0}.$$

Following Fagereng et al. (2022) and Del Canto et al. (2023), we focus on the notion of 'money-metric welfare' $\mathcal{W}_{i0}$. The welfare impact of the shock can be expressed as:

$$d\mathcal{W}_i = \frac{dV_{i0}/dz_0}{\lambda_{i0}} = \frac{dV_{i0}/dz_0}{u'(c_{i0})} P_{i0}. \tag{12}$$

Note that dV_{i0}/dz_0 is expressed in utils. Thus, dividing it by λ_{i0}, the shadow value of a euro at $t = 0$, is equivalent to first transforming it in real terms by dividing by the marginal utility of the individual consumption bundle, and then in nominal terms by multiplying it by the individual-level price index.[11]

Welfare decomposition. To clarify the sources of the various effects of the inflation shock, it is useful to split this welfare change into four additive components: (1) a short-run pre-government *direct* component $d\mathcal{W}_i^{DIR}$ which abstracts from all ad-hoc fiscal policies and from changes in nominal wages and asset prices caused by the shock, (2) a short-run *unconventional fiscal policy* component $d\mathcal{W}_i^{UFP}$ that incorporates all the ad-hoc government responses to the inflationary shock, (3) a short-run *indirect equilibrium* component $d\mathcal{W}_i^{IND}$ which captures short-run changes in nominal wages and asset prices, and (4) a long-run component $d\mathcal{W}_i^{LR}$ which

[11] In Appendix A we show that the household first order condition implies $u_i'(c_{i0}) = \lambda_{i0} P_{i0}$, which leads to the second term in equation (12).

captures the long-run realignment of relative good prices to the new price level. Overall,

$$d\mathcal{W}_i = d\mathcal{W}_i^{DIR} + d\mathcal{W}_i^{UFP} + d\mathcal{W}_i^{IND} + d\mathcal{W}_i^{LR}.$$

In our empirical implementation, we will compute each of these components step by step in successive stages. In what follows, we illustrate these components. All details of the derivations are contained in Appendix A.

2.4.1 Direct component

This component takes only into account the direct increase in cost of living for an individual on its total resources. It abstracts from the ad-hoc government response to the shock $\left(\tau_{jt}, T_{it}^{HOC}\right)$ and from all equilibrium effects on income (W_{it}, T_{it}, D_{kt}) and prices $(Q_{St}, Q_{Lt,} Q_{kt})$. We obtain:

$$\begin{aligned} d\mathcal{W}_i^{DIR} \quad = \quad & \left[\underbrace{-\frac{d\log \bar{P}_0^*}{dz_0}}_{\text{average } \pi} - \underbrace{\left(\frac{d\log P_{i0}^*}{dz_0} - \frac{d\log \bar{P}_0^*}{dz_0} \right)}_{\pi \text{ difference } (C)} \right] \times \\ & \left[\underbrace{W_{i0} - T_{i0}}_{\text{net income } (Y)} + \underbrace{B_{i,S0} + (1 + Q_{L0}\delta)\, B_{i,L0}}_{\text{net nominal position } (NNP)} + \underbrace{\sum_{k=1}^{K} D_{k0} a_{i,k0} + \sum_{k=1}^{K} Q_{0k} \left(a_{i,0k} - a_{i,1k} \right)}_{\text{dividends + capital gains } (K)} \right] \end{aligned} \tag{13}$$

The term on the right-hand side of $d\mathcal{W}_{i0}^{DIR}$ in the first line separates the role of aggregate-level inflation ('average π') vs individual-level inflation ('π difference'), both measured ex-ante with respect to ad-hoc government interventions (hence, the $*$ superscript). These expressions illustrate that the first-order partial-equilibrium effect of the shock is given by the weighted average change in the price of each consumption good, with weights given by the initial nominal expenditure share on each good. In other words, substitution effects can be ignored to first order. For example, an increase in the price of energy will produce different effects on households depending on the share of energy in their consumption bundle. To highlight these differences

in consumption bundles, in our empirical results we will separately report the average and the individual-specific inflationary effects.

The second term in square brackets in the second line of (13) collects all the items of the budget constraint at time $t = 0$ that are affected by the inflation shock. The first item is household's nominal disposable labor income, i.e. labor income plus transfers net of taxes. It captures the loss in purchasing power caused by the erosion of after-tax nominal wages and net transfers. In our empirical implementation we will denote this component as Y. The second item collects the so-called "net nominal positions" of the household (Doepke and Schneider, 2006).[12] Empirically, it includes bank deposits and bond holdings net of mortgage and other debt, whose value in terms of consumption goods will also be affected by inflation. In our empirical application net nominal positions will be denoted as NNP. The third and final item collects dividends and capital gains on real assets (including stocks and housing).[13] As explained for example by Fagereng et al. (2022), welfare is only affected by a change in the real value of assets caused by inflation to the extent that households modify their portfolio shares in such assets. Prospective buyers will gain from the surprise fall in prices, while prospective sellers will lose. In our empirical application we will denote dividends and capital gains as (K).

It is useful to note that nominal bonds are treated differently from stocks and housing in equation (13) . Welfare is affected by a devaluation of the nominal bond portfolio (or revaluation for borrowers) held by the household, irrespective of the household's plans to trade such bonds. Intuitively, all future coupons on outstanding long-term nominal bonds will be devalued by the permanent increase in the price level. By contrast, future nominal dividends on stocks (and rents on housing) will realign to the higher price level over the long term because they reflect the value of real yields. Thus, the capital gain or loss on real assets occurs only if the asset is traded at time $t = 0$.

[12] In Appendix A, we show that $\delta Q_{Lt} B_{lt}$ is the value of outstanding long-term bonds (or mortgage debt). Thus, technically, the value of net nominal positions $B_{St} + \delta Q_{Lt} B_{lt}$ includes interest payments for that period.

[13] Landlords' rental income from housing properties is included in this term.

2.4.2 Unconventional fiscal policy component

In this second stage, we collect the changes in ad-hoc government interventions specifically implemented in response to the inflation shock. We separate two types of interventions. First, subsidies to particular goods and services (e.g., subsidies and price controls in energy markets) which amount to reductions in τ_{j0} for some j which offset the rise in raw prices. Second, other ad-hoc transfers (or tax breaks) paid directly to households. In sum,

$$
\begin{aligned}
d\mathcal{W}_i^{UFP} \quad = \quad & \underbrace{\left(\frac{d\log P_{i0}^{*}}{dz_0} - \frac{d\log P_{i0}}{dz_0}\right)}_{\pi \text{ difference}} \times \\
& \left[W_{i0} - T_{i0} + B_{i,S0} + (1 + Q_{L0}\delta)\, B_{i,L0} + \sum_{k=1}^{K} D_{k0} a_{i,k0} + \sum_{k=1}^{K} Q_{0k}\left(a_{i,0k} - a_{i,1k}\right)\right] \\
& - \frac{dT_{i0}^{HOC}}{dz_0}.
\end{aligned}
\tag{14}
$$

The first term in the round brackets captures changes in τ_{j0} which affect the gap between raw prices and final prices faced by consumers since, from (4) , $d\log P_{i0} - d\log P_{i0}^{*} = d\log \mathcal{T}_{i0}$. Note that this effect is heterogeneous across the distribution because it depends on the individual expenditure share of the goods targeted by the fiscal intervention. The second term in the second line captures changes in ad-hoc direct taxes and transfers to households.[14]

[14] We write this component as the change in level, rather than as the log deviation times the initial level to allow for the fact that these ad-hoc transfers could be equal to zero before the shock. Since T^{HOC} is taxes net of transfers, a negative change captures the empirically relevant case of a rise in transfers to households.

2.4.3 Indirect equilibrium component

The third component includes all equilibrium price changes induced by the inflation shock – that is, the short-run shifts in nominal wages, taxes net of transfers, and asset prices:

$$d\mathcal{W}_i^{IND} = \underbrace{\frac{d\log W_0}{dz_0}W_0}_{\Delta \text{ wages}} - \underbrace{\frac{d\log T_{i0}^{AUT}}{dz_0}T_{i0}^{AUT}}_{\Delta \text{ net taxes}} - \underbrace{\frac{d\log Q_{S0}}{dz_0}Q_{S0}B_{S0} - \frac{d\log Q_{L0}}{dz_0}Q_{L0}\left(B_{i,L1} - \delta B_{i,L0}\right)}_{\Delta \text{ price of nominal assets}}$$
$$\underbrace{+\sum_{k=1}^{K}\frac{d\log Q_{k0}}{dz_0}Q_{k0}\left(a_{i,k0} - a_{i,k1}\right) + \sum_{k=1}^{K}\frac{d\log D_{k0}}{dz_0}D_{k0}a_{i,k0}}_{\Delta \text{ price of real assets}}. \tag{15}$$

These equilibrium effects can be expected to offset the impact of the inflation shock measured in the first stage. For example, lagged nominal indexation schemes and contractual renegotiations in the labor market would lead to an increase in nominal wages which would contain households' loss of purchasing power. Similar offsetting outcomes would be produced through an increase in the price of real assets which partially realigns with fundamentals. The extent to which this happens quantitatively is an empirical question.

2.4.4 Long-run adjustment

The fourth component, which we denote long-run adjustment component is obtained under *Assumption 3*, namely that in the long-run (i) all nominal variables (wages, taxes, dividends, and real asset prices) fully adjust to the change in the average price index, and (ii) relative prices return to their initial level, implying that long-run individual inflation equals aggregate inflation. This long-term adjustment component equals

$$d\mathcal{W}_i^{LR} = Q_{S0}\left(\frac{d\log P_{i0}}{dz_0} - \frac{d\log \bar{P}_1}{dz_0}\right)\underbrace{\left[B_{i,S1} + \left(1 + Q_{L1}\delta\right)B_{i,L1}\right]}_{\text{net nominal position at } t=1}. \tag{16}$$

Note that this component is discounted because it occurs at $t = 1$, while our money-metric welfare change is computed from the perspective of $t = 0$. In general, the welfare change in the

long-run is non-zero. $d\mathcal{W}_i^{LR}$ captures the revaluation of net nominal positions at $t = 1$ due to the realignment in relative prices. This component is zero only if there is the shock is neutral across different goods. In this case, $d \log P_{i0} = d \log \bar{P}_0 = d \log \bar{P}_1$. If, instead, individual i was subject to higher inflation than the mean in period $t = 0$, they will see a compensating welfare gain at $t = 1$.

Finally, note that because of *Assumption 4*, the long-run adjustment in the government budget constraint adds no additional complication to our welfare formulas. If this accommodation occurs via higher inflation, it has an impact on household welfare which is already incorporated into the change in the long-run price level $d \log \bar{P}_1$. If the adjustment is pushed far into the future through higher surpluses at $t > 1$, it does not affect households alive at the time of the shock.[15]

2.4.5 Old cohort

In Appendix A we show that a similar decomposition can be obtained for the old cohort who only lives through the short-run ($t = 0$) after the shock hits. Namely, let $d\widehat{\mathcal{W}}_i$ denote the welfare change for a household i belonging to the old cohort. Then

$$d\widehat{\mathcal{W}}_i = d\widehat{\mathcal{W}}_i^{DIR} + d\widehat{\mathcal{W}}_i^{UFP} + d\widehat{\mathcal{W}}_i^{IND}$$

[15] In future work, we plan to study also the case in which the fiscal adjustment occurs at $t = 1$ through higher taxes.

where

$$
\begin{aligned}
d\widehat{\mathcal{W}}_i^{DIR} &= -\frac{d\log P_{i0}^*}{dz_0}\left[W_{i0} - T_{i0} + B_{i,S0} + (1+Q_{L0}\delta)\,B_{i,L0} + \sum_{k=1}^{K}(Q_{k0}+D_{k0})\,a_{i,k0}\right] \\
d\widehat{\mathcal{W}}_i^{UFP} &= -\left(\frac{d\log P_{i0}}{dz_0} - \frac{d\log P_{i0}^*}{dz_0}\right)\left[W_{i0} - T_{i0} + B_{i,S0} + (1+Q_{L0}\delta)\,B_{i,L0} + \sum_{k=1}^{K}(Q_{k0}+D_{k0})\,a_{i,k0}\right] \\
&\quad -\frac{dT_{i0}^{HOC}}{dz_0} \\
d\widehat{\mathcal{W}}_i^{IND} &= \frac{d\log W_{i0}}{dz_0}W_{i0} - \frac{d\log T_{i0}^{AUT}}{dz_0}T_{i0}^{AUT} + \sum_{k=1}^{K}\left(\frac{d\log Q_{k0}}{dz_{i0}}Q_{k0} + \frac{d\log D_{k0}}{dz_0}D_{k0}\right)a_{i,k0} \\
&\quad +\frac{d\log Q_{L0}}{dz_0}\delta B_{i,L0}
\end{aligned}
$$

There are two main differences with respect to the welfare change of the young. The first is that the long-run component is zero, because the old cohort does not live through $t = 1$. The second is that the devaluation effect in the partial equilibrium component applies to all real assets as well, beyond the nominal ones, because being $t = 0$ the last period of life, all assets are sold.[16]

3 Empirical implementation

We use several micro datasets to document heterogeneity in the key components of the household budget constraint: consumption, income, net taxes, assets and liabilities. We sort households into fifteen groups: three age classes (25–44, 45–64, 65+) and five consumption quintiles. In addition, we use aggregate time series to identify the effects of inflation surprises on asset prices. We now turn to describing these different data sources and how we map them to the different elements of our framework. We present herein a broad overview, and refer the reader to Appendix D for further details on the measurement of each variable.

[16] In reality, older wealthy individuals do not liquidate all their assets in their last phase of life, but leave some bequest. In the empirical analysis, we'll make an adjustment to account for this observation.

3.1 First component: measuring the direct impact of inflation

This subsection describes the empirical measurement of our direct component, as outlined in equation (13). The calculation of individual-level price indexes also allows to compute the long-run component (16).

3.1.1 Household-specific inflation rates

We define the size of the inflation surprise for a given household as the difference between the inflation rate for the consumption basket of that specific household and inflation expectations. We calculate the inflation rate π_{ic} for household i in country c by weighting good-specific price changes π_{jc} with the individual i expenditure shares xsh_{jic} on goods $j = 1, ..., J$:

$$\pi_{ic} = \sum_{j=1}^{J} xsh_{jic} \; \pi_{jc}.$$

We obtain the weights xsh_{jic} from the latest wave available of the Household Budget Survey (HBS) carried out in 2015. We update these weights taking into account the evolution of prices from 2015 to 2020 under the assumption that relative quantities purchased remained fixed, as detailed in appendix D.1.[17] The corresponding good-specific price changes $\pi_{j,c}$ come from the micro data underlying the Harmonized Index of Consumer Prices (HICP) in each country. We use the average price changes within the period to devalue flows, and cumulated price changes in the period to devalue stocks.[18]

We focus on 20 consumption categories (indexed by j in the expressions above), which

[17] In appendix D.2, we use the 2005 and the 2015 HBS surveys to document a relatively stable composition of consumption baskets by income quintiles over time. The composition of aggregate expenditures has also been relatively stable according to National Accounts from 2015 to 2019. Moreover, using real-time data from credit card spending in Germany, Grigoli and Pugacheva (2022) showed that consumption baskets were returning to their pre-pandemic composition as Covid-19 restrictions abated. All this combined suggests that the 2015 HBS is a reasonable benchmark to represent consumer preferences at the time of the shock.

[18] Specifically, for 2021 flows we use the average of monthly year-over-year (YoY) price changes in 2021, while for 2022 flows we use the average of monthly YoY price changes in 2022, compounded to the YoY price changes in 2021. For stocks, we use the cumulated YoY price changes for 2021 and 2022. In our application, flows are disposable income, actual rent, dividends and capital gains, while stock the net nominal position is a stock.

Consumption Categories			
Class	Label	Class	Label
01	Food	07.21	Spare parts
02	Alcohol and tobacco	07.22	Fuels
03	Clothing	07.23	Vehicle maintenance
04.1	Actual rent	07.24	Other services for transport equipment
04.3	Dwelling maintenance	07.3	Transport services
04.4	Water supply	08	Communication
04.5	Electricity and gas	09	Recreation
05	Furnishings	10	Education
06	Health	11	Restaurants and Hotels
07.1	Vehicles	12	Miscellaneous

Table 1: Classification of consumption by purpose (COICOP) categories

Note: The remaining COICOP categories covering imputed rents are excluded from our measure of consumption.

are a refinement of the 12 top-level categories (divisions) of the Classification of Individual Consumption According to Purpose (COICOP), the international reference classification of household expenditure. In line with the measurement of inflation in the HICP (which is different from the US CPI, for example), we do not include imputed rent. Table 1 contains the full list of these categories.[19]

We measure inflation expectations in each country at the start of 2021 using data from Consensus Economics.[20]

3.1.2 Components of the household budget constraint

We use the latest wave of the Eurosystem Household Finance and Consumption Survey (HFCS), carried out in 2017, to estimate each component of the household budget constraint.[21] Except for Italy, after-tax income is not directly reported in the HFCS. We therefore estimate disposable income using data on effective marginal tax rates from the OECD as in Slacalek, Tristani, and Violante (2020). We measure net nominal positions in the HFCS as in Slacalek et al. (2020),

[19] We split some of the top-level categories into their sub-categories (groups and classes) in order to identify more precisely the role of energy and to exclude imputed rents from our measure of consumption.

[20] For 2021 flows, we subtract expectations for 2021. For 2022 flows and for stocks, we subtract 2021 expectations for 2022, compounded to expectations for 2021.

