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ABSTRACT

We measure the heterogeneous first-order welfare effects of the recent inflation surge across households in the euro area. A simple framework illustrating the numerous transmission channels of surprise inflation to household welfare guides our empirical exercise. By combining micro data and aggregate time series, we conclude that: (i) country-level average welfare costs –expressed as a share of triennial income–were sizable and heterogeneous: around 3% in France and Spain, 7% in Germany, and 9% in Italy;(ii) this inflation episode resembles an age-dependent tax, with the retirees losing up to 14%, 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 were 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 helped shield households. The counterpart of this household-sector loss is a significant gain for the government.

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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. Euro area headline inflation reached a peak of 10.6% in October 2022.[1] This upsurge was marked and unexpected, with energy and food prices being the main drivers of aggregate price dynamics. Did everyone bear the costs of this hike in the price level equally? Or, was the burden uneven across the population? If so, who were the winners and the losers? And, through what channels did inflation affect household welfare?

These classic distribution questions also surrounded 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*.[2] Friedman often referred to it as *the cruelest tax of all*. Behind this stance there is the commonly held perception that inflation is regressive because the nominal share of net worth is larger for the poor (Easterly and Fischer, 2001; Erosa and Ventura, 2002) and the elderly (Doepke and Schneider, 2006).[3] Unexpected inflation, however, operates through a number of additional mechanisms besides the dilution of nominal wealth. 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*.

In this paper, we focus on the most recent episode, and set out to estimate the heterogeneous footprints of surprise inflation across households in the four largest euro area countries: Germany, France, Italy and Spain. Figure B.1 in Appendix B illustrates price level dynamics in these countries. During 2021–23, the price index rose by roughly 14% in France and Spain, 16% in Italy and 20% in Germany. Figure B.2, 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 linked to Russia's invasion of Ukraine. Food inflation, however, was also severe, and the shock eventually transmitted to the bulk of other goods and services, with the notable exception of rents.

We begin our study by laying out a tractable dynamic framework that illustrates the various mechanisms through which surprise inflation can have repercussions on household welfare. By exploiting the envelope theorem, we break down the total money-metric welfare change into four easily interpretable channels, all of which are potentially heterogeneous across households.

[1]This value refers to year-on-year percentage change in the headline Harmonized Index of Consumer Prices (HICP) index.

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

[3]A recent survey finds that the vast majority of respondents believe that low-income people are much more likely to lose from inflation as compared to high-income people (Binetti et al., 2024).

To fully understand this decomposition, it is useful to recognize that, during high inflation episodes, governments often intervene to contain price surges for particular goods which are the drivers of inflation, and to offer support to certain demographic groups. This last episode was no exception: interventions on energy markets (electricity, natural gas and liquid fuels), such as subsidies and price controls, were significant. Ad-hoc transfers to households were too.

The first channel, which we label the *direct component*, measures the direct impact of raw inflation, i.e., before all these fiscal support measures and keeping wages and asset prices fixed at their pre-shock level. This component captures two key forces. First, because of the relative price shift, households with different consumption baskets experience different inflation rates. Second, through the Fisher effect, larger nominal income and holdings of nominal balances make households more exposed to surprise inflation. Conversely, those households with nominal long-term debt benefit from a higher price level.

The second channel, which we label the *unconventional fiscal policy component*, captures the welfare change associated to the ad-hoc government policies implemented to shield households from the shock. Some of these interventions 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 energy consumption in households' budgets.

The third channel, labeled the *indirect component*, embeds the response of income to the shock. Disposable income can accrue from different sources, such as wages and pensions, net transfers, rents, interests, dividends and capital gains, and is affected by the tax system. All these variables react differently to surprise inflation. For example, nominal labor contract rigidity varies substantially across countries, depending on wage setting institutions, and within country, depending on individual occupation and industry.[4] In addition, some countries feature automatic indexation of minimum wages, pensions and income tax brackets, and others do not. Thus, real labor income losses may vary even across households experiencing the same inflation rate. Finally, prices of nominal and real assets held by households may react to surprise inflation differently, depending on the asset class.

The fourth channel is the *long-run adjustment component.* This residual term descends from one of our assumptions, i.e., that relative prices (not the aggregate price level, whose jump is permanent) return to their pre-shock values in the long run. This realignment of relative prices generates further changes in the real value of nominal net positions across the distribution (although, not on average).

Our analytical expressions contain observable sufficient statistics and do not require making

[4]Heterogeneity in wage stickiness has long been recognized as a prominent institutional feature of labor markets in euro area countries—see for example Eurosystem Wage Dynamics Network (2009).

assumptions on functional forms or structural parameters. We then combine several micro and macro data sources to shed light on the quantitative relevance of these four mechanisms across the age (three groups: young 25–44, middle-age 45–64, old retirees 65+) and consumption expenditures distribution (five quintiles), separately for each country.

We estimate household-level expenditure shares on different goods and services from the 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. The components of the household budget constraint are measured from the Household Finance and Consumption Survey (HFCS). 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, and of house, stock and bond prices using a combination of event studies and high-frequency identification on days of HICP inflation announcements.

Our results show that the aggregate impact of this inflation episode is large and heterogeneous across countries. Expressed as a share of triennial income (because the length of the surprise inflation episode is 3 years), welfare losses average around 3% in France and Spain, 7% in Germany and 9% in Italy.[5] Comparing Italy, the country with the highest welfare cost, to France, the country with the lowest one, reveals four main reasons for this gap: (i) the size of the raw-price shock was bigger in Italy –a reflection of its energy import dependence and the structure of energy markets; (ii) extraordinary fiscal policy measures were generous in both countries, but entailed different approaches, and offset a more sizable share of the shock in France; (iii) nominal wages increased less than inflation in both countries, but much less so in Italy; (iv) in Italy, the nominal net position channel generates mostly losses across the entire distribution because middle-age and elderly households hold larger nominal asset positions, and the young borrow less, compared to France.

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 is holdings of nominal assets, which are 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 energy and food, whose prices increased the most relative to the rest. On the

[5] In other words, on average, households in each country would give up that share of pre-shock triennial income in order to avoid this inflation episode.

other hand, pensions grew faster than wages because they were quickly indexed to inflation, which mitigated the costs to retirees, particularly in Spain. Somewhat surprisingly, we do not find a significant slope of welfare effects across consumption quintiles (our proxy for permanent income). If we abstract from rents, we do estimate more severe losses for the poor, though, because of the higher inflation rate they suffer as a consequence of their sharper 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 to low-income households, for whom housing services represent a sizable share of total spending.

Turning to transmission channels of the shock, the key force behind our welfare results is the direct component, through the revaluation of nominal net positions and the loss of purchasing power of labor market income. The effect of heterogeneous consumption baskets is, in comparison, less relevant, with the exception of poor elderly households especially in Italy and Spain. The unconventional fiscal policy component, notably interventions that contained retail energy prices, played a nontrivial role in protecting households from the shock. The indirect component is sizeable for those groups who benefited from rises in minimum wages (Germany), in negotiated wages (France) and, most importantly, in pensions. Instead, the nominal wages of most workers increased relatively little. In Spain and in Italy, nominal income gains were partly taxed away due to the fiscal drag, i.e., the lack of inflation indexation of nominal tax brackets. 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. The increase in nominal interest rates that started in 2022 negatively impacted households with adjustable rate mortgages, particularly the young Spanish ones.

Quantitatively, the heterogeneity of welfare effects across households in the euro area is extensive: German and Italian retirees lost up to 14% of their triennial income, while young households roughly broke even in Spain and gained up to 7% in France. Middle-aged households lost roughly between 2% and 11% of their income across the four countries. Overall, though, around one quarter of households in the euro area –and roughly half of the 25–44 year-old– are net winners from the inflation shock.

In the last part of the paper we go beyond the household sector, and analyze the impact of the shock for the government and foreign sectors. With the possible exception of Germany, national governments were net winners –even when accounting for the additional spending due to the ad-hoc fiscal relief measures and the increased cost of public pensions and other expenditures– because they benefited substantially from the reduction in real value of public debt. If these extra resources in the government budget constraints were used to increase transfers or cut taxes, they would go a long way in reducing households' welfare losses.

1.1 Literature

Methodology. Our approach leverages the envelope theorem to analyze the first-order welfare effects of aggregate shocks across the household distribution, focusing on the notion of 'money metric welfare change' (i.e., welfare change measured in euros). There have been several recent applications of this approach. Auclert (2019) and Slacalek et al. (2020) decompose 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) analyze the different distributional effects of well identified inflationary shocks (i.e., monetary policy and oil prices) in the US. With respect to this paper, instead of particular shocks, we investigate a specific historical episode, as an event study.[6] Closer in spirit to our study is Cardoso et al. (2022) which applies the same approach to characterize the *direct channel* of the recent inflation shock and quantify it using administrative bank account and household survey data for Spain. Their analysis is a building block of ours, to which we add the other three channels described above. Finally, we note that the nature of our approach does not allow us to examine policy counterfactuals. Pugsley and Rubinton (2021), Olivi et al. (2023), and Yang (2023) investigate the distributional effects of inflationary (or deflationary) shocks in fully specified HANK models that are amenable to the analysis of alternative policy scenarios.

Empirical channels. Our empirical work is connected to the literature that investigates inflation heterogeneity across different household groups (e.g., Michael, 1979; Kaplan and Schulhofer-Wohl, 2017; Jaravel, 2021; Orchard, 2022). In general, these studies conclude that lower-income households in the US, historically, have experienced higher inflation than high-income ones, but that these differentials are not persistent. 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 on data which preceded 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, 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 estimates of the size of the indirect

[6]Investigating specific shocks at the root of surprise inflation has obvious advantages because, as shown by these authors, different shocks can have opposite distributional impact. In the context of this recent episode, however, studying the whole event might be a better strategy since multiple factors played a role and since, as we write, the jury is still out on the exact shock decomposition (Bernanke and Blanchard, 2024).

channel are 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 are not great hedges against core inflation (Fang et al., 2022).

Euro area inflation. Some papers contemporaneous to ours address the impact of the recent inflation shock across euro area households. Virtually all of them, however, 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; Amores et al., 2023). Two notable exceptions are Cardoso et al. (2022) which, as explained, quantifies the whole direct channel for Spain, and Chafwehé et al. (2024) which uses somewhat different data sources, but reaches similar conclusions.

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, various data sources, and empirical methodology.

2 Framework

We organize our empirical analysis around a simple reference framework aimed at analyzing the effects of an unanticipated 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 composition of their balance sheet, including the share of nominal assets and liabilities; (iii) earn different sources of nominal income (e.g., labor, capital, government transfers) which adjust differently to the shock; (iv) are differentially affected by the fiscal policy 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. 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. Before date $t = 0$, the economy rests in a steady state with inflation normalized to zero (constant price level).

Shock. The inflationary shock is an aggregate disturbance that induces a *permanent jump in the aggregate price level* at $t = 0$. We label the first period of the shock between $t = 0$ and $t = 1$ (or period 0), the *short run*. We also allow for relative prices to change in the short run. At $t = 1$, the shock has subsumed: the price level is constant again forever after, and relative prices have returned to their pre-steady-state ratios. We label period 1, between $t = 1$ and $t = 2$, the *long run*.[7]

2.2 Household problem

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

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

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

where $j = 1, \ldots, J$ 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 evaluated at the nationwide average ($\bar{c}_{jt}$). We also explicitly take into account that goods 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 lower it). Let

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

where $\mathcal{P}^*_{jt}$ is the pre-tax or raw price, and τ_{jt} is a wedge capturing good-specific taxes (if positive) or subsidies (if negative).[8] Consistently with 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 log-change in variable X from its pre-shock steady state value to its value at the end of period t (i.e., log deviation in period t from steady state). Up to the first

[7] 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.

[8] Changes in the parameter τ_{jt} can capture, for example, government interventions in the energy sector aimed at mitigating the hike in unit prices paid by consumers in the aftermath of the shock. As explained, this type of government actions were significant over this period in the countries we analyze. At the cost of heavier notation, it is straightforward to allow for nonlinearities in these taxes and subsidies.

order, the changes in actual and pre-tax household-specific price indexes realized at in period 0 after the shock hit are

$$
\begin{aligned}
d\log P_{i0} &= \sum\nolimits_{j=1}^{J} xsh_{ij,0} \cdot d\log \mathcal{P}_{j0}, \\
d\log P^{*}_{i0} &= \sum\nolimits_{j=1}^{J} xsh_{ij,0} \cdot d\log \mathcal{P}^{*}_{j0},
\end{aligned}
\tag{3}
$$

where $xsh_{ij,0} = \frac{c_{ij,0}\mathcal{P}_{j0}}{\sum_{j=1}^{J} c_{ij,0}\mathcal{P}_{j0}}$ is the nominal expenditure share on good j at the point of the expansion, i.e., in steady state before the inflation shock at $t = 0$. Using (2) evaluated at $t = 0$ into (3) , we obtain

$$
d\log P_{i0} \simeq d\log P^{*}_{i0} + d\log \mathcal{T}_{i0}, \tag{4}
$$

where

$$
d\log \mathcal{T}_{i0} = \sum\nolimits_{j=1}^{J} xsh_{ij,0} \cdot d\tau_{j0}
$$

measures the change in the post-tax individual price index caused by the good-specific government interventions. Similarly, if we let $\overline{xsh}_{j0}$ denote the *aggregate* share spent on good j in the period before the shock hits, we can define the changes in the post-tax and pre-tax aggregate price indexes as:

$$
\begin{aligned}
d\log \bar{P}_{0} &= \sum_{j=1}^{J} \overline{xsh}_{j0} \cdot d\log \mathcal{P}_{j0}, \\
d\log \bar{P}^{*}_{0} &= \sum_{j=1}^{J} \overline{xsh}_{j0} \cdot d\log \mathcal{P}^{*}_{j0}.
\end{aligned}
\tag{5}
$$

These definitions allow us to decompose the impact of the shock on individual-level prices P_{it} in two ways. First, we can separate the average effect from 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 from 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.

Budget constraint. Households earn nominal labor income W_{it} and pay nominal net tax liability (nominal taxes net of transfers) T_{it} to the government.[9] It is useful to split net house-

[9] 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. The dependence of net taxes on i 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. and affects the (nominal) fiscal drag component of welfare costs.

hold transfers T_{it} between two components, T_{it}^{AUT} and T_{it}^{HOC}. The first component represents automatic stabilizers already in place at the time of the shock. The second one represents the ad-hoc measures newly put in place only after $t = 0$ by the government to cushion households from the shock.

