

# Who Bears the Costs of Inflation?

## Euro Area Households and the 2021–2022 Shock\*

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### 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 for households –expressed as a share of pre-shock biennial income– were larger than a typical recession, and heterogeneous, e.g., 3% in France and 8% 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 consumption quantiles 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. The counterpart of this household sector loss is a significant gain for the government sector in all countries.

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

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

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# 1 Introduction

After three decades of low and stable inflation, prices rose sharply in advanced economies in the wake of the Covid-19 pandemic. In the euro area, headline inflation reached a peak of 10.6% in October 2022.<sup>1</sup> 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?

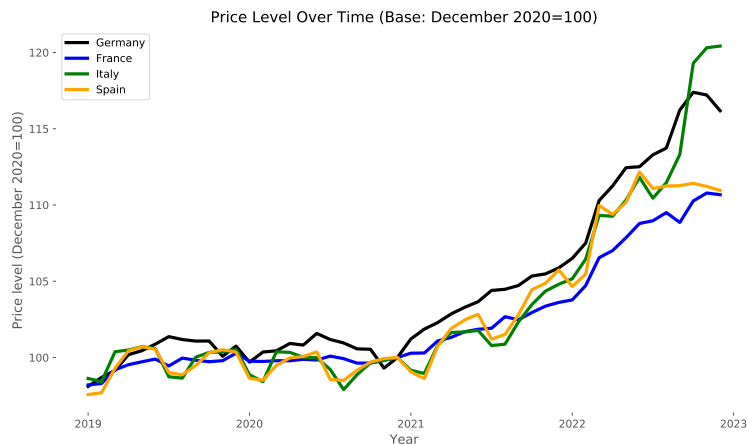
This classic question emerged in past historical episodes of high inflation. John Maynard Keynes and Milton Friedman, whose opinions differed on many core issues, concurred on the inequitable nature of inflation. Keynes considered inflation “unjust”.<sup>2</sup> Friedman called it “the cruelest tax of 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. Unexpected inflation, however, operates through a number of other channels besides the dilution of nominal wealth. In addition, the structural origin of the inflation shock matters for the answer, as recently illustrated by Del Canto et al. (2023). Thus, assessing the full distributional impact of inflation on household welfare is a complex task. This challenge was noted long ago by Fischer and Modigliani (1978) who concluded their study by admitting their surprise at *the length of the list of the real effects of inflation* and by stating that *measurement of the costs of the real effects that we have listed is obviously a task of importance*.

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. Figure 1 illustrates

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<sup>1</sup>This value refers to year-on-year percentage change in the headline HICP index.

<sup>2</sup>A Tract on Monetary Reform (1923).



**Figure 1:** Price level index (December 2020 = 100) for Germany, France, Italy and Spain.

Note: Not seasonally adjusted, January 2019–December 2022

Source: Eurostat, Harmonized Index of Consumer Prices, Household Budget Survey.

price level dynamics in these countries. During 2021–22, the price index rose by roughly 10% in France and Spain, 16% in Germany, and 20% in Italy.<sup>3</sup> Figure 15 in Appendix B, which breaks down inflation by major components of the consumption basket, shows that this episode consisted first and foremost of a major shock to the price of energy and fuel. However, food inflation was also severe, and the shock eventually transmitted to the bulk of other goods and services.

We begin by laying 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 us to shed light on the relevance of all these mechanisms across the age and income distribution, separately for each country, 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

<sup>3</sup>Throughout the paper, we derive inflation measures by weighting each consumption category according to the 2015 Household Budget Survey. Section 3.1.1 illustrates this step in detail. The resulting measures are only slightly different from those reported in official inflation statistics, but the differences tend to cumulate over time, especially in the case of Italy—see Appendix D.1 for a more extensive discussion.

restored starting from 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 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 to certain demographic groups. This last episode was no exception: namely, interventions on energy markets (electricity, natural gas and liquid fuels), such as subsidies and price controls, were significant. And ad-hoc transfers to households were too.

The first channel, which we label the *direct component*, measures the direct impact of raw pre-government inflation, i.e., before 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 the *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 the *indirect component*, embeds the equilibrium response of all prices to the shock. Households obtain their income from different sources, such as wages and pensions, net government transfers, rents, interests, dividends and capital gains. 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.<sup>4</sup> 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 interventions are based on the IMF methodology (Dao et al., 2023). Finally, we estimate the response of minimum wages, contractual wages, pensions, 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.

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<sup>4</sup>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 \(2009\)](#).

Our results show that the aggregate impact of this inflation episode is large. On average, welfare losses are between 3 and 4 percent of pre-shock biennial disposable household income in Germany, France and Spain, but exceed 8 percent in Italy. These values are one order of magnitude bigger than standard estimates of welfare costs of a typical business cycle. Comparing Italy, the country with the highest welfare cost, to France, the country with the lowest one, 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 consisted of different measures, and offset a more sizable share of the shock in France; (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 incidence 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 more severe losses for the poor because of the higher inflation rate they suffer due to their higher 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 con-

sumption 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 (mainly at the bottom via legislated ad-hoc increases in minimum wages) and pensions 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 pre-shock biennial income, while young households in Spain gained over 5%. Middle-aged households lost roughly 5% of their income across the four countries. Overall, around 30% of households in the euro area –and nearly half of the 25–44 year-old– are net winners from the inflation shock.

Given the aggregate losses suffered by households, we finally analyze which sectors of the economy benefited from the inflation surge. The main winners were governments, which substantially benefited from the reduction in real value of public debts. In Italy and Spain, government gains exceeded households losses. If these gains were used to cut public debts and future distortionary taxes, households' welfare losses would be substantially reduced. The performance of the foreign sector was more mixed. It enjoyed strong gains in Germany, broke even in France, and experienced losses in Italy and Spain.

## 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 et al. \(2022\)](#) 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 inflation 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.

In line with [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 et al., 2010](#), for survey-based evidence), and to the finding that stocks assets are not great hedges against core inflation ([Fang et al., 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 et al., 2022; Battistini et al., 2022; Menyhert, 2022; Bankowski et al., 2023; Basso et al., 2023; Amores et al., 2023). A notable exception is Cardoso et al. (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. Consistently with our findings, they highlight that the net nominal position and labor income channels are the key drivers of welfare losses in Spain, and find gains for the young and losses for the old. Our analysis is more extensive in several directions. First, we explicitly investigate government interventions and find that they substantially mitigated welfare losses. Second, we analyze the inflation shock in the four largest euro area economies. Compared to Spain, the other economies have different wealth and income distributions, have been impacted differently by the energy shock, and witnessed different types of government interventions through transfers, subsidies, and regulation to shield the household sector from the shock.<sup>5</sup> Third, they focus on 2021 alone, while we consider that the shock lasted for at least two years and impose monetary neutrality in the longer run, which is important for the final result. All considered, we find larger welfare losses, mainly because prices kept rising above trend inflation in 2022.

The rest of the paper is organized as follows. Section 2 outlines the model and the household welfare decomposition. Section 3 describes the data and some key measurement inputs. Section 4 presents the results. Section 5 extends our calculations to the government and the foreign sector. Section 6 concludes. The Appendix contains more details on the model, the various data sources, and the welfare calculations.

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<sup>5</sup>In fact, our results for Spain are quite different from those of the other countries we study. In particular, fiscal interventions in energy markets were particularly extensive in Spain, and the high home ownership rates of young households generate more heterogeneity in welfare impacts than in the other three countries we consider.

## 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, 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 without 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 subsided 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 and rents). Because of nominal rigidities, all these contractual arrangements may not be 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 get 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  $\beta_i$ . 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

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

where  $j = 1, \dots, J$  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

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

where  $\mathcal{P}_{jt}^*$  is the pre-tax or raw price, and  $\tau_{jt}$  is a wedge capturing good-specific taxes (if positive) or subsidies (if negative).<sup>6</sup> 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

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<sup>6</sup>Changes in the parameter  $\tau_{jt}$  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.

household specific price index (1) realized at  $t = 0$  is

$$d \log P_{i0} = \sum_{j=1}^J xsh_{ij,ss} \cdot d \log \mathcal{P}_{j0}, \quad (3)$$

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

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

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

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

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.<sup>7</sup> It is useful 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  $a_{i,kt}$ ,  $k = 1, \dots, K$ . Real assets trade at price  $Q_{kt}$  and pay a nominal dividend  $D_{kt}$ .<sup>8</sup> 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

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<sup>7</sup>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, 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.

<sup>8</sup>The dividend for housing is the rental rate.

bond issued in period  $t$  entails a promise to pay  $\delta^{s-1}$  units of currency (i.e., euros) in period  $t + s$ , for all  $s \geq 1$ .  $B_{i,Lt}$  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  $t$ .<sup>9</sup>

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

$$c_{it}P_{it} = W_{it} - T_{it} + B_{i,St} + B_{i,Lt} + \sum_{k=1}^K (Q_{kt} + D_{kt}) a_{i,kt} \quad (6)$$

$$- Q_{St}B_{i,St+1} - Q_{Lt} (B_{i,Lt+1} - \delta B_{i,Lt}) - \sum_{k=1}^K Q_{kt}a_{i,kt+1}. \quad (7)$$

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.<sup>10</sup>

**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

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<sup>9</sup>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  $\ell_{it}$  are new bond purchases if positive, and new bond sales if negative. When  $B_{i,Lt}$  is negative (and captures, e.g., mortgage debt),  $\ell_{it}$  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  $\delta_i$ . 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.

<sup>10</sup>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 straightforward. The challenge is its empirical measurement, thus for now we abstract from it.

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 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:

$$\frac{d \log \bar{P}_1}{dz_0} = \frac{d \log \bar{P}_0}{dz_0}, \quad (8)$$

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:

$$\frac{d \log W_{i1}}{dz_0} = \frac{d \log T_{i1}}{dz_0} = \frac{d \log D_{k1}}{dz_0} = \frac{d \log Q_{k1}}{dz_0} = \frac{d \log \bar{P}_1}{dz_0}. \quad (9)$$

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

$$\frac{d \log P_{i1}}{dz_0} = \frac{d \log \bar{P}_1}{dz_0}. \quad (10)$$

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.<sup>11</sup>

Finally, because expected inflation returns to its steady-state level, from  $t = 1$  onward nominal bond prices return to their initial value,

$$\frac{d \log Q_{L1}}{dz_0} = \frac{d \log Q_{S1}}{dz_0} = 0. \quad (11)$$

***Assumption 4: The adjustment in the government budget constraint either occurs through the price level, or through higher real surpluses at  $t > 1$ .*** The shock can affect the government budget constraint by changing both tax revenues and spending in the period of the shock. Tax revenues can, for example, rise through the “bracket creep” effect of inflation. Spending can also rise if some benefits are indexed to inflation or if the government implements ad-hoc transfer or price subsidy programs to contain the cost of inflation for households. In addition interest payments can change if the monetary authority moves nominal rates.

Because the government budget constraint needs hold after the shock, an accommodation

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<sup>11</sup>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 subsided 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.

is needed. *Assumption 4* states that we allow this accommodation to occur in two ways. First, through inflation itself, which appropriately modifies 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 an appropriate change in future real surpluses at  $t > 1$ . In the first case, the adjustment is already implicit in our welfare calculations for households. In the second case, it occurs beyond the lifespan of currently alive households, so it does not affect their welfare.

## 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  $\lambda_{it}$  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’  $\mathcal{W}_i$ . The welfare impact of the shock can be expressed as:

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

Note that  $dV_i/dz_0$  is expressed in utils. Thus, dividing it by  $\lambda_{i0}$ , 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 initial

individual-level price index at  $t = 0$  before the shock hits.<sup>12</sup>

**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 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  $(\tau_{jt}, T_{it}^{HOC})$  and from all equilibrium effects on disposable income  $(W_{it}, T_{it}, D_{kt})$  and prices

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<sup>12</sup>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).

$(Q_{St}, Q_{Lt}, Q_{kt})$ . We obtain:

$$d\mathcal{W}_i^{DIR} = \left[ \underbrace{-\frac{d \log \bar{P}_0^*}{dz_0}}_{\text{average } \pi} - \underbrace{\left( \frac{d \log P_{i0}^*}{dz_0} - \frac{d \log \bar{P}_0^*}{dz_0} \right)}_{\pi \text{ difference } (C)} \right] \times \quad (13)$$

$$\left[ \underbrace{W_{i0} - T_{i0}}_{\text{net income } (Y)} + \underbrace{B_{i,S0} + (1 + Q_{L0}\delta) B_{i,L0}}_{\text{net nominal position } (NNP)} + \underbrace{\sum_{k=1}^K D_{k0} a_{i,k0} + \sum_{k=1}^K Q_{k0} (a_{i,0k} - a_{i,1k})}_{\text{dividends + capital gains } (K)} \right]$$

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  $\pi$ ’) vs individual-level inflation (‘ $\pi$  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).<sup>13</sup> 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

<sup>13</sup>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.

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).<sup>14</sup> 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  $t = 0$ .

#### 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  $\tau_{j0}$  for some  $j$  which offset the rise in raw prices. Second, other

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<sup>14</sup>Landlords' rental income from housing properties is included in this term.

ad-hoc transfers (or tax breaks) paid directly to households. In sum,

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

The first term in the round brackets captures changes in  $\tau_{j0}$  which affect the gap between raw prices and final prices faced by consumers since, from (4),  $d \log P_{i0} - d \log P_{i0}^* = d \log \mathcal{J}_{i0}$ . 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.<sup>15</sup>

### 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:

$$dW_i^{IND} = \underbrace{\frac{d \log W_0}{dz_0} W_0}_{\Delta \text{ wages}} - \underbrace{\frac{d \log T_{i0}^{AUT}}{dz_0} T_{i0}^{AUT}}_{\Delta \text{ net taxes}} - \underbrace{\frac{d \log Q_{S0}}{dz_0} Q_{S0} B_{S1} - \frac{d \log Q_{L0}}{dz_0} Q_{L0} (B_{i,L1} - \delta B_{i,L0})}_{\Delta \text{ price of nominal assets}} + \underbrace{\sum_{k=1}^K \frac{d \log Q_{k0}}{dz_0} Q_{k0} (a_{i,k0} - a_{i,k1}) + \sum_{k=1}^K \frac{d \log D_{k0}}{dz_0} D_{k0} a_{i,k0}}_{\Delta \text{ price of real assets}}. \quad (15)$$

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

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<sup>15</sup>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.

contain households' loss of purchasing power. Inflation-indexed transfers would raise disposable income (but bracket creep effects of inflation would increase tax liabilities). 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

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

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.<sup>16</sup>

### 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  $d\widehat{W}_i$  denote the welfare change for a household  $i$  belonging to the old cohort. Then

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

where

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

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.<sup>17</sup>

<sup>16</sup>In future work, we plan to study also the case in which the fiscal adjustment occurs at  $t = 1$  through higher taxes.

<sup>17</sup>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 will make an adjustment to account for this observation.



### 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 (less than 45 years, 45–64 years, and older than 64 years) and five consumption quintiles (within each age class). 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 Appendices D, E and F for further details on the measurement of each variable.

#### 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  $\pi_{ic}$  for household  $i$  in country  $c$  by weighting good-specific price changes  $\pi_{jc}$  with the individual  $i$  expenditure shares  $xsh_{jic}$  on goods  $j = 1, \dots, J$ :

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

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.<sup>18</sup> The corresponding good-specific price changes  $\pi_{jc}$  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.<sup>19</sup>

We focus on 20 consumption categories (indexed by  $j$  in the expressions above), which 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 U.S. CPI, for example), we do not include imputed rent. Table 1 contains the full list of these categories.<sup>20</sup>

We measure inflation expectations in each country at the start of 2021 using data from Consensus Economics.<sup>21</sup>

### 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.<sup>22</sup> 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 et al. (2020).

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<sup>18</sup>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.

<sup>19</sup>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.

<sup>20</sup>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.

<sup>21</sup>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.

<sup>22</sup>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.

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.

We measure net nominal positions in the HFCS as in [Slacalek et al. \(2020\)](#), following the definition of [Doepke and Schneider \(2006\)](#) and [Adam and Zhu \(2016\)](#).<sup>23</sup> For real assets, which include housing and stocks, we take into account both income flows accruing to households via holding of the assets, 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:

$$SW_i \times \frac{\text{dividend}}{\text{stock price}}.$$

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 et al. \(2019\)](#) in [Macrohistory Database](#). In the four countries under analysis, it amounts to roughly 3%.<sup>24</sup>

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 immedi-

<sup>23</sup>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.

<sup>24</sup>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”.

ately 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 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 fuel prices, and 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 a summary.