[21] See Household Finance and Consumption Network (2020) for a description of the survey. We use the 2017 wave of the HFCS as it is the last one available preceding the period of the inflation shock, 2021–22.

following the definition of Doepke and Schneider (2006) and Adam and Zhu (2016).[22] For real assets, which include housing and stocks, we take into account both income flows and realized capital gains. Housing income flow corresponds to rental income reported in the HFCS. We calculate stock market dividends for individual i in the survey as:

$$\text{SW}_i \times \frac{\text{dividend}}{\text{stock price}}.$$

Where SW_i denotes holdings of stock market wealth (in EUR) as provided by the HFCS, and the dividend–stock price ratios is taken from the work of Jorda, Knoll, Kuvshinov, Schularick, and Taylor (2019) in Macrohistory Database. In the four countries under analysis, it amounts to roughly 3%.[23]

For realized capital gains, we need to estimate households medium-term investment plans prior to the shock. We first construct the life-cycle profile of stock market wealth and housing wealth by consumption quintile from the HFCS. We then assume that households in each age/income bracket plan to attain the same (housing and stock market) wealth as the immediately older age bracket in the same consumption quintile. As a result, young and middle-aged households will tend to be prospective buyers. We assume all wealth is passed on as bequest, hence older households keep their portfolio shares unchanged.

3.2 Second component: measuring government interventions

In response to the sudden rise in inflation, governments enacted a series of interventions aimed at shielding the most vulnerable households. We collect these measures from the Bruegel dataset on national fiscal policy responses to the energy crisis (Sgaravatti, Tagliapietra, and Zachmann, 2021), and we divide them in two broad groups. First, we incorporate all forms of

[22] In particular, we measure the direct net nominal position of households, i.e., we abstract from indirect nominal positions arising from ownership of shares in financial intermediaries and equity claims.

[23] To avoid double counting, we adjust our disposable income measure by deducting the actual rental income (as reported in the HFCS) and dividends from stocks (calculated as above). The HFCS does not distinctly report actual dividends; instead, they are bundled under the broader category income from "financial investments".

government intervention that directly reduced energy prices through market regulation. Second, we incorporate all direct compensations to households. These components allow us to compute the term (14) in the main text.

3.2.1 Fiscal measures that reduced energy prices

As a response to the crisis, the governments of all four countries we consider introduced measures that directly affected the price of goods, particularly those related to energy. These interventions include, for example, direct subsidies of petrol prices, or regulations in electricity markets. Because these policies directly impact retail prices, their effect is already incorporated in the evolution of the official HICP consumer price index for each of the countries. Thus, to study their impact on households we must compute counterfactual price indices. Specifically, for each country we calculate counterfactual price indices separately for gas, for transportation fuels (which include petrol and diesel), and for electricity.

We obtain counterfactual gas prices absent government intervention from Dao et al. (2023), and assume that they apply equally to all four countries.

For transportation fuels, most subsidies were discounts set as a fixed amount of cents per liter of fuel and were limited in time. The magnitudes and timing vary across countries. We use the information in Sgaravatti et al. (2021) to identify these measures and rely on their statutory start and end dates to quantify the months that they applied to. We assume that these subsidies were fully passed on to households.

France and Spain also introduced measures in wholesale electricity markets with the intention of moderating retail prices. These policies took the form of subsidies to producers or specific regulations that affected the determination of official electricity prices. For the case of France, we rely on Dao et al. (2023), who provide a series for counterfactual electricity prices without fiscal support. For Spain, this intervention took the form of decoupling electricity prices from world gas prices. We use data on counterfactual wholesale electricity prices based on information from OMIE, the Spanish electricity operator (see EPData, 2023, for details).

These data are available at the daily level. Appendix E describes these different sources of data and our computations of counterfactual prices in more detail.

3.2.2 Government transfers

We incorporate all government interventions that, motivated by the increase in the price level, sought to directly compensate households (such as lump-sum payments or income support for low income households). For all cases, we compute the statutory value of government transfers and attribute it accordingly to each country-age-consumption group. See Appendix F. for an exhaustive summary.

3.3 Third component: measuring changes wages and asset prices

We now briefly describe the measurement of the components of Equation (15), always referring to Appendix D for further details.

3.3.1 Wages

For wages we adopt an event-study approach, tracking down how labour markets reacted to the surge of inflation in 2021–22. We use data on negotiated wages to capture how the dynamics of wage arrangements within firm, sectoral, and national wage agreements have evolved over the two years.[24] On average, wages grew by around 2.5% in Germany and Spain, somewhat less in Italy and somewhat more in France (see Figures 15 and 16). Our data cover wages at the sectoral level, but allowing for this heterogeneity results in only small differences across households. We subtract the long term average growth from wages, based on past data, in order to isolate the unexpected component.

[24]These data are compiled by national statistical agencies. They are often based on the universe or a very large sample of contractual agreements in the country.

3.3.2 House prices

Absent high-frequency house price data across the four countries, we adopt a two-step approach to identify the effects of inflation surprises on house prices.

In the first step, we use daily data on the stock prices of real estate investment trusts (REITs) $R(Q_t)$ to estimate their reaction to the news about inflation on the days of releases of the German Harmonised Index of Consumer Prices (HICP) in 2021–2022:[25]

$$R(Q_t) = \beta\, \Delta ILS_{1Y,t} + \gamma R(S_t) + \varepsilon_t, \tag{17}$$

where $\Delta ILS_{1Y,t}$ denotes a surprise component of the HICP announcement measured as the daily change in 1-year-ahead euro area inflation-linked swaps, and $R(S_t)$ denotes euro area stock returns, obtained respectively from Refinitiv and Bloomberg.[26] The coefficient β measures the sensitivity of REITs returns to the inflation surprise. To measure the dependent variable we use the FTSE EPRA NAREIT Eurozone Residential Index of FTSE Russell.[27]

In the second step, we estimate the sensitivity of house prices returns $R(H_t)$ to lagged REITs returns $R(Q_{t-1})$ using a regression with quarterly data, 2006Q1–2022Q2:

$$R(H_t) - R_f = \alpha + \delta\big[R(Q_{t-1}) - R_f\big] + \tilde{\gamma}\big[R(S_t) - R_f\big] + \text{controls} + \varepsilon_t,$$

where R_f denotes the risk-free rate and the control variables are the broad effective exchange rate, slope of the term structure (German 10-year yield minus German 3-month yield), the growth rate of industrial production, and the growth rate of HICP in the euro area (using a similar specification as in Pavlov and Wachter, 2011). We obtain quarterly house prices returns from OECD data, and we weigh each country according to their share in the REIT index.

[25] The exact release dates are reported in Table 2 in Appendix C.

[26] The idea of measuring asset price changes during macroeconomic announcements dates back to the early 1980s, to Schwert (1981), Frenkel (1981) and many others, with more recent contributions by Faust, Rogers, Wang, and Wright (2007), Andersen, Bollerslev, Diebold, and Vega (2007) and others.

[27] Germany is by far the largest market for REITs in the euro area (see Appendix D.5.1 and Figure 18).

We then back out the estimate of the elasticity of house prices to inflation surprises as the product of the two elasticities: $\beta \times \delta$. Our estimated value $\beta \times \delta = -2.042 \times 0.015 = -0.031$ means that an inflation surprise of 10 percent implies a 0.3 percent drop in house prices. We multiply this elasticity by the size of the inflation surprise in each country, obtaining a small response of house prices.

We report all results from these regressions in Table 3 of Appendix C.

3.3.3 Stock and bond prices

For stocks and bonds, high-frequency data on prices are available, so we follow a procedure similar to the first step above to obtain the changes in stock prices linked to inflation surprises on the days of HICP data releases in 2021–22 for Germany. Specifically, we regress the main stock market index in each country on daily changes in euro-area inflation expectations extracted from inflation-linked swaps on days of German inflation releases, controlling for global stock market returns, as in (17).

We also follow an analogous strategy for bonds. We construct bond returns as a weighted average of euro-area government bonds and corporate bonds, in proportion to quantities outstanding, and estimate their reaction to HICP data releases, controlling for EU stock market returns.[28] The data is obtained from Bloomberg.

The corresponding elasticities for stock and bond prices are negative and larger than those for house prices: -0.423 and -0.429, respectively, reflecting a stronger reaction and larger volatility of financial asset prices, compared to house prices, as expected. These elasticities are broadly in line with existing empirical estimates, which typically document a negative response of asset prices to inflation surprises.[29] We also report the results from these regressions in Table

[28] While in the regression for stock returns we control for the global stock market returns, which are less correlated with country-level stock markets than EU stock returns, in the regression for bonds we control for the EU stock market.

[29] Existing work mostly focuses on the response of bond prices. The estimates for stock prices are less frequent and for house prices rare. Overall, our results are in line with Schwert (1981) and Fang et al. (2022); Gurkaynak, Kisacikoglu, and Wright (2020) provides recent evidence on bond prices.

3 in Appendix C.

4 Results

This section describes our estimates of the transmission channels of inflation surprises to various components of the household budget constraint. Consistently with our framework, we discuss the results in four sequential stages.

We present our findings by sorting households into three age groups (less that 45 years, 45–64 years and older than 64 years) and, within each age group, into five quintiles of nondurable consumption and services. The breakdown by age is relevant because there are substantial differences over the life cycle in the accumulation of net wealth. We employ consumption as a proxy for permanent income because it is less affected by transitory shocks than current income.[30]

4.1 Heterogeneity in inflation rates

The inflation spike in the euro area over 2021–2022 was heterogeneous across countries, age groups, and consumption quintiles (Figure 1). At the country level, the highest aggregate inflation rate occurred in Italy, where the price of the average consumption basket increased by more than 20 percent cumulatively over these two years, whilst the increase was much more muted in France and Spain, with an aggregate rise of just above 10 percent. Cross-country differences in inflation rates are driven by a plurality of reasons. Given that this inflationary episode was dominated by energy pressures, the structure of each country's energy market is crucial. First, countries which are more dependent on energy imports are more likely to have seen their energy prices increase by more. Second, how energy prices are passed on to consumers also matters: whilst in some countries electricity contracts have variable pricing and

[30] We sort households by nondurable and services —not total consumption—to avoid that households who have made a large durable purchase just before the survey interview would be over-represented at the top of the distribution.

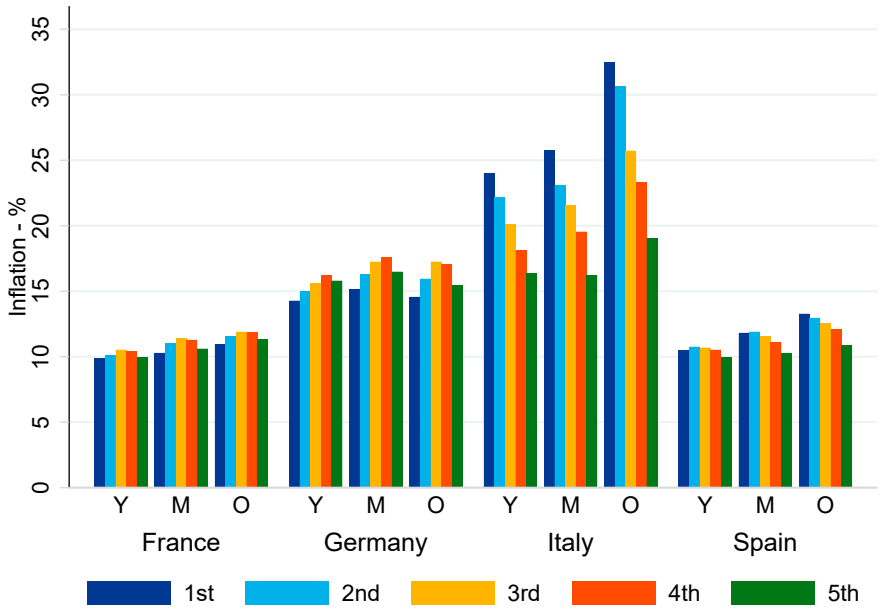


Figure 1: Household-level inflation rates by age classes and nondurable consumption quintiles, 2021–2022, cumulative 2-year rates in percent.

Note: The figure shows realized cumulative inflation rates in 2021–22 by age class and consumption quintiles within each age class. The groups Y, M and O denote ages of less that 45 years, 45–64 years and older than 64 years.
Source: Household Budget Survey 2015.

the increase of electricity prices is immediately transmitted to consumers (e.g., Spain), in others long-term contracts renegotiated at an annual frequency prevail (e.g., Germany). Finally, as explained, governments have intervened in different ways in energy markets.

Within countries, the inflation rate appears increasing with age, whereas within-age groups the gradient with respect to consumption quintiles varies by country. To understand these differences in inflation rates across households, it is crucial to recognize that households in lower quintiles spend a higher share of their budgets on energy and fuels, food, and rents. Figure 14 in Appendix B reports expenditure shares in each country-age-consumption group. The negative rent share-income gradient is prevalent everywhere. Italy and Spain are the countries for which the relation between the share spent on energy and food and total expenditures is the steepest.

The bulk of the recent inflation surge was driven by prices of energy, especially in Italy and Germany, and food, especially in Spain, as shown in Figure 2. This configuration meant that

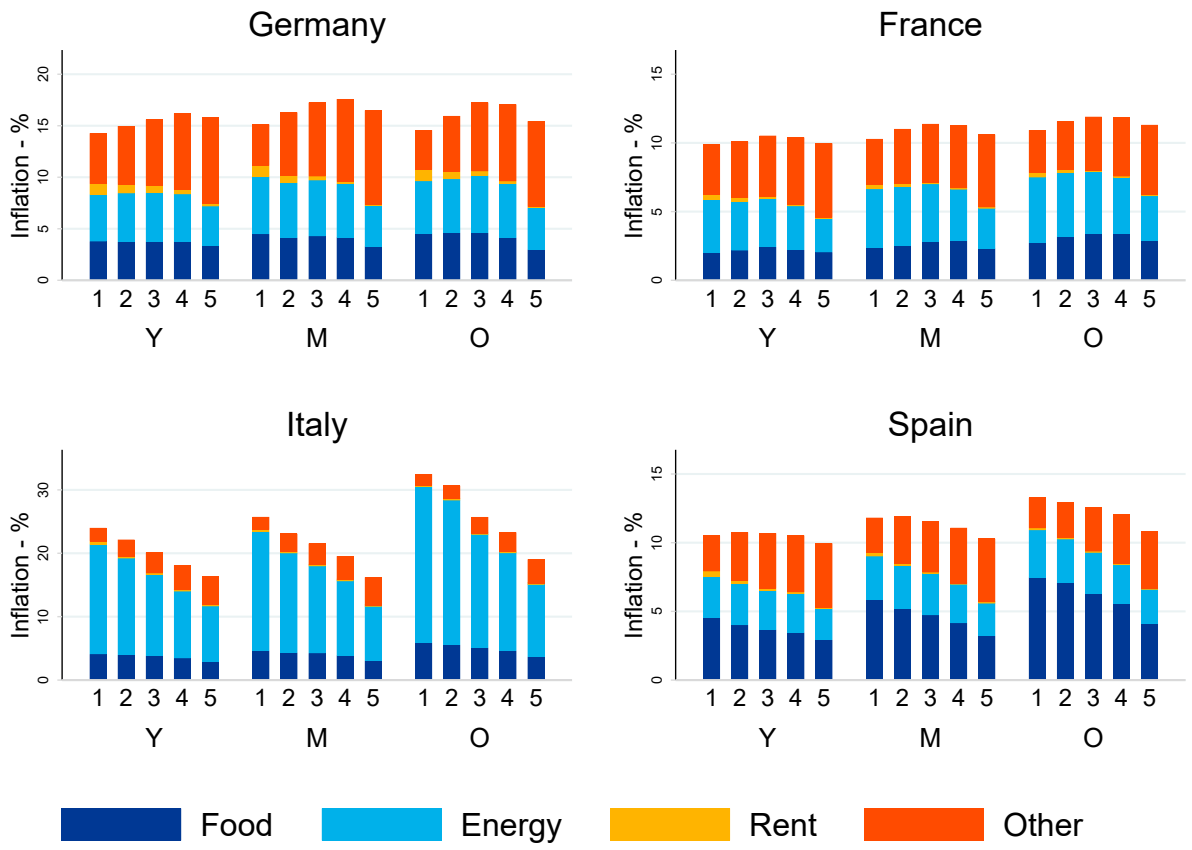


Figure 2: Decomposition of household-level inflation rates in pp by age classes and nondurable consumption quintiles within each age class, 2021–2022, cumulative 2-year rates in percent

Note: The figure shows the contribution of each consumption category to realized cumulative inflation rates in 2021–22. Food corresponds to "food at home" (COICOP 1), energy includes electricity and gas (4.5) and fuels (7.22), rent is actual rent (4.1), while other comprises all the rest of consumption categories. The groups Y, M and O denote ages of less that 45 years, 45–64 years and older than 64 years

Source: Household Budget Survey, 2015

the shock had a stronger impact on lower consumption households. The decreasing pattern in inflation rates across consumption quintiles, however, was weakened by modest increases in rents, which also account for a higher share of consumption expenditures at the bottom of the distribution.