Households can hold real and nominal assets. Real assets (e.g., stocks and housing) are denoted as $a_{i,kt}$, $k = 1, \ldots, K$. Real assets trade at price Q_{kt} and pay a nominal dividend D_{kt}.[10] Households can hold both one-period (short-term) nominal bonds $B_{i,St}$ with price Q_{St} and long-term nominal bonds (which also capture mortgage debt when they are held in negative amounts). To model long-term bonds we follow the conventional approach in the sovereign debt literature (e.g., Arellano and Ramanarayanan, 2012) and assume that they are a perpetuity contract with nominal coupon payments that decay geometrically at rate $\delta < 1$. Thus a long-term nominal bond issued in period t entails a promise to pay δ^{s-1} units of currency (i.e., euros) in period $t + s$, for all $s \geqslant 1$. $B_{i,Lt}$ represents the nominal face value of the long-term bond portfolio held by household i, and Q_{Lt} the price of new bond issuances at t.[11]

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

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

Finally, we assume that households only face natural debt limits which do not bind.[12]

Household maximization. A household born at $t = 0$ maximizes lifetime utility

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

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

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

[12] In this 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. Del Canto et al. (2023) illustrate how to generalize this envelope theorem logic to feasible sets that include ad-hoc borrowing constraints.

subject to the budget constraints (6) at $t = 0, 1$. The choice variables at $t = 0, 1$ are the J consumption goods $\{c_{i,jt}\}_{j=1}^{J}$, and holdings of real and nominal assets $\{a_{i,kt+1}\}_{k=1}^{K}$, $B_{i,St+1}$ and $B_{i,Lt+1}$. At every t, the household takes as given good prices $\{\mathcal{P}_{jt}\}_{j=1}^{J}$, wages W_{it}, net taxes T_{it}, dividend policies $\{D_{kt}\}_{k=1}^{K}$, and asset prices $\{Q_{kt}\}_{k=1}^{K}$, Q_{St} and Q_{Lt}. Appendix A lays out the sequential formulation of 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 time $t = 0$ and causes an increase in the price level equal to $d \log \bar{P}_0$ (recall that before the shock inflation is normalized to zero). We now state formally our four assumptions on the nature of the shock.

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 in period 0 (the short run) unrestricted to capture the different degrees of frictions and partial adjustment that occurs in the short run in goods, labor, housing, 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:

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

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

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

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

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

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

This assumption requires relative prices to return to their initial pre-shock ratios, i.e., all good-specific prices increase by the same amount in the long run. As a result, in the long run, individual inflation equals aggregate inflation.

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

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

We schematically depict the inflation shock in Figure B.3.

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 affects 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 fiscal drag (or bracket creep) effect of inflation. Spending can rise because government purchases are more expensive, because some benefits are indexed to inflation, or because the government implements ad-hoc transfer or price subsidy programs to contain the cost of inflation for households.[13] In addition, interest payments on debt can change if the monetary authority moves nominal rates.

Because the intertemporal government budget constraint needs to hold after the shock, an accommodation 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 $t > 1$. We return to the impact of the shock on the government budget constraint in Section 5.

[13] Altig et al. (2024) analyze in depth how inflation, even if anticipated and with full market adjustments, affects households through its interaction with the fiscal system in the United States.

2.4 Welfare analysis

Welfare metric. Following Fagereng et al. (2022) and Del Canto et al. (2023), we focus on the notion of 'money-metric welfare' $\mathcal{W}_i$, i.e., welfare gains and losses in unit of account (euros), which we formally define in Appendix A.

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 income and asset prices caused by the shock, (2) a short-run *unconventional fiscal policy* component $d\mathcal{W}_i^{UFP}$, which 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 income 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 into account only the direct increase in cost of living for an individual on its total resources, abstracting from the ad-hoc government response to the shock $\left(\tau_{jt}, T_{it}^{HOC}\right)$ and from all equilibrium effects on disposable income (W_{it}, T_{it}, D_{kt}) and prices (Q_{St}, Q_{Lt}, Q_{kt}). We obtain:

$$\begin{aligned} d\mathcal{W}_i^{DIR} \quad = \quad & \Bigg[\underbrace{-\frac{d\log \bar{P}_0^*}{dz_0}}_{\text{average } \pi} - \underbrace{\left(\frac{d\log P_{i0}^*}{dz_0} - \frac{d\log \bar{P}_0^*}{dz_0}\right)}_{\pi \text{ difference } (C)}\Bigg] \times \\ & \Bigg[\underbrace{W_{i0} - T_{i0}}_{\text{net income } (Y)} + \underbrace{B_{i,S0} + (1 + Q_{L0}\delta)\, B_{i,L0}}_{\text{net nominal position } (NNP)} + \underbrace{\sum_{k=1}^{K} D_{k0} a_{i,k0} + \sum_{k=1}^{K} Q_{k0}\left(a_{i,0k} - a_{i,1k}\right)}_{\text{dividends + capital gains } (K)}\Bigg]. \end{aligned} \tag{11}$$

The term on the right-hand side of $d\mathcal{W}_i^{DIR}$ in the first line separates the role of aggregate-level inflation ('average π') vs individual-level inflation ('π difference'), both measured before any ad-hoc government interventions (hence, the $*$ superscript). These expressions illustrate that the 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. For example, an increase in the price of energy will produce different effects on households depending on the share of energy in their initial consumption bundle. Note that we assume that substitution effects away from those goods whose price has increased the most can exist, but are not welfare relevant to a first order.

The term in square brackets in the second line of (11) collects all the nominal 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 "net nominal positions" in the household portfolio (Doepke and Schneider, 2006).[14] It includes bank deposits and bond holdings net of mortgage and other debt. In our empirical application net nominal positions will be denoted as NNP. The third and final item collects dividends and capital gains on real assets (including stocks and housing).[15] As explained by Fagereng et al. (2022), welfare is only affected by realized capital gains and losses. 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 (11). 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 in period 0.

2.4.2 Unconventional fiscal policy component

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

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

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

(or tax breaks) paid directly to households. In sum,

$$\begin{aligned} d\mathcal{W}_i^{UFP} \;=\; & \underbrace{\left(\frac{d\log P_{i0}^{*}}{dz_0}-\frac{d\log P_{i0}}{dz_0}\right)}_{\pi\text{ difference}}\times \\ & \left[W_{i0}-T_{i0}+B_{i,S0}+\left(1+Q_{L0}\delta\right)B_{i,L0}+\sum_{k=1}^{K}D_{k0}a_{i,k0}+\sum_{k=1}^{K}Q_{k0}\left(a_{i,0k}-a_{i,1k}\right)\right] \\ & -\frac{dT_{i0}^{HOC}}{dz_0}. \end{aligned} \tag{12}$$

The first term in the round brackets captures changes in τ_{j0} which affect the gap between raw prices and final prices faced by consumers since, from (4) , $d\log P_{i0}-d\log P_{i0}^{*}=d\log\mathcal{T}_{i0}$. Note that this effect is heterogeneous across the distribution because it depends on the individual expenditure share of the goods targeted by the fiscal intervention. The term on the third line captures changes in ad-hoc direct taxes and transfers to households.[16] Note that the unconventional fiscal policy component captures only the effect of these policies on prices of goods consumed by households or directly on their transfer income. Its impact, through equilibrium forces, on wages and asset prices is captured by the indirect component, which we analyze next.

2.4.3 Indirect component

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

$$\begin{aligned} d\mathcal{W}_i^{IND} \;=\; & \underbrace{\frac{d\log W_0}{dz_0}W_0}_{\Delta\text{ wages}}-\underbrace{\frac{d\log T_{i0}^{AUT}}{dz_0}T_{i0}^{AUT}}_{\Delta\text{ net taxes}}-\underbrace{\frac{d\log Q_{S0}}{dz_0}Q_{S0}B_{S1}-\frac{d\log Q_{L0}}{dz_0}Q_{L0}\left(B_{i,L1}-\delta B_{i,L0}\right)}_{\Delta\text{ price of nominal assets}} \\ & \underbrace{+\sum_{k=1}^{K}\frac{d\log Q_{k0}}{dz_0}Q_{k0}\left(a_{i,k0}-a_{i,k1}\right)+\sum_{k=1}^{K}\frac{d\log D_{k0}}{dz_0}D_{k0}a_{i,k0}}_{\Delta\text{ price of real assets}}. \end{aligned} \tag{13}$$

These 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 between workers and firms would lead to an increase in nominal wages which would contain

[16] 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.

households' loss of purchasing power. Inflation-indexed transfers and pensions would raise disposable income, but fiscal drag effects of inflation would increase tax liabilities. Similar offsetting outcomes would be produced through an increase in the equilibrium price of real assets which partially realigns with fundamentals. Finally, the monetary policy reaction to inflation would lead to a rise in nominal interest rates and a fall in bond prices for bond holders and to higher interest payments for borrowers with variable-rate debt.

2.4.4 Long-run adjustment

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

$$d\mathcal{W}_i^{LR} = Q_{S0}\left(\frac{d\log P_{i0}}{dz_0} - \frac{d\log \bar{P}_1}{dz_0}\right)\underbrace{\left[B_{i,S1} + \left(1 + Q_{L1}\delta\right)B_{i,L1}\right]}_{\text{net nominal position at } t=1}. \tag{14}$$

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. This component is zero only if the shock at $t = 0$ 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 $t = 1$ when relative prices get realigned.

Finally, note that in virtue of *Assumption 4*, the long-run adjustment in the government budget constraint adds no additional terms to our welfare formulas. If this accommodation occurs via higher inflation, its impact 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 a change in surpluses at $t > 1$, it does not affect households alive at the time of the shock.

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. There are two main differences with respect to the welfare change of the young: (i) the long-run component is zero, because the old cohort does not live through period 1; (ii) the devaluation effect in the partial equilibrium component applies to all real assets as well, beyond the nominal ones, because being period 0 the last period of life, all assets are sold.[17]

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 that 45 years, 45–64, and older than 64) and five consumption quintiles within each age class. We use consumption expenditures as a proxy for permanent income which we favor over current income because it is less affected by transitory shocks.[18] In addition, we use aggregate time series to identify the effects of inflation surprises on asset prices. We now turn to describing these 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, F, and G for further details on the measurement of each variable.

3.1 Measuring the direct impact of inflation

This section describes the empirical measurement of our direct component in equation (11). We note that the calculation of individual-level price indexes also allows to assess the long-run component (14).

3.1.1 Household-specific inflation rates

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

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

We obtain the weights xsh_{jic} from the latest wave 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

[17] 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.

[18] 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.

detailed in Appendix D.2.[19] The corresponding good-specific price changes π_{jc} come from the micro data underlying the Harmonized Index of Consumer Prices (HICP). We use the average price changes within the period to devalue flows, and cumulated price changes in the period to devalue stocks.[20]

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.[21]

We measure inflation expectations in each country at the start of 2021 using data from Consensus Economics. The expected inflation ranges between 0.4% and 1.7% per year.

3.1.2 Components of the household budget constraint

We use the 2017 wave of the Eurosystem Household Finance and Consumption Survey (HFCS) to estimate each component of the household budget constraint.[22] 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). 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).[23] 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

[19] In Appendix D.3, 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.

[20] Specifically, we deflate flows in each year $t = 2021, 2022, 2023$ by the cumulative year-on-year change in the price index up to the beginning of that year plus the average inflation over that year. We deflate stocks the cumulative year-on-year price changes from beginning of 2021 to end of 2023. Disposable income, rents, interests, dividends and capital gains are flows, while the net nominal position is a stock. See Appendix D.1 for details.

[21] 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.

In line with the measurement of inflation in the HICP (which is different from the US CPI, for example), we do not include imputed rent. Table C.1 contains the full list of these categories.

[22] 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 inflation shock.

[23] Here 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. This is consistent with the way we estimate indirect effects in Section 3.3. In our sectoral analysis of Section 5 we assign indirect holdings of nominal balances through firm shares to households.

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, which in the four countries under analysis amount to roughly 3%.[24]

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

3.2 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 in equation (12) in the welfare decomposition.

3.2.1 Fiscal measures that reduced energy prices

The governments of all four countries introduced measures that directly affected the price of goods, particularly those related to energy. These interventions include, for example, subsidies to fuel prices and regulations in electricity markets. Because these policies 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 in absence of interventions. For each country, we calculate counterfactual

[24] 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".

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 F describes these different sources of data and our computations of counterfactual prices in more detail.

3.2.2 Government transfers

We also incorporate all forms of income support from the government that sought to help low-income households coping with the rising cost of energy bills. For all cases, we compute the statutory value of government transfers and attribute it accordingly to each country-age-consumption group. See Appendix G for a summary.

3.3 Measuring the change in wages, pensions and asset prices

We now briefly describe the measurement of the components of equation (13), 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 2021–23. We use data on negotiated wages to capture how the dynamics of wage arrangements and national wage agreements have evolved over the three years.[25] On average, wages grew by around 2–3% in Germany, Spain and Italy, and by over 4% in France.[26] For countries with a minimum wage (France, Germany and Spain), 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-64 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 2021–23 nominal pensions often increased more than wages. To identify the adjustment related to the inflation shock, we subtract expected inflation from the nominal growth rates of all these income sources.

3.3.2 Fiscal drag

Due to the lack of, or imperfect, indexation of tax brackets, the increase in wages and pensions described above was accompanied by a change in households' tax burden, or fiscal drag. We compute the fiscal drag as the difference between actual income taxes and the income taxes that would have been paid in the absence of the inflation shock. The no-inflation-shock counterfactual assumes that all incomes would have grown at the expected rate of inflation. For the computation of the fiscal drag, we take into account possible adjustments in tax brackets triggered by inflation. In France and Germany, tax brackets were indexed almost in real time. In Spain and in Italy, no adjustments were made over the 2021–23 period. See Appendix E for further details.

3.3.3 House prices

Absent high-frequency house price data across the four countries, we adopt a two-step approach to identify the effects of inflation surprises on house prices. In the first step, we use daily data on the stock prices of Real Estate Investment Trusts (REITs) $R(Q_t)$ to estimate their reaction to the news about inflation on the days of releases of the German Harmonized Index of Consumer Prices (HICP) in 2021–2023:

$$R(Q_t) = \beta\,\Delta ILS_{1Y,t} + \gamma R(S_t) + \varepsilon_t. \tag{15}$$

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

[26] 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 dependent variable $R(Q_t)$ is the FTSE EPRA NAREIT Eurozone Residential Index of FTSE Russell.[27] The regressor $\Delta ILS_{1Y,t}$ denotes the surprise component of the HICP announcement measured as the daily change in 1-year-ahead euro area Inflation-Linked Swaps obtained from Refinitiv.[28] We also control for euro area stock returns $R(S_t)$ obtained from Bloomberg. The coefficient of interest is β which measures the sensitivity of REITs returns to the inflation surprise.

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 from 2006Q1–2023Q4:

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

where R_f denotes the risk-free rate and the control variables are the broad effective exchange rate, the 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 the euro-area HICP (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 back out the estimate of the elasticity of house prices to inflation surprises as the product $\beta \times \delta$. Our estimated value $\beta \times \delta = -3.995 \times 0.035 = -0.138$ means that an inflation surprise of 10% implies a 1.38% drop in house prices. We multiply this elasticity by the size of the inflation surprise in each country, obtaining a small response of house prices. We report all results from these regressions in Table C.3 of Appendix C.

3.3.4 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 the German HICP data release in 2021–23. Specifically, we regress daily data on 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 equation (15).

We follow an analogous strategy for bonds. We construct daily bond returns as a weighted average of euro-area government and corporate bonds, in proportion to quantities outstanding, and estimate their reaction to the German HICP data releases, controlling for EU stock market returns.[29] The data are obtained from Bloomberg.

[27] Germany is by far the largest market for REITs in the euro area (see Appendix D.6.1 and Figure B.8).