## **3.3 Third component: measuring changes wages and asset prices**

We now briefly describe the measurement of the components of equation [\(15\)](#), and refer to [Appendix D](#) for further details.

### 3.3.1 Wages and pensions

For wages and pensions 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 and national wage agreements have evolved over the two years.<sup>25</sup> On average, wages grew by around 2% in Germany, Spain and Italy, and by approximately twice as much in France.<sup>26</sup>

For countries where it exists (all four except Italy), we also take minimum wages into account. We assume that the wage of all working age individuals in the bottom income decile grows at the same rate as the official minimum wage. Data on minimum wages are obtained from national official sources.

Finally, for the over-65 we rely on national data on pensions. In many euro area countries, pensions are at least partially indexed – see [Checherita-Westphal \(2022\)](#). As a result, in 2021–22 nominal pensions often increased more than wages.

We subtract expected inflation from the nominal growth rates of all these income sources to identify the adjustment related to the inflation shock.

### 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

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<sup>25</sup>These data are compiled by national statistical agencies. They refer to collectively agreed wages for most euro area countries. The national data is not harmonised and the coverage of collectively agreed wages varies across countries – see also [European Central Bank \(2002\)](#).

<sup>26</sup>Our data cover wages also at the sectoral level, but incorporating this source of heterogeneity results in only small differences across households because the broad sectoral distribution of workers is not too dissimilar across age and income groups.

the German Harmonised Index of Consumer Prices (HICP) in 2021–2022:<sup>27</sup>

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

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.<sup>28</sup> The coefficient  $\beta$  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.<sup>29</sup>

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:

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

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.

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.

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<sup>27</sup>The exact release dates are reported in [Table 9](#) in [Appendix C](#).

<sup>28</sup>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.

<sup>29</sup>Germany is by far the largest market for REITs in the euro area (see [Appendix D.5.1](#) and [Figure 20](#)).

We report all results from these regressions in Table 10 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.<sup>30</sup> 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.<sup>31</sup>

We report the results from these regressions in Table 10 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 present

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<sup>30</sup>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.

<sup>31</sup>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 et al. (2020) provides recent evidence on bond prices.



our findings in four sequential stages.

For each country, we illustrate the distributional impact of the shock by sorting households into three age groups (less than 45 years, 45–64 years, and older than 64 years) and, within each age group, into five expenditure quintiles. The breakdown by age is relevant because there are substantial differences over the life cycle in the accumulation of net wealth, and type of income earned. We use consumption expenditures as a proxy for permanent income because it is less affected by transitory shocks than current income.<sup>32</sup> We express welfare gains as a fraction of household disposable income over the two years we consider, expressed in 2020 (pre-shock) prices, consistently with our money metric welfare change.

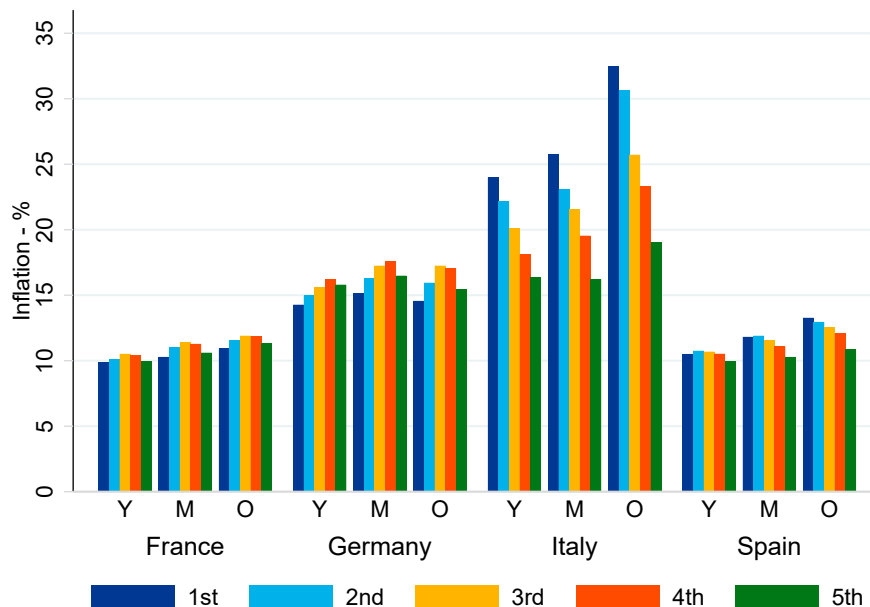
## 4.1 Heterogeneity in inflation rates

The inflation spike in the euro area over 2021–2022 was heterogeneous across countries, age groups, and consumption quintiles (Figure 2). 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. The jump in the price level was much more muted in France and Spain, with an aggregate rise of just above 10 percent.

Figure 3 shows that the bulk of the inflation surge was driven by energy prices, especially in Italy and Germany, and food prices, especially in Spain. Housing rents, instead, remained stable. Why would a common energy shock have such different impact across countries? First, countries which are more dependent on energy imports are more likely to have seen their energy prices increase by more. In addition, how energy prices are passed on to consumers depends on market structure and contractual arrangements: while in some countries electricity contracts have variable pricing and 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

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<sup>32</sup>We sort households by spending on nondurables and services —not total consumption— to avoid over-representing at the top of the distribution households who have made a large durable purchase just before the survey interview.



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

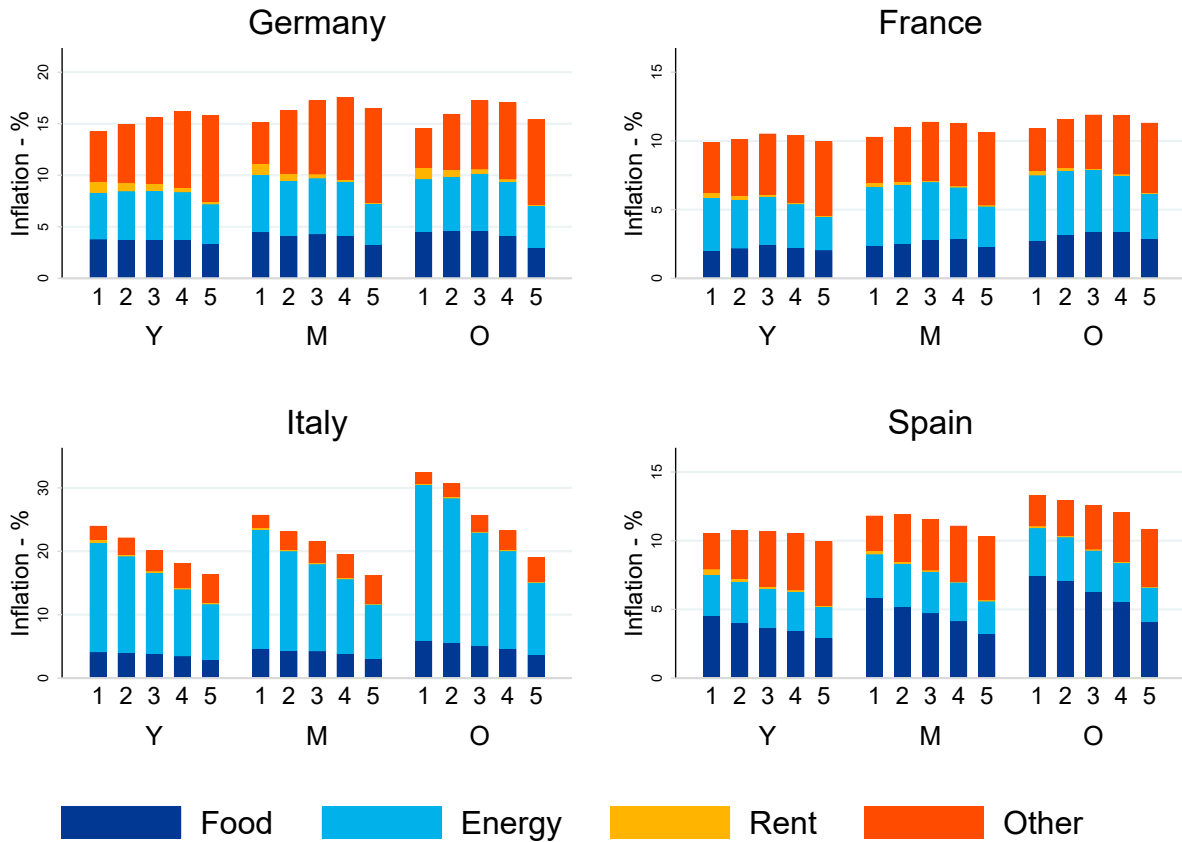
Note: The figure shows realized cumulative inflation rates in 2021–22 by age class and consumption quintiles within each age class. The groups Y, M and O denote ages of less than 45 years, 45–64 years and older than 64 years.

Source: Household Budget Survey 2015.

in energy markets.

Within countries, the inflation rate is generally increasing with age. Within age groups, instead, the gradient with respect to consumption quintiles varies by country: it is negative in Italy and Spain, hump-shaped in Germany, and slightly increasing in France. To understand these differences in inflation rates across households, it is crucial to recognize that (i) older households spend relatively more in energy and food, but less in rents, whereas (ii) households in lower quintiles spend a higher share of their budgets on energy, food, as well as rents (see Figure 16 in Appendix B). 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 negative rent share-income gradient is prevalent everywhere.

This configuration of spending shares across age and income classes meant that the shock had a stronger impact on older households. The decreasing pattern in inflation rates across



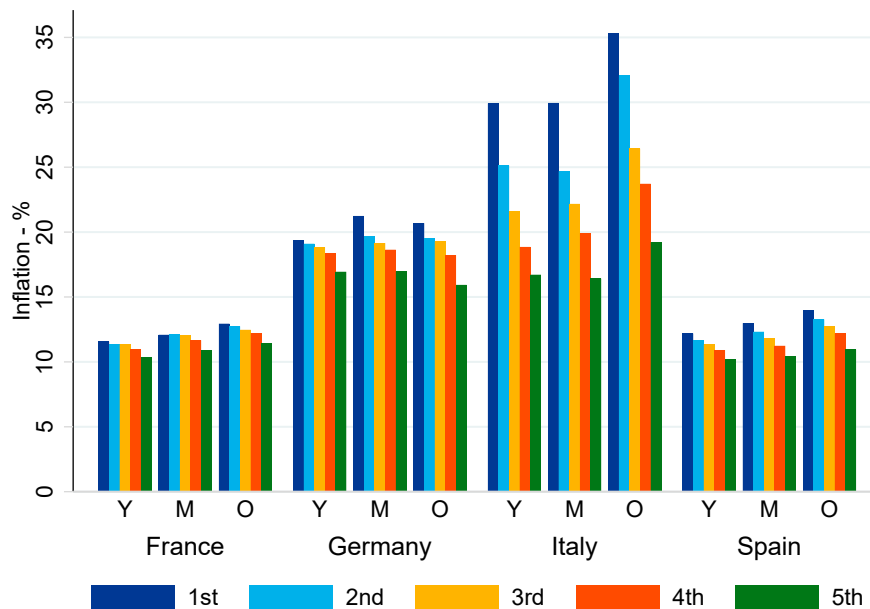
**Figure 3:** Decomposition of household-level inflation rates in pp by age classes and nondurable consumption quintiles within each age class, 2021–2022, cumulative 2-year rates in percent

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 than 45 years, 45–64 years and older than 64 years

Source: Household Budget Survey, 2015

consumption quintiles driven by energy and food prices, instead, is counterbalanced by the modest increases in rents. To illustrate this point more concretely, Figure 4 reports inflation across age and consumption quintiles when rents are excluded from the consumption basket. The negative inflation-income gradient is visible in every country. Comparing Figures 2 and 4, the strongest effect appears in Germany which has a large share of renters.

In general, these patterns of heterogeneity are consistent with previous evidence from the U.S. in a low-inflation environment (Michael, 1979; Kaplan and Schulhofer-Wohl, 2017; Jaravel,



**Figure 4:** Household-level inflation rates by age classes and nondurable consumption quintiles, 2021–2022, cumulative two-year rates in percent, consumption baskets *excluding rents*

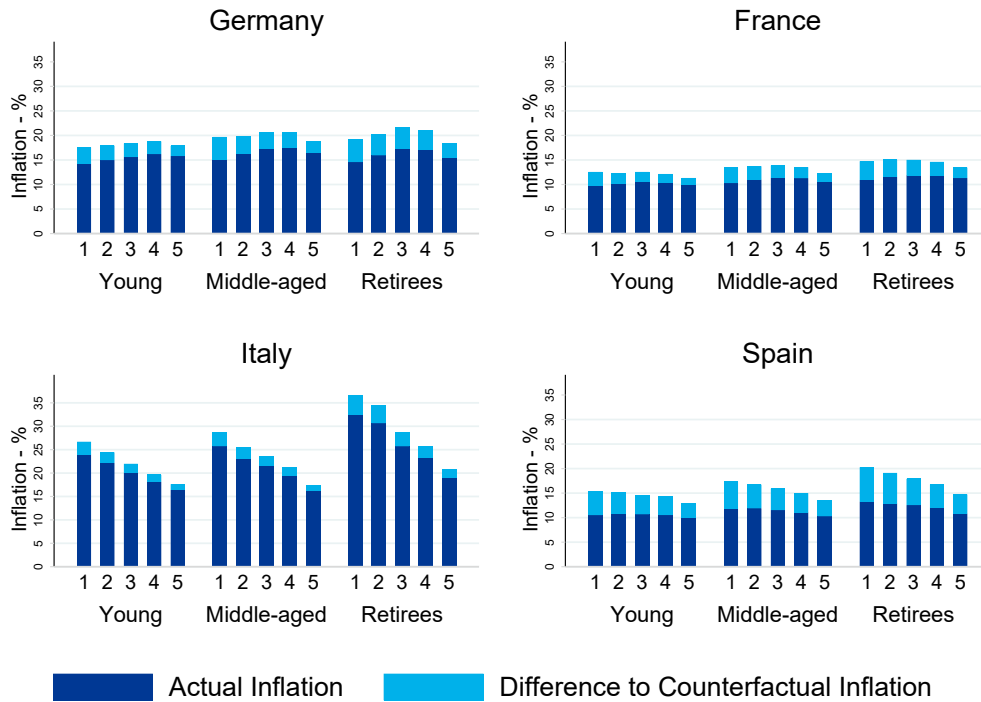
Note: The figure shows realized cumulative inflation rates in 2021–22 by age class and consumption quintiles within each age class. The groups Y, M and O denote ages of less than 45 years, 45–64 years and older than 64 years.

Source: Household Budget Survey 2015.

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 and 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 inflation rate.

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 5 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 and fuels, i.e., those with low income and older



**Figure 5:** 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 than 45 years, 45–64 years and older than 64 years.

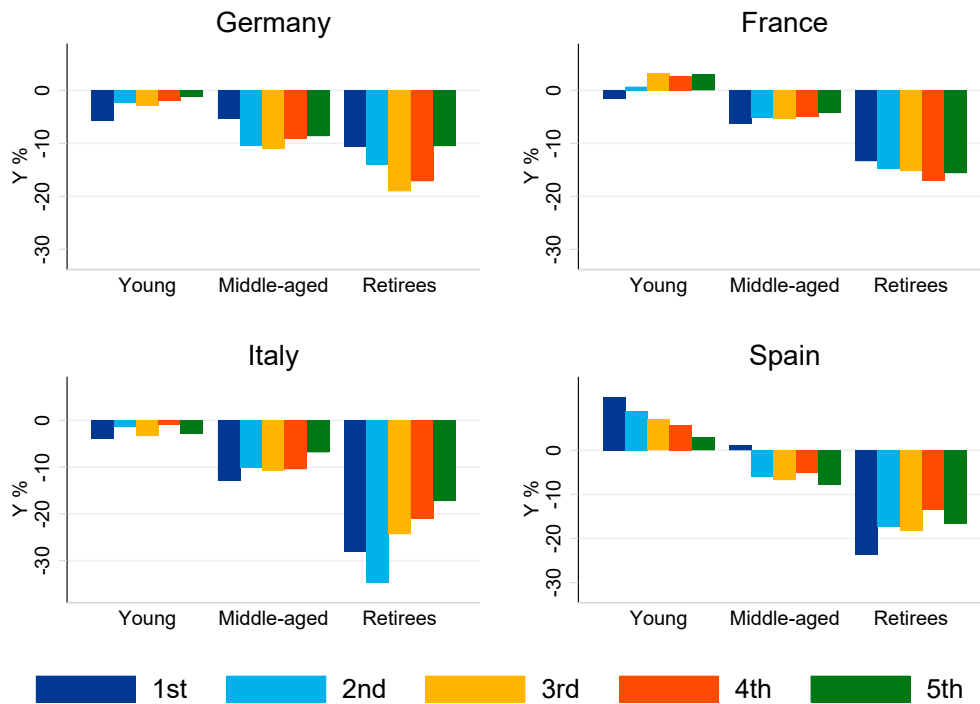
Source: Household Budget Survey 2015.