Figure 3 documents a marked decreasing pattern of inflation across consumption quintiles when rents are excluded from the consumption basket. Once rents are included—as we do when calculating the costs of inflation below—the negative relation survives for Italy and Spain, but

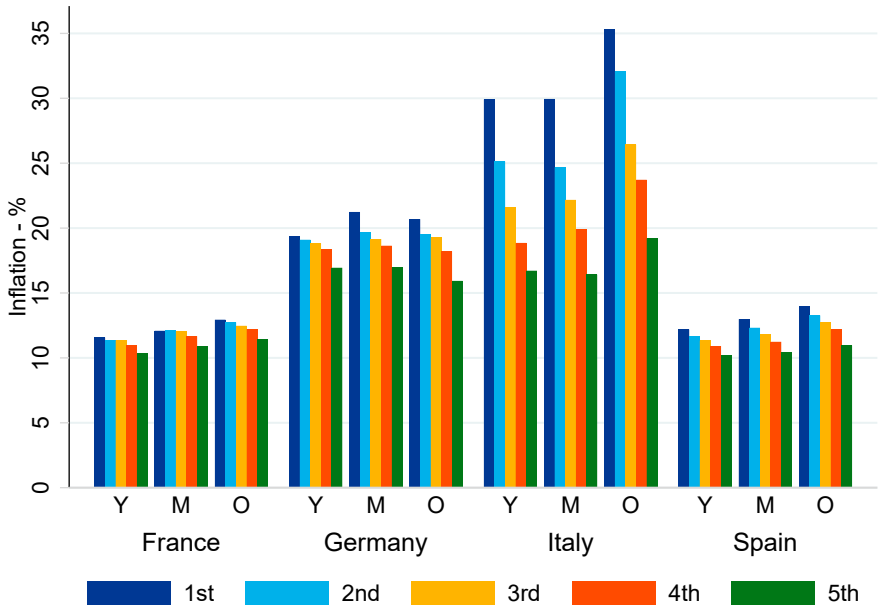


Figure 3: Household-level inflation rates by age classes and nondurable consumption quintiles, 2021–2022, cumulative two-year rates in percent, consumption baskets *excluding rents*

Note: The figure shows realized cumulative inflation rates in 2021–22 by age class and consumption quintiles within each age class. The groups Y, M and O denote ages of less that 45 years, 45–64 years and older than 64 years.
Source: Household Budget Survey 2015.

vanishes in France and Germany where the inflation rates are quite flat across the distribution (or have an inverse U shape, with middle quintiles experiencing somewhat higher inflation), as shown in Figure 1.[31]

In general, this heterogeneity is consistent with previous evidence from the US in a low-inflation environment (Michael, 1979; Kaplan and Schulhofer-Wohl, 2017; Jaravel, 2021), but inequalities are more apparent here because of the high aggregate inflation rate.

As mentioned, various measures of unconventional fiscal policy were put in place to contain inflation. In some countries (e.g., Spain, France) this intervention was directed to regulate energy prices or energy markets, which reduced prices at the point of sale and thus implied a lower recorded inflation rate for energy. In other countries (e.g., Italy), interventions happened ex-post, through bonuses or transfers to households, and thus did not mitigate the reported

[31] As the share of renters is high in Germany, including rents in the consumption basket has a strong effect on inflation rates across quintiles: compare Figures 1 and 3.

inflation rate.

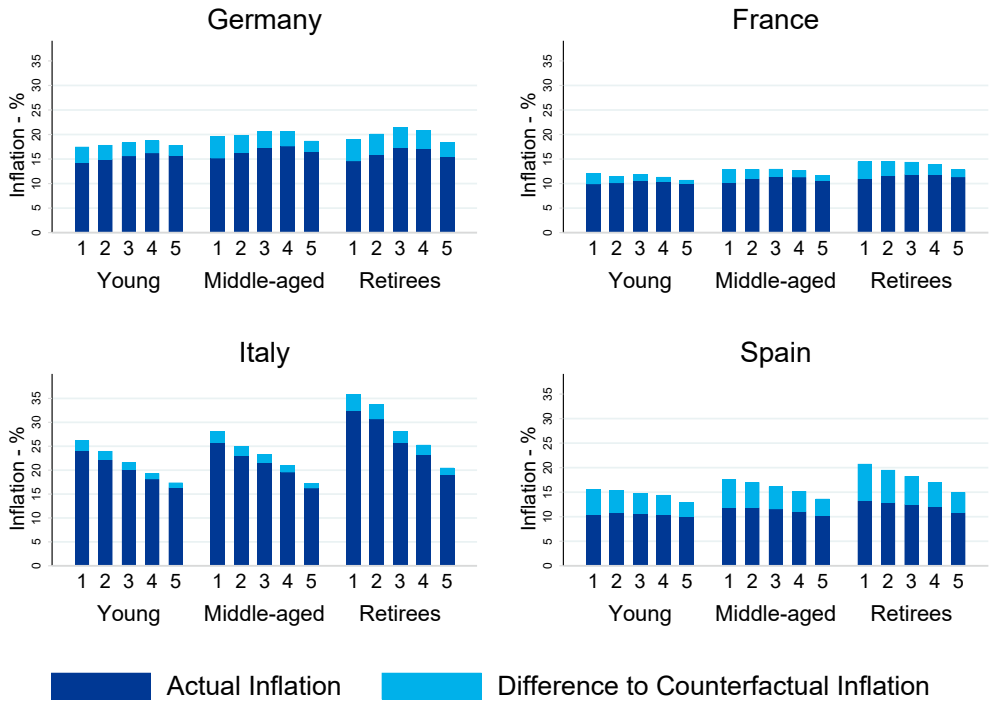


Figure 4: Actual and counterfactual household-level inflation rates by age classes and nondurable consumption quintiles within each age class, 2021–2022, cumulative 2-year rates in percent

Note: The figure shows realized cumulative inflation rates in 2021–22 by age class and consumption quintile. The groups Young, Middle-aged and Retirees denote ages of less that 45 years, 45–64 years and older than 64 years.
Source: Household Budget Survey 2015.

To account for these government interventions that affected price levels, we compute counterfactual increases in energy prices as described in Section 3.2.1. Figure 4 shows that, absent these government interventions, inflation rates would have been several percentage points higher. Because these policies mostly targeted energy prices, their effect was stronger for households that spend a higher share on energy, i.e., those with low consumption and older households.

4.2 First component: direct effect

Recall that the direct component measures the implications of the raw (i.e., before government interventions) inflationary shock for households, and abstracts from any adjustment in wages and asset prices.

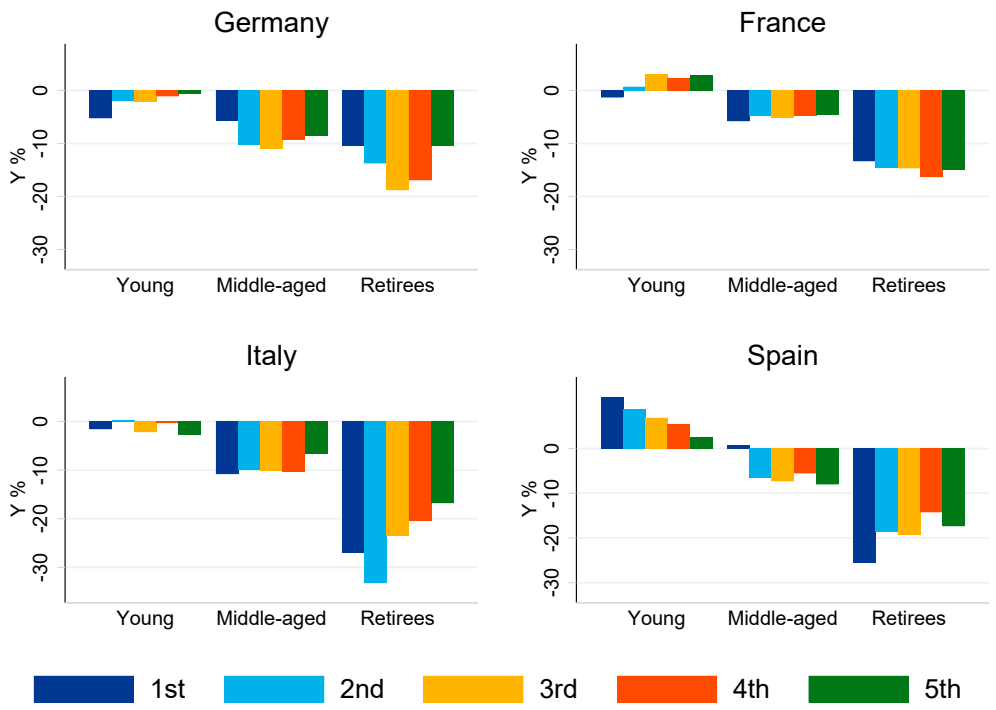


Figure 5: Average direct effect as a percentage of biannual disposable income by age class and nondurable consumption quintile

Note: The figure reports the average direct effects of the inflation shock across age class and consumption quintiles within each age class. Young , Middle-aged and Retirees are defined respectively as less that 45 years, 45–64 years and older than 64 years.
Source: Household Finance and Consumption Survey 2017.

The overall losses or gains from this direct component vary substantially across households (Figure 5). Although most households have experienced substantial costs (as a fraction of their disposable income over the two years), there is considerable heterogeneity. First, losses are markedly larger for Italian households, for whom aggregate inflation rates were higher. Second, we observe a clear age pattern in all countries, with the old losing more than the young. This pattern is particularly striking in Spain and France, where the young lose much less, and even

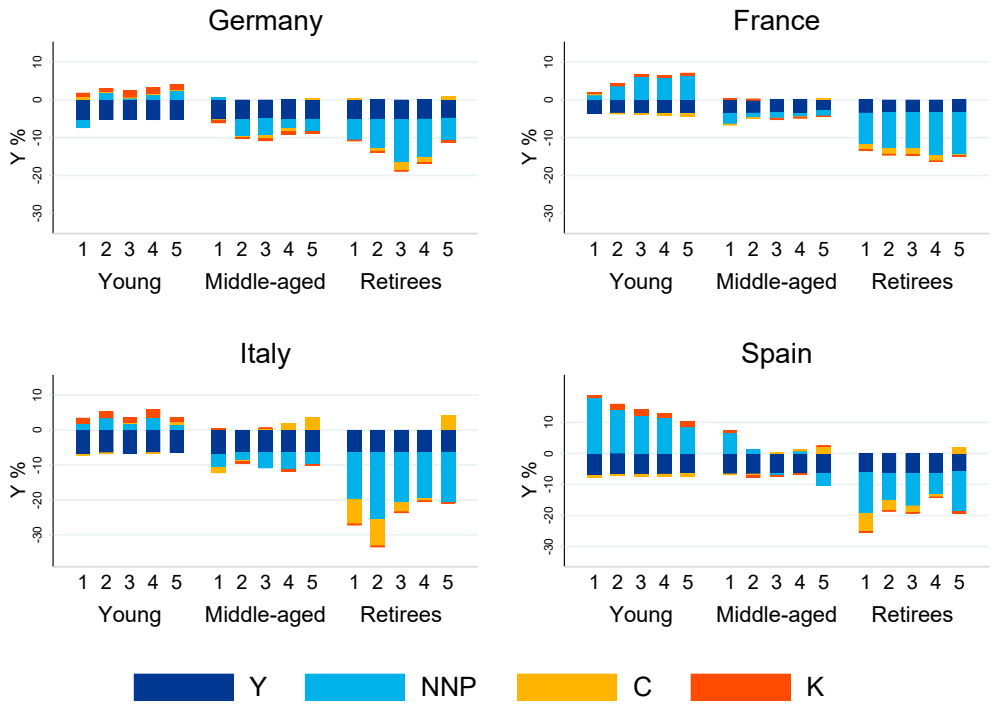


Figure 6: Decomposition of average direct effect into its components as percentage of biannual income by age class and nondurable consumption quintiles

Note: The figure reports a decomposition of the average direct effect into its components: Y denotes net income, NNP net nominal position, C consumption basket, K dividends and capital gains. Young , Middle-aged and Retirees are defined respectively as less that 45 years, 45–64 years and older than 64 years.
Source: Household Finance and Consumption Survey 2017.

show gains (on average).

Let us now look into which channels drive these composite effects (Figure 6). For most groups, the largest component of the drop is the net income (Y). The key driver of the heterogeneity by age is the nominal net positions (NNP) channel: older households own on average more nominal assets, such as bank deposits or savings accounts, which lost real value due to the increased price level. In contrast, younger households are less likely to own large balances of nominal assets and much more likely to hold nominal debt, mostly in the form of mortgages. As a result, they benefited from the rise in inflation, which reduces the real value of the balances they need to pay. This effect is especially strong in the case of Spain, a country with relatively high home-ownership rates, but much less so in the case of Germany, where few households are

homeowners with debt.

In comparison with these two channels, other elements contribute less. The heterogeneity in consumption baskets across households (C) produces a small negative effect on households at the bottom of the consumption distribution and a small positive effect on households at the top of the distribution. This channel is sizable only for elderly in Italy (and to a lesser extent, Spain), as their deviation from the average inflation rate in the economy is the largest (Figure 1).

Overall, the effects of dividends and capital gains (K) are relatively small, mostly concentrated amongst the young in Germany and Italy, many of whom are renters who plan on buying a house soon.

4.3 Second component: unconventional fiscal policy

In our second stage we incorporate the fiscal interventions that intended to cushion the effect of the inflation shock on household's well being. Figure 7 shows their welfare impact, compared with those of the first stage, and dividing measures into two main groups: those that affected goods prices directly (reported in yellow) and transfers to households (reported in light blue).

The effect of fiscal interventions was substantial, reducing the welfare losses implied by the first stage by 25% for most countries and age groups. Overall, the role of energy caps was more relevant than that of transfers.

Across countries, fiscal measures had the strongest repercussions in Spain, where substantial interventions in the energy markets took place with the objective of decoupling average electricity prices from the price of natural gas on international markets. In comparison with the size of the first stage effects, energy caps had the smallest impact in Italy.

Looking at the heterogeneity within a country, retirees benefited the most from these measures, which is consistent both with the relatively larger effect that the shock had on them and with the fact that some countries introduced transfers or energy price reliefs which were

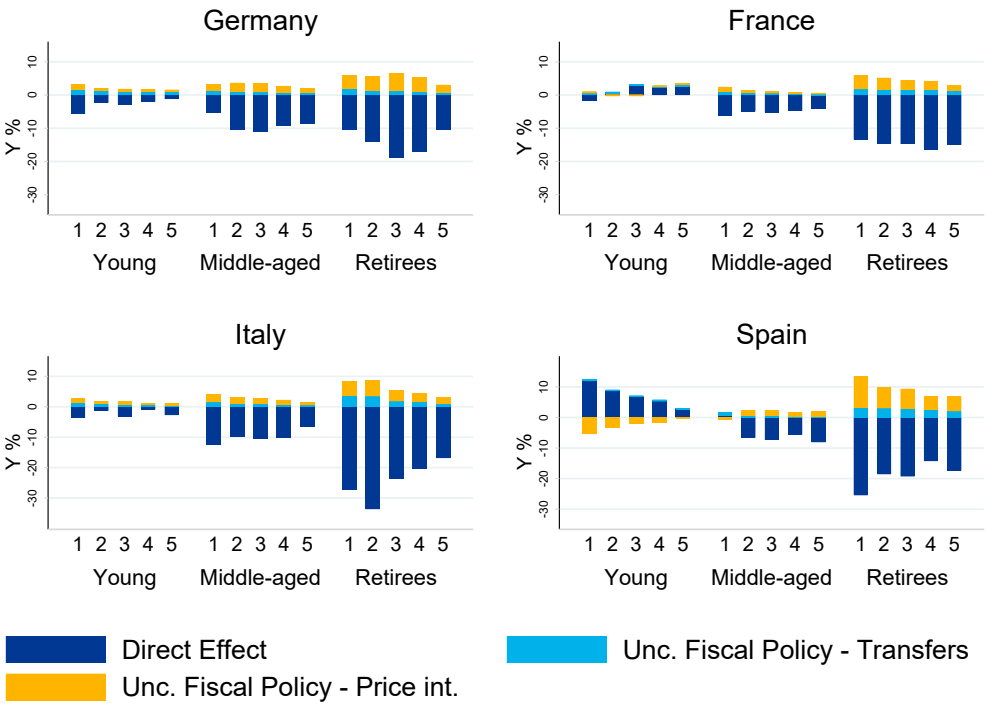


Figure 7: Average direct effect and unconventional fiscal policy effects, decomposed into price interventions and direct transfers. Results in terms of percentage of biannual disposable income for each age class and consumption quintiles

Note: The figure reports the average direct effect and unconventional fiscal policy effects. Young , Middle-aged and Retirees are defined respectively as less that 45 years, 45–64 years and older than 64 years.
Source: Household Finance and Consumption Survey 2017.

specifically targeted to this group. The groups who were benefiting from the inflationary shock (younger households in France and Spain) are naturally affected negatively by fiscal interventions that reduce the price levels, because these reduce the extent to which their nominal debt gets eroded.

We conclude that fiscal measures stabilizing energy prices had material effect to alleviate welfare losses of households.

4.4 Third component: indirect effect

Our results so far have assumed that neither nominal asset prices nor nominal wages adjust as a result of the inflationary shock. This third component incorporate the welfare effects of

adjustments in these variables.

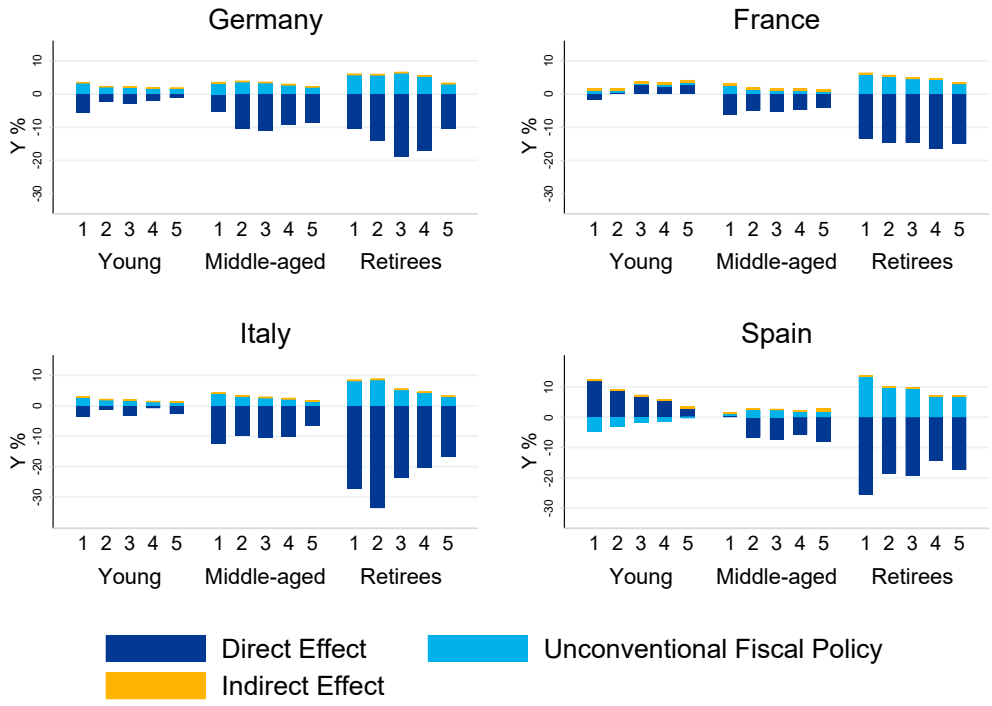


Figure 8: Average direct effect, unconventional fiscal policy and indirect effect as a percentage of biannual disposable income for each age class and nondurable consumption quintiles.