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

[29] While in the regression for stock returns we control for the global stock market returns, which are less

The corresponding elasticities for stock and bond prices are negative, and larger than those for house prices: -0.410 and -0.726, 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.[30] We report the results from these regressions in Table C.3 in Appendix C.

4 Results

This section describes our estimates of the transmission channels of inflation surprises to various components of the household budget constraint. Consistently with our framework, we present our findings in four sequential stages. We express money-metric welfare gain or loss as a share of three times annual household disposable income in 2019, i.e., we ask households what fraction of their income over a three year period –the duration of the shock– they would be willing to give up (in case of loss) or they would need to be compensated with (in case of gain) to avoid the surge in the price level.

4.1 Heterogeneity in inflation rates

The inflation spike in the euro area over 2021–2023 was heterogeneous across countries, age groups, and consumption quintiles (Figure 1). At the country level, the highest aggregate inflation rate occurred in Italy and Germany, where the price of the average consumption basket increased roughly by 15 to 20% cumulatively over these three years. The jump in the price level was much more muted in France and Spain, with an aggregate rise of just above 10%Figure 1 also shows that the bulk of the inflation surge was driven by energy prices, especially in Italy, 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

correlated with country-level stock markets than EU stock returns, in the regression for bonds we control for the EU stock market.

[30] Existing work mostly focuses on the response of bond prices, e.g., Gurkaynak et al. (2020). 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).

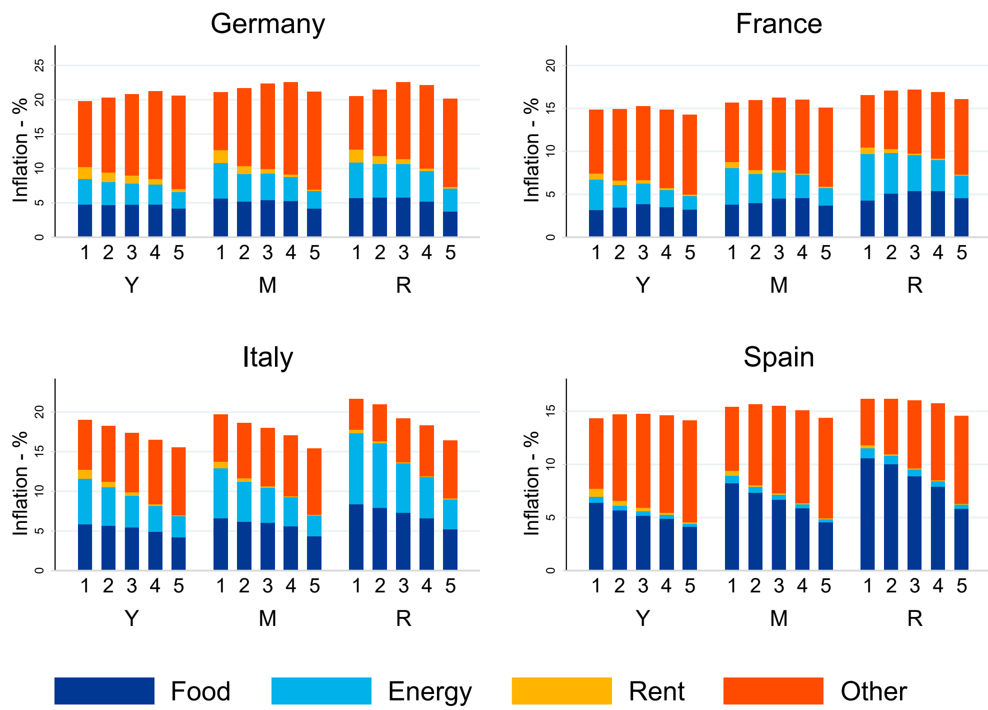

Figure 1: Decomposition of household-level inflation rates in pp by age classes and nondurable consumption quintiles within each age class, 2021–2023, cumulative 3-year rates in percent

Note: The figure shows the contribution of each consumption category to realized cumulative inflation rates in 2021–23. Food corresponds to “food at home” (COICOP 1), energy includes electricity and gas (4.5) and fuels (7.22), rent is actual rent (4.1), while other comprises all the rest of consumption categories. The groups Y, M and O denote ages of less that 45 years, 45–64 years and older than 64 years. Source: Household Budget Survey, 2015

prevail (e.g., Germany). Finally, as explained, governments have intervened in different ways in energy markets.

Within countries, the inflation rate is generally slightly 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 France. To understand these differences in inflation rates across households, it is crucial to recognize that (i) older households spend relatively more on energy and food, but less on rents, whereas (ii) households in lower quintiles spend a higher share of their budgets on energy, food, as well as rents (see Figure B.4 in Appendix B). Italy and Spain are the countries for which the negative relation between the share spent on energy and food and income is the steepest. The negative rent share-income gradient is prevalent everywhere.

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

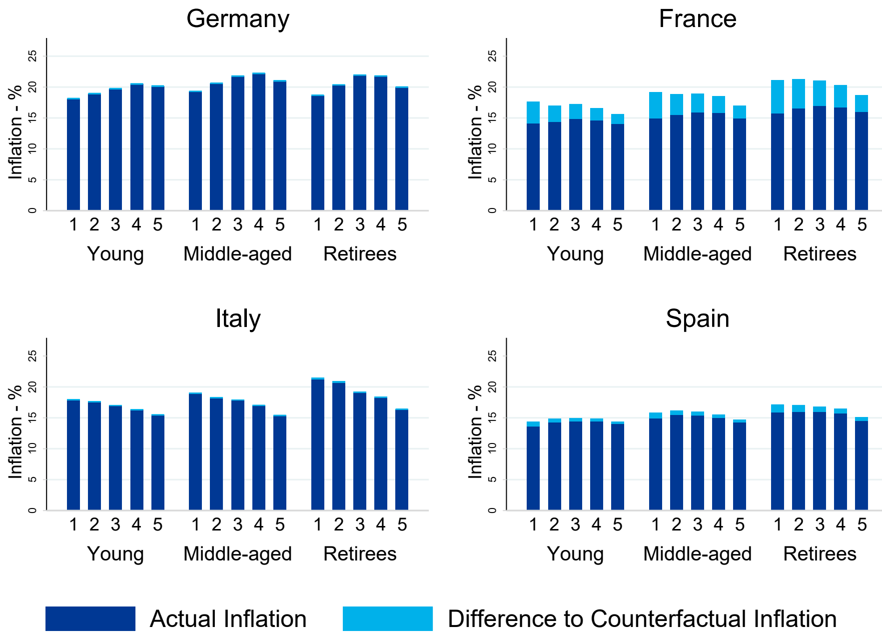

Figure 2: Actual and counterfactual household-level inflation rates by age classes and nondurable consumption quintiles within each age class, 2021–2023, cumulative 3-year rates in percent

Source: Household Budget Survey 2015.

driven by energy and food prices, instead, is counterbalanced by the modest increases in rents. To illustrate this point more concretely, Figure B.5 reports inflation across age and consumption quintiles when rents are excluded from the consumption basket. The negative inflation-income gradient is now visible in every country. Comparing Figures 1 and B.5, the strongest effect appears for low-income households, who are mostly renters and, across countries, in Germany which has a large share of renters.[31]

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 2 shows that because

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

the interventions were phased out by the end of 2023 and the counterfactual levels returned toward actual ones (see also Figures F.1–F.3), the inflation rate was not noticeably affected, except for France, where interventions reduced inflation by around 2 p.p. However, the interventions still supported households, especially those that spend a higher share on energy and fuels, i.e., those with low income and older households, as we discuss below. Figure B.6 documents that over the period 2021–22, the first two years of the shock, government interventions reduced the inflation rates by several percentage points.

4.2 First component: direct effect

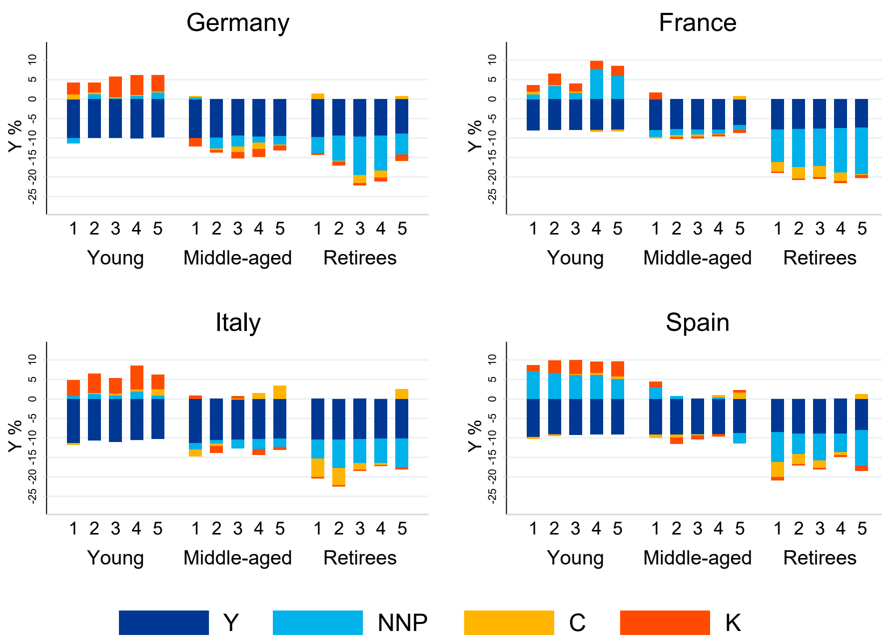

Figure 3: Gains from the inflation shock, in percent of triennial disposable income, by age class and nondurable consumption quintile: decomposition of the direct effect into its components.

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

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 3). Although most households experience substantial costs (as a fraction of their triennial disposable income), there is considerable heterogeneity.

First, losses are larger for German and Italian households, for whom aggregate inflation rates were higher. Second, we observe a clear age pattern in all countries, with the old losing more than the young. This pattern is particularly striking in Spain and France, where the young can experience net gains.

Figure 3 looks into which channels account for 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. The effects of dividends and capital gains (K) are also heterogeneous across ages, although less relevant than NNPs. They benefit particularly the young in Germany and Italy, many of whom are renters who plan on buying a house soon.[32] The net income component (Y), which is the largest contributor to welfare losses, is quite uniform across age and expenditure groups in absolute terms, and plays its biggest role for middle-aged households.[33] In comparison with these channels, the heterogeneity in consumption baskets across households (C) contributes less. It 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 the elderly in Italy (and to a lesser extent, Spain), as their deviation from the aggregate inflation rate in the economy is the largest (Figure 1).

4.3 Second component: unconventional fiscal policy

In our second stage, we incorporate fiscal interventions intended to cushion the effect of the inflation shock on households' well being. Figure 4 shows their welfare impact, compared with those of the first stage, and dividing measures into two main groups: those that affected consumer prices directly (in yellow) and transfers to households (in light blue).

The effect of fiscal interventions was noticeable, reducing the welfare consequences implied

[32] In the empirical implementation, we assume that retirees sell one tenth of their houses, which results in losses for them. This reflects the fact that the cohort spans about 30 years and around 3/30 of the people will pass away in the model's long run (which lasts three years). Correspondingly, young people only buy one tenth of their average housing share.

[33] The Y component is not exactly equal across all households because it refers to disposable *labor* income, whereas we normalized welfare changes by *total* disposable income, which also includes capital income.

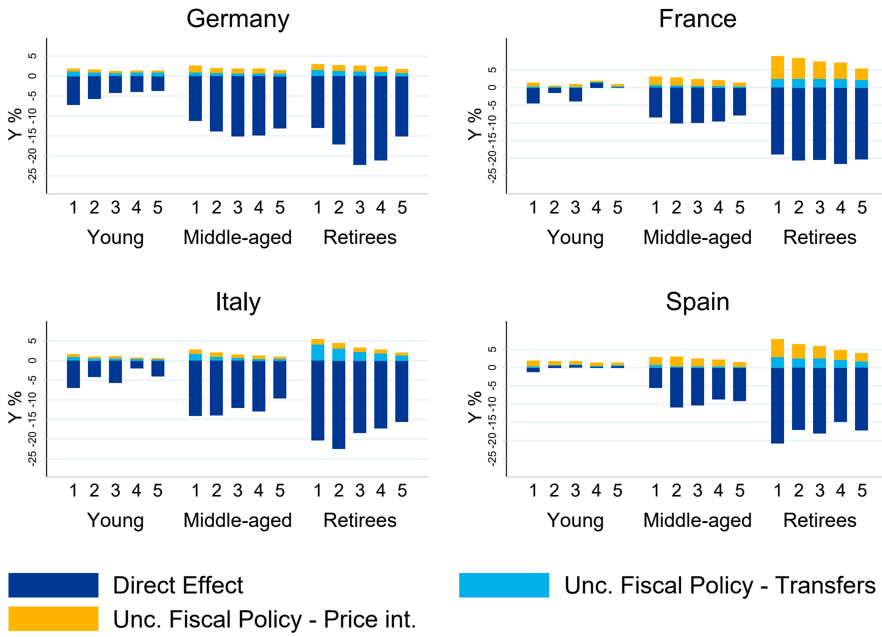

Figure 4: Gains from the inflation shock, in percent of triennial disposable income, by age class and consumption quintile: direct effect and unconventional fiscal policy effects, decomposed into price interventions and direct transfers.

Note: Negative values denote losses. Source: Household Finance and Consumption Survey 2017.

by the first stage by one-fifth on average across countries and household types. Overall, the role of energy price caps was more relevant than that of transfers. This was the case especially in 2022, when price caps were active in all countries and supported the purchasing power of incomes. 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.

4.4 Third component: indirect effect

Our results so far have assumed that nominal asset prices, nominal wages, and pensions did not catch up with inflation in the aftermath of the shock. The third component incorporates the welfare effects of adjustments in these variables. The top panel of Figure 5 shows that the effects of the third stage are in general positive, but very heterogeneous across countries and age groups, and rarely large enough to compensate the negative effects arising from the direct effect, even in combination with the fiscal measures.