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 also abstracts from any adjustment in wages and asset prices.

The overall losses or gains originating from this direct component vary substantially across households (Figure 6). Although most households experience 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,

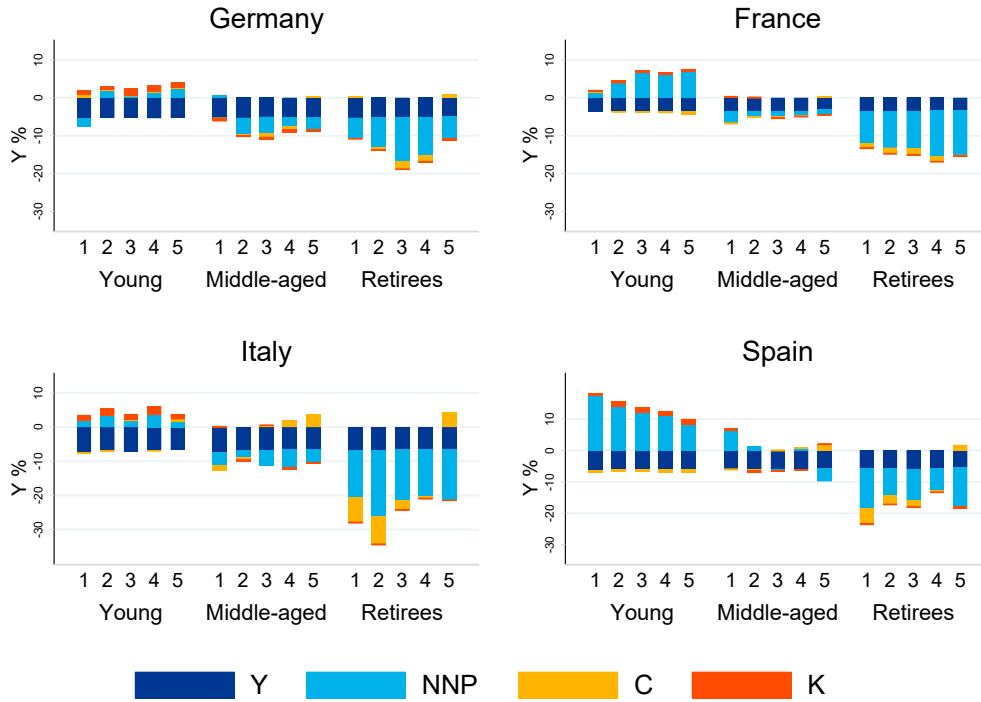


**Figure 6:** Average direct effect as a percentage of biennial disposable income by age class and nondurable consumption quintile

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 than 45 years, 45–64 years and older than 64 years. Source: Household Finance and Consumption Survey 2017.

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 show gains (on average).

Figure 7 looks into which channels drive these composite effects. 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 Spain, a country with relatively high home-ownership rates, but much less so in Germany, where few households are homeowners with debt.

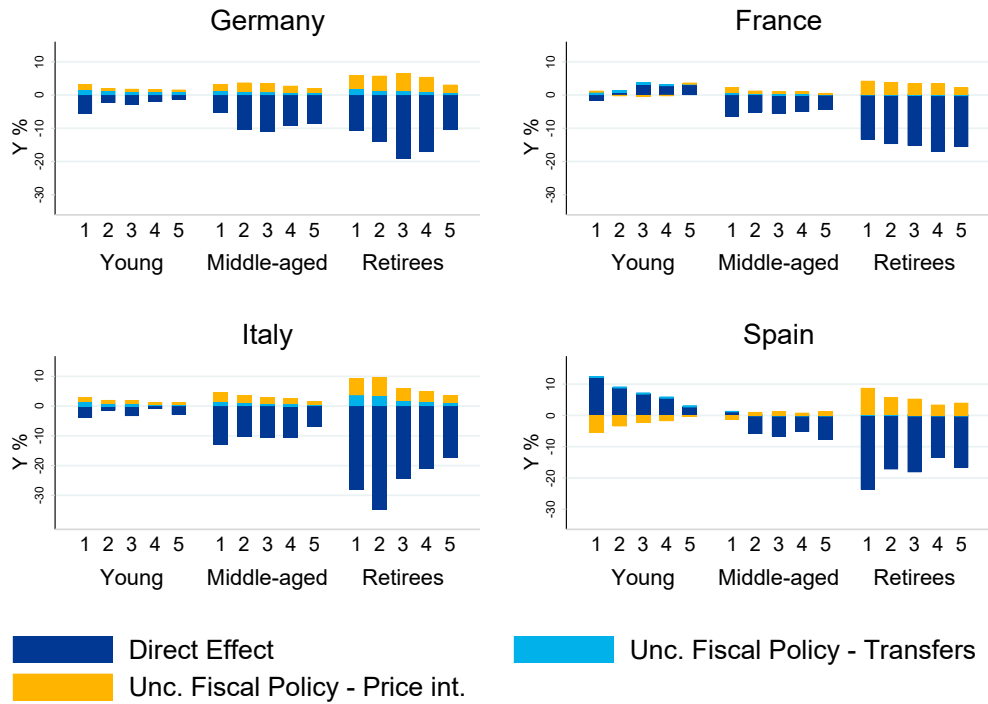


**Figure 7:** Decomposition of average direct effect into its components as percentage of biennial income by age class and nondurable consumption quintiles

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 than 45 years, 45–64 years and older than 64 years.

Source: Household Finance and Consumption Survey 2017.

The net income component ( $Y$ ) is quite uniform across age and expenditure groups in absolute terms, and plays its biggest role for middle-aged households. 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 aggregate inflation rate in the economy is the largest (Figure 2). Finally, the effects of dividends and capital gains ( $K$ ) are relatively small, mostly concentrated amongst the young, many of whom are renters who plan on buying a house soon.



**Figure 8:** Average direct effect and unconventional fiscal policy effects, decomposed into price interventions and direct transfers. Results in terms of percentage of biennial 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 than 45 years, 45–64 years and older than 64 years.

Source: Household Finance and Consumption Survey 2017.

### 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 8 shows their welfare impact, compared with those of the first stage, and dividing measures into two main groups: those that affected consumer prices directly (reported in yellow) and transfers to households (reported in light blue).

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

In terms of the heterogeneity across age groups, retirees benefited the most from these



measures. This is consistent with the relatively larger impact that the shock had on them, with their relatively high share of energy and food consumption, and with the fact that some countries introduced transfers and energy price reliefs which were specifically targeted to this category. The groups who benefit from the inflationary shock (in particular, younger households in Spain) are affected negatively by fiscal interventions that curtailed inflation, because these actions also reduced the extent to which their nominal debt gets eroded.

In sum, 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 catch up with inflation in the aftermath of the shock. The third component incorporates the welfare effects of adjustments in these variables.

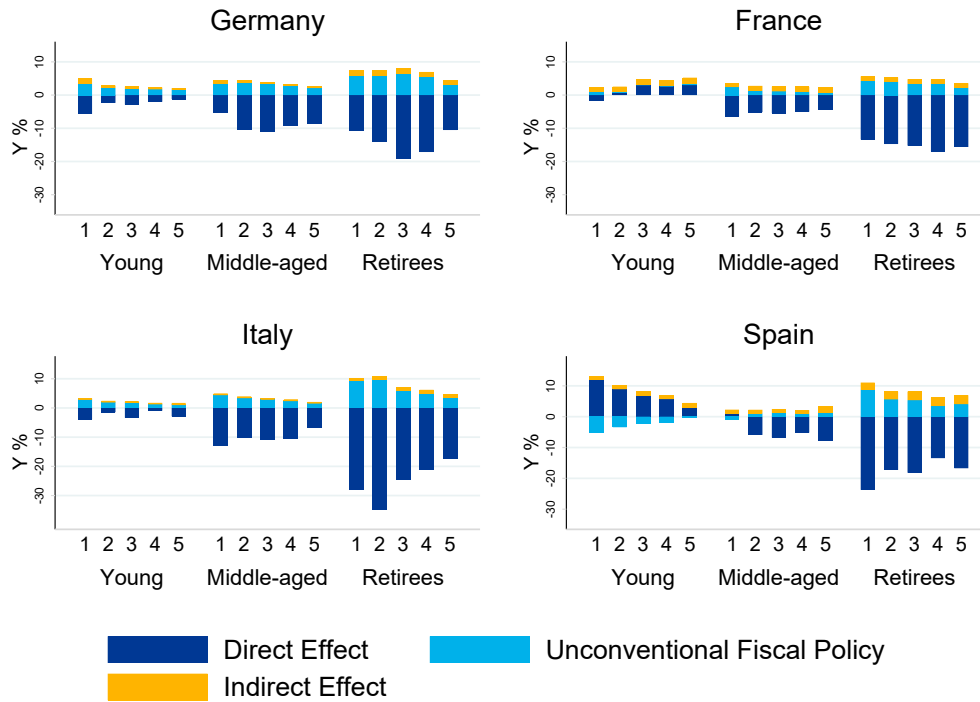
Figure 9 shows that the effects of the third stage are positive but small, staying in general well below 2 percent of income, which implies that they only mildly alleviate the direct losses that summarised in the first two stages.

Decomposing this indirect channel (Figure 10), the effect of adjustment in net income arises from its three components: negotiated wages, minimum wages and pensions. Increases in negotiated wages somewhat alleviated the losses for the young and middle-aged households in France and Spain, where many sectoral agreements were quickly revised upwards by roughly 1 to 1.5 percent. Nominal wages in Germany and Italy, instead, barely changed in the first two years after the shock. In Germany, however, rising minimum wages came to the rescue of low-consumption households. Pensions is the component that grew the most, by 1 to 3 percent on average.

Overall, the indirect impact of net income was rather limited, typically amounting to around 1.5 percent of income.<sup>33</sup>

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<sup>33</sup>In line with Assumption 3, this decomposition supposes that real wages completely catch up with their



**Figure 9:** Average direct effect, unconventional fiscal policy and indirect effect as a percentage of biennial 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 than 45 years, 45–64 years and older than 64 years.

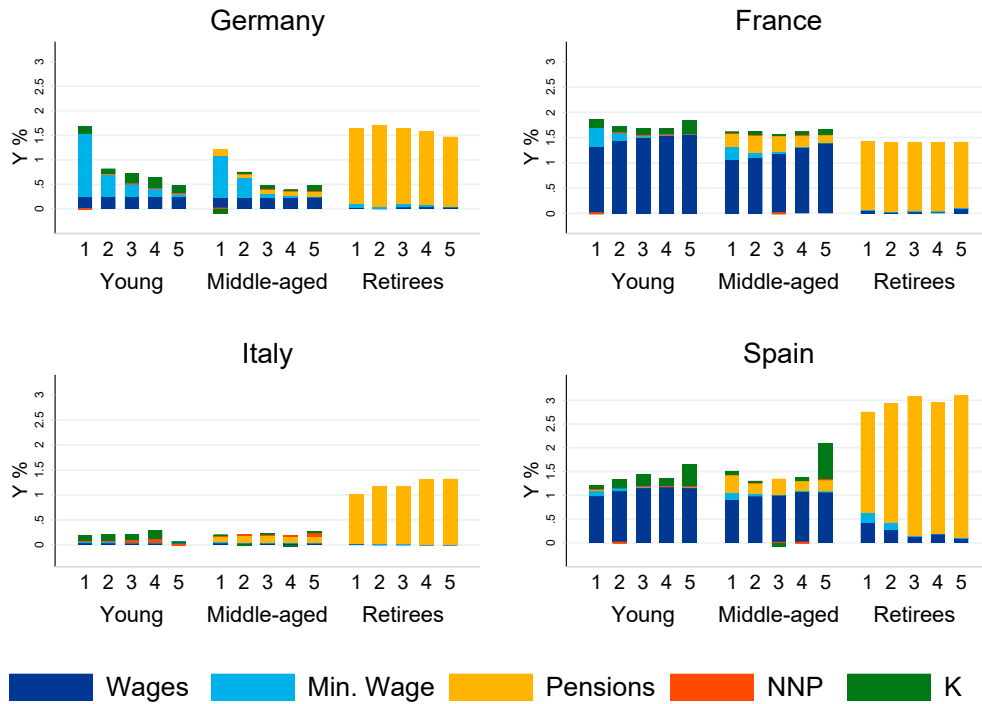
Source: Household Finance and Consumption Survey 2017.

Finally, the size of the asset price channel ( $K$ ) is very small because short-run housing and stock price elasticities to inflation surprises are estimated to be 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 yet materialise during the 2021–2022 period, which is the focus of our study.

As Figure 11 shows, these effects are non-negligible, albeit lower in magnitude than our pre-shock levels starting from 2023. A slower adjustment of real wages would increase the costs further via the additional labor income losses of employees.

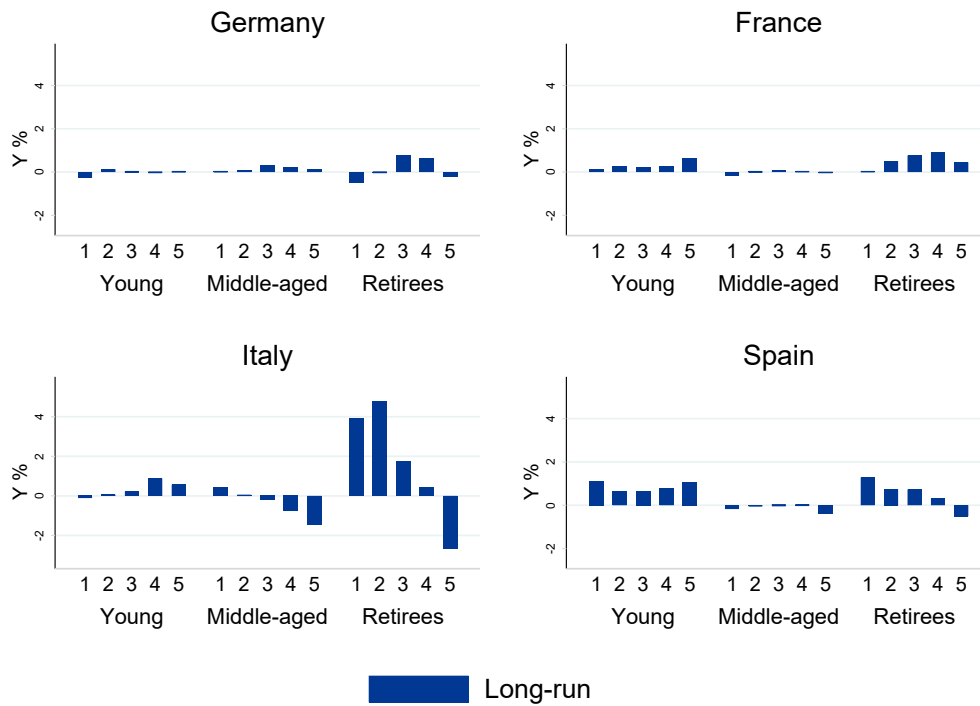


**Figure 10:** Decomposition of the average indirect effect into its components, as a percentage of biennial disposable income by age class and nondurable consumption quintiles

Note: The figure reports the decomposition of the average direct effect into its components: Neg. W denotes negotiated wages, Min. W minimum wage, NNP denotes net nominal position, K dividends and capital gains. Young, Middle-aged and Retirees are defined respectively as less than 45 years, 45–64 years and older than 64 years.