Note: The figure reports the average direct effect and unconventional fiscal policy effects. Young , Middle-aged and Retirees are defined respectively as less that 45 years, 45–64 years and older than 64 years.
Source: Household Finance and Consumption Survey 2017.

Figure 8 shows that the effects of the third stage are positive but small, staying in general below 1 percent of income, which implies that they only mildly alleviate the direct losses that summarised in the first stage.

In Figure 9, we zoom in on the decomposition of this indirect component. The effect of variation in wages is, as expected, positive, but limited, typically amounting to less than 1 percent of income, due to the relatively small upward nominal wage adjustments that occurred in most countries and for most workers. This channel is stronger in Spain and France, where many sectoral agreements were revised upwards, particularly in 2022, but almost non-existent in Germany and Italy.

The size of the asset price channel is very small because their elasticities to inflation surprises

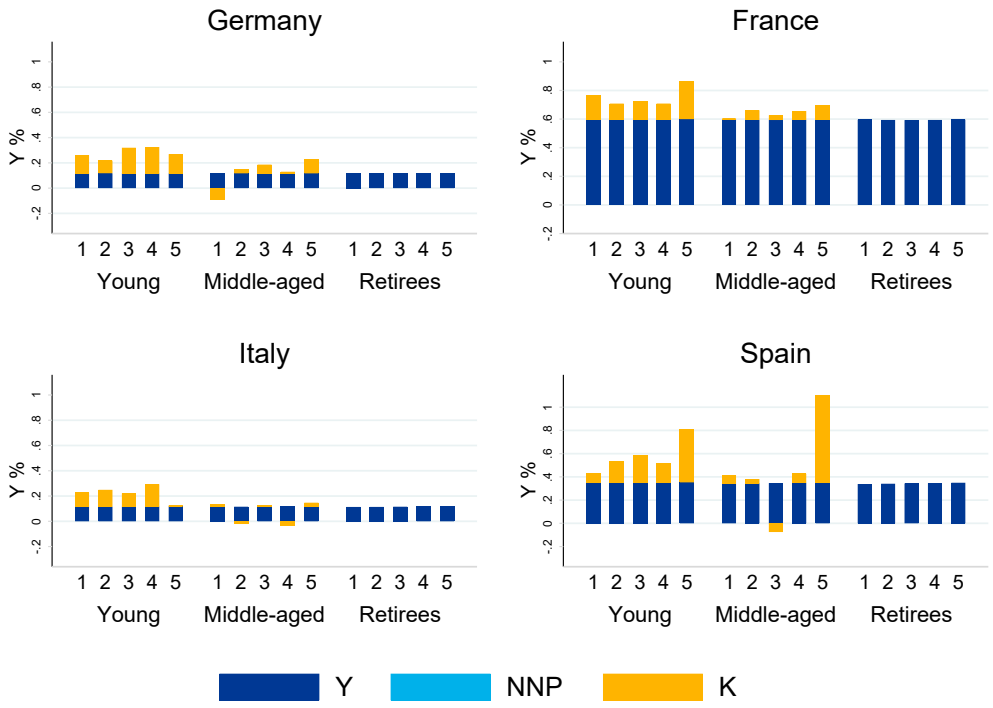


Figure 9: Decomposition of the average indirect effect into its components, as a percentage of biannual disposable income by age class and nondurable consumption quintiles

Note: The figure reports the decomposition of the average direct effect into its components: Y denotes net income, NNP denotes net nominal position, K dividends and capital gains. Young, Middle-aged and Retirees are defined respectively as less that 45 years, 45–64 years and older than 64 years.
Source: Household Finance and Consumption Survey 2017.

are low, often coupled with low holdings of these assets, except at the top of the consumption distribution.

4.5 Fourth component: long-run

In our fourth and final stage we compute the welfare change associated with the return of relative prices to their pre-shock values. We report these separately because most of these changes did not materialise during the 2021–2022 period, which is the focus of our study.

As Figure 10 shows, these effects are non-negligible, albeit lower in magnitude than our direct effects (stage 1) or than the fiscal effects (stage 2). In general, they are smaller than one percent of disposable income during the period because post-fiscal policy inflation differentials

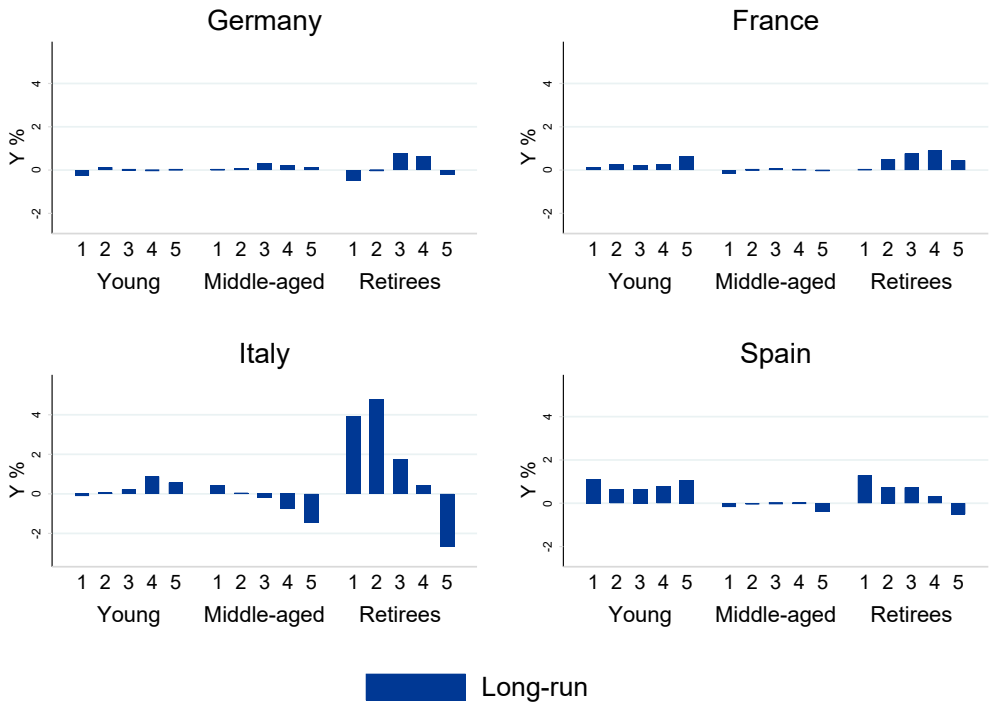


Figure 10: Average long-run effect as a percentage of biannual disposable income for each age class and nondurable consumption quintiles

Note: The figure reports the average long-run effect. Young, Middle-aged and Retirees are defined respectively as less that 45 years, 45–64 years and older than 64 years.
Source: Household Finance and Consumption Survey 2017.

over the income distribution were relatively small in most countries. The only exception are Italian retirees at the middle and the bottom of the income distribution. These households had positive net nominal positions and experienced largely negative inflation differentials during 2021–2022 because of their higher spending share of energy. As a result, the return to the pre-existing levels of relative prices benefits them, because it means that they must face relatively lower inflation than the rest of the population. The elderly rich, in contrast, lose, as they faced lower inflation rates during 2021–2022.

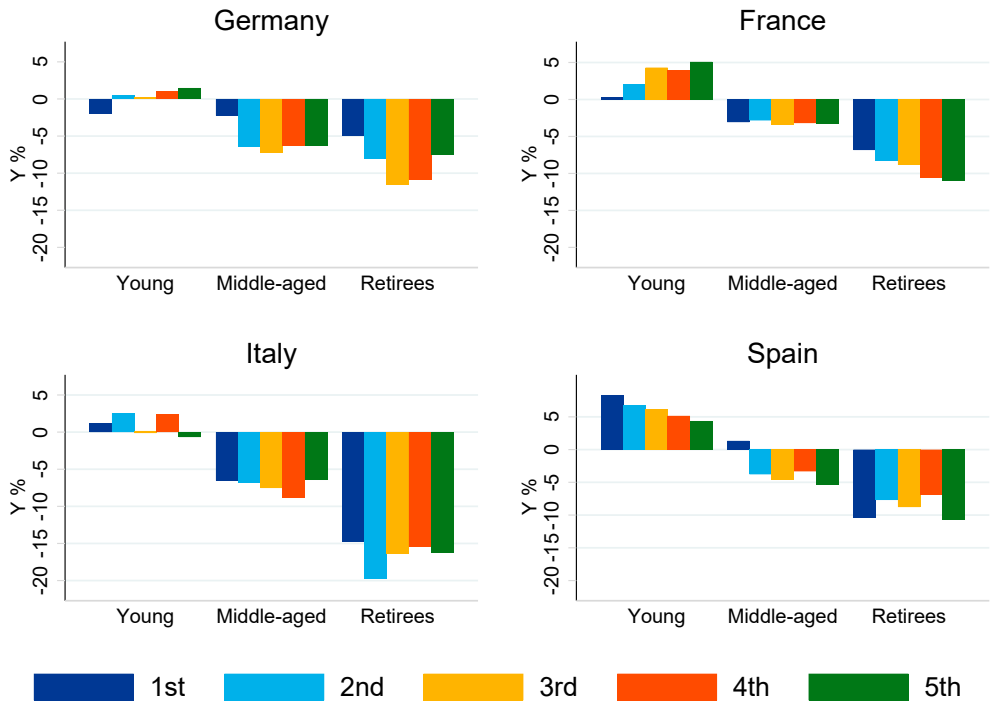


Figure 11: Average total effect as a percentage of biannual disposable income for each age class and nondurable consumption quintiles.

Note: The figure reports the average total effect combining direct effect, unconventional fiscal policy, indirect effect and long-run. Young, Middle-aged and Retirees are defined respectively as less that 45 years, 45–64 years and older than 64 years.
Source: Household Finance and Consumption Survey 2017.

4.6 Total welfare effect

Overall, combining the direct, fiscal, indirect and long-run effects (Figure 11), young households tend to break even in Germany and Italy, and benefit by about 3–6 percent of income in France and Spain. Middle-age households tend to lose between 3-6 percent of income, and retirees 10 percent or more. Across countries, the average losses are: 3.1 percent in France, 3.3 percent in Spain, 5 percent in Germany, and 8.7 percent in Italy. The biggest winners are low-income young in Spain (+8.7%), and the biggest losers low-income retirees in Italy (-20%). Table 4 summarizes all these total welfare changes.

Figure 12 illustrates that the bulk of the welfare effects come from the direct component (first stage), mitigated by fiscal interventions (second stage), particularly in Spain. In comparison,

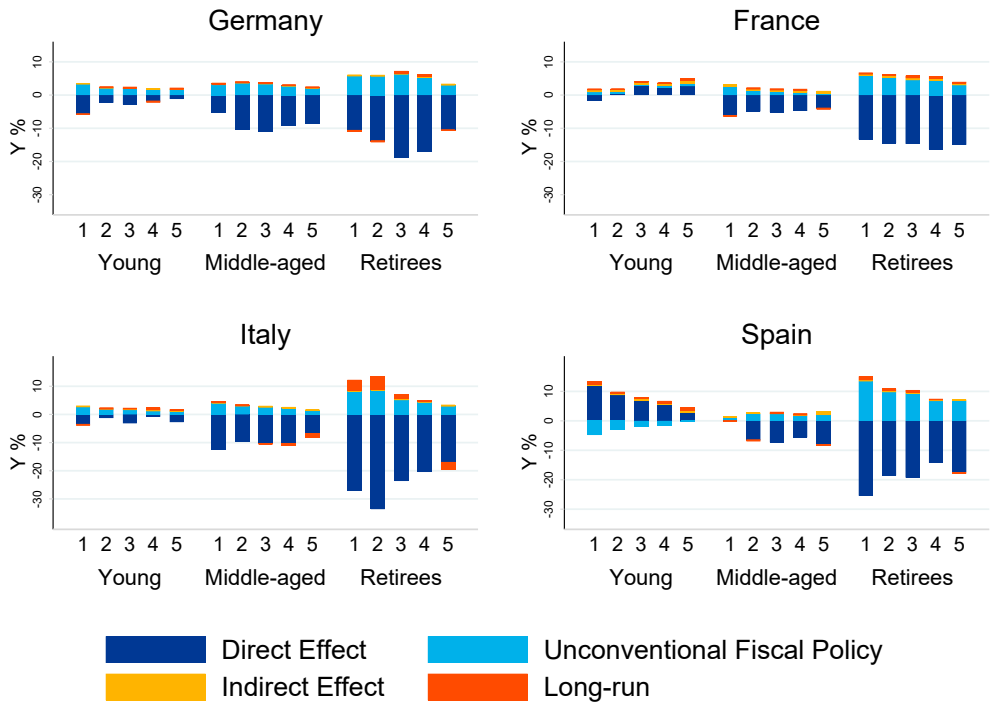


Figure 12: Average direct effect, unconventional fiscal policy, indirect effect and long-run as a percentage of biannual disposable income for each age class and nondurable consumption quintiles

Note: The figure a decomposition of the total net effect into its component: direct effect, unconventional fiscal policy, indirect effect and long-run. Young, Middle-aged and Retirees are defined respectively as less that 45 years, 45–64 years and older than 64 years. Source: Household Finance and Consumption Survey 2017.

the welfare effects induced by indirect price adjustments (third stage) and long-run relative price adjustments (fourth stage) are smaller.

4.7 How many households benefit?

All of the welfare calculations we have shown so far are averages conditional on an age–consumption–country bin. There is, however, some heterogeneity also within each bin, in particular in terms of net nominal positions. For example, homeowners are more likely to hold mortgages, and thus benefit from nominal gains, whilst renters are more likely not to benefit from them. To better understand the extent of this heterogeneity, Figure 13 shows the share of households that, within each group, experienced net gains. On average about 25 percent of

households gained, and most of them are concentrated in the young age groups, who are more likely to have a mortgage. In Germany, France and Spain, roughly half of the young are net winners. There is, instead, no clear gradient over the consumption distribution.

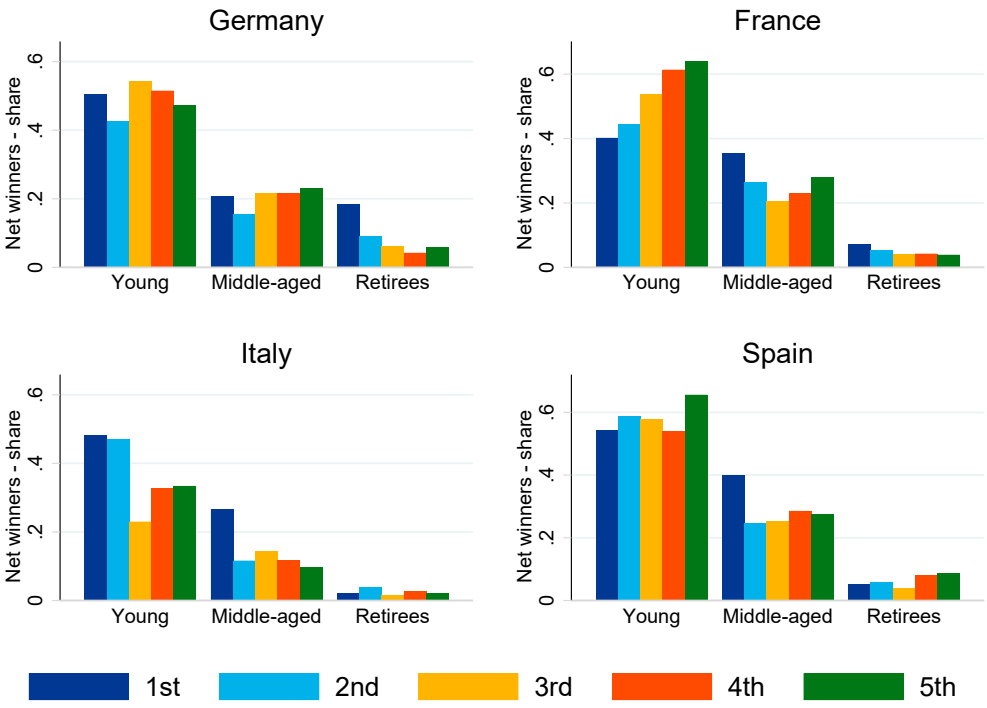


Figure 13: Share of net winners from the inflation shock within each age and consumption quintile class

Note: The figure the share households experiencing a positive net effect from the inflation shock. Young, Middle-aged and Retirees are defined respectively as less that 45 years, 45–64 years and older than 64 years.
Source: Household Finance and Consumption Survey 2017.

5 Conclusions

In this paper, we have measured the heterogeneous welfare effects on households of the recent inflation outburst in the euro area. A simple theoretical framework, combined with micro and macro data, instructs our empirical exercise. We have found large average losses, especially when compared to commonly estimated costs of a typical recession. We have also estimated a significant level of heterogeneity across countries and, within countries, across age groups, but

not across income groups.

The cross-country heterogeneity was mostly driven by the size of the inflation surprises, due to the different dynamics of the national HICPs. This wide variation posed a serious challenge for monetary policy, but government interventions through unconventional fiscal policy measures that mitigated the pass through from international prices to retail prices helped compressing these inflation differentials. Thus, this historical episode highlights the importance of fiscal policy in responding to country-specific dynamics within a monetary union, where monetary policy cannot be tailored to address union-wide shocks.