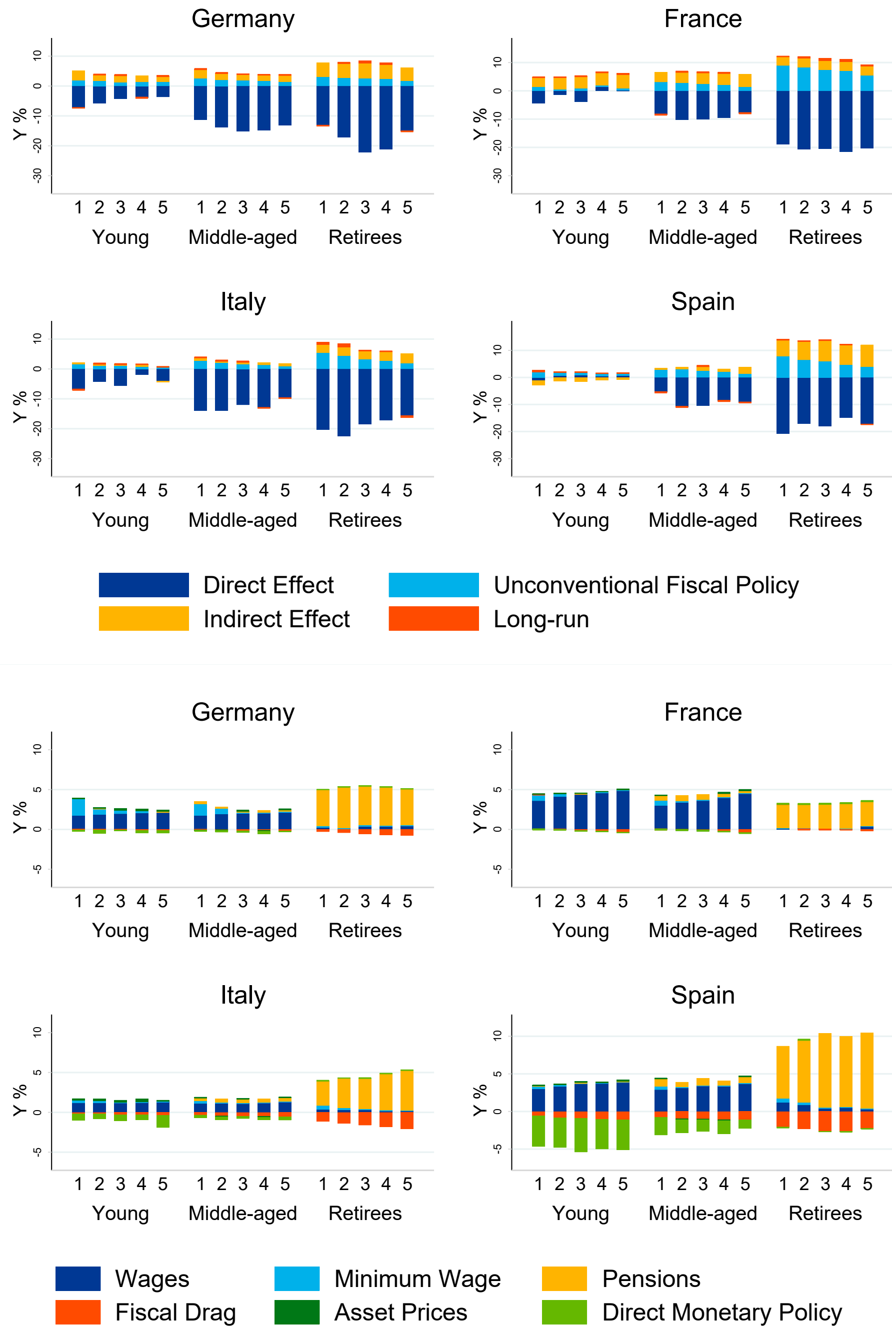

Figure 5: Gains from the inflation shock, in percent of triennial disposable income, by age class and nondurable consumption quintile. Top panel: Effect from the four components. Bottom panel: Decomposition of the indirect effect.

Note: Negative values denote losses. Source: Household Finance and Consumption Survey 2017.

Decomposing this indirect channel (bottom panel of Figure 5) allows us to see the sources of this heterogeneity. Although nominal wages increased during this period, in general these increases were modest and only generate a welfare gain of about 3% of disposable income, much smaller than the loss derived from the direct effect on nominal wages, which is around 9.5% of disposable income.[34] Wage increases were comparably larger for French workers, for whom wages increased more quickly as a result of adjustments in sectoral agreements, and German workers in the lowest quintile of the distribution, who benefited from a large rise in minimum wages in October 2022. Compared with wages, pensions grew much more in all four countries, mostly because they are indexed in different forms to past inflation. As a result, retirees gained substantially from the indirect component, particularly in Spain, where pensions increased the most (9.5% for most pensioners in 2023). Due to the constancy of tax brackets, however, nominal income gains were accompanied by a sizable fiscal drag in Italy and Spain. Our estimates suggest that this effect was particularly large for pensioners in higher consumption quintiles, who lost up to 2.5% in the two countries. The fiscal drag was smaller for younger and middle-aged households in Italy and Spain, and much smaller in France and Germany, due to the quasi-indexation of income tax brackets.

The size of the asset price channel, which combines the shift in house, long-term bond, stock prices, is negligible because short-run housing price elasticities to inflation surprises are estimated to be small and because bonds and stock holdings are low, except at the very top of the consumption distribution.

Finally, households were also affected by the gradual rise in nominal interest rates initiated by the ECB in July 2022. The monetary policy tightening produced an impact on households through many channels, including general equilibrium effects on incomes and asset prices –see Slacalek et al. (2020) for empirical estimates of the relative importance of these channels in the euro area. In the bottom panel of Figure 5, we isolate one of these many channels, i.e. the direct effect produced by changes in interest earned on deposits and paid on debt.[35] In Spain, where many young households hold an adjustable-rate mortgage, the pass-through of rate hikes to mortgage rates implied a substantial increase in interest payments, which partially wiped out some of their gains through the loss in real value of their negative NNPs. The effect was much smaller in the other countries, where fixed-rate mortgages are more pervasive, and for savers, since the pass-through of policy rates to deposit rates was very limited.

[34] For our benchmark results, we assume that wages do not incorporate any productivity gains over this period. If we assume instead that trend growth in labor productivity is 0.75 pct per year (the average over the four countries for the decade before the shock), and that the rise in nominal wages partly reflects this trend and not a catch up of purchasing power, then our welfare losses increase by roughly 1.5% of disposable income.

[35] All other equilibrium effects of monetary policy on wage and asset prices are already included in the other terms in the indirect component.

4.5 Fourth component: long-run adjustment

In our fourth and final stage, we compute the welfare change associated with the return of relative prices to their pre-shock values in the long run. As Figure B.7 shows, these effects are non-negligible, albeit lower in magnitude than our direct, fiscal and indirect effects. In general, they are smaller than 1% of disposable income 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 large negative inflation differentials during 2021–2023 because of their high spending share of energy. As a result, the return to the pre-existing levels of relative prices benefits them: going forward, they face relatively lower inflation than the rest of the population. The elderly rich, in contrast, lose as, during 2021–2023, they faced lower inflation rates than the average.

4.6 Total welfare effect

The top panel of Figure 5, which combines the direct, fiscal, indirect and long-run effects, shows that the bulk of the welfare effects come from the direct component, only partially mitigated by fiscal interventions and by the indirect component, particularly for the young and middle-aged in France and for the retirees in France and Spain.

Table 1 summarizes all these total welfare changes, and expresses them also in euros. Young households tend to roughly break even in Spain, record small losses in Germany and Italy, and small gains in France, in general all below 5% of income. Middle-aged households tend to lose between 2–11% of income, with those in France losing the least and in Germany and Italy the most. Retirees lose around 3–7% in Spain, around 6–14% in Germany, France and Italy. Thus, German and Italian retirees are the largest losers in the euro area, while the young in France are those who mostly benefited from the shock. In euros, cumulatively over this episode, losses of the high-income retirees average to more than €10,000. Among the winners, young French gained around €4,000 on average.

4.7 How many households benefited?

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.

Age group	Consumption quintile	Germany		France		Italy		Spain	
		%	€	%	€	%	€	%	€
Young	1	−2.2	−1400	0.5	200	−4.7	−1900	−0.3	−100
	2	−1.8	−1700	3.6	2600	−2.4	−1200	0.8	500
	3	−0.6	−600	1.3	1400	−4.0	−2200	0.6	400
	4	−0.5	−700	6.7	7600	−0.3	−200	0.6	500
	5	−0.3	−500	6.2	9400	−3.6	−3900	0.9	1000
Middle-aged	1	−5.5	−4200	−1.9	−1100	−10.0	−4100	−2.0	−800
	2	−9.4	−9800	−3.4	−3000	−11.1	−7000	−7.0	−3900
	3	−11.0	−15800	−3.5	−3900	−9.6	−6600	−6.1	−4500
	4	−11.0	−18500	−3.2	−4300	−11.0	−11100	−5.5	−5400
	5	−9.3	−21900	−2.1	−4300	−8.1	−11600	−5.4	−8000
Retirees	1	−5.7	−2700	−6.6	−4100	−11.3	−4200	−6.6	−2000
	2	−9.3	−5500	−8.5	−6400	−14.0	−6100	−3.4	−1300
	3	−13.7	−10800	−8.9	−8000	−12.0	−6800	−4.0	−2100
	4	−13.3	−12300	−10.4	−11000	−11.2	−7800	−2.6	−2000
	5	−9.1	−12600	−11.0	−17400	−11.2	−12100	−5.4	−6800
All		−7.0	−8000	−2.5	−2700	−9.0	−6400	−3.5	−2600

Table 1: Combined net effect of the inflation shock by age class and consumption quintile. The first column expresses welfare changes as percentage of triennial disposable income and the second column as the cumulative gain/loss in euro over the three years.

To better understand the extent of this heterogeneity, Figure 6 shows the share of households that, within each group, experienced net gains. On average a bit more than one quarter of households gained, and most of them are concentrated in the young age groups. In France and Spain, more than half of the young are net winners, in Germany around 50% and in Italy around 30%. Among the retirees, instead, much fewer are winners. The only exception is Spain, where extensive pension indexation implied that around 50% of the retirees benefited. With the exception of Spain, where it is positive, there is no clear gradient over the consumption distribution.

5 Redistribution across sectors of the economy

Up to this point, we have analyzed welfare gains and losses from inflation across the distribution of households. We now take a broader 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

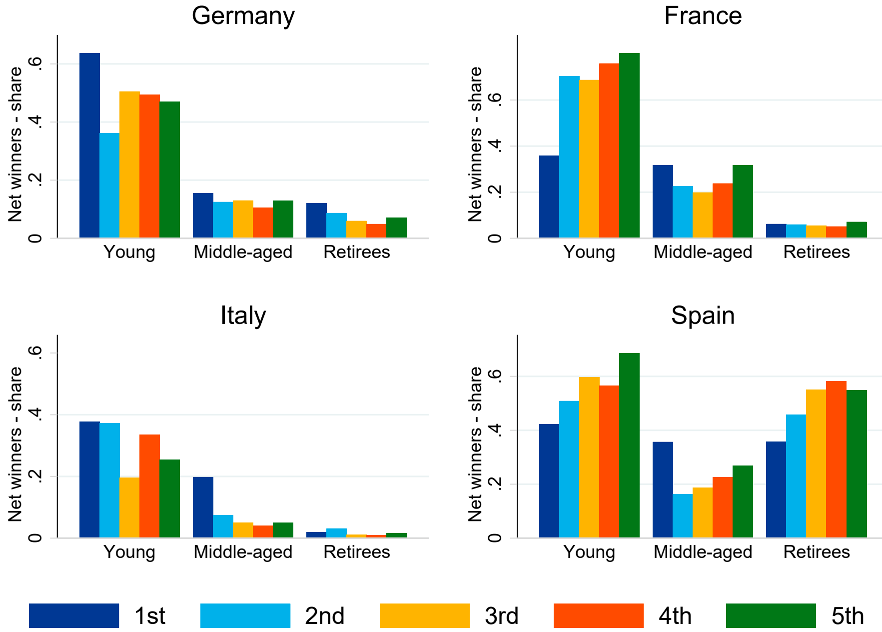

Figure 6: Share of net winners from the inflation shock within each age and consumption quintile class

Source: Household Finance and Consumption Survey 2017.

these three sectors? Or 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 focus on the revaluation of nominal wealth positions as the source of redistribution, since our results of Section 4 suggest that it is the key component of gains and losses for the household sector. Next, in order to get a fuller picture for the government sector, we incorporate the cost of additional fiscal outlays due to the ad-hoc interventions and the higher cost of purchases.

5.1 Sectoral redistribution of nominal wealth

5.1.1 Theory

We introduce explicitly into the model three other agents, besides households (h): firms (f), government (g), and foreigners (x). We denote the agent holding nominal assets with superscripts, and the agent issuing nominal liabilities with subscripts. For example, $B^f_{ht} > 0$ denotes firm holdings of debt issued by households (e.g., mortgage debt), and $B^x_{gt} > 0$ denotes foreign holdings of government debt. Finally, we let $B^j_{jt} < 0$ denote total liabilities issued by sector j (and held by the other three sectors). Hence, by market clearing, $\sum_{s=h,f,g,x} B^s_{jt} = 0$ for all j. Consistently with the notation of Section 2, we denote the coupon decay rate of debt issued by sector j by δ_j and its price by Q_{jt}. Without loss of generality, to simplify notation, we fold short-term government debt into B^g_{gt}. 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, with shares held by sector s denoted by A^s_t, dividends per share by D_t, and ex-dividend share price by Q_{At}.[36] It is also convenient to let $\alpha^s_j = B^s_{j0}/(-B^j_{j0})$ denote the initial share of total liabilities issued by sector j held by sector s at $t = 0$, before the shock, with the understanding that $\alpha^j_j = -1$. Similarly, $\alpha^s_A = A^s_0/A_0$ and $\alpha^f_A = -1$ for firm equity.

Appendix A.7 shows that, by aggregating the budget constraints of all sectors, one obtains the fundamental national accounting identity for an open economy. This derivation highlights that asset devaluations for one sector must correspond to asset revaluations for another, i.e., inflation causes a transfer of wealth across sectors. In the rest of this section, we articulate this message by following closely the approach of Doepke and Schneider (2006) and Adam and Zhu (2016) and focusing, for now, on nominal wealth redistribution.

Let NNP^s_0 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:

$$\begin{aligned} NNP^h_0 &= \alpha^h_A NNP^f_0 + \sum_{j=h,f,g,x} \alpha^h_j Q_{j0}\,(1+\delta_j)\,(-B^j_{j0}), \\ NNP^g_0 &= \alpha^g_A NNP^f_0 + \sum_{j=h,f,g,x} \alpha^g_j Q_{j0}\,(1+\delta_j)\,(-B^j_{j0}), \\ NNP^x_0 &= \alpha^x_A NNP^f_0 + \sum_{j=h,f,g,x} \alpha^x_j Q_{j0}\,(1+\delta_j)\,(-B^j_{j0}), \\ NNP^f_0 &= \sum_{j=h,f,g,x} \alpha^f_j Q_{j0}\,(1+\delta_j)\,(-B^j_{j0}). \end{aligned} \tag{16}$$

Here, nominal net positions of the firm sector are appropriately distributed to households, government and foreigners according to their claims on domestic businesses summarized by the shares α^s_A. It is also useful to define the direct nominal net positions of sector s, $DNNP^s_0$ as those positions held outright, i.e., excluding indirect holdings through claims on the firm sector:

$$DNNP^s_0 = NNP^s_0 - \alpha^s_A NNP^f_0.$$

This definition is the closest counterpart to what we measure in the HFCS microdata.

[36] We impose no restrictions on asset holdings across sectors. 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.

Unfolding the NNP_0^f term for the household sector in equation (16), we obtain:

$$NNP_0^h = \sum_{j=h,g,x} \left(\alpha_j^h + \alpha_A^h \alpha_j^f\right) Q_{j0} \left(1+\delta_j\right) (-B_{j0}^j) + \left(\alpha_f^h - \alpha_A^h\right) Q_{f0} \left(1+\delta_f\right) (-B_{f0}^f), \qquad (17)$$

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 directly as well as indirectly through holdings of these assets by the business sector α_A^h. These two corrections appear in the first term. Similarly, the second term shows that direct household holdings of debt issued by firms must be reduced by the household share of business wealth α_A^h. Similar expressions can be obtained for the government and foreign sectors by swapping the h superscript in equation (17) with superscripts g and x, respectively.