Source: Household Finance and Consumption Survey 2017.

direct effects (stage 1) or 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 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, going forward, 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 long-run effect as a percentage of biennial disposable income for each age class and nondurable consumption quintiles

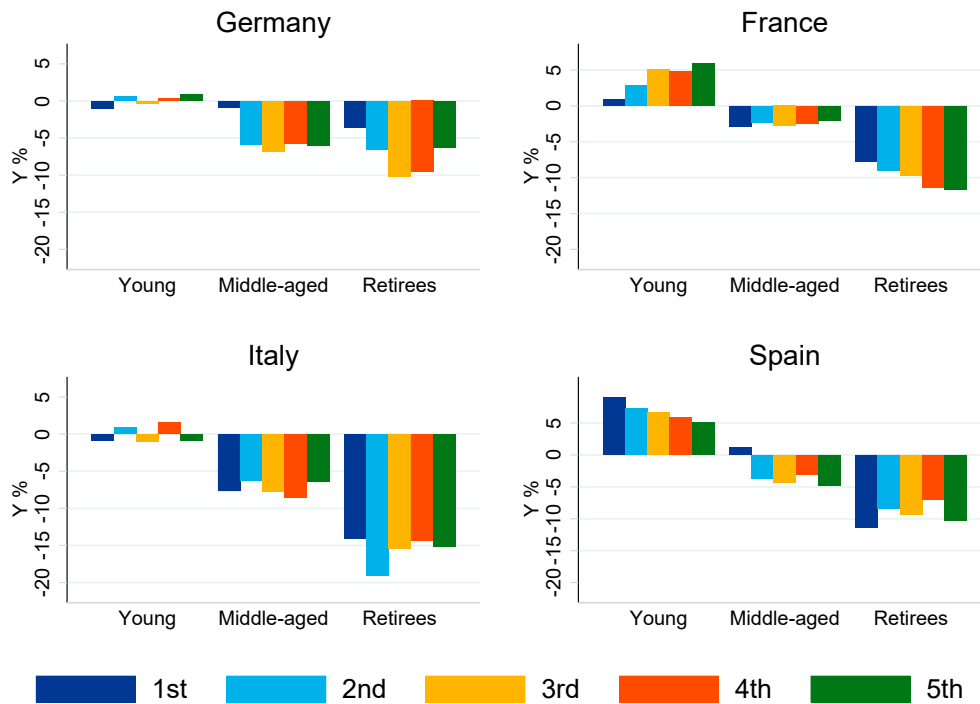
Note: The figure reports the average long-run effect. Young, Middle-aged and Retirees are defined respectively as less than 45 years, 45–64 years and older than 64 years.

Source: Household Finance and Consumption Survey 2017.

## 4.6 Total welfare effect

Figure 12 combines the direct, fiscal, indirect and long-run effects. Young households tend to break even in Germany and Italy, and display gains of 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 percent in France and Spain, 4 percent in Germany, and 8 percent in Italy. The biggest winners are low-income young in Spain (+9%), and the biggest losers low-income retirees in Italy (almost –19%). Table 2 summarizes all these total welfare changes.

Figure 13 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 total effect as a percentage of biennial 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 than 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 14 shows the share of households that, within each group, experienced net gains. On average about 30 percent

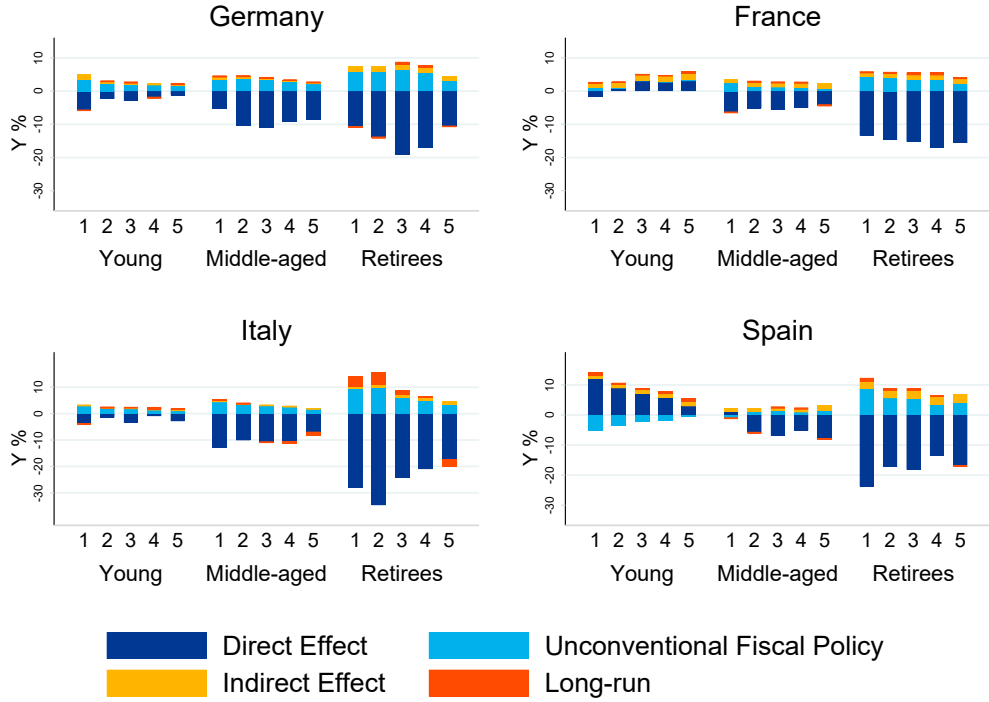
Age class	Consumption				
	quintile	Germany	France	Italy	Spain
Young	1	-1.05	0.94	-0.83	9.08
	2	0.66	2.82	0.86	7.32
	3	-0.30	5.02	-0.99	6.73
	4	0.28	4.75	1.59	5.90
	5	0.91	5.87	-0.93	5.11
Middle age	1	-0.86	-2.87	-7.68	1.14
	2	-5.89	-2.34	-6.33	-3.70
	3	-6.75	-2.80	-7.70	-4.27
	4	-5.73	-2.48	-8.49	-3.00
	5	-5.98	-2.06	-6.37	-4.81
Retirees	1	-3.56	-7.69	-14.03	-11.35
	2	-6.54	-8.96	-19.07	-8.37
	3	-10.23	-9.68	-15.47	-9.29
	4	-9.57	-11.37	-14.38	-6.95
	5	-6.21	-11.60	-15.19	-10.27
All		-4.32	-2.80	-8.36	-3.01

**Table 2:** Combined net effect of the inflation shock as a percentage of disposable income by age class and consumption quintile

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. Among the retirees, instead, typically less than 10 percent are winners. There is, instead, no clear gradient over the consumption distribution.

## 5 Gains and losses for government and foreigners

Up to this point, we have analyzed welfare gains and losses from this inflation episode across the distribution of households in the largest four countries in the euro area. We now take a more macroeconomic perspective and distinguish, for each country, a domestic household sector –the aggregation of all individual households we studied so far– a domestic government sector, and an external sector. We ask: what are the gains and losses for each of these three sectors? Or

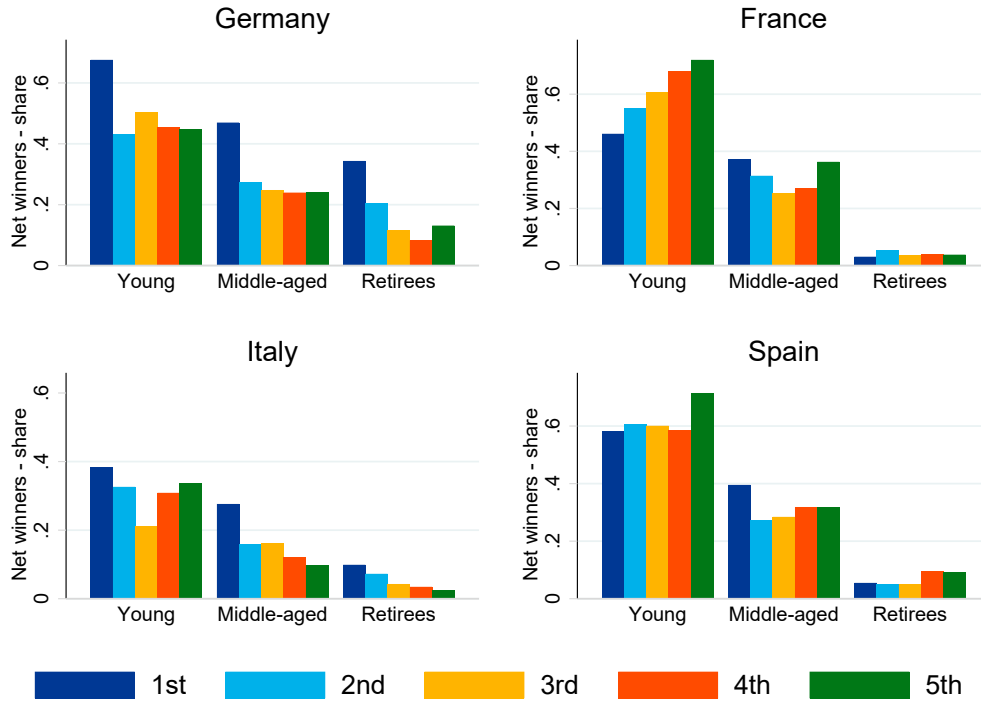


**Figure 13:** Average direct effect, unconventional fiscal policy, indirect effect and long-run as a percentage of biennial disposable income for each age class and nondurable consumption quintiles

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.

put differently, since we have already shown that the household sector loses as a whole, what is the counterpart of this loss for the government and foreign sectors?

We thus introduce explicitly into the model three other agents, besides households: firms, government, and foreigners. Gains and losses of the firm sector will be appropriately distributed to households, government and foreigners according to their claims on domestic businesses. We denote holdings of nominal assets with superscripts  $s = h, f, g, x$ , and liabilities with subscripts  $j = H, F, G, X$ , respectively, for households, firms, government and foreigners. For example,  $B_{Ht}^f > 0$  denotes firm holdings of debt issued by households (e.g., mortgage debt), and  $B_{Gt}^x > 0$  denotes foreign holdings of government debt. Concurrently, for example,  $B_{Ft}^f < 0$  denotes total liabilities of the firm sectors. Consistently with the notation of Section 2, we denote the decay rate of debt by  $\delta_j$  and its price by  $Q_{jt}$ . Without loss of generality, to simplify notation, we fold



**Figure 14:** 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.

short-term government debt into  $B_G^s$ . Again, to ease notation and without loss of generality, we only allow for a single real asset ( $K = 1$  in the notation of Section 2) which represents the consolidated value of corporate and private businesses and housing, with shares held by sector  $s$  denoted by  $A_t^s$ , dividends per share by  $D_t$  (which include, for example, rental income), and ex-dividend share price by  $Q_{A_t}$ . We impose no restrictions on asset holdings across sectors.<sup>34</sup>

Note that, by market clearing

$$\sum_{s=h,f,g,x} B_{jt}^s = 0, \quad \text{for } j = H, F, G, X. \quad (18)$$

$$\sum_{s=h,g,x} A_t^s = 1.$$

<sup>34</sup>In particular, we also allow the government to trade shares of the firm sector and debt issued by firms (e.g., as done through quantitative easing and tightening policies of central banks), as well as foreign bonds.



**Household sector.** Summing across all households  $i$  (young and old) budget constraints at  $t = 0$  in equation (6), we obtain the consolidated budget constraint of the household sector

$$\bar{P}_0 C_0 + Q_{A0} A_1^h + \sum_{j=H,F,G,X} Q_{j0} (B_{j1}^h - \delta_j B_{j0}^h) = W_0 - T_0 + (Q_{A0} + D_0) A_0^h + \sum_{j=H,F,G,X} B_{j0}^h \quad (19)$$

where  $\bar{P}_0 = \bar{P}_0^* (1 + \mathcal{T}_0)$  is the price index gross of taxes/subsidies. In addition,  $\bar{P}_0 C_0 = \sum_{i=1}^I P_{i0} c_{i0}$ ,  $W_0 = \sum_{i=1}^I W_{i0}$ ,  $A_0^h = \sum_{i=1}^I a_{i0}^h$ , and so on. Note that, compared to equation (6), the only differences are that 1) we combine all  $K$  real assets into one, and 2) we combine short-term and long-term nominal positions of households, denoted by  $B_{St}$  and  $B_{Lt}$  in equation (6), and re-express them in terms of debt issued by the four sectors.

**Firm sector.** The consolidated value of all firms in the economy at  $t = 0$  can be written recursively as:

$$(Q_{A0} + D_0) A_0 = \bar{P}_0^Y Y_0 - \bar{P}_0^I I_0 - W_0 - \sum_{j=H,F,G,X} Q_{j0} (B_{j1}^f - \delta_j B_{j0}^f) + \sum_{j=H,F,G,X} B_{j0}^f + Q_{S0} (Q_{A1} + D_1) A_1 \quad (20)$$

where  $Y_0$  is total real output,  $I_0$  is real gross investment, and  $\bar{P}_0^Y$  and  $\bar{P}_0^I$  are the output and investment deflator, respectively. This equation clarifies the origin of the capital gain component due to the change in the price of real assets which appears in equation (15). For instance, if nominal wages are stickier than prices, the inflation shock raises firm profits, which contributes to the rise in  $Q_{A0}$ . Or, if the firm sector is, on net, a borrower, inflation will dilute debt and the value of the firm sector will rise. And so on. All these effects, jointly, are captured in our estimates of Sections 3.3.2 and 3.3.3. Thus, for example, the reduction of real wages induces a loss for households showing up as one of the components of equation (15). The same force, however, contributes to a capital gain for those households who hold shares of the business sector showing up in that same equation in a different term.

**Government sector.** The intertemporal government budget constraint at  $t = 0$  reads

$$(Q_{A0} + D_0) A_0^g + \sum_{j=H,F,G,X} B_{j0}^g = \bar{P}_0^G G_0 - T_0 - \bar{P}_0^* \mathcal{T}_0 C_0 + Q_{A0} A_1^g + \sum_{j=H,F,G,X} Q_{j0} (B_{j1}^g - \delta_j B_{j0}^g). \quad (21)$$

where  $G_0$  are real government expenditures and  $\bar{P}_0^G$  denotes their deflator.

**Foreign sector.** The domestic net asset position of the foreign sector toward the domestic economy evolves according to

$$Q_{A0} A_1^x + \sum_{j=H,F,G,X} Q_{j0} (B_{j1}^x - \delta_j B_{j0}^x) + \bar{P}_0^E E_0 = (Q_{A0} + D_0) A_0^x + \sum_{j=H,F,G,X} B_{j0}^x + \bar{P}_0^M M_0 \quad (22)$$

where  $E_0$  and  $M_0$  denote, respectively, exports from and imports into the domestic economy, with corresponding aggregate price indexes  $\bar{P}_0^E$  and  $\bar{P}_0^M$ . This equation also states that the current account surplus plus the capital account surplus of the domestic economy must sum to zero.

Appendix A.7 shows that, once we aggregate equations (19)-(22), we obtain the national accounting identity

$$\bar{P}_0^* C_0 + P_0^I I_t + \bar{P}_0^G G_0 + \bar{P}_0^E E_0 - \bar{P}_0^M M_0 = \bar{P}_0^Y Y_0. \quad (23)$$

## 5.1 Nominal Wealth Redistribution Across Sectors

In Section 4 we have shown that revaluation effects for nominal wealth account for the lion's share of households' welfare gains and losses across the distribution. Here, we follow closely the approach of Doepke and Schneider (2006) and Adam and Zhu (2016), and assess how this channel operates across our four sectors: households, firms, government and foreigners. It is useful to change notation slightly and let  $\alpha_j^s = B_{j0}^s/B_{j0}$  denote the share of total liabilities issued by sector  $j$  held by sector  $s$ , with the understanding that  $\alpha_s^s = -1$ . Similarly,  $\alpha_A^s = A_0^s/A_0$  and  $\alpha_A^f = -1$ . Finally, let  $NNP_0^s$  be the nominal net position of sector  $s$  at date  $t = 0$ , before the

unexpected jump in the price level.

The nominal net positions of the four sectors are given by

$$\begin{aligned}
NNP_0^h &= \alpha_A^h NNP_0^f + \sum_{j=H,F,G,X} \alpha_{B_j}^h Q_{j0} (1 + \delta_j) B_{j0} \\
NNP_0^f &= \sum_{j=H,F,G,X} \alpha_{B_j}^f Q_{j0} (1 + \delta_j) B_{j0} \\
NNP_0^g &= \alpha_A^g NNP_0^f + \sum_{j=H,F,G,X} \alpha_{B_j}^g Q_{j0} (1 + \delta_j) B_{j0} \\
NNP_0^x &= \alpha_A^x NNP_0^f + \sum_{j=H,G,F,X} \alpha_{B_j}^x Q_{j0} (1 + \delta_j) B_{j0}
\end{aligned} \tag{24}$$

It also useful to define the direct nominal net positions of sector  $s$ ,  $DNNP_0^s$  as those held outright, i.e. excluding indirect holdings through claims on the firm sector:

$$DNNP_0^s = NNP_0^s - \alpha_A^s NNP_0^f$$

Unfolding the  $NNP_0^f$  term for the household sector, we obtain:

$$NNP_0^h = \sum_{j=H,G,X} \left( \alpha_A^h \alpha_{B_j}^f + \alpha_{B_j}^h \right) Q_{j0} (1 + \delta_j) B_{j0} + (\alpha_{B_F}^h - \alpha_A^h) Q_{F0} (1 + \delta_F) B_{F0} \tag{25}$$

which makes it clear that the amount of household liabilities must be reduced by a share which is the product of the household share of business wealth times the share of household debt held by businesses. In addition, the household sector holds claims to nominal assets of the government and foreign sectors both directly and indirectly through its share of the business sector  $\alpha_A^h$ . Similarly, the direct household holdings of debt issued by firms must be reduced by the household share of business wealth  $\alpha_A^h$ .