The larger burden on the elderly, in general, could represent a problem to the extent that this is the group with the shortest horizon to recover from the negative shock. This particular episode, however, occurred at a time when households excess-saving from the pandemic were still relatively high, and thus could cushion the erosion of purchasing power. In addition, euro area countries, like most advanced economies, have large debts whose repayment burden falls on future generations. In this sense, the inflation tax transfers from retirees to the young and partially offsets this looming fiscal adjustment.

Finally, the finding that the losses from inflation do not show a marked pattern across income groups, once controlling for age, is somewhat surprising. In the next draft, we plan to add an additional year of data to our empirical exercise to verify whether this finding is robust.

References

Adam, Klaus, and Junyi Zhu (2016), "Price-Level Changes and the Redistribution of Nominal Wealth across the Euro Area," *Journal of the European Economic Association*, 14(4), 871–906.

Andersen, Torben G., Tim Bollerslev, Francis X. Diebold, and Clara Vega (2007), "Real-Time Price Discovery in Global Stock, Bond and Foreign Exchange Markets," *Journal of International Economics*, 73(2), 251–277.

Arellano, Cristina, and Ananth Ramanarayanan (2012), "Default and the Maturity Structure in Sovereign Bonds," *Journal of Political Economy*, 120(2), 187–232.

Argente, David, and Munseob Lee (2020), "Cost of Living Inequality During the Great Recession," *Journal of the European Economic Association*, 19(2), 913–952.

Auclert, Adrien (2019), "Monetary Policy and the Redistribution Channel," *American Economic Review*, 109(6), 2333–67.

Babecký, Jan, Philip Du Caju, Theodora Kosma, Martina Lawless, Julián Messina, and Tairi Rõõm (2010), "Downward Nominal and Real Wage Rigidity: Survey Evidence from European Firms," *Scandinavian Journal of Economics*, 112(4), 884–910.

Battistini, Niccolo, Virginia Di Nino, Maarten Dossche, and Aleksandra Kolndrekaj (2022), "Energy Prices and Private Consumption: What Are the Channels?" *ECB Economic Bulletin*, 3, 69–84, European Central Bank.

Cardoso, Miguel, Clodomiro Ferreira, José Miguel Leiva, Galo Nuño, Álvaro Ortiz, Tomasa Rodrigo, and Sirenia Vazquez (2022), "The Heterogeneous Impact of Inflation on Households' Balance Sheets," working paper, Red Nacional de Investigadores en Economıa.

Cochrane, John H (2023), *The Fiscal Theory of the Price Level*, Princeton University Press.

Curci, Nicola, Marco Savegnago, Giordano Zevi, and Roberta Zizza (2022), "The Redistributive Effects of Inflation: A Microsimulation Analysis for Italy," occasional paper 738, Banca d'Italia, Economic Research and International Relations Area.

Dao, Mai Chi, Allan Dizioli, Chris Jackson, Pierre-Olivier Gourinchas, and Daniel Leigh (2023), "Unconventional Fiscal Policy in Times of High Inflation," ECB Forum on Central Banking, working paper.

Del Canto, Felipe N., John R. Grigsby, Eric Qian, and Conor Walsh (2023), "Are Inflationary Shocks Regressive? A Feasible Set Approach," working paper 31124, National Bureau of Economic Research.

Doepke, Matthias, and Martin Schneider (2006), "Inflation and the Redistribution of Nominal Wealth," *Journal of Political Economy*, 114(6), 1069–1097.

EPData (2023), "Daily prices on wholesale electricity markets," Obtained from the Spanish electricity market operator OMIE, see.

Erosa, Andres, and Gustavo Ventura (2002), "On Inflation as a Regressive Consumption Tax," *Journal of Monetary Economics*, 49(4), 761–795.

Eurosystem Wage Dynamics Network (2009), "Wage Dynamics in Europe: Final Report of the Wage Dynamics Network (WDN)," report, European Central Bank, https://www.ecb.europa.eu/home/pdf/wdn_finalreport_dec2009.pdf.

Fagereng, Andreas, Matthieu Gomez, Emilien Gouin-Bonenfant, Martin Holm, Benjamin Moll, and Gisle Natvik (2022), "Asset-Price Redistribution," working paper, London School of Economics.

Fang, Xiang, Yang Liu, and Nikolai Roussanov (2022), "Getting to the Core: Inflation Risks within and across Asset Classes," working paper 30169, National Bureau of Economic Research.

Faust, Jon, John H. Rogers, Shing-Yi B. Wang, and Jonathan H. Wright (2007), "The High-Frequency Response of Exchange Rates and Interest Rates to Macroeconomic Announcements," *Journal of Monetary Economics*, 54(4), 1051–1068.

Frenkel, Jacob A. (1981), "Flexible Exchange Rates, Prices, and the Role of "News": Lessons from the 1970s," *Journal of Political Economy*, 89(4), 665–705.

Grigoli, Francesco, and Evgenia Pugacheva (2022), "Updating Inflation Weights in the UK and Germany during COVID-19," working paper 204, International Monetary Fund.

Gurkaynak, Refet S., Burcin Kisacikoglu, and Jonathan H. Wright (2020), "Missing Events in Event Studies: Identifying the Effects of Partially Measured News Surprises," *American Economic Review*, 110(12), 3871–3912.

Hobijn, Bart, and David Lagakos (2005), "Inflation Inequality in the United States," *Review of Income and Wealth*, 51(4), 581–606.

Household Finance and Consumption Network (2020), "The Household Finance and Consumption Survey—Results from the 2017 Wave," Statistics Paper Series 36, European Central Bank, https://www.ecb.europa.eu/pub/pdf/scpsps/ecb.sps36~0245ed80c7.en.pdf.

Jaravel, Xavier (2021), "Inflation Inequality: Measurement, Causes, and Policy Implications," *Annual Review of Economics*, 13, 599–629.

Jorda, Oscar, Katharina Knoll, Dmitry Kuvshinov, Moritz Schularick, and Alan M. Taylor (2019), "The Rate of Return on Everything, 1870–2015," *The Quarterly Journal of Economics*, 134(3), 1225–1298.

Kaplan, Greg, and Sam Schulhofer-Wohl (2017), "Inflation at the Household Level," *Journal of Monetary Economics*, 91(C), 19–38.

Menyhert, Balint (2022), "The Effect of Rising Energy and Consumer Prices on Household Finances, Poverty and Social Exclusion in the EU," JRC Science for Policy report JRC130650, European Commission Joint Research Centre, Ispra.

Michael, Robert T. (1979), "Variation Across Households in the Rate of Inflation," *Journal of Money, Credit and Banking*, 11(1), 32–46.

Orchard, Jacob (2022), "Cyclical Demand Shifts and Cost of Living Inequality," mimeo, University of California, San Diego.

Pallotti, Filippo (2022), "Winners and Losers from Unexpected Inflation," working paper, University College London.

Pavlov, Andrey D., and Susan M. Wachter (2011), "REITs and Underlying Real Estate Markets: Is There a Link?" research paper 11-20, Institute for Law and Economics, University of Pennsylvania.

Schwert, G. William (1981), "The Adjustment of Stock Prices to Information About Inflation," *The Journal of Finance*, 36(1), 15–29.

Sgaravatti, Giovanni, Simone Tagliapietra, and Georg Zachmann (2021), "National Policies to Shield Consumers from Rising Energy Prices," dataset, Bruegel, https://www.bruegel.org/dataset/national-policies-shield-consumers-rising-energy-prices.

Slacalek, Jiri, Oreste Tristani, and Giovanni L Violante (2020), "Household Balance Sheet Channels of Monetary Policy: A Back of the Envelope Calculation for the Euro Area," *Journal of Economic Dynamics and Control*, 115, 103879.

Appendix A Theoretical framework

A.1 Short and long-term debt

We model nominal short-term bonds as a contract whereby individual i buys $B_{i,St+1}$ units of bonds at the prevailing market price Q_{St} at date t and next period, they receive $B_{S,t+1}$ units of currency. Thus Q_{St}^{-1} is the nominal gross interest rate between t and $t+1$.

We model long-term bonds as a perpetuity contract with nominal coupon payments that decay geometrically at rate $\delta > 0$. A perpetuity contract specifies a price Q_{Lt} and a purchase ℓ_{it} such that household i spends $Q_{Lt}\ell_{it}$ at date t in exchange for a promise to receive $\delta^{n-1}\ell_t$ units of currency in every future period $t+n$, with $n > 0$. Let $B_{i,Lt}$ denote the nominal *face value* of the long-term bond portfolio held by household i at time t as the total payments due in period t on all purchases of past issuances.

$$B_{i,Lt} = \sum_{n=1}^{t} \delta^{n-1}\ell_{i,t-n} = \ell_{i,t-1} + \delta\ell_{i,t-2} + \delta^2\ell_{i,t-3} + ... + \delta^{t-1}\ell_{i,0}. \tag{18}$$

Rearranging (18), it is easy to obtain the recursive relation

$$B_{i,Lt+1} = \delta B_{i,Lt} + \ell_{it}.$$

where $\delta B_{i,Lt}$ is outstanding nominal debt and ℓ_{it} are new bond purchases at time t.

We want to obtain the market value of outstanding nominal debt, which is defined as the discounted present value of all future payments from $t+1$ onward:

$$\begin{aligned} \text{MktValue_LTBond}_t &= Q_{St}\left[\delta\ell_{t-1} + \delta^2\ell_{t-2} + \delta^3\ell_{t-3} + ...\right] + Q_{St}Q_{St+1}\left[\delta^2\ell_{t-1} + \delta^3\ell_{t-2} + \delta^4\ell_{t-3} + ...\right] + ... \\ &= Q_{St}\left[1 + Q_{St+1}\delta + Q_{St+1}Q_{St+2}\delta^2 + ...\right]\delta B_{i,Lt} \end{aligned} \tag{19}$$

Now consider the no-arbitrage condition between short and long term bond (see the derivation below for details)

$$Q_{Lt} = Q_{St}\left(1 + \delta Q_{Lt+1}\right)$$

and substitute out Q_{Lt+n}, $n > 0$, recursively to obtain

$$Q_{Lt} = Q_{St}\left[1 + \delta Q_{St+1}\left(1 + \delta\left(Q_{St+2}\left(1 + \delta Q_{Lt+3}\right)\right)\right)\right]$$

which, compared to the second line in (19), illustrates that the market value of outstanding long-term bonds at t is $Q_{Lt}\delta B_{i,Lt}$. The case $\delta = 0$ corresponds to short-term one-period bonds which we denoted by $B_{i,St}$.

A.2 Price indexes

Let P_{it} be the individual-level price index faced by household i and defined as the deflator for basket c_{it} which satisfies the relation (1) in the main text

$$c_{it}P_{it} = \sum_{j=1}^{J} c_{ij,t}\mathcal{P}_{jt}, \tag{20}$$

where $j = 1, ..., J$ denotes a specific consumption category and $\mathcal{P}_{jt}$ its price. Taking logs of (20) and evaluating the effect of small changes in the entire vector $\{\mathcal{P}_{jt}\}$, at a date where the economy rests in steady state (denoted by the subscript ss), on the individual price index P_{it} we obtain

$$\begin{aligned}
\log P_{it} &\simeq \log P_{i,ss} + \sum_{j=1}^{J} \frac{\left(\frac{c_{ij,ss}}{c_{i,ss}}\right)}{\sum_{j=1}^{J}\left(\frac{c_{ij,ss}}{c_{i,ss}}\right)\mathcal{P}_{j,ss}} \left(\mathcal{P}_{jt} - \mathcal{P}_{j,ss}\right) \\
&= \log P_{i,ss} + \sum_{j=1}^{J} \frac{c_{ij,ss}\mathcal{P}_{j,ss}}{\sum_{j=1}^{J} c_{ij,ss}\mathcal{P}_{j,ss}} \left(\frac{\mathcal{P}_{jt} - \mathcal{P}_{j,ss}}{\mathcal{P}_{j,ss}}\right)
\end{aligned}$$

which yields

$$d\log P_{it} \simeq \sum_{j=1}^{J} xsh_{ij,ss} \cdot d\log \mathcal{P}_{jt}$$

where $xsh_{ij,ss}$ is the expenditure share of household i on good j at the initial time, the point of the expansion, i.e. before the price change. The notation $d\log X_{it}$ represents the log change of variable X_{it} from the pre-shock period to period t.

Recall that $\mathcal{P}_{jt} = \mathcal{P}^*_{jt}(1 + \tau_{jt})$, where $\mathcal{P}^*_{jt}$ is the raw price and τ_{jt} denote good-specific wedges (interpreted as taxes is positive and subsidies if negative). For our decomposition in the main text, it is useful to separate the effect of deviations in raw prices $\mathcal{P}_{jt}$ from the effect of deviations in taxes τ_{jt}. We generalize the previous derivation as

$$\begin{aligned}
\log P_{it} &\simeq \log P_{i,ss} + \sum_{j=1}^{J} \frac{\left(\frac{c_{ij,ss}}{c_{i,ss}}\right)(1+\tau_{j,ss})}{\sum_{j=1}^{J}\left(\frac{c_{ij,ss}}{c_{i,ss}}\right)\mathcal{P}_{j,ss}} \left(\mathcal{P}^*_{jt} - \mathcal{P}^*_{j,ss}\right) + \sum_{j=1}^{J} \frac{\left(\frac{c_{ij,ss}}{c_{i,ss}}\right)\mathcal{P}^*_{j,ss}}{\sum_{j=1}^{J}\left(\frac{c_{ij,ss}}{c_{i,ss}}\right)\mathcal{P}_{j,ss}} \left(\tau_{jt} - \tau_{j,ss}\right) \\
&= \log P_{i,ss} + \sum_{j=1}^{J} \frac{c_{ij,ss}\mathcal{P}_{j,ss}}{\sum_{j=1}^{J} c_{ij,ss}\mathcal{P}_{j,ss}} \left(\frac{\mathcal{P}^*_{jt} - \mathcal{P}^*_{j,ss}}{\mathcal{P}^*_{j,ss}}\right) + \sum_{j=1}^{J} \frac{c_{ij,ss}\mathcal{P}_{j,ss}}{\sum_{j=1}^{J} c_{ij,ss}\mathcal{P}_{j,ss}} \left(\frac{\tau_{jt} - \tau_{j,ss}}{1+\tau_{j,ss}}\right)
\end{aligned}$$

which yields

$$d\log P_{it} \simeq \sum_{j=1}^{J} xsh_{ij,ss} \cdot d\log \mathcal{P}^*_{jt} + \sum_{j=1}^{J} xsh_{ij,ss} \cdot d\tau_{jt}$$

In the main text, we use the notation

$$\begin{aligned}
d\log P^*_{it} &= \sum_{j=1}^{J} xsh_{ij,ss} \cdot d\log \mathcal{P}^*_{jt} \\
d\log \mathcal{T}_{it} &= \sum_{j=1}^{J} xsh_{ij,ss} \cdot d\tau_{jt}.
\end{aligned}$$

A.3 Household problem and optimality

We restate periods $t = 0, 1$ budget constraints for a cohort born at $t = 0$:

$$\begin{aligned} c_{i0}P_{i0} &= W_{i0} - T_{i0} + B_{i,S0} + B_{i,L0} + \sum_{k=1}^{K} (Q_{k0} + D_{k0})\, a_{i,k0} - Q_{S0}B_{i,S1} - Q_{L0}\left(B_{i,L1} - \delta B_{i,L0}\right) - \sum_{k=1}^{K} Q_{k0}a_{i,k1} \\ c_{i1}P_{i1} &= W_{i1} - T_{i1} + B_{i,S1} + (1 + Q_{L1}\delta)\, B_{i,L1} + \sum_{k=1}^{K} (Q_{k1} + D_{k1})\, a_{i,k1} \end{aligned} \tag{21}$$

where the $t = 1$ constraint encodes the fact that it is the last period of this cohort's lifetime, and thus optimality implies that $B_{i,S2} = B_{i,L2} = a_{i,k2} = 0$ for all k.

The Lagrangean of this problem is

$$\begin{aligned} \mathcal{L}_i = \sum_{t=0}^{1} \beta^t u_i\left(c_{it}\right) + \sum_{t=0}^{1} \beta_i^t \lambda_{it} \quad & \Bigg[W_{it} - T_{it} + B_{i,St} + (1 + \delta Q_{Lt})\, B_{i,Lt} + \sum_{k=1}^{K} (Q_{kt} + D_{kt})\, a_{i,kt} \\ & - c_{it}P_{it} - Q_{St}B_{i,St+1} - Q_{Lt}B_{i,Lt+1} - \sum_{k=1}^{K} Q_{kt}a_{i,kt+1} \Bigg] \end{aligned} \tag{22}$$

where λ_{it} is the shadow value of one unit of account (e.g., one euro) for individual i at date t.