Note that the equivalent of the market clearing conditions (A26) expressed in terms of shares are $\sum_{s=h,g,x} \alpha_A^s = 1$ and $\sum_{s=h,f,g,x} \alpha_j^s = 0$ 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

$$-\frac{d \log \bar{P}_0}{dz_0}\, NNP_0^s, \quad \text{for } s = h, g, x. \qquad (18)$$

5.1.2 Measurement

As in Adam and Zhu (2016), to measure net nominal positions for households, firms, government, and foreigners, we use the Euro Area Sector (Financial) Accounts for our four countries. For comparability with our analysis based on the HFCS, we use the data for 2017.

Table 2 shows that the household sector holds positive nominal net positions. Since firms are net nominal debtors, households' direct nominal positions are significantly higher than their total one. Unsurprisingly, governments have a negative position. The foreign sector is a creditor against all countries, except Germany.

Table 3 reports the change in the value of NNP for each sector/country as a result of the inflation shock during 2021–23, see equation (18). We confirm the finding of Section 4 that 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 closer to zero (Spain). Also the foreign sector loses in every country except for Germany. The counterpart of these losses are the large gains for the governments, which reflect the large outstanding stock of nominal public

Country	Households		Government	Foreign
	NNP_0^h	$DNNP_0^h$	NNP_0^g	NNP_0^x
Germany	0.25	0.28	−0.23	−0.02
France	0.24	0.31	−0.39	0.15
Italy	0.26	0.35	−0.50	0.24
Spain	0.04	0.13	−0.37	0.33

Table 2: Total net nominal position (NNP) and directly held nominal net positions (DNNP), by broad sector and country, as a share of triennial GDP.

debt.

We conclude by noting that, for the household sector, nominal positions reported in Table 2 should in theory correspond to those obtained by summing up the individual positions based on micro data that we used in Section 4. In practice, there are known inconsistencies between the two data sources which lead to significant discrepancies. Survey-based measures of nominal asset are 2–3 times smaller than those in financial accounts. One key reason is that surveys undersample the very rich households, who hold a disproportionate share of national wealth. Thus, our results of Section 4 are probably better understood representing the population, except for the top of the wealth distribution. We document and discuss this discrepancy in more detail in Appendix I.

Country	Households	Government	Foreign
Germany	−3.8	3.5	0.3
France	−2.9	4.8	−1.9
Italy	−3.9	7.5	−3.6
Spain	−0.5	4.5	−3.9

Table 3: Gains from the NNP channel, by broad sector and country, percent of triennial GDP

5.2 Full impact on the government

To calculate the full impact of inflation on the government beyond the gain from the devaluation of its nominal debt, we add four components: (i) the additional revenues due to the lack of indexation of the tax system and its progressivity (fiscal drag); (ii) the budgetary cost of the fiscal support measures introduced in response to the inflation shock; (iii) the increase in nominal government expenditure due to the higher public pensions; (iv) and the increase in

Country	NNP	Fiscal drag	Fiscal support	Pensions	Government consumption		**Total**
					Lower bound	Upper bound	
Germany	3.5	0.2	−1.6	−1.1	−0.5	−1.6	−0.6 to 0.5
France	4.8	0.1	−1.3	−0.6	−0.8	−1.6	1.3 to 2.1
Italy	7.5	0.6	−1.8	−0.9	−0.3	−0.9	4.5 to 5.1
Spain	4.5	1.0	−1.2	−1.7	−0.4	−1.0	1.6 to 2.2

Table 4: Sources of gains and losses for the government sector, % of triennial GDP

nominal government expenditures caused by the rise in its relative price.

We estimate the extra government revenues from the fiscal drag by assessing how the average tax rates change with inflation; see Appendix E. The second column of Table 4 shows that these revenues lay below 0.2% of GDP in Germany and France, where the tax system is indexed, and amounted to around 0.6–1% of GDP in Italy and Spain (see OECD, 2023 for related evidence).

We obtain an estimate of the budgetary costs of the ad hoc government interventions from Sgaravatti et al. (2021). The third column of Table 4 reports that these fiscal outlays amounted to approximately 1% of triennial 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.[37] We also provide an estimate for the increase in pension expenditure over GDP over this period, based on our average pension growth data.

We obtain data on the total cost of public pensions from Eurostat (Social protection statistics). The fourth column of Table 4 shows that that these costs also hovered around 1% of triennial GDP, with a peak of 1.7% in Italy.

The increase in nominal government expenditure is challenging to measure because many goods provided by the government are not traded in the market and hence no suitable price index is available. Thus, we resort to measuring only the increase in nominal expenditure which was caused by higher energy prices, based on the energy content of government purchases, which we extract from input-output tables. We provide two estimates: a lower bound that only considers fossil fuels and an upper bound that considers all types of energy. We provide more details and results in Appendix H. The results reported Table 4 show that these additional costs tend to range between 0.3 and 1.6% of triennial GDP.

To estimate the total gains of the government sector from the inflationary episode, we subtract these three sources of costs from the gains due to the improvement in NNPs and the

[37]More precisely, the share of total costs directed to firms in Germany is 14%, in France is 5%, in Italy and in Spain above 35%.

fiscal drag. The last column of Table 4 summarizes the results. Governments in France, Italy and Spain gained from the inflation surge, while the government finances in Germany roughly broke even. 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. Comparing our estimated household-sector losses from surveys (Table 1, taking into account the ratios of disposable income to GDP of around 0.7) and from financial accounts (Table 3) to the gains for the government sectors (Table 4), we conclude that in principle, if governments in France, Italy and Spain redistributed all their gains to households (in the form of higher transfers or lower taxes), they would go a long way in compensating them for their losses.

6 Conclusions

In this paper, we have quantified the heterogeneous welfare effects of the recent inflation outburst on euro area households. A simple theoretical framework, combined with micro and macro data, instructs the measurement. Our approach, based on the envelope theorem, assumes that adjustments in the consumption basket and household portfolios following the shock only have second-order effects on welfare. With high-frequency granular data on household expenditures and asset positions which cover the pre and post inflation episode –data not available to us as we write– one could gauge the extent to which this assumption is well founded.

We have uncovered sizable average losses and a significant level of heterogeneity across countries and, within countries, across age groups, but not across income groups.

The cross-country heterogeneity was affected 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 fiscal policy came to the rescue: extraordinary 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 is especially remarkable because 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 savings 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 will fall on future generations. In this perspective, inflation tax redistributes from retirees to the young, and partially offsets this looming fiscal adjustment. In the same vein, our sectoral analysis suggests that the inflation shock offered European governments the opportunity to substantially reduce public debts, thanks to the erosion of their real value, relative to output. This is the case even after accounting for the additional cost of government purchases and the ad-hoc fiscal support measures.

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Online Appendix

The Appendix is organized as follows. Section A contains more details on the theoretical model and its derivations. Section B contains additional figures and Section C additional tables. Section D.1 outlines in more detail the measurement of price indexes, expenditure shares, household balance sheets, wages, and asset prices. Section F summarizes the calculations of counterfactual energy price indexes, in absence of government interventions. Section G summarizes the main transfer payment programs implemented in the four countries in 2021–2022. Section H explains how we compute losses for the government budget constraints due to rising energy prices. Section I discusses discrepancies between measures of nominal assets and liabilities in survey data and aggregate data on financial accounts.

Appendix A Theoretical framework

A.1 Short- and long-term debt

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

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

$$B_{i,Lt} = \sum_{n=1}^{t} \delta^{n-1}\ell_{i,t-n} = \ell_{i,t-1} + \delta\ell_{i,t-2} + \delta^2\ell_{i,t-3} + \cdots + \delta^{t-1}\ell_{i,0}. \tag{A1}$$

Rearranging ($A1$) , it is easy to obtain the recursive relation

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

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

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

$$\begin{aligned}
\text{MktValue_LTBond}_{it} &= Q_{St}\left[\delta\ell_{i,t-1} + \delta^2\ell_{i,t-2} + \delta^3\ell_{i,t-3} + \dots\right] \\
&+ Q_{St}Q_{S,t+1}\left[\delta^2\ell_{i,t-1} + \delta^3\ell_{i,t-2} + \delta^4\ell_{i,t-3} + \dots\right] \\
&+ \dots \\
&= Q_{St}\left[1 + Q_{S,t+1}\delta + Q_{S,t+1}Q_{S,t+2}\delta^2 + \dots\right]\delta B_{i,Lt}.
\end{aligned} \tag{A2}$$

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

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

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

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

which, compared to the second line in (A2), illustrates that the market value of outstanding long-term bonds at t is $Q_{Lt}\delta B_{i,Lt}$. The case $\delta = 0$ corresponds to short-term one-period bonds which we denoted by $B_{i,St}$.

A.2 Price indexes

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

$$c_{it}P_{it} = \sum_{j=1}^{J} c_{ij,t}\mathcal{P}_{jt}, \tag{A3}$$

where $j = 1, \ldots, J$ denotes a specific consumption category and $\mathcal{P}_{jt}$ its price. Taking logs of (A3) and evaluating the effect of small changes in the entire vector $\{\mathcal{P}_{jt}\}$, at $t = 0$ where the economy rests in steady state, on the individual price index P_{it} we obtain

$$\begin{aligned} \log P_{it} &\simeq \log P_{i0} + \sum\nolimits_{j=1}^{J} \frac{\left(\frac{c_{ij,0}}{c_{i,0}}\right)}{\sum_{j=1}^{J}\left(\frac{c_{ij,0}}{c_{i0}}\right)\mathcal{P}_{j0}}\left(\mathcal{P}_{jt} - \mathcal{P}_{j0}\right) \\ &= \log P_{i0} + \sum\nolimits_{j=1}^{J} \frac{c_{ij,0}\mathcal{P}_{j0}}{\sum_{j=1}^{J} c_{ij,0}\mathcal{P}_{j0}}\left(\frac{\mathcal{P}_{jt} - \mathcal{P}_{j0}}{\mathcal{P}_{j0}}\right), \end{aligned}$$

which yields

$$d\log P_{it} \simeq \sum\nolimits_{j=1}^{J} xsh_{ij,0} \cdot d\log \mathcal{P}_{jt},$$

where $xsh_{ij,0}$ 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_i between its steady-state value and its value at $t+1$.

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

We generalize the previous derivation as

$$
\begin{aligned}
\log P_{it} &\simeq \log P_{i0} + \sum\nolimits_{j=1}^{J} \frac{\left(\frac{c_{ij,0}}{c_{i0}}\right)(1+\tau_{j0})}{\sum\nolimits_{j=1}^{J}\left(\frac{c_{ij,0}}{c_{i0}}\right)\mathcal{P}_{j0}} \left(\mathcal{P}^*_{jt} - \mathcal{P}^*_{j0}\right) + \sum\nolimits_{j=1}^{J} \frac{\left(\frac{c_{ij,0}}{c_{i0}}\right)\mathcal{P}^*_{j0}}{\sum\nolimits_{j=1}^{J}\left(\frac{c_{ij,0}}{c_{i0}}\right)\mathcal{P}_{j0}} \left(\tau_{jt} - \tau_{j0}\right) \\
&= \log P_{i0} + \sum\nolimits_{j=1}^{J} \frac{c_{ij,0}\mathcal{P}_{j0}}{\sum\nolimits_{j=1}^{J} c_{ij,0}\mathcal{P}_{j0}} \left(\frac{\mathcal{P}^*_{jt} - \mathcal{P}^*_{j0}}{\mathcal{P}^*_{j0}}\right) + \sum\nolimits_{j=1}^{J} \frac{c_{ij,0}\mathcal{P}_{j0}}{\sum\nolimits_{j=1}^{J} c_{ij,0}\mathcal{P}_{j0}} \left(\frac{\tau_{jt} - \tau_{j0}}{1+\tau_{j0}}\right),
\end{aligned}
$$

which yields

$$
d\log P_{it} \simeq \sum\nolimits_{j=1}^{J} xsh_{ij,0} \cdot d\log \mathcal{P}^*_{jt} + \sum\nolimits_{j=1}^{J} xsh_{ij,0} \cdot d\tau_{jt}.
$$

In the main text, we use the notation

$$
\begin{aligned}
d\log P^*_{it} &= \sum\nolimits_{j=1}^{J} xsh_{ij,0} \cdot d\log \mathcal{P}^*_{jt}, \\
d\log \mathcal{T}_{it} &= \sum\nolimits_{j=1}^{J} xsh_{ij,0} \cdot d\tau_{jt}.
\end{aligned}
$$

A.3 Household problem and optimality

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

$$
\begin{aligned}
c_{i0}P_{i0} &= W_{i0} - T_{i0} + B_{i,S0} + B_{i,L0} + \sum_{k=1}^{K} (Q_{k0} + D_{k0})\, a_{i,k0} - Q_{S0}B_{i,S1} - Q_{L0}\left(B_{i,L1} - \delta B_{i,L0}\right) - \sum_{k=1}^{K} Q_{k0}a_{i,k1} \\
c_{i1}P_{i1} &= W_{i1} - T_{i1} + B_{i,S1} + (1 + Q_{L1}\delta)\, B_{i,L1} + \sum_{k=1}^{K} (Q_{k1} + D_{k1})\, a_{i,k1},
\end{aligned}
\tag{A4}
$$

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

The Lagrangean of this problem is

$$
\begin{aligned}
\mathcal{L}_i = \sum_{t=0}^{1} \beta_i^t u_i(c_{it}) + \sum_{t=0}^{1} \beta_i^t \lambda_{it} \quad & \Bigg[W_{it} - T_{it} + B_{i,St} + (1 + \delta Q_{Lt})\, B_{i,Lt} + \sum_{k=1}^{K} (Q_{kt} + D_{kt})\, a_{i,kt} \\
& - c_{it}P_{it} - Q_{St}B_{i,St+1} - Q_{Lt}B_{i,Lt+1} - \sum_{k=1}^{K} Q_{kt}a_{i,kt+1} \Bigg]
\end{aligned}
\tag{A5}
$$

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

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

$$\begin{aligned} u_i'(c_{it}) &= \lambda_{it}P_{it} \text{ for } t=0,1 \\ \lambda_{i0}Q_{S0} &= \beta_i\lambda_{i1} \\ \lambda_{i0}Q_{L0} &= \beta_i\lambda_{i1}(1+Q_{L1}\delta) \\ \lambda_{i0}Q_{k0} &= \beta_i\lambda_{i1}(Q_{k1}+D_{k1}) \text{ for all } k. \end{aligned} \tag{A6}$$

Combining the first two equations yields

$$\beta_i\lambda_{i1} = Q_{S0}\cdot\frac{u'(c_{i0})}{P_{i0}}. \tag{A7}$$

Note that the FOCs can be rewritten as

$$\begin{aligned} Q_{S0} &= \beta_i\frac{u_i'(c_{i1})}{u_i'(c_{i0})}\left(\frac{P_{i0}}{P_{i1}}\right) \\ Q_{L0} &= Q_{S0}(1+Q_{L1}\delta) \\ Q_{k0} &= Q_{S0}(Q_{k1}+D_{k1}) \text{ for all } k. \end{aligned} \tag{A8}$$

A.4 Welfare impact of the shock

By invoking the envelope theorem, the impact of the shock on a household's welfare can be computed from the Lagrangean abstracting from any change in choice variables (i.e., the composition of the consumption basket and the asset portfolio) because, to a first-order, whether the agent adjusts optimally or not at all does not matter:

$$\frac{dV_i}{dz_0} = \frac{d\mathcal{L}_i}{dz_0}. \tag{A9}$$

We focus on the notion of 'money-metric welfare' $\mathcal{W}_i$ defined as:

$$d\mathcal{W}_i = \frac{dV_i/dz_0}{\lambda_{i0}} = \frac{dV_i/dz_0}{u'(c_{i0})}P_{i0}, \tag{A10}$$

where for the second equality we have used (A6). Note that dV_i/dz_0 is expressed in utils. Thus, as clear from the second equality, dividing it by λ_{i0} 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.