A similar logic applies to the government and foreign sectors, whose nominal net positions

amount to

$$\begin{aligned}
NNP_0^g &= \sum_{j=H,G,X} \left( \alpha_A^g \alpha_{B_j}^f + \alpha_{B_j}^g \right) Q_{j0} (1 + \delta_j) B_{j0} + \left( \alpha_{B_F}^g - \alpha_A^g \right) Q_{F0} (1 + \delta_F) B_{F0} \\
NNP_0^x &= \sum_{j=H,G,X} \left( \alpha_A^x \alpha_{B_j}^f + \alpha_{B_j}^x \right) Q_{j0} (1 + \delta_j) B_{j0} + \left( \alpha_{B_F}^x - \alpha_A^x \right) Q_{F0} (1 + \delta_F) B_{F0}.
\end{aligned}$$

Note that the equivalent of the market clearing conditions (18) expressed in terms of shares are  $\sum_{s=H,G,X} \alpha_A^s = 1$  and  $\sum_{s=H,F,G,X} \alpha_{B_j}^s = 0$  for all  $j = H, F, G, X$ . In light of these restrictions, it is easy to show that the sum of nominal net positions held across all sectors equal zero, or  $NNP_0^h + NNP_0^g + NNP_0^x = 0$ .

Finally, the change in the value of nominal net position of sector  $s$  as a consequence of the surprise change in the price index  $\bar{P}_0^*$  is

$$-\frac{d \log \bar{P}_0^*}{dz_0} NNP_0^s, \quad \text{for } s = h, g, x. \quad (26)$$

## 5.2 Redistribution Across Sectors: Measurement

We now turn to quantify how the inflation surge affected the three sectors: households, the government and the foreign sector via their nominal positions, fiscal expenditures and the terms of trade change.

To preview the results of this analysis, while the household sector lost, all governments gained from the inflation surge. These gains were contained in Germany and Spain, larger in France and substantial in Italy. In Germany, the foreign sector also gained, by a similar amount to that of the government. In Italy, Spain and to some extent also in France, it is instead a net loser.

### 5.2.1 Sectoral Net Nominal Positions

We measure net nominal positions  $NNP_0^s$ , as defined in Section 5.1, for four macro-sectors  $s$ : households; firms, including both financial and non-financial firms; the government; and the foreign sector. These total positions can be decomposed into a direct component ( $DNNP_0^s$ ), which corresponds to nominal assets and liabilities held outright by each sector, and an indirect component, which are nominal positions emerging through the ownership of firms. As in [Adam and Zhu \(2016\)](#), we use the [Euro Area Sector \(Financial\) Accounts](#) for our four countries.

Table 3 reports total net positions as a share of biennial GDP. For the household sector, we also report direct nominal positions, and we discuss in Section 5.3.4 below how these compare to the aggregated NNPs from household-level data. For comparability with our previous results, all net nominal positions are computed based on the 2017 financial accounts. Table 3 shows that the household sector holds positive nominal positions, while governments accumulate much more debt than nominal assets. Since firms are net nominal debtors, households' direct nominal positions are significantly higher than their total net positions. The foreign sector tends to hold a positive net nominal position, except for Germany.

Country	Households		Government	Foreign
	$NNP_0^h$	$DNNP_0^h$	$NNP_0^g$	$NNP_0^x$
Germany	0.37	0.45	-0.26	-0.11
France	0.40	0.48	-0.50	0.10
Italy	0.40	0.54	-0.67	0.27
Spain	0.09	0.22	-0.48	0.39

**Table 3:** Total net nominal position, by broad sector, as a share of biennial GDP

Using these total nominal positions, we can compute the change in their value for each sector as a result of the inflation shock – see equation (26). Table 4 presents the results, in percent of biennial GDP. We observe, in general, large gains for the governments, whose net nominal position are negative and sizeable. The aggregate households sector loses, and more so in countries where net nominal positions are large and positive (Italy) than in those in

which they are very close to zero (Spain). The foreign sector loses in every country except for Germany.

Country	Households	Government	Foreign
Germany	-6.0	4.2	1.8
France	-4.3	5.4	-1.1
Italy	-8.2	13.6	-5.4
Spain	-1.0	5.3	-4.3

**Table 4:** Gains/losses from the NNP channel, by broad sector, percent of biennial GDP

### 5.2.2 Government redistribution

To describe the full impact of inflation for the government, besides the change in nominal net positions, we capture empirically two additional components: the budgetary cost of the fiscal support measures introduced in response to the inflation shock and the increase in nominal government expenditure caused by the increase in its relative price.

We obtain an estimate of the budgetary costs of the ad hoc government interventions from [Sgaravatti et al. \(2021\)](#). The first three columns of [Table 5](#) report that these fiscal costs amounted to approximately 2% of biennial GDP in all countries. There are however noticeable differences in how the measures were targeted. In Germany and France, they were mostly directed at households, while in Italy and Spain firms also benefited from government transfers.

Country	Fiscal support			Increased costs of government consumption	
	Total	Households	Firms	Lower bound	Upper bound
Germany	-2.0	-1.7	-0.3	-0.6	-1.8
France	-1.9	-1.8	-0.1	-0.3	-1.0
Italy	-2.4	-1.5	-0.9	-0.8	-1.7
Spain	-2.0	-1.1	-0.9	-0.4	-1.0

**Table 5:** Cost of government interventions and increased expenditure, % of biennial GDP

Estimating the increase in nominal government expenditure due to the inflationary shock is

challenging, given that many of the goods directly provided by the government (such as public education and healthcare) are not traded in the market and therefore no suitable price index is available. We circumvent this issue by assuming that the increase in nominal government expenditure was only caused by the increase in energy prices, taking into account both direct government expenditures in energy and the energy content of all of the goods included in government consumption. Thus, we proceed in two steps: first, we estimate the share of energy in government consumption; second, we use this share to compute the increase in the cost of government expenditure due to the higher energy prices.

We use two estimates of the share of energy in government expenditure, both of which include direct and indirect terms (e.g., the electricity bill paid by hospitals owned by the government). The first estimate provides a lower bound. It takes into account only the increase in prices of fossil fuel and how it propagated through the production network down to government-bought goods. The second estimate, an upper bound, assumes that the increase in fossil fuel prices also applied to other primary sources of energy, such as electricity (e.g., directly imported electricity or electricity produced with other goods other than fossil fuels). The results are reported in Appendix G. To derive the increase in the cost of government expenditure, we apply the increase in the price of energy to the energy shares computed above. The results in the last two columns of Table 5 show that these additional costs tend to range between 0.5 and 1.5% of biennial GDP.

To estimate the total gains of the government from the inflationary episode, we subtract the total costs presented in the first, fourth and fifth columns of Table 5 from the NNP gains of the government shown in Table 4. Table 6 summarizes the results. It demonstrates that all governments gained from the inflation surge. Since the costs of fiscal support measures and of the higher energy prices were comparable across countries, the main cross-country differences are determined by the size of the outstanding stock of government debt. Total government gains are the highest in Italy and the lowest in Germany. In Italy and Spain, total government gains were somewhat higher than the households' aggregate losses shown in Table 4; in France

and Germany they were smaller.

Country	Upper bound	Lower bound
Germany	1.6	0.4
France	3.2	2.5
Italy	10.4	9.5
Spain	2.9	2.3

**Table 6:** Total government gains, % of biennial GDP

### 5.2.3 Redistribution through the foreign sector

We now provide a measure of the loss through the terms of trade channel. As in the case of the government, we focus on the impact of energy prices on terms of trade. We give more details in Appendix H.

The results are shown in the first column of Table 7, where a positive sign implies gains for abroad (and losses for the home country). Due to the increased energy costs, terms of trade worsened in all countries, which means that the price of exports increased relatively less than the price of imports. The foreign sector therefore gains via this channel, more for Germany and Italy and less for France.

Country	Gain/loss through terms of trade 2020–2022	Total gain/loss for foreign sector
Germany	3.4	5.2
France	1.0	-0.1
Italy	3.4	-2.0
Spain	2.5	-1.8

**Table 7:** Gains of the foreign sector: through the terms of trade and total, % of biennial GDP

The second column reports the total gain/loss of the foreign sector, i.e., the sum of the NNP gains/losses already shown in Table 4 and the gains/losses due to the terms of trade adjustment. In Italy and Spain, the gains through the terms of trade channel are outweighed



by the NNP losses, so that the foreign sector is a net loser from the inflation shock. In Germany, the foreign sector enjoys strong gains, while it essentially breaks even in France.

#### 5.2.4 Reconciling micro and macro data on nominal positions of households

For the household sector, the sectoral nominal positions that we computed in this section should in theory correspond to those that can be obtained summing up the positions based on micro data that we used in section 4. In practice, there are known inconsistencies between the two data sources. We now highlight these inconsistencies and discuss their implications for our results.

Table 8 compares for the household sector aggregated net nominal positions from surveys with those recorded in aggregate data.

Country	Micro data (HFCS)			Aggregate data (Sector Accounts)		
	NNP	Nominal assets	Liabilities	NNP	Nominal assets	Liabilities
Germany	7,449	22,106	14,657	35,360	55,995	20,636
France	4,975	20,439	15,465	33,158	56,772	23,614
Italy	5,588	10,039	4,451	31,074	46,100	15,026
Spain	760	14,231	13,471	11,072	27,251	16,179

**Table 8:** Direct nominal positions in micro and aggregate data, EUR per capita, 2017

Aggregated positions in surveys are substantially lower than those in aggregate data. Differences are more pronounced for assets than for liabilities: Per capita nominal assets in aggregate data are roughly 2.5–3 times larger than in surveys; the corresponding factor for liabilities is around 1.5–2. These discrepancies are magnified when computing net positions.

There are multiple reasons for discrepancies between survey and aggregate data (see also [European Central Bank, 2024](#)).

As far as survey data are concerned, there are two main sources of potential measurement errors. The first one is under-coverage, because households sometimes under-report their assets and liabilities. The second one is related to the difficulty to interview extremely wealthy

households, which account for a disproportionate share of total wealth and its components (item- and unit non-response). This limitation is not completely eliminated even when surveys employ effective strategies to over-sample wealthy households. The limitation is more severe for net nominal positions, a variable which is extremely unevenly distributed (even more so than net wealth). Some discrepancies are also due to differences in the target population, since households in institutions such as prisons or retirement homes are excluded from the HFCS sample.

Regarding aggregate data, measurement issues can arise because they sometimes treat households as a residual when allocating assets and liabilities across economic sectors.

All in all, table 8 suggests that our results in section 4 underestimate the loss suffered by certain households through the devaluation of their net nominal positions. It is however hard to assess whether the underestimation affects the household groups that we focus on in that section. A plausible conjecture is that significant measurement errors are only present for individuals at the top of the wealth distribution. In this case, the results in section 4 would remain valid, if they are understood as abstracting from the very rich.

## 6 Conclusions

In this paper, we have measured the heterogeneous welfare effects on households of the recent inflation outburst in the euro area. A stylized 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 incidence 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.

Our sectoral analysis suggests that the inflation shock gave European governments the opportunity to substantially reduce public debts, thanks to the erosion of their real value. This is the case even after accounting for the cost of fiscal support measures.

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# Appendix A Theoretical framework

## A.1 Short and long-term debt

We model nominal short-term bonds as a contract whereby individual  $i$  buys  $B_{i,S_{t+1}}$  units of bonds at the prevailing market price  $Q_{S_t}$  at date  $t$  and next period, they receive  $B_{i,S_{t+1}}$  units of currency. Thus  $Q_{S_t}^{-1}$  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  $Q_{L_t}$  and a purchase  $\ell_{it}$  such that household  $i$  spends  $Q_{L_t}\ell_{it}$  at date  $t$  in exchange for a promise to receive  $\delta^{n-1}\ell_{it}$  units of currency in every future period  $t + n$ , with  $n > 0$ . Let  $B_{i,L_t}$  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.

$$B_{i,L_t} = \sum_{n=1}^t \delta^{n-1}\ell_{i,t-n} = \ell_{i,t-1} + \delta\ell_{i,t-2} + \delta^2\ell_{i,t-3} + \dots + \delta^{t-1}\ell_{i,0}. \quad (27)$$

Rearranging (27), it is easy to obtain the recursive relation

$$B_{i,L_{t+1}} = \delta B_{i,L_t} + \ell_{it}.$$

where  $\delta B_{i,L_t}$  is outstanding nominal debt and  $\ell_{it}$  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:

$$\begin{aligned} \text{MktValue\_LTBond}_{it} &= Q_{S_t} [\delta\ell_{i,t-1} + \delta^2\ell_{i,t-2} + \delta^3\ell_{i,t-3} + \dots] + Q_{S_t}Q_{S_{t+1}} [\delta^2\ell_{i,t-1} + \delta^3\ell_{i,t-2} + \delta^4\ell_{i,t-3} + \dots] + \dots \\ &= Q_{S_t} [1 + Q_{S_{t+1}}\delta + Q_{S_{t+1}}Q_{S_{t+2}}\delta^2 + \dots] \delta B_{i,L_t} \end{aligned}$$

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

$$Q_{L_t} = Q_{S_t} (1 + \delta Q_{L_{t+1}})$$

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

$$Q_{L_t} = Q_{S_t} [1 + \delta Q_{S_{t+1}} (1 + \delta (Q_{S_{t+2}} (1 + \delta Q_{L_{t+3}})))]$$

which, compared to the second line in (28), illustrates that the market value of outstanding long-term bonds at  $t$  is  $Q_{L_t}\delta B_{i,L_t}$ . The case  $\delta = 0$  corresponds to short-term one-period bonds which we denoted by  $B_{i,S_t}$ .

## 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

$$c_{it}P_{it} = \sum_{j=1}^J c_{ij,t}\mathcal{P}_{jt}, \quad (29)$$

where  $j = 1, \dots, J$  denotes a specific consumption category and  $\mathcal{P}_{jt}$  its price. Taking logs of (29) 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

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

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  $\tau_{jt}$  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  $\tau_{jt}$ . We generalize the previous derivation as

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

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  $t = 0$ :

$$\begin{aligned}
c_{i0}P_{i0} &= W_{i0} - T_{i0} + B_{i,S0} + B_{i,L0} + \sum_{k=1}^K (Q_{k0} + D_{k0}) a_{i,k0} - Q_{S0}B_{i,S1} - Q_{L0}(B_{i,L1} - \delta B_{i,L0}) - \sum_{k=1}^K Q_{k0}a_{i,k1} \\
c_{i1}P_{i1} &= W_{i1} - T_{i1} + B_{i,S1} + (1 + Q_{L1}\delta) B_{i,L1} + \sum_{k=1}^K (Q_{k1} + D_{k1}) a_{i,k1}
\end{aligned} \tag{30}$$

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

$$\mathcal{L}_i = \sum_{t=0}^1 \beta_i^t u_i(c_{it}) + \sum_{t=0}^1 \beta_i^t \lambda_{it} \left[ W_{it} - T_{it} + B_{i,St} + (1 + \delta Q_{Lt}) B_{i,Lt} + \sum_{k=1}^K (Q_{kt} + D_{kt}) a_{i,kt} - c_{it}P_{it} - Q_{St}B_{i,S,t+1} - Q_{Lt}B_{i,L,t+1} - \sum_{k=1}^K Q_{kt}a_{i,kt+1} \right] \tag{31}$$

where  $\lambda_{it}$  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

$$\begin{aligned}
u'_i(c_{it}) &= \lambda_{it}P_{it} \text{ for } t = 0, 1 \\
\lambda_{i0}Q_{S0} &= \beta_i\lambda_{i1} \\
\lambda_{i0}Q_{L0} &= \beta_i\lambda_{i1}(1 + Q_{L1}\delta) \\
\lambda_{i0}Q_{k0} &= \beta_i\lambda_{i1}(Q_{k1} + D_{k1}) \text{ for all } k
\end{aligned} \tag{32}$$