The first order conditions (FOCs) with respect to $(c_{it}, B_{i,S1}, B_{i,L1}, a_{i,k1})$ are

$$\begin{aligned} u_i'\left(c_{it}\right) &= \lambda_{it}P_{it} \text{ for } t = 0, 1 \\ \lambda_{i0}Q_{S0} &= \beta_i \lambda_{i1} \\ \lambda_{i0}Q_{L0} &= \beta_i \lambda_{i1}\left(1 + Q_{L1}\delta\right) \\ \lambda_{i0}Q_{k0} &= \beta_i \lambda_{i1}\left(Q_{k1} + D_{k1}\right) \text{ for all } k \end{aligned} \tag{23}$$

Combining the first two equations yields

$$\beta_i \lambda_{i1} = Q_{S0} \cdot \frac{u'\left(c_{i0}\right)}{P_{i0}} \tag{24}$$

Note that the FOCs can be rewritten as

$$\begin{aligned} Q_{S0} &= \beta_i \frac{u_i'\left(c_{i1}\right)}{u_i'\left(c_{i0}\right)} \left(\frac{P_{i0}}{P_{i1}}\right) \\ Q_{L0} &= Q_{S0}\left(1 + Q_{L1}\delta\right) \\ Q_{k0} &= Q_{S0}\left(Q_{k1} + D_{k1}\right) \text{ for all } k. \end{aligned} \tag{25}$$

A.4 Welfare impact of the shock

We know from the envelope theorem that, if V_i denotes the maximized lifetime value of the household, and if we let dz_0 denote an exogenous shock that affects the household budget constraint

$$\frac{dV_i}{dz_0} = \frac{d\mathcal{L}_i}{dz_0}. \tag{26}$$

Recall our definition of money-metric welfare

$$d\mathcal{W}_i = \frac{dV_i/dz_0}{u'(c_{i0})} P_{i0}, \tag{27}$$

which we split into the first period and second-period welfare changes as

$$d\mathcal{W}_i = d\mathcal{W}_{i0} + d\mathcal{W}_{i1}.$$

Differentiating the Lagrangean with respect to z_0 yields:

$$\begin{aligned}
\frac{d\mathcal{L}_i}{dz_0} = \lambda_{i0} \quad & \left[-\frac{d\log P_{i0}}{dz_0} c_{i0} P_{i0} + \frac{d\log W_{i0}}{dz_0} W_{i0} - \frac{d\log T_{i0}}{dz_0} T_{i0} + \sum_{k=1}^{K} \frac{d\log Q_{k0}}{dz_{i0}} Q_{k0} \left(a_{i,k0} - a_{i,k1}\right) \right. \\
& \left. + \sum_{k=1}^{K} \frac{d\log D_{k0}}{dz_0} D_{k0} a_{i,k0} \right] \\
& + \lambda_{i0} \left[-\frac{d\log Q_{S0}}{dz_0} Q_{S0} B_{i,S1} - \frac{d\log Q_{L0}}{dz_0} Q_{L0} \left(B_{i,L1} - \delta B_{i,L0}\right) \right] \\
+\beta\lambda_{i1} \quad & \left[-\frac{d\log P_{i1}}{dz_0} c_{i1} P_{i1} + \frac{d\log W_{i1}}{dz_0} W_{i1} - \frac{d\log T_{i1}}{dz_0} T_{i1} + \sum_{k=1}^{K} \frac{d\log Q_{k1}}{dz_0} Q_{k1} a_{i,k1} \right. \\
& \left. + \sum_{k=1}^{K} \frac{d\log D_{k1}}{dz_0} D_{k1} a_{i,k1} \right] \\
+\beta\lambda_{i1} \quad & \frac{d\log Q_{L1}}{dz_0} \delta Q_{L1} B_{i,L1}
\end{aligned} \tag{28}$$

Note that the last term is zero because of *Assumption 3*.

Using (23) and (24) to substitute out the multipliers, exploiting the envelope theorem result in (26), and applying our definition of welfare in (27) we arrive at:

$$\begin{aligned}
d\mathcal{W}_{i0} \quad = \quad & -\frac{d\log P_{i0}}{dz_0} c_{i0} P_{i0} + \frac{d\log W_{i0}}{dz_0} W_{i0} - \frac{d\log T_{i0}}{dz_0} T_{i0} + \sum_{k=1}^{K} \frac{d\log Q_{k0}}{dz_{i0}} Q_{k0} \left(a_{i,k0} - a_{i,k1}\right) \\
& + \sum_{k=1}^{K} \frac{d\log D_{k0}}{dz_0} D_{k0} a_{i,k0} - \frac{d\log Q_{S0}}{dZ_0} Q_{S0} B_{i,S1} - \frac{d\log Q_{L0}}{dZ_0} Q_{L0} \left(B_{i,L1} - \delta B_{i,L0}\right)
\end{aligned} \tag{29}$$

for the first period and

$$d\mathcal{W}_{i1} = Q_{S0}\left[-\frac{d\log P_{i1}}{dz_0}c_{i1}P_{i1} + \frac{d\log W_{i1}}{dz_0}W_{i1} - \frac{d\log T_{i1}}{dz_0}T_{i1} + \sum_{k=1}^{K}\frac{d\log Q_{k1}}{dz_0}Q_{k1}a_{i,k1} + \sum_{k=1}^{K}\frac{d\log D_{k1}}{dz_0}D_{k1}a_{i,k1}\right] \tag{30}$$

for the second period.

Assumptions 2-3 on duration and long run neutrality of the shocks state that

$$\frac{d\log W_{i1}}{dz_0} = \frac{d\log T_{i1}}{dz_0} = \frac{d\log D_{k1}}{dz_0} = \frac{d\log Q_{k1}}{dz_0} = \frac{d\log \bar{P}_{i1}}{dz_0} = \frac{d\log \bar{P}_1}{dz_0}.$$

Thus, collecting terms, we can rewrite the second-period welfare change $d\mathcal{W}_{i1}$ as

$$d\mathcal{W}_{i1} = \frac{d\log \bar{P}_1}{dz_0}Q_{S0}\left[-c_{i1}P_{i1} + W_{i1} - T_{i1} + \sum_{k=1}^{K}\left(Q_{k1} + D_{k1}\right)a_{i,k1}\right]$$

Using period $t = 1$ budget constraint from (21), we arrive at

$$d\mathcal{W}_{i1} = -\frac{d\log \bar{P}_1}{dz_0}Q_{S0}\left[B_{i,S1} + \left(1 + Q_{L0}\delta\right)B_{i,L1}\right]. \tag{31}$$

A.5 Decomposition

We now derive the breakdown of this welfare change into four components: (i) a short-run pre-government direct component, (ii) an unconventional fiscal policy component, (iii) a short-run indirect component, and (iv) a long-run component:

$$d\mathcal{W}_i = d\mathcal{W}_i^{DIR} + d\mathcal{W}_i^{UFP} + d\mathcal{W}_i^{IND} + d\mathcal{W}_i^{LR}$$

The direct component $d\mathcal{W}_i^{DIR}$ takes into account only the increase in the raw cost of living for an individual, and abstracts from ad-hoc government interventions in response to the shock $\left(\tau_{jt}, T_{it}^{HOC}\right)$, from all equilibrium changes in wages and net transfers $\left(W_{it}, T_{it}^{AUT}\right)$, as well as from changes in prices $(Q_{St}, Q_{Lt}, Q_{kt}, D_{kt})$.

Consider the first term of $d\mathcal{W}_{i0}$ in equation (29) and use the period $t=0$ budget constraint (21)

$$\begin{aligned}
-\frac{d\log P_{i0}}{dz_0}c_{i0}P_{i0} &= -\frac{d\log P_{i0}}{dz_0}\left[W_{i0}-T_{i0}+B_{i,S0}+\left(1+Q_{L0}\delta\right)B_{i,L0}+\sum_{k=1}^{K}Q_{0k}\left(a_{i,0k}-a_{i,1k}\right)\right.\\
&\qquad \left.+\sum_{k=1}^{K}D_{0k}a_{i,0k}-Q_{S0}B_{i,S1}-Q_{L0}B_{i,L1}\right] \qquad (32)\\
&= -\frac{d\log P_{i0}}{dz_0}\left[W_{i0}-T_{i0}+B_{i,S0}+\left(1+Q_{L0}\delta\right)B_{i,L0}+\sum_{k=1}^{K}Q_{0k}\left(a_{i,0k}-a_{i,1k}\right)+\sum_{k=1}^{K}D_{0k}a_{i,0k}\right]\\
&\quad +\frac{d\log P_{i0}}{dz_0}\left[Q_{S0}B_{i,S1}+Q_{L0}B_{i,L1}\right]
\end{aligned}$$

Recall that from our derivation of Section 2

$$\frac{d\log P_{i0}}{dz_0}=\frac{d\log P^{*}_{i0}}{dz_0}+\frac{d\log \Im_{i0}}{dz_0}. \qquad (33)$$

We define the short-run direct component of the welfare change as the term in the second line of equation (32) which is driven by the change in raw individual-level price indexes P^{*}_{i0}

$$d\mathcal{W}_i^{DIR}=-\frac{d\log P^{*}_{i0}}{dz_0}\left[W_{i0}-T_{i0}+B_{i,S0}+\left(1+Q_{L0}\delta\right)B_{i,L0}+\sum_{k=1}^{K}Q_{0k}\left(a_{i,0k}-a_{i,1k}\right)+\sum_{k=1}^{K}D_{0k}a_{i,0k}\right]. \qquad (34)$$

The main text provides an interpretation, term by term.

To determine the unconventional fiscal policy component, it is useful to distinguish between two components of net transfers to households

$$T_{i0}^{AUT}+T_{i0}^{HOC},$$

and define $d\log T_{i0}^{AUT}$ as the automatic adjustment to the shock, for a given tax and transfer system already in place at the time of the shock, and $d\log T_{i0}^{HOC}$ as all ad-hoc direct fiscal transfers to households adopted to fight the inflationary shock. This welfare component collects this latter term as well as the ad-hoc government interventions that directly mitigate the rise in certain prices, i.e. $d\log \Im_{i0}$ in equation (33). Combining terms

$$\begin{aligned}
d\mathcal{W}_i^{UFP} &= -\frac{d\log \Im_{i0}}{dz_0}\left[W_{i0}-T_{i0}+B_{i,S0}+\left(1+Q_{L0}\delta\right)B_{i,L0}+\sum_{k=1}^{K}Q_{0k}\left(a_{i,0k}-a_{i,1k}\right)+\sum_{k=1}^{K}D_{0k}a_{i,0k}\right]\\
&\quad -\frac{dT_{i0}^{HOC}}{dz_0} \qquad (35)
\end{aligned}$$

It is easy to see that by summing (34) and (35) one obtains (32), net of the term in the third line of (32).

Consider now precisely this term in the third line of (32) and add it to $t = 1$ welfare change $d\mathcal{W}_{i1}$ computed in (31) . We define the long-run component of the welfare change as

$$d\mathcal{W}_i^{LR} = d\mathcal{W}_{i1} + \frac{d\log P_{i0}}{dz_0}\left[Q_{S0}B_{i,S1} + Q_{L0}B_{i,L1}\right]$$

Using the expression for $d\mathcal{W}_{i1}$ in (31) together with the no-arbitrage condition $Q_{L0} = Q_{S0}\left(1 + Q_{L1}\delta\right)$ between short-term and long-term bonds in (25) yields

$$d\mathcal{W}_i^{LR} = Q_{S0}\left(\frac{d\log P_{i0}}{dz_0} - \frac{d\log \bar{P}_1}{dz_0}\right)\left[B_{i,S1} + \left(1 + Q_{L0}\delta\right)B_{i,L1}\right]. \tag{36}$$

The main text contains the interpretation of each term of this component.

The remaining term is the short-run general equilibrium welfare change which collects all the remaining terms in $d\mathcal{W}_{i0}$

$$\begin{aligned} d\mathcal{W}_i^{IND} &= \frac{d\log W_{i0}}{dz_0}W_{i0} - \frac{d\log T_{i0}^{AUT}}{dz_0}T_{i0}^{AUT} + \sum_{k=1}^{K}\frac{d\log Q_{k0}}{dz_{i0}}Q_{k0}\left(a_{i,k0} - a_{i,k1}\right) + \sum_{k=1}^{K}\frac{d\log D_{k0}}{dz_0}D_{k0}a_{i,k0} \\ &\quad - \frac{d\log Q_{S0}}{dz_0}Q_{S0}B_{i,S1} - \frac{d\log Q_{L0}}{dz_0}Q_{L0}\left(B_{i,L1} - \delta B_{i,L0}\right) \end{aligned} \tag{37}$$

The main text contains an interpretation of this last component.

A.6 Old cohort

These derivations apply to the young cohort who lives through the short-run and the long-run. We now obtain similar derivations for the old cohort, which we denote with the hat symbol. Their Lagrangean satisfies:

$$\widehat{\mathcal{L}}_i = u\left(c_{i0}\right) + \lambda_{i0}\left[W_{i0} - T_{i0} + B_{i,S0} + B_{i,L0} + \sum_{k=1}^{K}\left(Q_{k0} + D_{k0}\right)a_{i,k0} - c_{i0}P_{i0} + Q_{L0}\delta B_{i,L0}\right]$$

Differentiating with respect to the shock dz_0, and following the same steps as before, we obtain:

$$\begin{aligned} d\widehat{\mathcal{W}}_i &= -\frac{d\log P_{i0}}{dz_0}c_{i0}P_{i0} + \frac{d\log W_{i0}}{dz_0}W_{i0} - \frac{d\log T_{i0}}{dz_0}T_{i0} + \sum_{k=1}^{K}\frac{d\log Q_{k0}}{dz_{i0}}Q_{k0}a_{i,k0} \\ &\quad + \sum_{k=1}^{K}\frac{d\log D_{k0}}{dz_0}D_{k0}a_{i,k0} + \frac{d\log Q_{L0}}{dz_0}\delta B_{i,L0} \end{aligned} \tag{38}$$

The decomposition becomes:

$$
\begin{aligned}
d\widehat{\mathcal{W}}_i^{DIR} &= -\frac{d\log P_{i0}^*}{dz_0}\left[W_{i0} - T_{i0} + Q_{L0}\delta B_{i,L0} + B_{i,S0} + B_{i,L0} + \sum_{k=1}^{K} Q_{k0}a_{i,k0} + \sum_{k=1}^{K} D_{k0}a_{i,k0}\right] \\
d\widehat{\mathcal{W}}_i^{UFP} &= \left(\frac{d\log P_{i0}^*}{dz_0} - \frac{d\log P_{i0}}{dz_0}\right)\left[W_{i0} - T_{i0} + Q_{L0}\delta B_{i,L0} + B_{i,S0} + B_{i,L0} + \sum_{k=1}^{K} Q_{k0}a_{i,k0} + \sum_{k=1}^{K} D_{k0}a_{i,k0}\right] \\
&\quad -\frac{dT_{i0}^{HOC}}{dz_0} \\
d\widehat{\mathcal{W}}_i^{IND} &= \frac{d\log W_{i0}}{dz_0}W_{i0} - \frac{d\log T_{i0}^{AUT}}{dz_0}T_{i0}^{AUT} + \sum_{k=1}^{K}\frac{d\log Q_{k0}}{dz_{i0}}Q_{k0}a_{i,k0} + \sum_{k=1}^{K}\frac{d\log D_{k0}}{dz_0}D_{k0}a_{i,k0} \\
&\quad +\frac{d\log Q_{L0}}{dz_0}\delta B_{i,L0}.
\end{aligned}
$$

Appendix B Additional figures

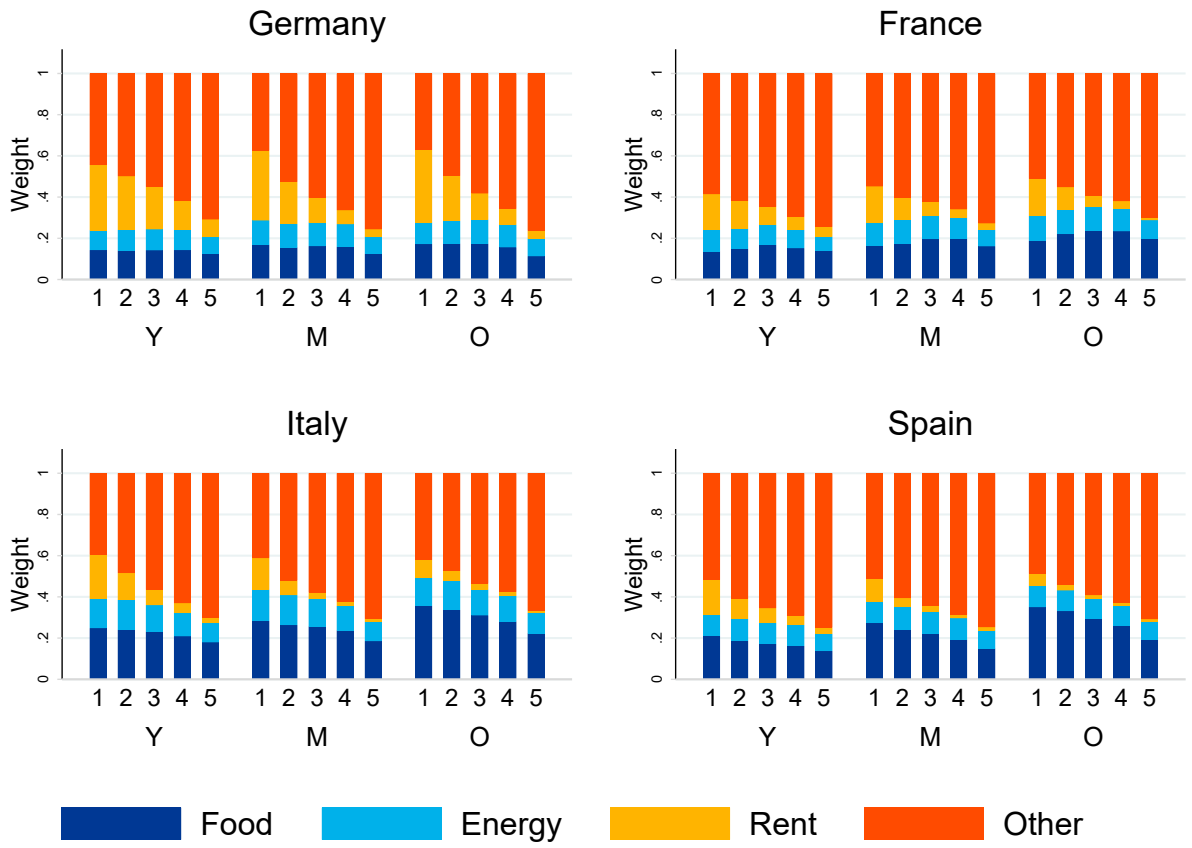


Figure 14: Structure of consumption expenditures by age classes and nondurable consumption quintiles within each age class

Note: The chart show the shares of main consumption components on total consumption in percent; the complement to 1 are the remaining consumption components. The groups Y, M and O denote ages of less that 45 years, 45–64 years and older than 64 years
Source: Household Budget Survey, 2015

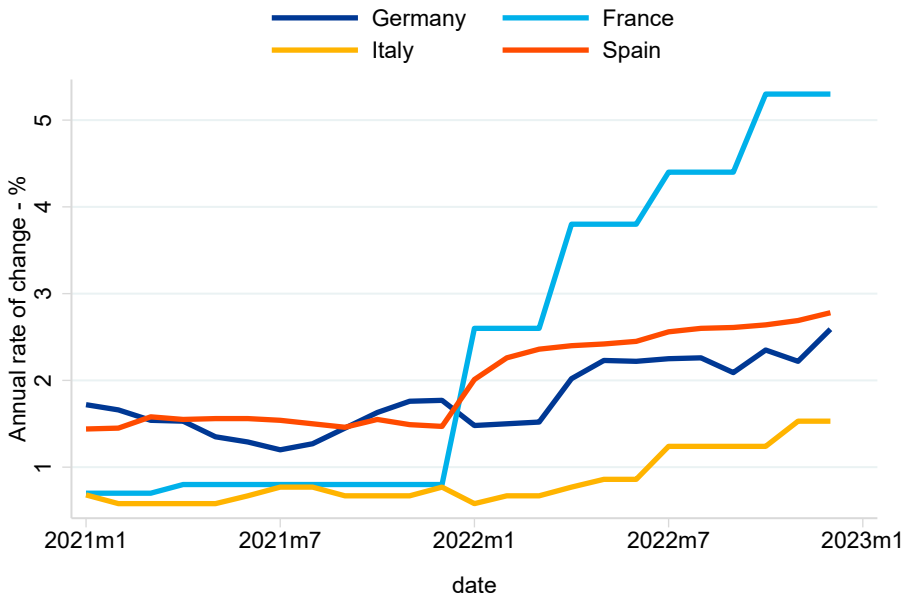


Figure 15: Average annual rate of change for negotiated wages, monthly data, 2021–2022

Source: National Statistical Agencies.