We now split welfare into the first period and second-period welfare changes as:

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

Differentiating the Lagrangean with respect to z_0 yields:

$$\begin{aligned}
\frac{d\mathcal{L}_i}{dz_0} = \lambda_{i0} \quad & \left[-\frac{d\log P_{i0}}{dz_0} c_{i0} P_{i0} + \frac{d\log W_{i0}}{dz_0} W_{i0} - \frac{d\log T_{i0}}{dz_0} T_{i0} + \sum_{k=1}^{K} \frac{d\log Q_{k0}}{dz_{i0}} Q_{k0} \left(a_{i,k0} - a_{i,k1}\right) \right. \\
& \left. + \sum_{k=1}^{K} \frac{d\log D_{k0}}{dz_0} D_{k0} a_{i,k0} \right] \\
& + \lambda_{i0} \left[-\frac{d\log Q_{S0}}{dz_0} Q_{S0} B_{i,S1} - \frac{d\log Q_{L0}}{dz_0} Q_{L0} \left(B_{i,L1} - \delta B_{i,L0}\right) \right] \\
+\beta_i \lambda_{i1} \quad & \left[-\frac{d\log P_{i1}}{dz_0} c_{i1} P_{i1} + \frac{d\log W_{i1}}{dz_0} W_{i1} - \frac{d\log T_{i1}}{dz_0} T_{i1} + \sum_{k=1}^{K} \frac{d\log Q_{k1}}{dz_0} Q_{k1} a_{i,k1} \right. \\
& \left. + \sum_{k=1}^{K} \frac{d\log D_{k1}}{dz_0} D_{k1} a_{i,k1} \right] \\
+\beta_i \lambda_{i1} \quad & \frac{d\log Q_{L1}}{dz_0} \delta Q_{L1} B_{i,L1}.
\end{aligned} \tag{A11}$$

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

Using ($A6$) and ($A7$) to substitute out the multipliers, exploiting the envelope theorem result in ($A9$), and applying our definition of welfare in ($A10$) we arrive at:

$$\begin{aligned}
d\mathcal{W}_{i0} \quad = \quad & -\frac{d\log P_{i0}}{dz_0} c_{i0} P_{i0} + \frac{d\log W_{i0}}{dz_0} W_{i0} - \frac{d\log T_{i0}}{dz_0} T_{i0} + \sum_{k=1}^{K} \frac{d\log Q_{k0}}{dz_{i0}} Q_{k0} \left(a_{i,k0} - a_{i,k1}\right) \\
& + \sum_{k=1}^{K} \frac{d\log D_{k0}}{dz_0} D_{k0} a_{i,k0} - \frac{d\log Q_{S0}}{dZ_0} Q_{S0} B_{i,S1} - \frac{d\log Q_{L0}}{dZ_0} Q_{L0} \left(B_{i,L1} - \delta B_{i,L0}\right)
\end{aligned} \tag{A12}$$

for the first period and

$$d\mathcal{W}_{i1} = Q_{S0} \left[-\frac{d\log P_{i1}}{dz_0} c_{i1} P_{i1} + \frac{d\log W_{i1}}{dz_0} W_{i1} - \frac{d\log T_{i1}}{dz_0} T_{i1} + \sum_{k=1}^{K} \frac{d\log Q_{k1}}{dz_0} Q_{k1} a_{i,k1} + \sum_{k=1}^{K} \frac{d\log D_{k1}}{dz_0} D_{k1} a_{i,k1} \right] \tag{A13}$$

for the second period.

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

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

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

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

Using period $t = 1$ budget constraint from ($A4$), we arrive at

$$d\mathcal{W}_{i1} = -\frac{d\log \bar{P}_1}{dz_0} Q_{S0} \left[B_{i,S1} + \left(1 + Q_{L1}\delta\right) B_{i,L1}\right]. \tag{A14}$$

A.5 Decomposition

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

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

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

Consider the first term of $d\mathcal{W}_{i0}$ in equation ($A12$) and use the period $t = 0$ budget constraint ($A4$):

$$\begin{aligned}
-\frac{d\log P_{i0}}{dz_0} c_{i0} P_{i0} \quad &= \quad -\frac{d\log P_{i0}}{dz_0} \left[W_{i0} - T_{i0} + B_{i,S0} + \left(1 + Q_{L0}\delta\right) B_{i,L0} + \sum_{k=1}^{K} Q_{0k}\left(a_{i,0k} - a_{i,1k}\right)\right. \\
&\qquad \left. + \sum_{k=1}^{K} D_{0k} a_{i,0k} - Q_{S0} B_{i,S1} - Q_{L0} B_{i,L1}\right] \\
&= \quad -\frac{d\log P_{i0}}{dz_0} \left[W_{i0} - T_{i0} + B_{i,S0} + \left(1 + Q_{L0}\delta\right) B_{i,L0} + \sum_{k=1}^{K} Q_{0k}\left(a_{i,0k} - a_{i,1k}\right) + \sum_{k=1}^{K} D_{0k} a_{i,0k}\right] \\
&\qquad + \frac{d\log P_{i0}}{dz_0} \left[Q_{S0} B_{i,S1} + Q_{L0} B_{i,L1}\right].
\end{aligned} \tag{A15}$$

Recall that from our derivation of Section 2:

$$\frac{d\log P_{i0}}{dz_0} = \frac{d\log P_{i0}^{*}}{dz_0} + \frac{d\log \mathcal{T}_{i0}}{dz_0}. \tag{A16}$$

We define the short-run direct component of the welfare change as the term in the second line of equation ($A15$) which is driven by the change in raw individual-level price indexes P_{i0}^{*}:

$$d\mathcal{W}_i^{DIR} = -\frac{d\log P_{i0}^{*}}{dz_0} \left[W_{i0} - T_{i0} + B_{i,S0} + \left(1 + Q_{L0}\delta\right) B_{i,L0} + \sum_{k=1}^{K} Q_{0k}\left(a_{i,0k} - a_{i,1k}\right) + \sum_{k=1}^{K} D_{0k} a_{i,0k}\right]. \tag{A17}$$

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. $d\log \mathcal{T}_{i0}$ in equation ($A16$). Combining terms

$$\begin{aligned} d\mathcal{W}_i^{UFP} &= -\frac{d\log \mathcal{T}_{i0}}{dz_0}\left[W_{i0} - T_{i0} + B_{i,S0} + (1+Q_{L0}\delta)\, B_{i,L0} + \sum_{k=1}^{K} Q_{0k}\left(a_{i,0k} - a_{i,1k}\right) + \sum_{k=1}^{K} D_{0k} a_{i,0k}\right] \\ &\quad -\frac{dT_{i0}^{HOC}}{dz_0}. \end{aligned} \tag{A18}$$

It is easy to see that by summing ($A17$) and ($A18$) one obtains ($A15$), net of the term in the fourth line of ($A15$).

Consider now precisely this term in the third line of ($A15$) and add it to $t = 1$ welfare change $d\mathcal{W}_{i1}$ computed in ($A14$). We define the long-run component of the welfare change as

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

Using the expression for $d\mathcal{W}_{i1}$ in ($A14$) together with the no-arbitrage condition $Q_{L0} = Q_{S0}\left(1 + Q_{L1}\delta\right)$ between short-term and long-term bonds in ($A8$) yields

$$d\mathcal{W}_i^{LR} = Q_{S0}\left(\frac{d\log P_{i0}}{dz_0} - \frac{d\log \bar{P}_1}{dz_0}\right)\left[B_{i,S1} + (1+Q_{L1}\delta)\, B_{i,L1}\right]. \tag{A19}$$

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

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

$$\begin{aligned} d\mathcal{W}_i^{IND} &= \frac{d\log W_{i0}}{dz_0}W_{i0} - \frac{d\log T_{i0}^{AUT}}{dz_0}T_{i0}^{AUT} + \sum_{k=1}^{K}\frac{d\log Q_{k0}}{dz_0}Q_{k0}\left(a_{i,k0} - a_{i,k1}\right) + \sum_{k=1}^{K}\frac{d\log D_{k0}}{dz_0}D_{k0}a_{i,k0} \\ &\quad -\frac{d\log Q_{S0}}{dz_0}Q_{S0}B_{i,S1} - \frac{d\log Q_{L0}}{dz_0}Q_{L0}\left(B_{i,L1} - \delta B_{i,L0}\right). \end{aligned} \tag{A20}$$

The main text contains an interpretation of this last component.

A.6 Old cohort

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

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

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

$$\begin{aligned} d\widehat{\mathbb{W}}_i &= -\frac{d\log P_{i0}}{dz_0}c_{i0}P_{i0} + \frac{d\log W_{i0}}{dz_0}W_{i0} - \frac{d\log T_{i0}}{dz_0}T_{i0} + \sum_{k=1}^{K}\frac{d\log Q_{k0}}{dz_{i0}}Q_{k0}a_{i,k0} \\ &\quad + \sum_{k=1}^{K}\frac{d\log D_{k0}}{dz_0}D_{k0}a_{i,k0} + \frac{d\log Q_{L0}}{dz_0}\delta B_{i,L0}. \end{aligned} \tag{A21}$$

The decomposition becomes:

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

A.7 Sectoral aggregation

In this section, we describe the budget constraints of the household, government and foreign sectors, as well as the value of the firm sector, and show that, by aggregating them, one obtains the fundamental national income account identity.

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

$$\bar{P}_0C_0 + Q_{A0}A_1^h + \sum_{j=h,f,g,x}Q_{j0}\left(B_{j1}^h - \delta_jB_{j0}^h\right) = W_0 - T_0 + \left(Q_{A0} + D_0\right)A_0^h + \sum_{j=h,f,g,x}B_{j0}^h, \tag{A22}$$

where $\bar{P}_0 = \bar{P}_0^*\left(1 + \mathcal{T}_0\right)$ is the price index gross of taxes/subsidies. In addition, $\bar{P}_0C_0 = \sum_{i=1}^{I}P_{i0}c_{i0}$,

$W_0 = \sum_{i=1}^{I} W_{i0}, A_0^h = \sum_{i=1}^{I} a_{i0}^h$, 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:

$$(Q_{A0} + D_0)\,A_0 = \bar{P}_0^Y Y_0 - P_0^I I_0 - W_0 - \sum_{j=h,f,g,x} Q_{j0}\left(B_{j1}^f - \delta_j B_{j0}^f\right) + \sum_{j=h,f,g,x} B_{j0}^f + Q_{S0}\,(Q_{A1} + D_1)\,A_1, \tag{A23}$$

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 (13). 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 3.3.3 and 3.3.4. Thus, for example, the reduction of real wages induces a loss for households showing up as one of the components of equation (13). 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

$$(Q_{A0} + D_0)\,A_0^g + \sum_{j=h,f,g,x} B_{j0}^g = \bar{P}_0^G G_0 - T_0 - \bar{P}_0^* \mathcal{T}_0 C_0 + Q_{A0} A_1^g + \sum_{j=h,f,g,x} Q_{j0}\left(B_{j1}^g - \delta_j B_{j0}^g\right), \tag{A24}$$

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

$$Q_{A0} A_1^x + \sum_{j=h,f,g,x} Q_{j0}\left(B_{j1}^x - \delta_j B_{j0}^x\right) + \bar{P}_0^E E_0 = (Q_{A0} + D_0)\,A_0^x + \sum_{j=h,f,g,x} B_{j0}^x + \bar{P}_0^M M_0 \tag{A25}$$

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.

Finally, note that, by market clearing:

$$\begin{aligned} \sum_{s=h,f,g,x} B_{jt}^s &= 0, \qquad \text{for } j = h, f, g, x, \\ \sum_{s=h,g,x} A_t^s &= 1. \end{aligned} \tag{A26}$$

We now show that equations ($A22$) to ($A25$) aggregate properly and yield the national income identity in nominal terms. From the household budget constraint ($A22$) and the market clearing conditions ($A26$) :

$$\begin{aligned}
& \bar{P}_0^* \left(1 + \mathfrak{T}_0\right) C_0 + Q_{A0} \left(A_1 - A_1^g - A_1^x\right) + Q_{f0} \left(B_{f1} - \delta_f B_{f0}\right) + Q_{g0} \left(B_{g1} - \delta_g B_{g0}\right) + Q_{x0} \left(B_{x1} - \delta_x B_{x0}\right) \\
& - \sum_{j=h,g,x} Q_{j0} \left(B_{j1}^f - \delta_j B_{j0}^f\right) - \sum_{j=h,f,x} Q_{j0} \left(B_{j1}^g - \delta_j B_{j0}^g\right) - \sum_{j=h,f,g} Q_{j0} \left(B_{j1}^x - \delta_j B_{j0}^x\right) + \sum_{j=f,g,x} B_{h0}^j \\
= \; & W_0 - T_0 + \left(Q_{A0} + D_0\right) A_0 - \left(Q_{A0} + D_0\right) A_0^g - \left(Q_{A0} + D_0\right) A_0^x + B_{f0} + B_{g0} + B_{x0} \\
& - \sum_{j=h,g,x} B_{j0}^f - \sum_{j=h,f,x} B_{j0}^g - \sum_{j=h,f,g} B_{j0}^x + \sum_{j=f,g,x} Q_{h0} \left(B_{h1}^j - \delta_h B_{h0}^j\right).
\end{aligned}$$

Using the government budget constraint ($A24$) to substitute out $Q_{g0} \left(B_{g1} - \delta_g B_{G0}\right)$, the expression above simplifies to:

$$\begin{aligned}
& \bar{P}_0^* C_0 + \bar{P}_0^G G_0 + Q_{A0} \left(A_1 - A_1^x\right) + Q_{f0} \left(B_{f1} - \delta_f B_{f0}\right) + Q_{x0} \left(B_{x1} - \delta_x B_{x0}\right) \\
& - \sum_{j=h,g,x} Q_{j0} \left(B_{j1}^f - \delta_j B_{j0}^f\right) - \sum_{j=h,f,g} Q_{j0} \left(B_{j1}^x - \delta_j B_{j0}^x\right) + \sum_{j=f,x} B_{h0}^j \\
= \; & W_0 + \left(Q_{A0} + D_0\right) A_0 - \left(Q_{A0} + D_0\right) A_0^x + B_{f0} + B_{x0} \\
& - \sum_{j=h,g,x} B_{j0}^f - \sum_{j=h,f,g} B_{j0}^x + \sum_{j=f,x} Q_{h0} \left(B_{h1}^j - \delta_h B_{h0}^j\right).
\end{aligned}$$