Combining the first two equations yields

$$\beta_i\lambda_{i1} = Q_{S0} \cdot \frac{u'(c_{i0})}{P_{i0}} \tag{33}$$

Note that the FOCs can be rewritten as

$$\begin{aligned}
Q_{S0} &= \beta_i \frac{u'_i(c_{i1})}{u'_i(c_{i0})} \left( \frac{P_{i0}}{P_{i1}} \right) \\
Q_{L0} &= Q_{S0}(1 + Q_{L1}\delta) \\
Q_{k0} &= Q_{S0}(Q_{k1} + D_{k1}) \text{ for all } k.
\end{aligned} \tag{34}$$

## 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

$$\frac{dV_i}{dz_0} = \frac{d\mathcal{L}_i}{dz_0}. \quad (35)$$

Recall our definition of money-metric welfare

$$d\mathcal{W}_i = \frac{dV_i/dz_0}{u'(c_{i0})} P_{i0}, \quad (36)$$

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:

$$\begin{aligned} \frac{d\mathcal{L}_i}{dz_0} = \lambda_{i0} & \left[ -\frac{d \log P_{i0}}{dz_0} c_{i0} P_{i0} + \frac{d \log W_{i0}}{dz_0} W_{i0} - \frac{d \log T_{i0}}{dz_0} T_{i0} + \sum_{k=1}^K \frac{d \log Q_{k0}}{dz_{i0}} Q_{k0} (a_{i,k0} - a_{i,k1}) \right. \\ & \left. + \sum_{k=1}^K \frac{d \log D_{k0}}{dz_0} D_{k0} a_{i,k0} \right] \\ & + \lambda_{i0} \left[ -\frac{d \log Q_{S0}}{dz_0} Q_{S0} B_{i,S1} - \frac{d \log Q_{L0}}{dz_0} Q_{L0} (B_{i,L1} - \delta B_{i,L0}) \right] \\ + \beta_i \lambda_{i1} & \left[ -\frac{d \log P_{i1}}{dz_0} c_{i1} P_{i1} + \frac{d \log W_{i1}}{dz_0} W_{i1} - \frac{d \log T_{i1}}{dz_0} T_{i1} + \sum_{k=1}^K \frac{d \log Q_{k1}}{dz_0} Q_{k1} a_{i,k1} \right. \\ & \left. + \sum_{k=1}^K \frac{d \log D_{k1}}{dz_0} D_{k1} a_{i,k1} \right] \\ + \beta_i \lambda_{i1} & \frac{d \log Q_{L1}}{dz_0} \delta Q_{L1} B_{i,L1} \end{aligned} \quad (37)$$

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

Using (32) and (33) to substitute out the multipliers, exploiting the envelope theorem result in (35), and applying our definition of welfare in (36) we arrive at:

$$\begin{aligned} d\mathcal{W}_{i0} = & -\frac{d \log P_{i0}}{dz_0} c_{i0} P_{i0} + \frac{d \log W_{i0}}{dz_0} W_{i0} - \frac{d \log T_{i0}}{dz_0} T_{i0} + \sum_{k=1}^K \frac{d \log Q_{k0}}{dz_{i0}} Q_{k0} (a_{i,k0} - a_{i,k1}) \\ & + \sum_{k=1}^K \frac{d \log D_{k0}}{dz_0} D_{k0} a_{i,k0} - \frac{d \log Q_{S0}}{dz_0} Q_{S0} B_{i,S1} - \frac{d \log Q_{L0}}{dz_0} Q_{L0} (B_{i,L1} - \delta B_{i,L0}) \end{aligned} \quad (38)$$

for the first period and

$$d\mathcal{W}_{i1} = Q_{S0} \left[ -\frac{d \log P_{i1}}{dz_0} c_{i1} P_{i1} + \frac{d \log W_{i1}}{dz_0} W_{i1} - \frac{d \log T_{i1}}{dz_0} T_{i1} + \sum_{k=1}^K \frac{d \log Q_{k1}}{dz_0} Q_{k1} a_{i,k1} + \sum_{k=1}^K \frac{d \log D_{k1}}{dz_0} D_{k1} a_{i,k1} \right] \quad (39)$$

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

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

Using period  $t = 1$  budget constraint from (30), we arrive at

$$d\mathcal{W}_{i1} = -\frac{d \log \bar{P}_1}{dz_0} Q_{S0} [B_{i,S1} + (1 + Q_{L1} \delta) B_{i,L1}]. \quad (40)$$

## 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  $(\tau_{jt}, T_{it}^{HOC})$ , from all equilibrium changes in wages and net transfers  $(W_{it}, T_{it}^{AUT})$ , 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 (38) and use the period  $t = 0$  budget constraint (30)

$$\begin{aligned}
-\frac{d \log P_{i0}}{dz_0} c_{i0} P_{i0} &= -\frac{d \log P_{i0}}{dz_0} \left[ W_{i0} - T_{i0} + B_{i,S0} + (1 + Q_{L0} \delta) B_{i,L0} + \sum_{k=1}^K Q_{0k} (a_{i,0k} - a_{i,1k}) \right. \\
&\quad \left. + \sum_{k=1}^K D_{0k} a_{i,0k} - Q_{S0} B_{i,S1} - Q_{L0} B_{i,L1} \right] \\
&= -\frac{d \log P_{i0}}{dz_0} \left[ W_{i0} - T_{i0} + B_{i,S0} + (1 + Q_{L0} \delta) B_{i,L0} + \sum_{k=1}^K Q_{0k} (a_{i,0k} - a_{i,1k}) + \sum_{k=1}^K D_{0k} a_{i,0k} \right] \\
&\quad + \frac{d \log P_{i0}}{dz_0} [Q_{S0} B_{i,S1} + Q_{L0} B_{i,L1}]
\end{aligned} \tag{41}$$

Recall that from our derivation of Section 2

$$\frac{d \log P_{i0}}{dz_0} = \frac{d \log P_{i0}^*}{dz_0} + \frac{d \log \mathcal{J}_{i0}}{dz_0}. \tag{42}$$

We define the short-run direct component of the welfare change as the term in the second line of equation (41) which is driven by the change in raw individual-level price indexes  $P_{i0}^*$

$$d\mathcal{W}_i^{DIR} = -\frac{d \log P_{i0}^*}{dz_0} \left[ W_{i0} - T_{i0} + B_{i,S0} + (1 + Q_{L0} \delta) B_{i,L0} + \sum_{k=1}^K Q_{0k} (a_{i,0k} - a_{i,1k}) + \sum_{k=1}^K D_{0k} a_{i,0k} \right]. \tag{43}$$

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.  $d \log \mathcal{J}_{i0}$  in equation (42). Combining terms

$$\begin{aligned}
d\mathcal{W}_i^{UFP} &= -\frac{d \log \mathcal{J}_{i0}}{dz_0} \left[ W_{i0} - T_{i0} + B_{i,S0} + (1 + Q_{L0} \delta) B_{i,L0} + \sum_{k=1}^K Q_{0k} (a_{i,0k} - a_{i,1k}) + \sum_{k=1}^K D_{0k} a_{i,0k} \right] \\
&\quad - \frac{dT_{i0}^{HOC}}{dz_0}
\end{aligned} \tag{44}$$

It is easy to see that by summing (43) and (44) one obtains (41), net of the term in the fourth line of (41).

Consider now precisely this term in the third line of (41) and add it to  $t = 1$  welfare change  $dW_{i1}$  computed in (40). We define the long-run component of the welfare change as

$$dW_i^{LR} = dW_{i1} + \frac{d \log P_{i0}}{dz_0} [Q_{S0} B_{i,S1} + Q_{L0} B_{i,L1}]$$

Using the expression for  $dW_{i1}$  in (40) together with the no-arbitrage condition  $Q_{L0} = Q_{S0} (1 + Q_{L1} \delta)$  between short-term and long-term bonds in (34) yields

$$dW_i^{LR} = Q_{S0} \left( \frac{d \log P_{i0}}{dz_0} - \frac{d \log \bar{P}_1}{dz_0} \right) [B_{i,S1} + (1 + Q_{L1} \delta) B_{i,L1}]. \quad (45)$$

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  $dW_{i0}$

$$\begin{aligned} dW_i^{IND} &= \frac{d \log W_{i0}}{dz_0} W_{i0} - \frac{d \log T_{i0}^{AUT}}{dz_0} T_{i0}^{AUT} + \sum_{k=1}^K \frac{d \log Q_{k0}}{dz_0} Q_{k0} (a_{i,k0} - a_{i,k1}) + \sum_{k=1}^K \frac{d \log D_{k0}}{dz_0} D_{k0} a_{i,k0} \\ &\quad - \frac{d \log Q_{S0}}{dz_0} Q_{S0} B_{i,S1} - \frac{d \log Q_{L0}}{dz_0} Q_{L0} (B_{i,L1} - \delta B_{i,L0}) \end{aligned} \quad (46)$$

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:

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

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

$$\begin{aligned} d\hat{W}_i &= -\frac{d \log P_{i0}}{dz_0} c_{i0} P_{i0} + \frac{d \log W_{i0}}{dz_0} W_{i0} - \frac{d \log T_{i0}}{dz_0} T_{i0} + \sum_{k=1}^K \frac{d \log Q_{k0}}{dz_0} Q_{k0} a_{i,k0} \\ &\quad + \sum_{k=1}^K \frac{d \log D_{k0}}{dz_0} D_{k0} a_{i,k0} + \frac{d \log Q_{L0}}{dz_0} \delta B_{i,L0} \end{aligned} \quad (47)$$

The decomposition becomes:

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

## A.7 Sectoral aggregation

In this section we show that equations (19) to (22) aggregate properly and yield the national income identity in nominal terms. From the household budget constraint (19) and the market clearing conditions (18)

$$\begin{aligned}
&\bar{P}_0^* (1 + \mathcal{T}_0) C_0 + Q_{A0} (A_1 - A_1^g - A_1^x) + Q_{F0} (B_{F1} - \delta_F B_{F0}) + Q_{G0} (B_{G1} - \delta_G B_{G0}) + Q_{X0} (B_{X1} - \delta_X B_{X0}) \\
&- \sum_{j=H,G,X} Q_{j0} (B_{j1}^f - \delta_j B_{j0}^f) - \sum_{j=H,F,X} Q_{j0} (B_{j1}^g - \delta_j B_{j0}^g) - \sum_{j=H,F,G} Q_{j0} (B_{j1}^x - \delta_j B_{j0}^x) + \sum_{j=f,g,x} B_{H0}^j \\
= &W_0 - T_0 + (Q_{A0} + D_0) A_0 - (Q_{A0} + D_0) A_0^g - (Q_{A0} + D_0) A_0^x + B_{F0} + B_{G0} + B_{X0} \\
&- \sum_{j=H,G,X} B_{j0}^f - \sum_{j=H,F,X} B_{j0}^g - \sum_{j=H,F,G} B_{j0}^x + \sum_{j=f,g,x} Q_{H0} (B_{H1}^j - \delta_H B_{H0}^j)
\end{aligned}$$

Using the government budget constraint (21) to substitute out  $Q_{G0} (B_{G1} - \delta_G B_{G0})$ , the expression above simplifies to

$$\begin{aligned}
&\bar{P}_0^* C_0 + \bar{P}_0^G G_0 + Q_{A0} (A_1 - A_1^x) + Q_{F0} (B_{F1} - \delta_F B_{F0}) + Q_{X0} (B_{X1} - \delta_X B_{X0}) \\
&- \sum_{j=H,G,X} Q_{j0} (B_{j1}^f - \delta_j B_{j0}^f) - \sum_{j=H,F,G} Q_{j0} (B_{j1}^x - \delta_j B_{j0}^x) + \sum_{j=f,x} B_{H0}^j \\
= &W_0 + (Q_{A0} + D_0) A_0 - (Q_{A0} + D_0) A_0^x + B_{F0} + B_{X0} \\
&- \sum_{j=H,G,X} B_{j0}^f - \sum_{j=H,F,G} B_{j0}^x + \sum_{j=f,x} Q_{H0} (B_{H1}^j - \delta_H B_{H0}^j)
\end{aligned}$$

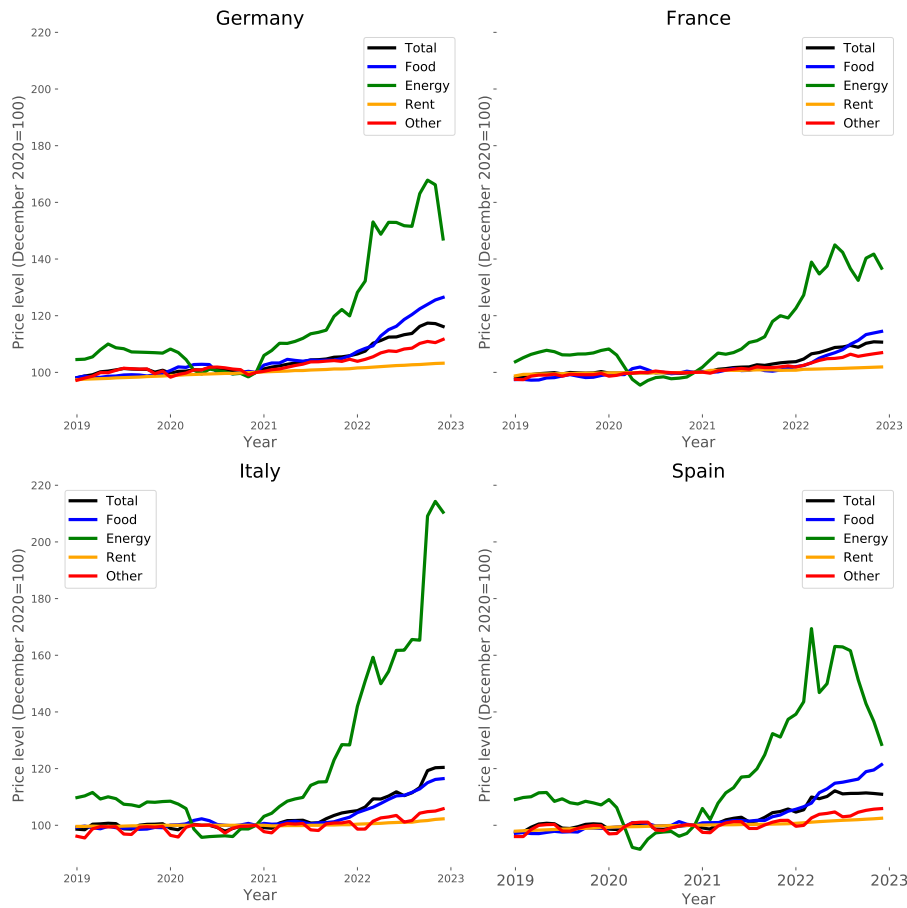
Using the firm sector budget constraint (20) to substitute out  $(Q_{A0} + D_0) A_0$ , the expression above

simplifies to

$$\begin{aligned} \bar{P}_0^* C_0 + P_0^I I_t + \bar{P}_0^G G_0 - Q_{A0} A_1^x + Q_{X0} (B_{X1} - \delta_X B_{X0}) - \sum_{j=H,F,G,S} Q_{j0} (B_{j1}^x - \delta_j B_{j0}^x) + B_{H0}^x = \\ \bar{P}_0^Y Y_0 - (Q_{A0} + D_0) A_0^x + B_{X0} - \sum_{j=F,G,S} B_{j0}^x + Q_{H0} (B_{H1}^x - \delta_H B_{H0}^x) \end{aligned}$$

where we have used the no-arbitrage condition  $Q_{A0} = Q_{S0} (Q_{A1} + D_1)$ . Finally, using the foreign sector equation (22) to substitute out  $Q_{A0} A_1^x$ , we obtain the national income identity (23).