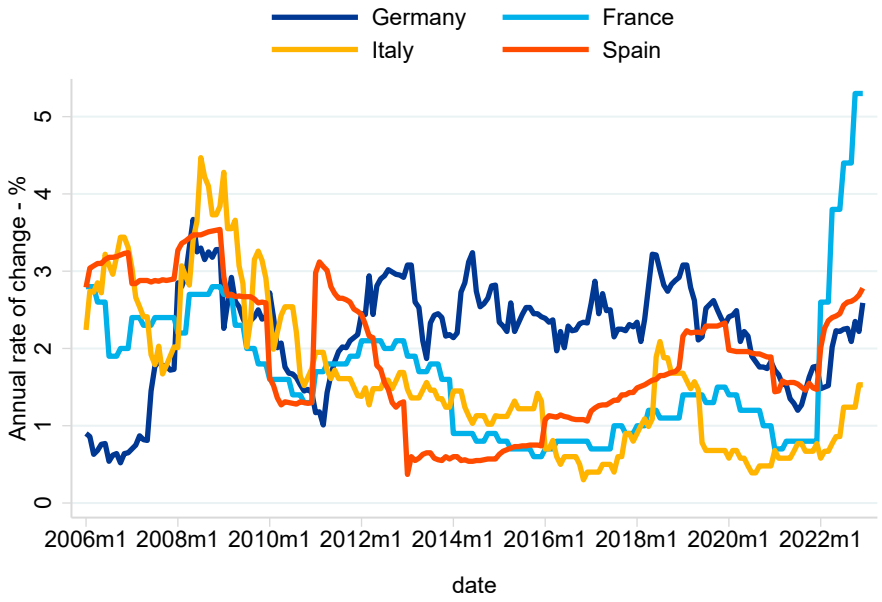


Figure 16: Average annual rate of change for negotiated wages, monthly data, 2006–2022

Source: National Statistical Agencies.

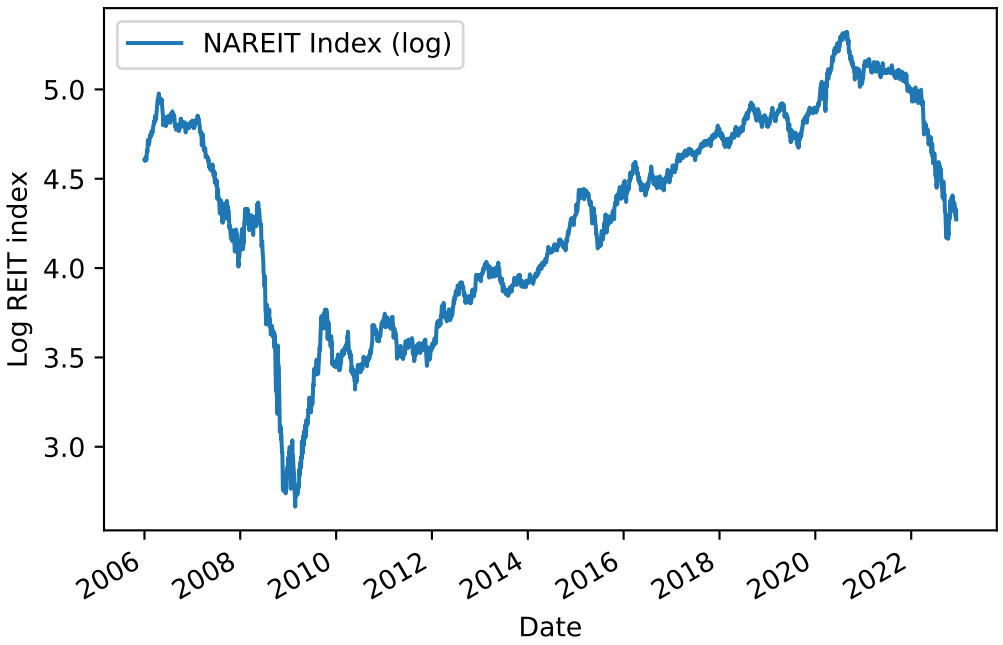


Figure 17: NAREIT Euro zone Residential Index ; in logs.

Source: Bloomberg.

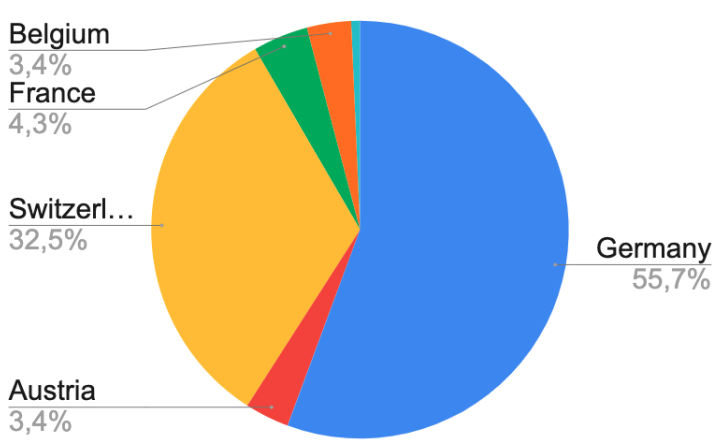


Figure 18: Distribution of the REITs by country.

Source: FACTSET.

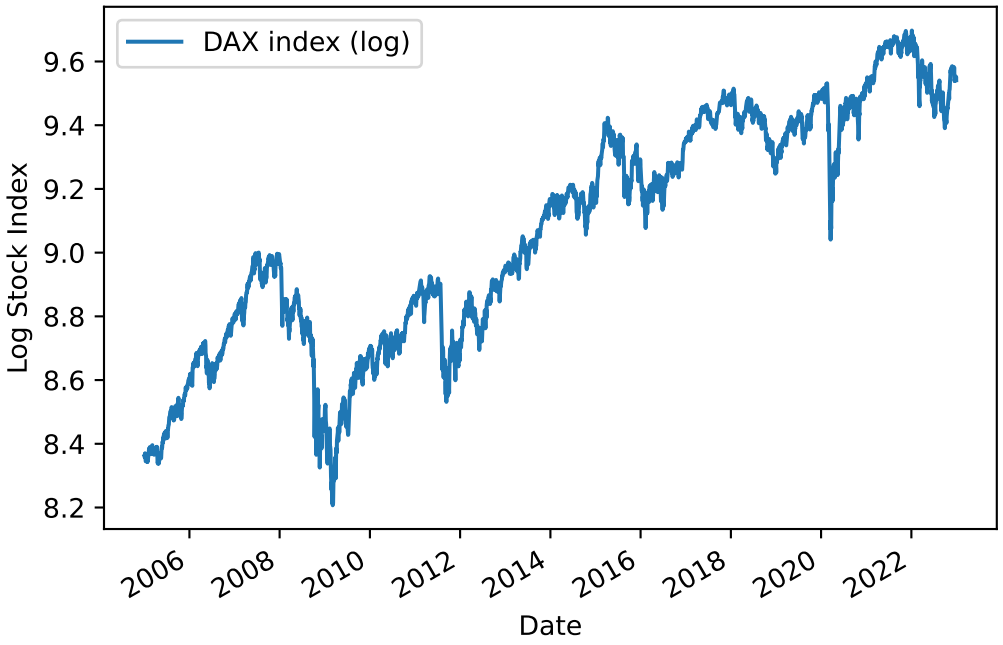


Figure 19: Value of the DAX Index ; in logs.

Source: Bloomberg.

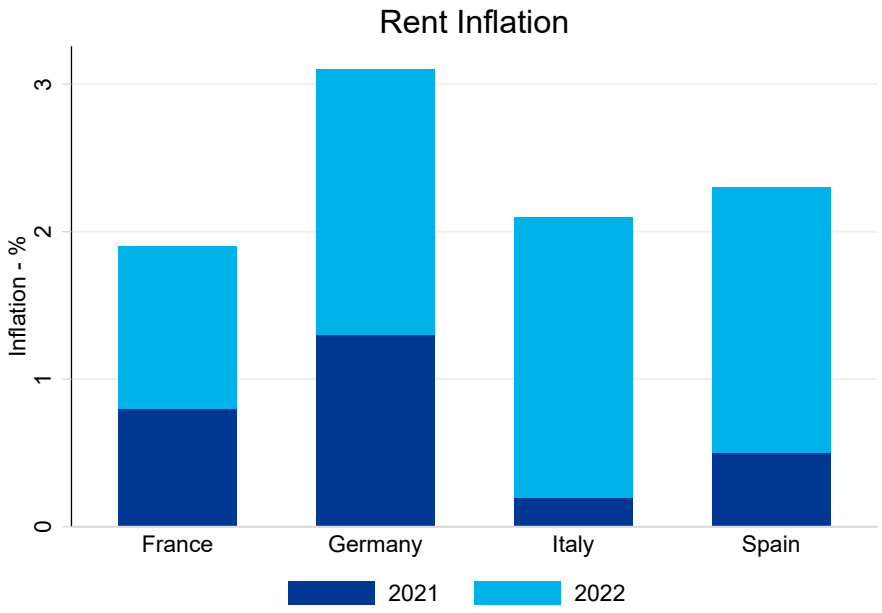


Figure 20: Rent inflation during 2021 and 2022 for France, Germany, Italy and Spain.

Source: HICP.

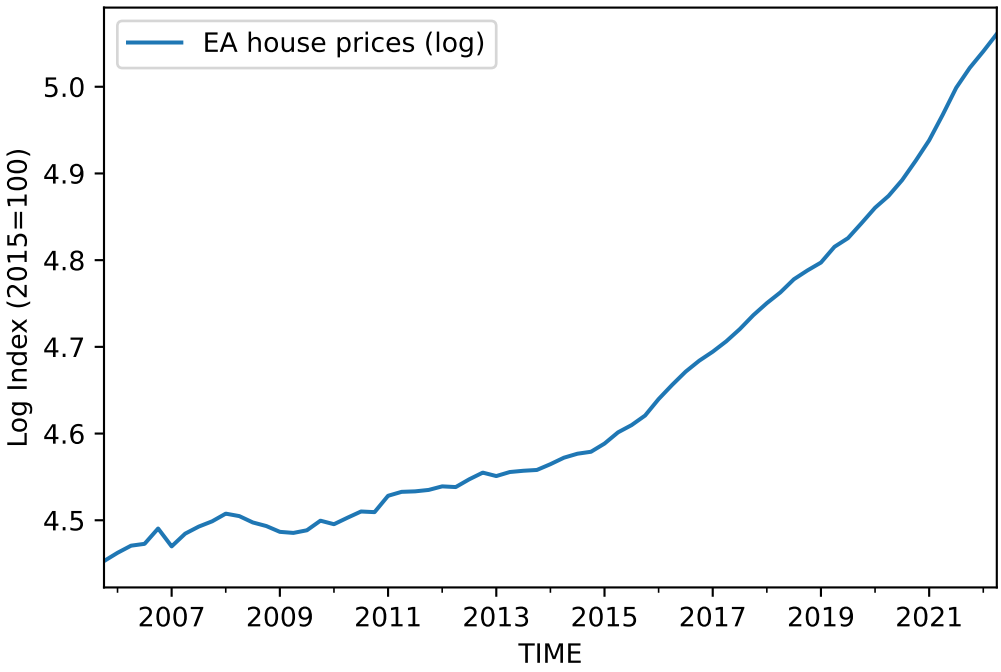


Figure 21: Weighted average of euro area house prices according to the share of each country in the residential REIT index.

Source: OECD

Appendix C Additional tables

Germany CPI Release Dates		
19 Jan 2021	30 Aug 2021	28 Apr 2022
28 Jan 2021	10 Sep 2021	11 May 2022
10 Feb 2021	30 Sep 2021	30 May 2022
01 Mar 2021	13 Oct 2021	14 Jun 2022
12 Mar 2021	28 Oct 2021	29 Jun 2022
30 Mar 2021	10 Nov 2021	13 Jul 2022
15 Apr 2021	29 Nov 2021	28 Jul 2022
29 Apr 2021	10 Dec 2021	30 Aug 2022
12 May 2021	19 Jan 2022	12 Sep 2022
31 May 2021	31 Jan 2022	13 Sep 2022
15 Jun 2021	11 Feb 2022	29 Sep 2022
29 Jun 2021	01 Mar 2022	13 Oct 2022
13 Jul 2021	11 Mar 2022	28 Oct 2022
29 Jul 2021	30 Mar 2022	11 Nov 2022
11 Aug 2021	12 Apr 2022	29 Nov 2022

Table 2: Press Release Dates for CPI in Germany (2021–22)

Source: German Federal Statistical Office

Step 1:	$R(Q_t) = \beta\,\Delta ILS_{1Y,t} + \gamma R(S_t) + \varepsilon_t$		
	REITs	**Bonds**	**Stocks**
Inflation surprise $\Delta ILS_{1Y,t}$	−2.042	−0.423	−0.429
	(2.467)	(0.596)	(1.546)
$R(S_t)$	0.466	−0.025	0.069
	(0.298)	(0.073)	(0.167)
const	−0.309	−0.009	0.115
	(0.306)	(0.072)	(0.188)
Obs	39	46	44
Adj. R^2	0.021	−0.031	−0.043
F-stat	1.412	0.330	0.115

Step 2: $R(H_t) - R_f = \alpha + \delta\big[R(Q_{t-1}) - R_f\big] + \tilde{\gamma}\big[R(S_t) - R_f\big] + \text{controls} + \varepsilon_t$	
	House returns
$R(Q_{t-1}) - R_f$	0.015*
	(0.018)
$R(S_t) - R_f$	0.012
	(0.018)
Exchange Rate	−0.262**
	(0.028)
Industrial Production	0.013
	(0.052)
Inflation	−0.085
	(0.118)
Term Structure	−0.571$^+$
	(0.218)
const	27.087**
	(2.908)
Obs	64
Adj. R^2	0.630
F-stat	23.316

Table 3: Sensitivities of asset prices to inflation surprises

For stocks, the table reports the results for Germany. The market returns $R(S_t)$ are proxied with the EU returns for REITs and bonds, and with global returns for stocks. See Appendix D.6.1 for further details.

Age class	Consumption quintile	Germany	France	Italy	Spain
	1	−2.33	0.21	0.78	8.69
	2	0.12	1.90	0.91	6.83
Young	3	−0.66	4.05	−0.96	6.18
	4	−0.00	3.75	1.60	5.22
	5	0.73	4.87	−0.85	4.45
	1	−1.87	−3.26	−7.73	1.26
	2	−6.43	−2.89	−6.40	−3.91
Middle age	3	−7.02	−3.41	−7.79	−4.64
	4	−5.96	−3.22	−8.55	−3.37
	5	−6.21	−2.86	−6.48	−5.44
	1	−5.01	−6.84	−14.83	−10.34
	2	−8.05	−8.17	−20.04	−7.70
Retirees	3	−11.65	−8.86	−16.44	−8.80
	4	−10.94	−10.60	−15.49	−6.85
	5	−7.48	−10.97	−16.31	−10.75
All		−4.97	−3.12	−8.72	−3.28

Table 4: Combined net effect of the inflation shock as a percentage of disposable income by age class and consumption quintile

Appendix D Measurement of variables

D.1 Inflation rates

We take the inflation rate of each of our consumption categories reported in Table 1 from the Harmonised Index of Consumer Prices (HICP). As described in the main text, we then weigh each inflation rate by the share of the related expenditures reported in 2015 Household Budget Survey (HBS), which is the latest one available. We construct these weights for each of our household cohort by aggregating over fifteen groups defined in terms of age (25-44, 45-64, 65+) and consumption quintiles.