Using the firm sector budget constraint ($A23$) to substitute out $\left(Q_{A0} + D_0\right) A_0$, the expression above simplifies to:

$$\begin{aligned}
& \bar{P}_0^* C_0 + P_0^I I_t + \bar{P}_0^G G_0 - Q_{A0} A_1^x + Q_{x0} \left(B_{x1} - \delta_x B_{x0}\right) - \sum_{j=h,f,g,x} Q_{j0} \left(B_{j1}^x - \delta_j B_{j0}^x\right) + B_{h0}^x = \\
& \bar{P}_0^Y Y_0 - \left(Q_{A0} + D_0\right) A_0^x + B_{x0} - \sum_{j=f,g,S} B_{j0}^x + Q_{h0} \left(B_{h1}^x - \delta_h B_{h0}^x\right),
\end{aligned}$$

where we have used the no-arbitrage condition $Q_{A0} = Q_{S0} \left(Q_{A1} + D_1\right)$. Finally, using the foreign sector equation ($A25$) to substitute out $Q_{A0} A_1^x$, we obtain the national income identity:

$$\bar{P}_0^* C_0 + P_0^I I_t + \bar{P}_0^G G_0 + \bar{P}_0^E E_0 - \bar{P}_0^M M_0 = \bar{P}_0^Y Y_0. \tag{A27}$$

Appendix B Additional figures

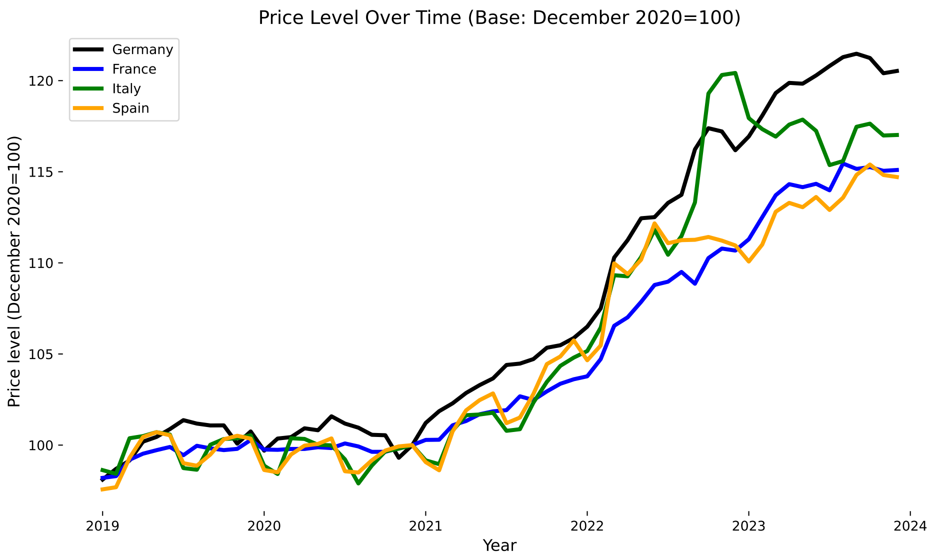

Figure B.1: Price level index (December 2020 = 100) for Germany, France, Italy and Spain.

Note: Not seasonally adjusted, January 2019–December 2023
Source: Eurostat, Harmonized Index of Consumer Prices, Household Budget Survey.

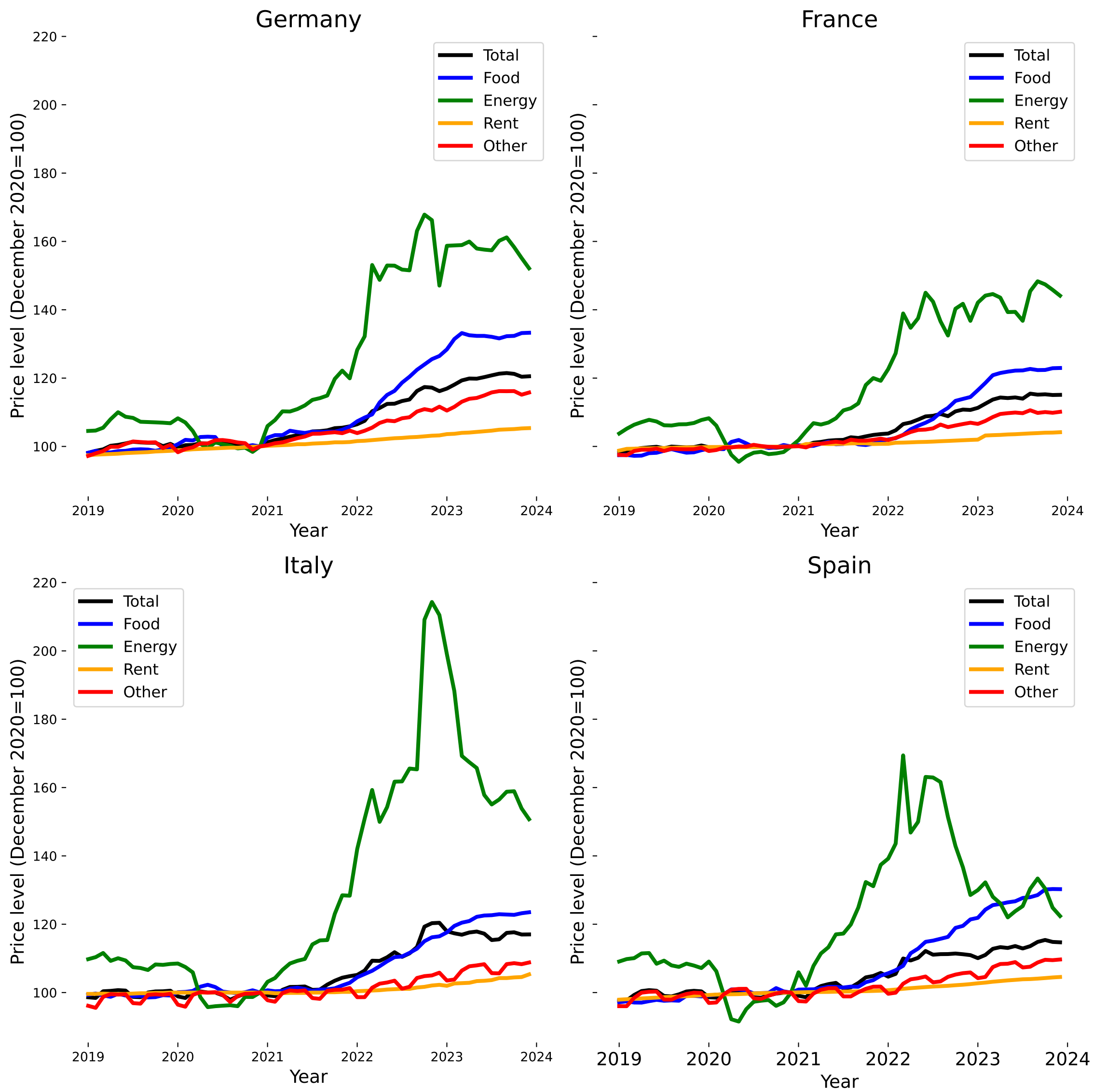

Figure B.2: Price level index (December 2020 = 100) for Germany, France, Italy and Spain. Total and subcomponents (Food, Energy, Rent, Other).

Note: Not seasonally adjusted, January 2019–December 2023. 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.

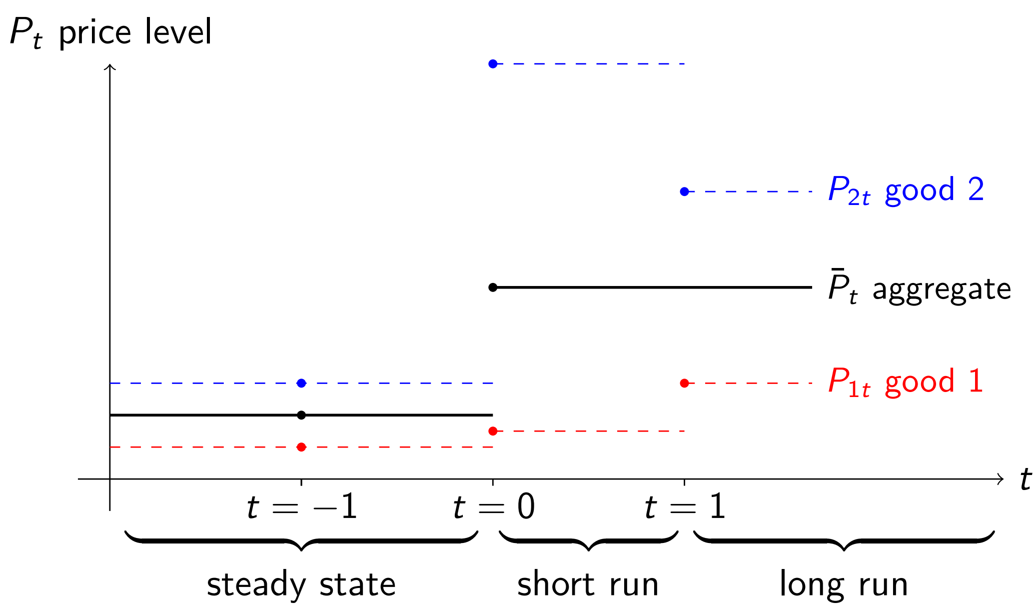

Figure B.3: Schematic depiction of the inflation shock

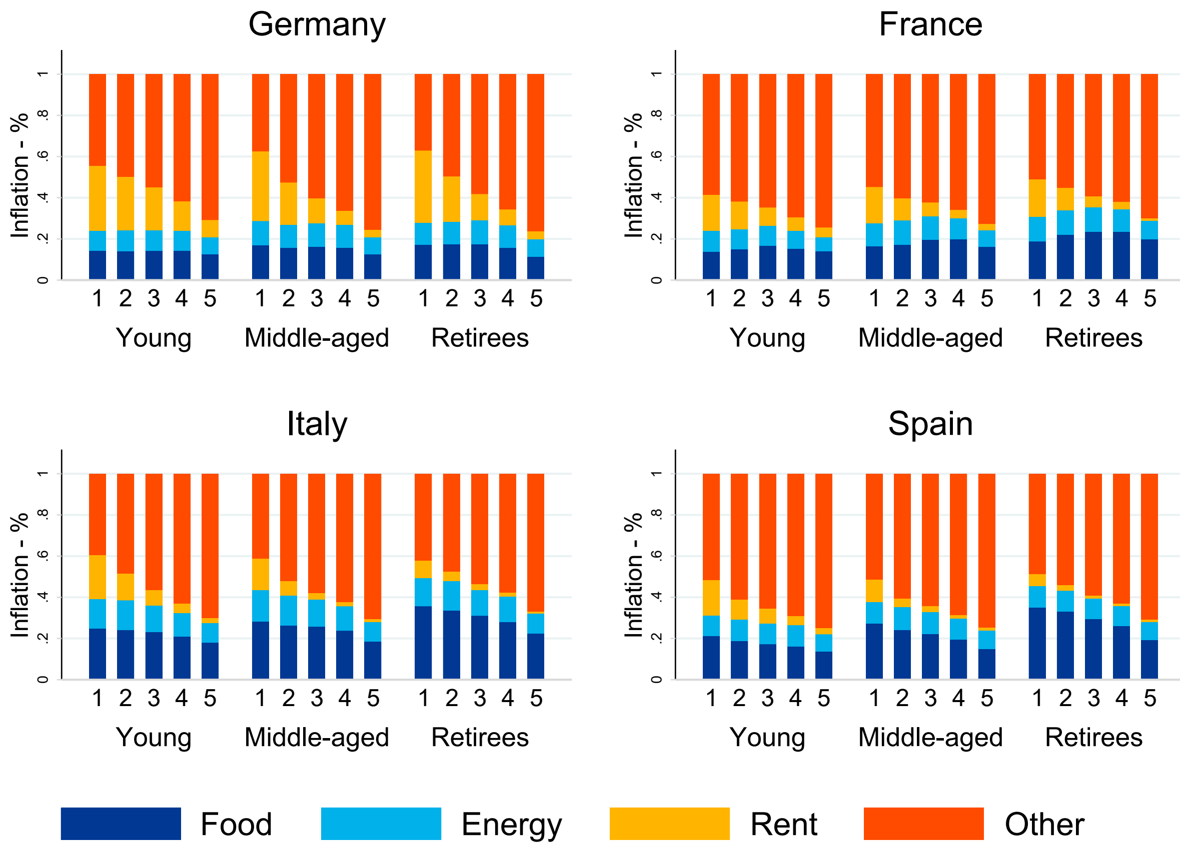

Figure B.4: Structure of consumption expenditures by age classes and nondurable consumption quintiles within each age class

Note: The chart show the shares of main consumption components on total consumption in percent; the complement to 1 are the remaining consumption components. 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

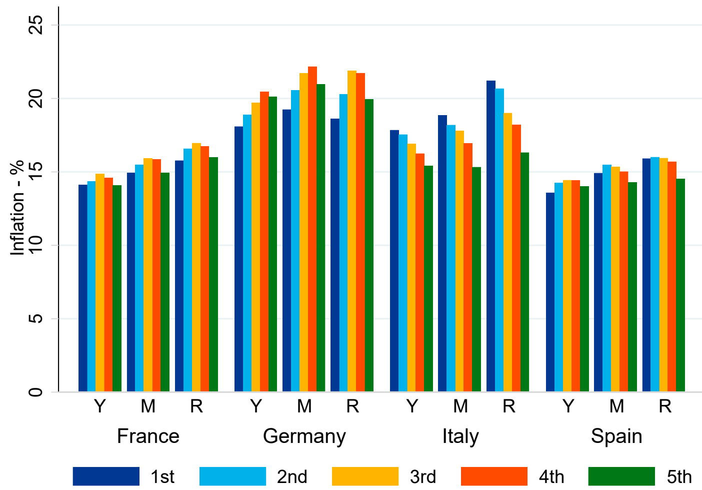

Figure B.5: Household-level inflation rates by age classes and nondurable consumption quintiles, 2021–2023, cumulative two-year rates in percent, consumption baskets *excluding rents*

Note: The figure shows realized cumulative inflation rates in 2021–23 by age class and consumption quintiles within each age class. The groups Y, M and R denote ages of less than 45 years, 45–64 years and older than 64 years.
Source: Household Budget Survey 2015.