## Appendix B Additional figures

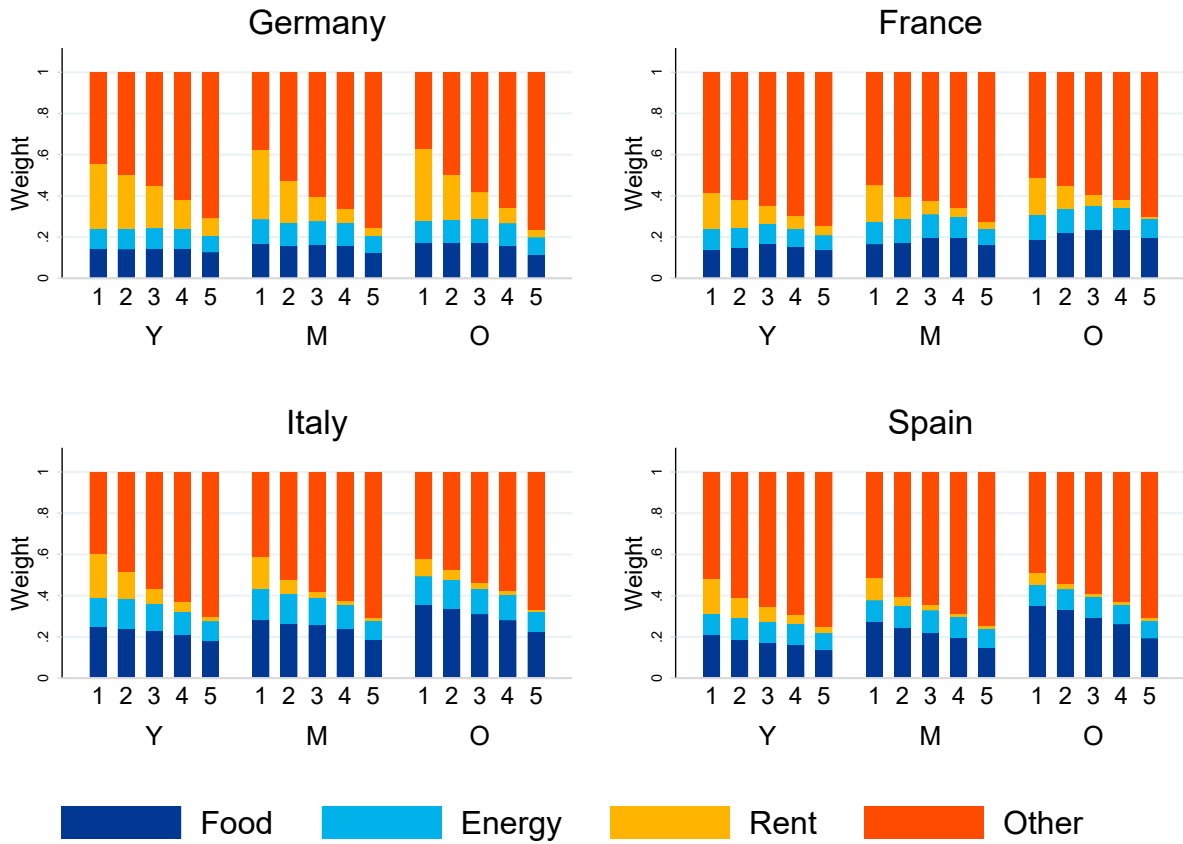


**Figure 15:** Price level index (December 2020 = 100) for Germany, France, Italy and Spain. Total and subcomponents (Food, Energy, Rent, Other).

Note: Not seasonally adjusted, January 2019–December 2022. 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 weights for each category to construct the sub-indexes come from HBS 2015, as in the rest of the paper.

Source: Eurostat, Harmonized Index of Consumer Prices, Household Budget Survey 2015.

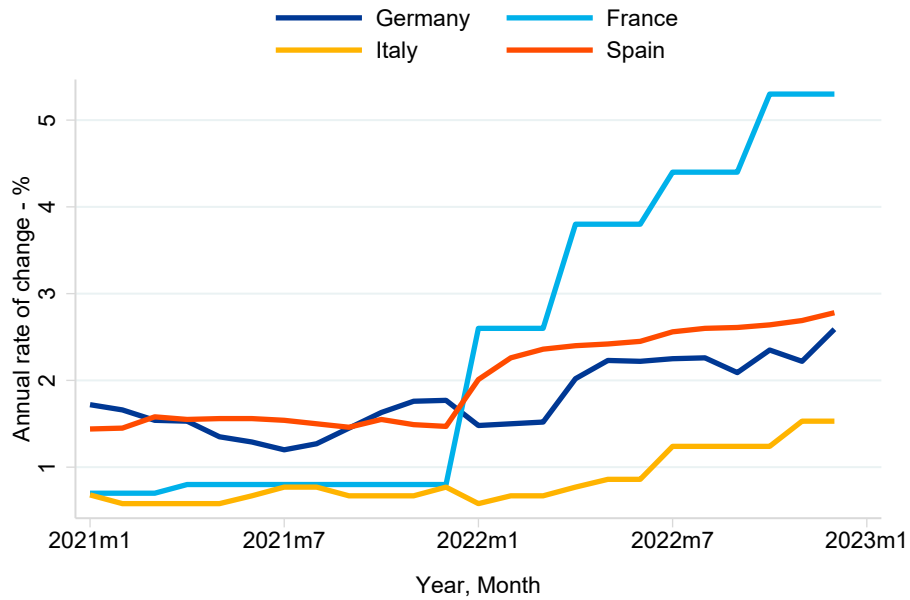




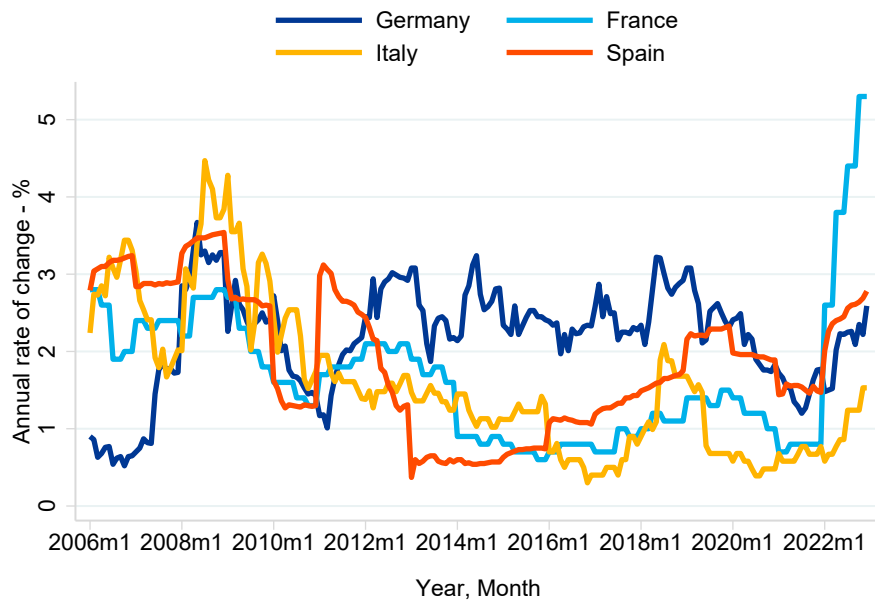
**Figure 16:** Structure of consumption expenditures by age classes and nondurable consumption quintiles within each age class

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 than 45 years, 45-64 years and older than 64 years

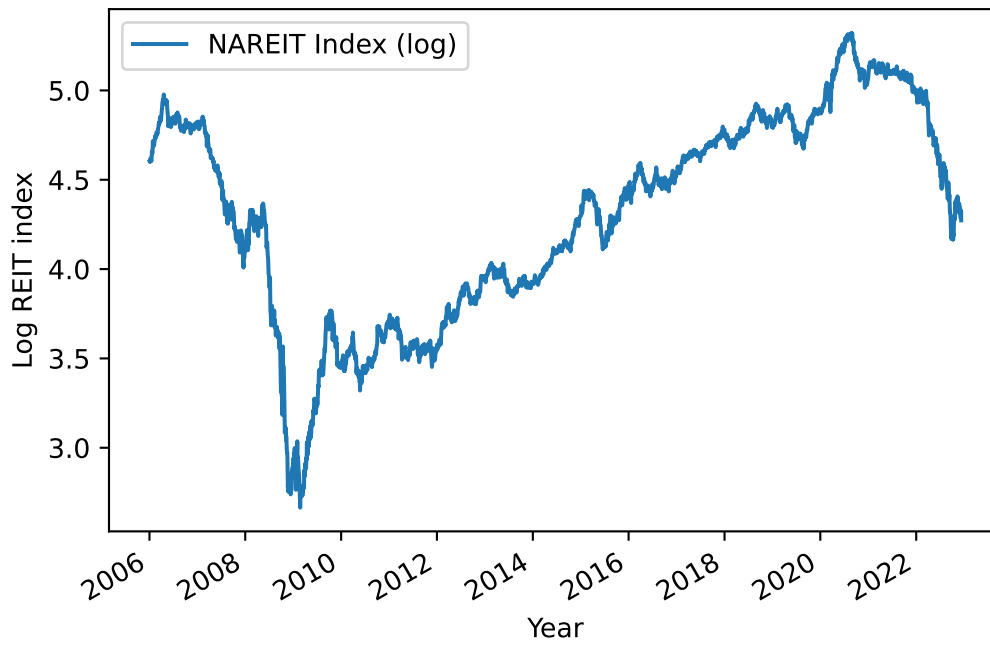
Source: Household Budget Survey, 2015



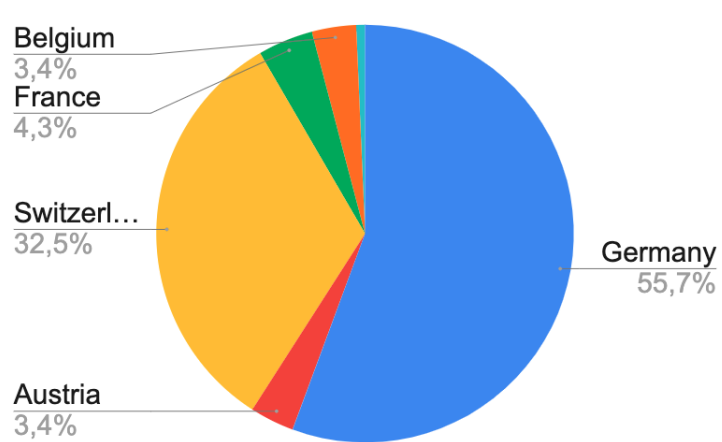
**Figure 17:** Average annual rate of change for negotiated wages, monthly data, 2021–2022  
 Source: National Statistical Agencies.



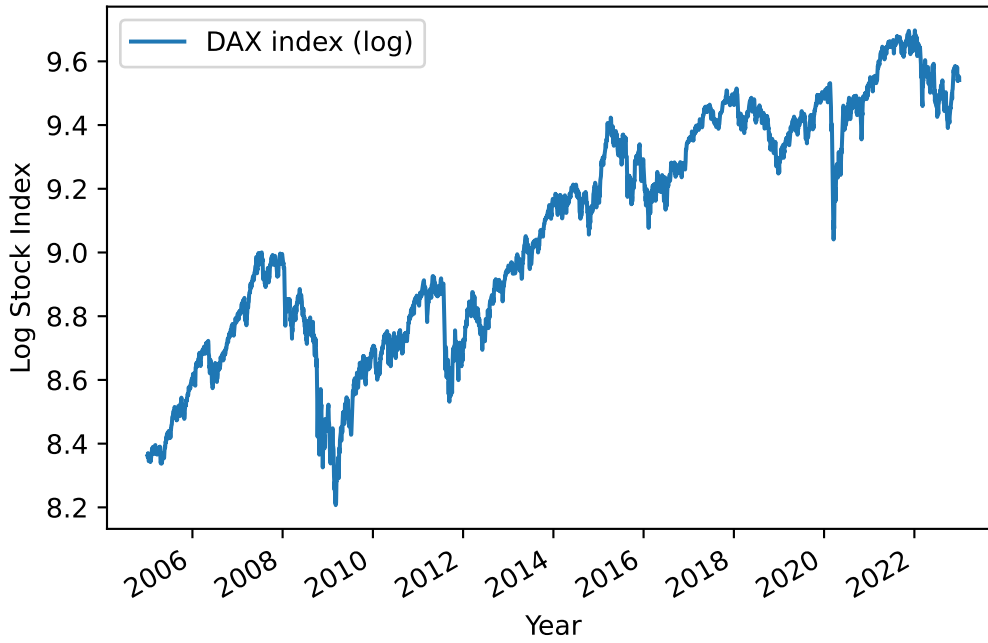
**Figure 18:** Average annual rate of change for negotiated wages, monthly data, 2006–2022  
 Source: National Statistical Agencies.



**Figure 19:** NAREIT Euro zone Residential Index; in logs.  
Source: Bloomberg.

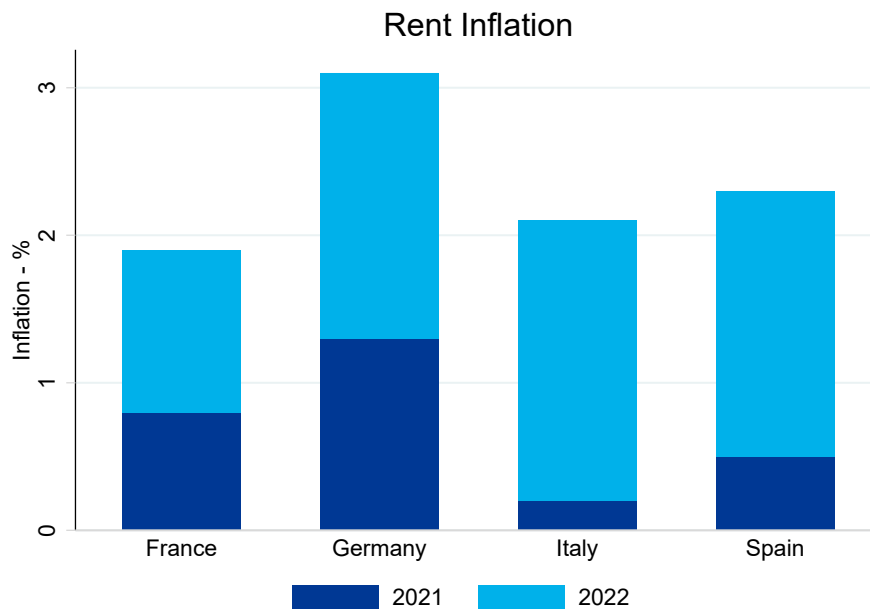


**Figure 20:** Distribution of the REITs by country.  
Source: REITs websites.



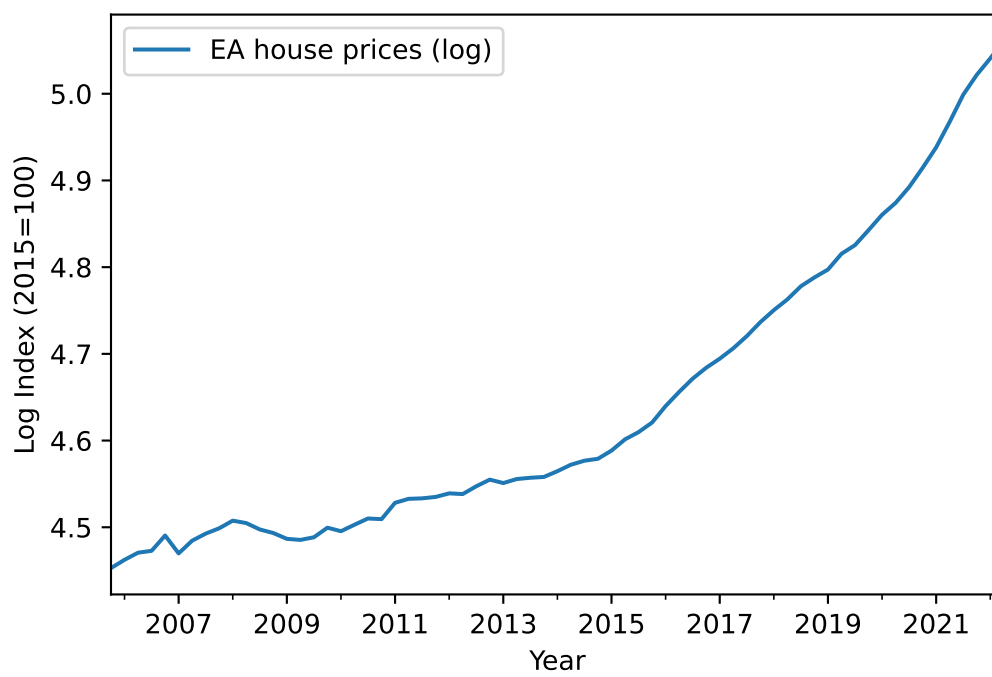
**Figure 21:** Value of the DAX Index; in logs.

Source: Bloomberg.



**Figure 22:** Rent inflation during 2021 and 2022 for France, Germany, Italy and Spain.

Source: HICP.