To take into account the evolution of prices from 2015 to 2020, we update the expenditure shares by assuming households keep the quantities purchased q_j of each category j fixed. Namely, defining xsh_j as the budget share of category j in 2015 HBS, we calculate the share in 2020 xsh'_j as:

$$xsh'_j = \frac{xsh_j(1+\pi_j)}{\sum_{i=1}^{I} xsh_i(1+\pi_i)}.$$

This approximation implies inflation rates that are close to the official numbers, see Table 5. For Germany and France, our benchmark estimates are within 0.4 pp of the official measures. Our benchmark rates are somewhat higher in Italy and lower in Spain—by 1.5–3 pp.[32] The third row reports the results using the original weights from the 2015 Household Budget Survey (i.e., without adjusting for the evolution of prices to year 2020, as described above), which are further from official statistics in Italy, but similar for the other countries.[33]

	Italy	Germany	France	Spain
Official	17.2	15.9	10.3	12.5
Our benchmark	20.4	16.2	10.7	11.0
No weight adjustment	21.5	16.3	10.6	11.3

Table 5: Comparison between cumulated inflation rates for 2021-2022: official sources (HICP) versus our benchmark results using the 2015 Household Budget Survey, adjusted for the evolution of prices between 2015 and 2020. "No weight adjustment" reports the results by using the 2015 Household Budget Survey without adjusting for prices.

D.2 Expenditure shares

All the figures containing the evolution of expenditure shares by income quintile from 2005 to 2015 using the Household Budget Survey can be found in our public folder at this link. The folder contains also the shares of these categories in terms of aggregate consumption using National Accounts from 2015 to 2019. Almost all consumption categories exhibit a flat trend from 2015 to 2019, and relatively stable rankings across income quintiles from 2005 to 2015.

[32] For average inflation rates over 2021 and 2022, which we use to devalue flows, the differences are smaller.

[33] Most of the discrepancy for Italy is generated by the share of electricity: the official weight in the HICP in Italy for 2021 is 4.9%, while in our results we have 6% or 6.5% (depending respectively on whether we adjust for prices or not). By setting the weight of electricity to the official one, we get a cumulated inflation rate of 18.3%, closer to official statistics.

D.3 The Household Finance and Consumption Survey

Net income. We take gross income from the HFCS, and we apply the methodology by Slacalek et al. (2020) to estimate disposable income. Specifically, for France, Germany and Spain we approximate after-tax income by applying marginal tax rates available from the OECD on taxable income (variable `di1100`) + $\frac{2}{3}\times$ self-employment income (`di1200`) and adding non-taxable income. For Italy, after-tax income is available directly in the HFCS. We refer the reader to their paper for further details on the procedure, as we follow closely in each step.

Net nominal position. Following Doepke and Schneider (2006), the net nominal position is defined as the sum of nominal assets `da2101` (deposits), `da2103` (bonds), `da2107` ("money owed to households") less liabilities `dl1000` ("Total outstanding balance of household's liabilities"), which consist of mortgages and non-mortgage debt (credit lines, credit cards and other non-collateralized loans). It thus excludes exposure arising from ownership of shares in financial intermediaries (e.g., mutual funds) or equity.

Other items. We measure housing wealth in the HFCS using variables `da1110` ("Value of household's main residence") and `da1120` ("Value of other real estate properties"). For stocks, we use directly held stocks reported in variable `da2105` ("Shares, publicly traded"). For rental income, we use `di1300` ("Rental income from real estate property").

D.4 Wages

The evolution of nominal wages in 2021 and 2022 is obtained from data on negotiated wages from National Statistical Agencies. Figures 15 and 16 report their evolution over time.

D.5 Financial data

D.5.1 REITs and house prices

To measure REITs returns in the euro area, we use the FTSE EPRA Nareit Developed Europe REITS Index, produced by Russell. Figure 17 reports its evolution from 2006. We compiled a list of the largest residential REITs in Europe and checked the countries in which most of their investment are concentrated using information on their domicile and on their investments where publicly available. More than half of the residential properties are concentrated in Germany, as reported in Figure 18.[34]

We obtain house prices from the OECD, weighting each EU country according to the geographical distribution of REIT index described above.[35] Figure 21 traces the evolution over time of our index.

D.6 Inflation surprises

The dates for the releases of the German HICP are reported in table 2. We use daily data from one-year-ahead Inflation Linked Swaps, obtained from Refinitiv.

[34]The list includes Vonovia, Swiss Prime Site, Gecina Societe anonyme, LEG Immobilien SE, PSP Swiss Property AG, Aedifica SA, Covivio, Kojamo Oyj, Cofinimmo, Allreal Holding AG, Swiss Life Holding AG and Nextensa.

[35]For REITs domiciled in Switzerland, we assume they have a porfolio of properties across the euro area.

D.6.1 Stocks and bond indices

For stock prices, we use the main index in each country (i.e., DAX for Germany, CAC 40 for France, IBEX 35 for Spain, FTSE MIB for Italy). Figure 19 reports its change since 2006. We control for global stock returns using iShares Core MSCI World All Cap ETF. For bond prices in the euro area, we construct a weighted average of a government bond index and a corporate bond index in proportion to the total value outstanding (with the weights correspoinding to two thirds and one third, respectively). For the government bond index, we use iShares Core Euro Govt Bond UCITS ETF, while for the corporate we use iShares Core Euro Corp Bond UCITS ETF.

Appendix E Interventions in energy markets

This appendix summarizes calculations of actual and counterfactual price indices for natural gas, electricity, and transportation fuels for our four EA economies. Data for observed indices were obtained from the Harmonised Index of Consumer Prices, which is compiled by Eurostat and measures consumer price inflation. Counterfactal price indices were calculated from variety of other sources including: Dao et al. (2023), OMIE (electricity operator in Spain), and Epdata.

E.1 Natural gas

Actual price indices for natural gas were obtained from the Harmonised Index of Consumer Prices. To estimate the effects of direct government interventions in the gas market, we use data provided by Dao et al. (2023), which is monthly series of counterfactual natural gas prices in France (EUR per kWh) from January 1, 2021 until December 1, 2022, and assume other countries would follow the same trajectory—which seems reasonable given the tight co-movement of natural gas prices in France and on international markets. To check the initial levels of natural gas prices (EUR per kWh) in all four countries, we visit Eurostat, where such data is provided on biannual basis. Combining these initial prices in our economies, time series of counterfactual prices, and actual price indices on January 1, 2021 (when governments intervened in energy markets) enabled us to construct counterfactual price indices.

The counterfactual prices of natural gas substantially exceed the actual ones, reflecting the large interventions in the gas market; Figure 22. The counterfactual prices peak around 0.3 EUR/kWh, compared to the peak of actual prices at around 0.13 EUR/kWh in Germany and France. The actual prices in Spain peaked around 0.08 EUR/kWh and around EUR 0.18 EUR/kWh in Italy.

E.2 Electricity

Actual price indices for electricity were obtained from the Harmonised Index of Consumer Prices. In order to calculate counterfactual electricity price index for France, we again employ data from Dao et al. (2023), which presents time series of counterfactual electricity prices in EUR per kWh for France on a monthly basis.

In Spain, the government intervened in energy markets to decouple local electricity prices from international gas prices. Usually, most of the energy in Spain is produced at a lower cost than the price of gas, but gas-fired power plants tend to be the marginal producers of electricity and as such they set the price of every unit of electricity. Effectively, the government set a cap on the price of gas used for the production of electricity and compensated gas-fired power plants accordingly. As a result, counterfactual electricity prices in the absence of the intervention can be computed by looking at the corresponding outstanding prices of gas in international markets. We obtain daily data of actual and counterfactual wholesale electricity prices in EUR per kWh for Spain from OMIE (electricity operator) and Epdata. It ranges from 1.12.2018 until 31.12.2023, therefore it encompasses the period of government intervention in the energy market. For our analysis, we regress daily counterfactual wholesale electricity price, $P_t^{\text{counterfactual}}$ on actual wholesale electricity price, P_t^{actual}:

$$P_t^{\text{counterfactual}} = a + b \cdot P_t^{\text{actual}}. \tag{39}$$

Next, we assume that retail counterfactual electricity prices can be scaled in the same way from retail actual electricity prices. To construct monthly data of actual retail electricity prices, we use

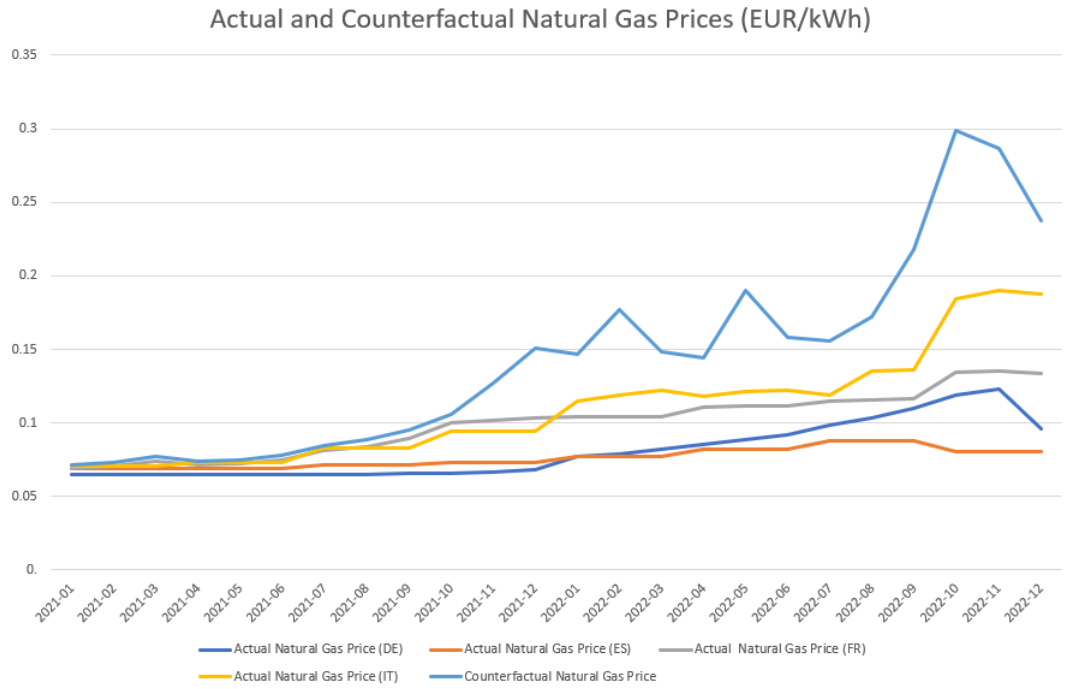


Figure 22: Actual and Counterfactual prices for natural gas in Germany, Spain, France, and Italy; EUR

Source: Harmonised Index of Consumer Prices, Eurostat; Dao et al. (2023).

Eurostat data for average electricity prices for Spanish households in the first half of 2021 and then scale them up according to the actual price index for Spain (from HICP). We then apply scaling by coefficients a and b from equation (39) to construct retail counterfactual prices. Lastly, by combining time series of retail counterfactual prices and actual price index on 1.1.2021 (when Spanish government intervened in the energy market) we construct counterfactual price index for Spain.

The effect of fiscal interventions on electricity prices was material, but smaller than for natural gas prices; Figure 23. In France, the counterfactual prices peaked at around 0.28 EUR/kWh, compared to the maximum of actual prices around 0.21 EUR/kWh. In Spain the effect was larger, with a counterfactual peak around 0.55 EUR/kWh and actual one around 0.41 EUR/kWh.

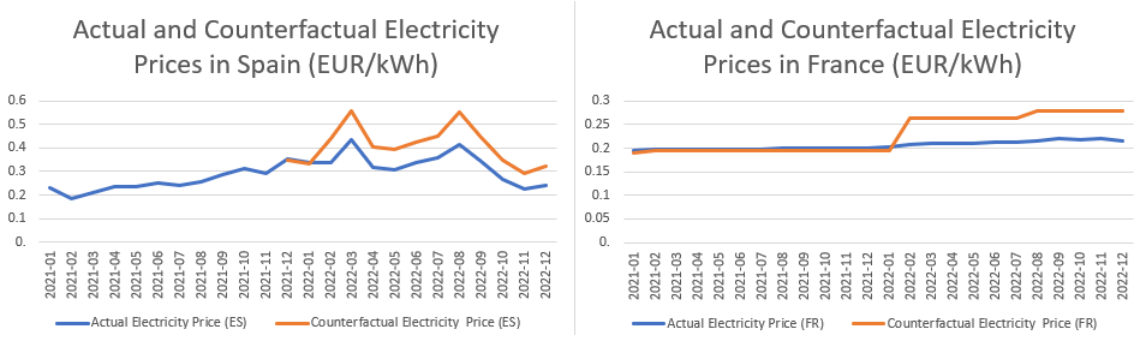


Figure 23: Actual and Counterfactual prices for electricity in Spain and France; EUR

Source: Harmonised Index of Consumer Prices, Eurostat; Dao et al. (2023); additional sources.

E.3 Petrol

Actual price indices for petrol were obtained from the Harmonised Index of Consumer Prices. To calculate counterfactual prices, we use Bruegelâs database containing subsidies that were applied to petrol. In all countries those discounts were set as a fixed amount of cents per liter of fuel, between 10 and 30 cents, and were enacted only for couple of months. We assumed full pass through to households. Since subsidies were applied in absolute terms, it is necessary to know petrol prices in EUR per liter. We obtain them from: Institut national de la statistique et des études économiques (Insee, France), Statista (Spain), myLPG.eu (Germany), and Mise.gov.it (Italy). Lastly, we converted counterfactual prices in EUR per liter into counterfactual price indices.

Fiscal interventions to reduce petrol prices had a smaller effect than for natural gas prices; Figure 24. We estimate that they reduced the prices by about 20 percent in 2021–22 (with some heterogeneity across countries).

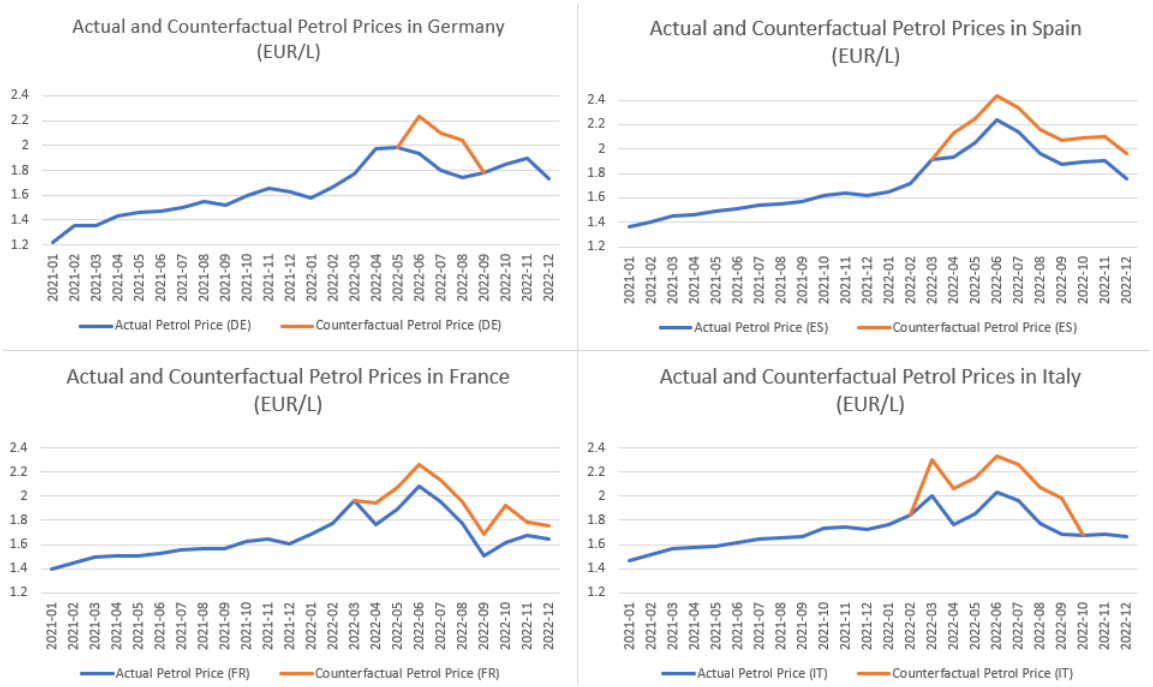


Figure 24: Actual and Counterfactual prices for petrol in Germany, Spain, France, and Italy; EUR

Source: Harmonised Index of Consumer Prices, Eurostat; additional sources.

Appendix F Summary of 2021–22 transfer payments

This appendix summarizes the transfer payment programs implemented in the four countries in 2021–2022.

- In our measures of transfers (in the second stage) we include the lump-sum payments or other forms of income support below, obtained from a dataset from Bruegel (link).
- Direct interventions in energy markets (e.g., temporary reductions of VAT rates, excise duties, price caps) are included in HICP, which measures (average) "purchase prices" (link).

F.1 Germany

- EUR 135 lump-sum payment for students and vulnerable citizens
- One-time payment of EUR 300 for every taxpayer, a EUR 100 cheque to boost child support and a monthly reduction to EUR 9/month for public transport
- One-time lump sum of EUR 300 to pensioners and EUR 200 to university students
- Increase in welfare payments (by EUR 500)
- EUR 100 subsidy to unemployed people (in 2022)

F.2 France

- EUR 100 one-off bonus to workers earning less than EUR 2,000 net
- 4% increase in benefits to those in the national safety net, including low-income families, pensioners, and those on disability benefits
- One-time back-to-school payment for low-income families on social assistance of EUR 100 per parent and EUR 50 per dependent child

F.3 Italy

- EUR 200 one-off bonus for workers and pensioners with an income level lower than EUR 35,000
- EUR 150 payment to workers with income level lower than EUR 20,000
- Households with ISEE lower than 12k pay electricity and gas at 2021 summer's prices (proxied with net income)
- Tax discount of 1.2 pp for workers with an income below EUR 35,000 (in 2022)
- 2% increment for pensioners with income lower than EUR 35,000 (in 2022)

F.4 Spain

- EUR 200 subsidy for low incomes, and raised non-contributory pensions by 15%