**Figure 23:** 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

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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

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**Table 9:** Press Release Dates for CPI in Germany (2021–22)

Source: [German Federal Statistical Office](#)

<b>Step 1:</b>	$R(Q_t) = \beta \Delta ILS_{1Y,t} + \gamma R(S_t) + \varepsilon_t$		
	<b>REITs</b>	<b>Bonds</b>	<b>Stocks</b>
Inflation surprise $\Delta ILS_{1Y,t}$	-2.042 (2.467)	-0.423 (0.596)	-0.429 (1.546)
$R(S_t)$	0.466 (0.298)	-0.025 (0.073)	0.069 (0.167)
const	-0.309 (0.306)	-0.009 (0.072)	0.115 (0.188)
Obs	39	46	44
Adj. R <sup>2</sup>	0.021	-0.031	-0.043
F-stat	1.412	0.330	0.115
<hr/>			
<b>Step 2:</b>	$R(H_t) - R_f = \alpha + \delta[R(Q_{t-1}) - R_f] + \tilde{\gamma}[R(S_t) - R_f] + \text{controls} + \varepsilon_t$		
	<b>House returns</b>		
$R(Q_{t-1}) - R_f$	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 <sup>2</sup>	0.630		
F-stat	23.316		

**Table 10:** 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.

Country	Indicator	Year	
		2021	2022
Germany	Negotiated Wages	1.51	2.06
	Minimum Wage	1.60	10.76
France	Negotiated Wages	0.78	4.03
	Minimum Wage	0.98	3.12
Italy	Negotiated Wages	0.67	1.04
	Minimum Wage	NA	NA
Spain	Negotiated Wages	1.51	2.48
	Minimum Wage	0.53	4.71

**Table 11:** Growth rates of negotiated nominal wages and legislated minimum wages. Negotiated wages come from National Statistical Agencies and minimum wages from official sources. Italy does not have a legislated minimum wage.



# 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 the Household Budget Survey (HBS). 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.

The latest available HBS is from 2015. 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 estimate 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 produces aggregate, cumulated inflation rates that are close to the official numbers, see Table 12. For Germany and France, our benchmark estimates are within 0.4 pp of the official measures. Our benchmark rates are somewhat higher in Italy (by 3 pp) and lower in Spain (by 1.5 pp). The third row reports the results of 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). These results demonstrate that the adjustment is important in the case of Italy, but less consequential for the other countries. Most of the remaining discrepancy for Italy is due to a reduction over time in the share of electricity and gas (COICOP 4.5).<sup>35</sup>

The discrepancies reported in Table 12 refer to HICP inflation rates *cumulated* over 2021-22. Discrepancies are smaller for average annual inflation rates, which we use to devalue flows (notably income).

	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 12:** 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

<sup>35</sup>The official weight of electricity 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 and gas to the official one, we get a cumulated inflation rate of 18.3%, closer to official statistics.

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.

### 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 `d11000` (“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. [Figure 17](#) plots growth rates over this period, whereas [18](#) reports their evolution over time starting from 2006, to put this last two years in a historical perspective. [Table 11](#) summarizes the growth rate of negotiated wages and the minimum wage over the period in the four countries.

### 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 19](#) 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 20](#).<sup>36</sup>

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<sup>36</sup>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.

We obtain house prices from the OECD, weighting each EU country according to the geographical distribution of REIT index described above.<sup>37</sup> Figure 23 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 9. We use daily data from one-year-ahead Inflation Linked Swaps, obtained from Refinitiv.

### 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 21 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 corresponding 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.

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<sup>37</sup>For REITs domiciled in Switzerland, we assume they have a portfolio of properties across the euro area.

## Appendix E Government interventions in energy markets: Estimation of counterfactual prices

This appendix summarizes our calculations of actual price indices for household group  $i$ ,  $P_{it}$ , and counterfactual price indices  $P_{it}^*$  – that is, indices absent government interventions in energy prices and energy markets. We focus on three energy-related consumption categories in which governments intervened substantially with taxes and subsidies to dampen the adverse effects of the shock: petrol (and other transportation fuels), natural gas used for household heating and electricity.

We obtained actual (post-tax, post-government intervention) prices  $P_{it}$  for the three energy-related components of the Harmonised Index of Consumer Prices from the Eurostat.

### E.1 Petrol

The governments implemented price reductions in petrol and other transportation fuels that mostly took the form of a fixed amount of euro cent per liter (see Table 13).

To compute counterfactual prices we proceed in two steps. First, we combine actual petrol prices (EUR/L) at the beginning of 2021 (January 11, 2021) from the European Commission’s Weekly Oil Bulletin with indices on petrol from the Eurostat’s Harmonised Index of Consumer Prices to create a time series of actual petrol prices (in EUR/L). Second, we subtract the impact of the price reductions measures listed in Table 13, assuming full pass through to households.

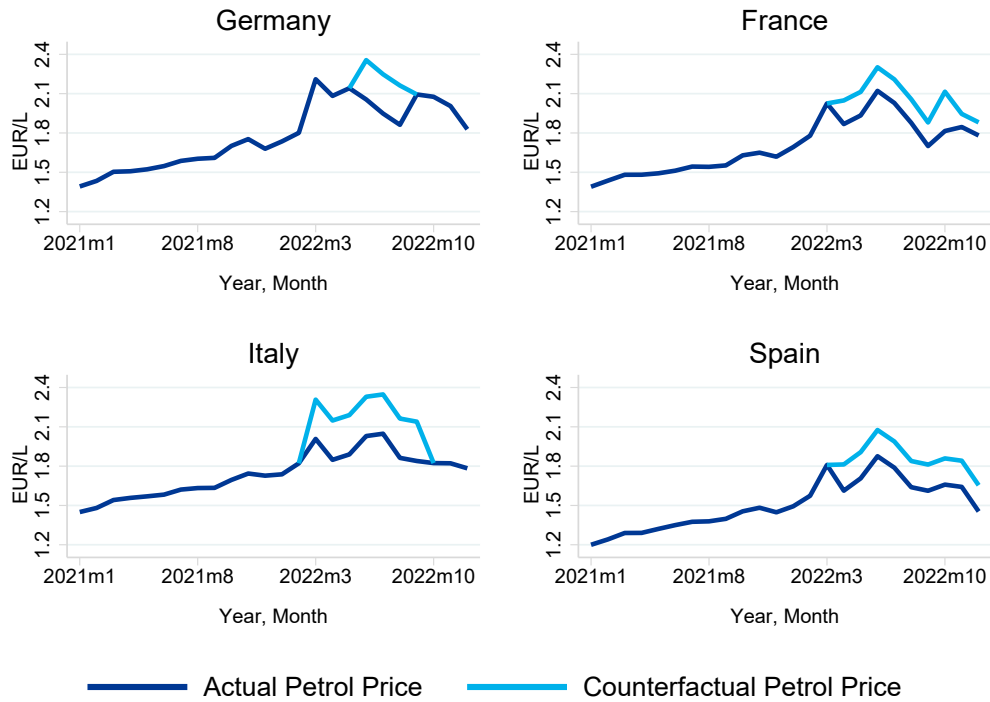
The resulting evolution of actual and counterfactual petrol prices (EUR/L) is plotted in Figure 24. Although relatively short lived, the fiscal measures were significant, particularly taking into account that transportation fuels are an important part of household budget shares. We estimate that the measures reduced prices by about 20 percent in 2021–22 (with some heterogeneity across countries).

### E.2 Natural gas

To quantify the effects of direct government interventions in the gas market, we use data provided by Dao et al. (2023), who use a model-based approach to estimate counterfactual natural gas prices in France during this time period. Because gas is traded internationally, we assume that counterfactual gas prices would have been the same in other countries. This assumption is somewhat restrictive to the extent that bottlenecks in supply systems and other trading frictions can generate differences in prices across countries.

Country	Measure	Time period
Germany	30 cents per liter	June–August 2022
Spain	20 cents per liter	April–December 2022
France	18 cents per liter	April–September 2022
France	30 cents per liter	October 2022
France	10 cents per liter	November–December 2022
Italy	30 cents per liter	March–September 2022

**Table 13:** Subsidies to petrol and other transportation fuels. Source: Sgaravatti et al. (2021)



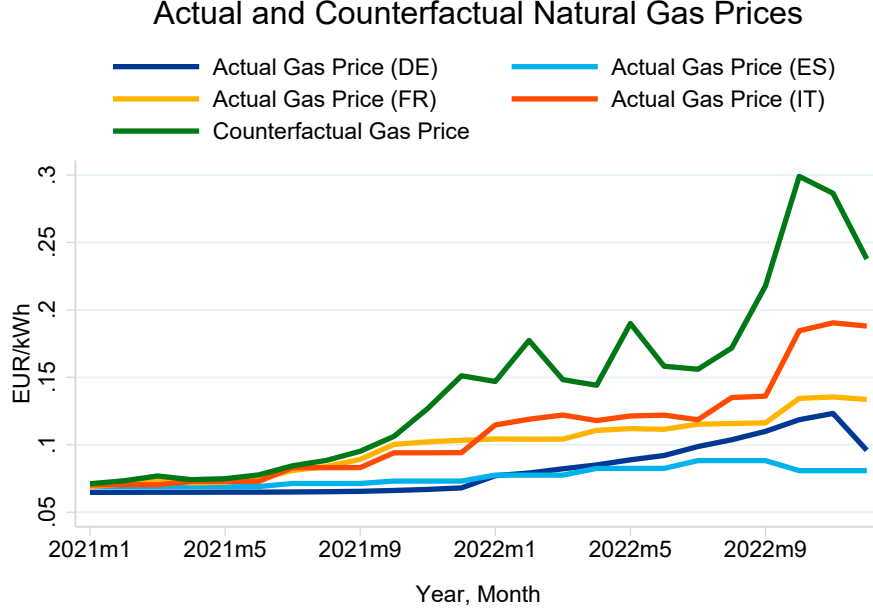
**Figure 24:** Actual and Counterfactual prices for petrol in Germany, France, Italy, and Spain; EUR  
Source: Eurostat, Insee, Statista, myLPG.eu, mise.gov.it and [Sgaravatti et al. \(2021\)](#).

Figure 25 shows actual gas prices and our counterfactual series. 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, 0.08 EUR/kWh in Spain and around EUR 0.18 EUR/kWh in Italy. These differences imply that the fiscal interventions in natural gas markets were more substantial in Germany and Spain (reducing prices by about 70 to 80%) than in France and Italy (reducing prices by about 25 to 35%).

### E.3 Electricity

France and Spain introduced substantial direct interventions in their electricity markets. In order to calculate counterfactual electricity price index for France, we again employ data from [Dao et al. \(2023\)](#), which presents monthly time series of counterfactual electricity prices. We show the series in the left panel of Figure 26.

In Spain, the government also intervened 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. Thus, we obtain daily data of actual and counterfactual wholesale electricity prices for 2021 and 2022 from the electricity operator OMIE ([EPData, 2023](#)).



**Figure 25:** Actual and Counterfactual prices for natural gas in Germany, Spain, France, and Italy; EUR  
Source: Eurostat and [Dao et al. \(2023\)](#).

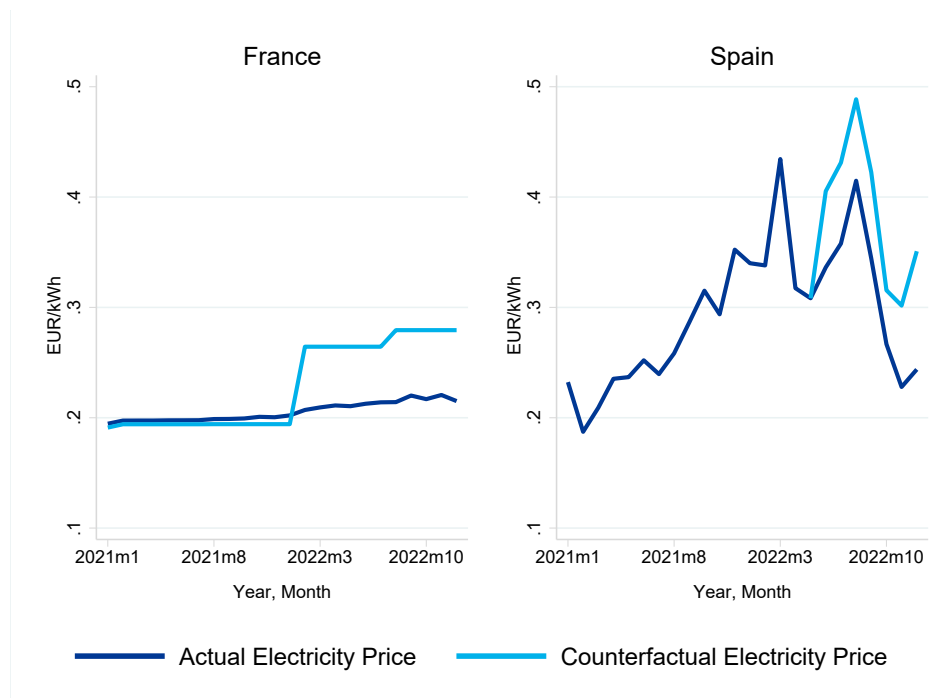
In order to accommodate possible incomplete pass-through of wholesale prices to retail prices, we begin by running a regression of daily observed retail electricity prices on daily observed wholesale electricity prices:

$$P_t^{\text{retail,actual}} = a + b \cdot P_t^{\text{wholesale,actual}}. \quad (48)$$

Next, we assume that the pass-through coefficient  $b$  would remain unchanged under the counterfactual wholesale prices  $P_t^{\text{wholesale,count}}$  and predict counterfactual retail prices  $P_t^{\text{retail,count}}$  by computing:

$$\hat{P}_t^{\text{retail,count}} = a + b \cdot P_t^{\text{wholesale,count}}. \quad (49)$$

The right panel of Figure 26 shows the implied counterfactual electricity prices for Spain together with actual prices. The differences induced by government intervention are comparable to, but slightly larger than, those in France, staying in general below 10 cents per kWh (a reduction of 20–35% in the effective price of electricity).



**Figure 26:** Actual and Counterfactual prices for electricity in France and Spain; EUR  
 Source: Eurostat, OMIE and [Dao et al. \(2023\)](#).

## Appendix F Summary of 2021–22 transfer payments

This appendix summarizes the main transfer payment programs implemented in the four countries in 2021–2022. These include lump-sum payments and other forms of income support. We obtain the information from a dataset put together by [Bruegel](#) and take these measures into account in our analysis. Appendix [E](#) describes how we account for direct interventions in energy markets (e.g., temporary reductions of VAT rates, excise duties, price caps).

### 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, 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 (in 2022)



## Appendix G Computing losses from energy prices for the government

In order to compute the losses for the government originated from the energy price shock, we follow the following approach using the input-output matrix.

Let  $A$  denote the input-output matrix in which rows represent sectors of origin of a given flow and columns represent sectors of destination. For example  $A_{ij}$  represents how much sector  $i$  sells to sector  $j$  in a given year.

We also have information on the shares of government consumption for each sector  $i$ ,  $sh_i^G$ , and on the rise in imported fossil fuel prices  $\pi_{it}^{Me}$ . For our lower bound estimates, we assume that the only price increase that affected the government was the rise in imported fossil fuel prices and how it spread through the value chain. For our upper bound estimates, we apply this same price increase to other energy-related goods (namely, refined petroleum and electricity) and how they spread through the value chain. We adjust the latter calculation using import shares to make sure that there is no double-counting.

Thus,

$$L^{lower} = \pi_{it}^{Me} e^e (\mathbb{I} - A)^{-1} sh_i^G$$

$$L^{higher} = \sum_{j=1}^J \pi_{it}^{Me} sh_j^M e^j (\mathbb{I} - A)^{-1} sh_i^G$$

where  $e^e$  is a row vector of zeros with a 1 in the fossil fuel sector,  $e^j$  is a row vector of zeros with a 1 in the  $j$  sector,  $sh_j^M$  denotes the import share of sector  $j$  and  $sh_i^G$  is a column vector of shares of government consumption, and the  $J$  sectors are fossil fuels, refined fuels and electricity. For consistency with the rest of our empirical approach, we scale these values by biennial GDP.

## Appendix H Effects on the foreign sector via the terms of trade channel

We are interested to calculate the effects on the foreign sector via changes in the prices of imports and exports:

$$d\mathcal{W}_0^x = -\frac{d \log \bar{P}_0^*}{dz_0} \left[ \frac{d(\log \bar{P}_0^E / P_0^*)}{dz_0} E_0 - \frac{d \log (\bar{P}_0^M / P_0^*)}{dz_0} M_0 \right] \quad (50)$$

Simplifying the notation:

$$d\mathcal{W}_0^x = \tilde{P}_0^E E_0 - \tilde{P}_0^M M_0, \quad (51)$$

we observe the change in terms-of-trade, i.e.:

$$ToT = \tilde{P}_0^E - \tilde{P}_0^M \quad (52)$$

We use the measure in the change of the terms of trade provided by the OECD and available up to

2022. To translate it into gains/losses for the foreign sector, we multiply it by the average of imports and exports over GDP, as a measure of the average exposure of the economy to the terms of trade shock:

$$dW_0^x = \frac{1}{2}ToT(E_0 + M_0). \quad (53)$$