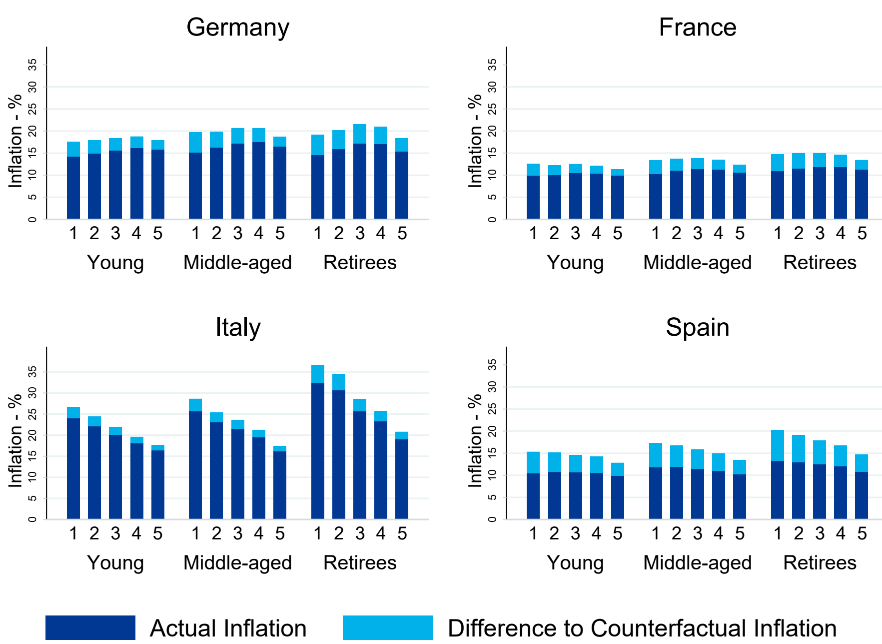

Figure B.6: Actual and counterfactual household-level inflation rates by age classes and nondurable consumption quintiles within each age class, 2021–2022, cumulative 2-year rates in percent

Source: Household Budget Survey 2015.

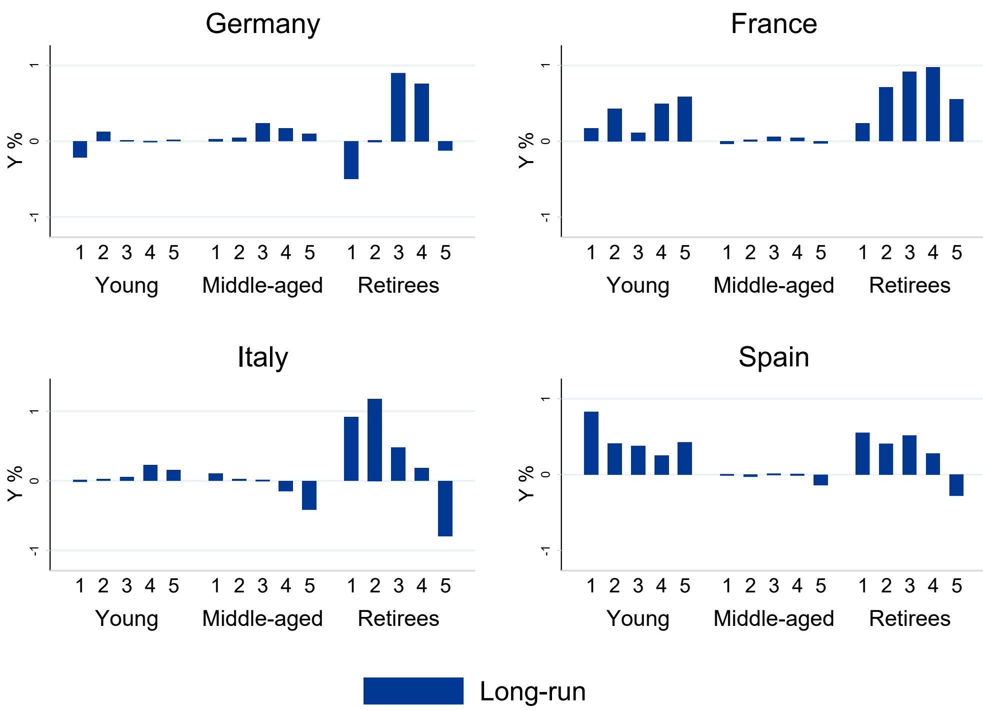

Figure B.7: Average long-run effect, in percent of triennial disposable income, by age class and nondurable consumption quintile.

Note: The figure reports the average long-run effect. Young, Middle-aged and Retirees denote ages of less than 45 years, 45–64 years and older than 64 years.
Source: Household Finance and Consumption Survey 2017.

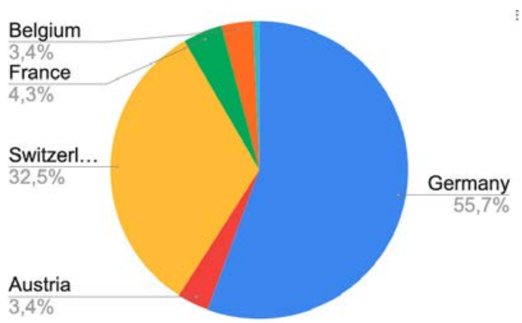

Figure B.8: Distribution of the REITs by country.

Source: REITs websites.

Appendix C Additional tables

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 C.1: Classification of consumption by purpose (COICOP) categories

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

Germany CPI Release Dates			
10 Dec 2021	12 Mar 2021	13 Jul 2022	13 Apr 2023
29 Nov 2021	1 Mar 2021	28 Jul 2022	28 Apr 2023
10 Nov 2021	10 Feb 2021	30 Aug 2022	10 May 2023
28 Oct 2021	28 Jan 2021	12 Sep 2022	31 May 2023
13 Oct 2021	19 Jan 2021	13 Sep 2022	13 Jun 2023
30 Sep 2021	6 Jan 2021	29 Sep 2022	29 Jun 2023
10 Sep 2021	19 Jan 2022	13 Oct 2022	11 Jul 2023
30 Aug 2021	31 Jan 2022	28 Oct 2022	28 Jul 2023
11 Aug 2021	11 Feb 2022	11 Nov 2022	8 Aug 2023
29 Jul 2021	1 Mar 2022	29 Nov 2022	30 Aug 2023
13 Jul 2021	11 Mar 2022	13 Dec 2022	8 Sep 2023
29 Jun 2021	30 Mar 2022	3 Jan 2023	28 Sep 2023
15 Jun 2021	12 Apr 2022	17 Jan 2023	11 Oct 2023
31 May 2021	28 Apr 2022	9 Feb 2023	30 Oct 2023
12 May 2021	11 May 2022	22 Feb 2023	8 Nov 2023
29 Apr 2021	30 May 2022	1 Mar 2023	29 Nov 2023
15 Apr 2021	14 Jun 2022	10 Mar 2023	8 Dec 2023
30 Mar 2021	29 Jun 2022	30 Mar 2023	

Table C.2: Press Release Dates for CPI in Germany (2021–23)

Source: German Federal Statistical Office

Step 1:	$R(Q_t) = \beta\, \Delta ILS_{1Y,t} + \gamma R(S_t) + \varepsilon_t$		
	REITs	**Bonds**	**Stocks**
Inflation surprise $\Delta ILS_{1Y,t}$	−3.955	−0.726	−0.410
	(3.108)	(2.160)	(0.514)
$R(S_t)$	1.011	−0.066	0.134
	(4.804)	(1.089)	(1.088)
const	−0.107	0.059	0.159
	(0.524)	(1.103)	(1.246)
Obs	71	71	69
Adj. R^2	0.314	−0.007	−0.043
F-stat	17.06	2.92	0.75

Step 2: $R(H_t) - R_f = \alpha + \delta\big[R(Q_{t-1}) - R_f\big] + \tilde{\gamma}\big[R(S_t) - R_f\big] + \text{controls} + \varepsilon_t$	
	House returns
$R(Q_{t-1}) - R_f$	0.035*
	(0.017)
$R(S_t) - R_f$	−0.007
	(0.020)
Exchange Rate	−0.240**
	(0.029)
Industrial Production	−0.002
	(0.043)
Inflation	-0.299^{+}
	(0.173)
Term Structure	−0.644**
	(0.233)
const	25.184**
	(2.883)
Obs	65
Adj. R^2	0.616
F-stat	26.324

Table C.3: Sensitivities of asset prices to inflation surprises

For stocks, the table reports the results for Germany. The market returns $R(S_t)$ are proxied with the EU returns for REITs and bonds, and with global returns for stocks. See Appendix D.7.1 for further details.

Appendix D Data

This section contains a detailed description of our data sources and some of some key steps of our measurement exercise.

D.1 Measurement of direct and indirect components

We are interested in the effects of an inflation shock dz_0. In our empirical implementation, we therefore abstract from expected trends that would have unfolded independently of the shock.

D.1.1 Direct components

Regarding direct components, we need to compute terms of the sort $-\frac{d\log P_0}{dz_0} \times X_{i,0}$, where P_0 is a (average, or household-specific) price level and $X_{i,0}$ is an element of the household budget constraint. We proceed differently for stock and flow variables. For illustrative purposes, we refer to bond holdings $B_{i,S0}$ and net income $Y_{i,0} = W_{i,0} - T_{i,0}$ as representative of these two variable types.

In the first case, we measure pre-shock holdings $B_{i,S0}$ as $B_{i,S0} = B_{i,S,Dec2017}$; in the second, $Y_{i,0} = Y_{i,2017}$. We then compute the price shock $\frac{d\log P_0}{dz_0}$ in deviation from the expected trend growth in prices expected in the absence of the shock. More specifically, for stock variables we compute

$$-\frac{d\log P_0}{dz_0} \times X_{i,0} = -\left[\log \frac{P_{Dec2023}}{P_{Dec2020}} - \log\left(\frac{P_{Dec2023}}{P_{Dec2020}}\right)^*\right] \times B_{i,S,Dec2017}$$

where $\left(\frac{P_{Dec2023}}{P_{Dec2020}}\right)^*$ is measured through inflation expectations prior to the dz_0 shock.

For flow variables such as income, assuming that it is received monthly and mostly consumed the same month, we use monthly inflation rates to devalue monthly income. For 2021, for example, this would imply

$$\begin{aligned}
-\frac{d\log P_0}{dz_0} Y_{i,0} = &-\left[\log \frac{P_{Jan2021}}{P_{Dec2020}} - \log\left(\frac{P_{Jan2021}}{P_{Dec2020}}\right)^*\right] \times Y_{i,Jan2017} \\
&-\left[\log \frac{P_{Feb2021}}{P_{Dec2020}} - \log\left(\frac{P_{Feb2021}}{P_{Dec2020}}\right)^*\right] \times Y_{i,Feb2017} \\
&- \ldots \\
&-\left[\log \frac{P_{Dec2021}}{P_{Dec2020}} - \log\left(\frac{P_{Dec2021}}{P_{Dec2020}}\right)^*\right] \times Y_{i,Dec2017}
\end{aligned}$$

Since we have no information on monthly income, we assume that each month is equal to 1/12 of the yearly income. The above expression can therefore be rewritten as

$$\begin{aligned}
-\frac{d\log P_0}{dz_0} Y_{i,0} = &-\left[\log \frac{P_{Jan2021}}{P_{Dec2020}} + \log \frac{P_{Feb2021}}{P_{Dec2020}} + \ldots + \log \frac{P_{Dec2021}}{P_{Dec2020}}\right] \times \frac{Y_{i,2017}}{12} \\
&-\left[-\log\left(\frac{P_{Jan2021}}{P_{Dec2020}}\right)^* - \log\left(\frac{P_{Feb2021}}{P_{Dec2020}}\right)^* - \ldots - \log\left(\frac{P_{Dec2021}}{P_{Dec2020}}\right)^*\right] \times \frac{Y_{i,2017}}{12}
\end{aligned}$$

or

$$-\frac{d\log P_0}{dz_0}Y_{i,0} = -\left[\frac{\log\frac{P_{Jan2021}}{P_{Dec2020}} + \log\frac{P_{Feb2021}}{P_{Dec2020}} + ... + \log\frac{P_{Dec2021}}{P_{Dec2020}}}{12}\right] \times Y_{i,2017}$$
$$-\left[-\frac{\log\left(\frac{P_{Jan2021}}{P_{Dec2020}}\right)^* + \log\left(\frac{P_{Feb2021}}{P_{Dec2020}}\right)^* + ... + \log\left(\frac{P_{Dec2021}}{P_{Dec2020}}\right)^*}{12}\right] \times Y_{i,2017}$$

For an appropriately defined average inflation rate – i.e. the inflation rate in each month of 2021 compared to December 20202 – or

$$\log\frac{P_{2021}}{P_{Dec2020}} \equiv \frac{1}{12}\left[\log\frac{P_{Jan2021}}{P_{Dec2020}} + \log\frac{P_{Feb2021}}{P_{Dec2020}} + ... + \log\frac{P_{Dec2021}}{P_{Dec2020}}\right]$$

we can finally write

$$-\frac{d\log P_0}{dz_0}Y_{i,0} = -\left[\log\frac{P_{2021}}{P_{Dec2020}} - \log\left(\frac{P_{2021}}{P_{Dec2020}}\right)^*\right] \times Y_{i,2017}$$

Over the entire 2021-23 period we obtain

$$\begin{aligned}-\frac{d\log P_0}{dz_0}Y_{i,0} = &-\left[\log\frac{P_{2021}}{P_{Dec2020}} - \log\left(\frac{P_{2021}}{P_{Dec2020}}\right)^*\right] \times Y_{i,2017}\\ &-\left[\log\frac{P_{2022}}{P_{Dec2020}} - \log\left(\frac{P_{2022}}{P_{Dec2020}}\right)^*\right] \times Y_{i,2017}\\ &-\left[\log\frac{P_{2023}}{P_{Dec2020}} - \log\left(\frac{P_{2023}}{P_{Dec2020}}\right)^*\right] \times Y_{i,2017}\end{aligned}$$

where

$$\log\frac{P_{2022}}{P_{Dec2020}} \equiv \frac{1}{12}\left[\log\frac{P_{Jan2022}}{P_{Dec2020}} + \log\frac{P_{Feb2022}}{P_{Dec2020}} + ... + \log\frac{P_{Dec2022}}{P_{Dec2020}}\right]$$
$$\log\frac{P_{2023}}{P_{Dec2020}} \equiv \frac{1}{12}\left[\log\frac{P_{Jan2023}}{P_{Dec2020}} + \log\frac{P_{Feb2023}}{P_{Dec2020}} + ... + \log\frac{P_{Dec2023}}{P_{Dec2020}}\right]$$

D.1.2 Indirect components

For the indirect component we follow a more differentiated approach.

Regarding short-term nominal assets, we assume that the change in interest rates is the monetary policy response to the inflation shock. We also assume no change in net nominal asset holdings, so that $B_{S1} = B_{S0}$. We therefore compute

$$\frac{d\log Q_{S0}}{dz_0} \times Q_{S0} \times B_{S1} = \left[\log\frac{Q_{S,Dec2023}}{Q_{S,Dec2020}} - \log\left(\frac{Q_{S,Dec2023}}{Q_{S,Dec2020}}\right)^*\right] \times Q_{S,Dec2020} \times B_{i,S,Dec2017}$$

where we assume that interest rates were expected to remain unchanged over the 2021-2023 period and therefore $\left(\frac{Q_{S,Dec2021}}{Q_{S,Dec2020}}\right)^* = 1$. We compute the change $\log Q_{S,Dec2023} - \log Q_{S,Dec2020}$ using the actual change interest rates over this period. We treat positive holdings (mostly bank deposits) and negative holdings (debt) differently. For the former we use the evolution of bank deposit rates, for the latter the evolution of bank lending rates.

Regarding real asset k, we proceed in a comparable manner and compute

$$\frac{d\log D_{k0}}{dz_0} \times D_{k0} \times a_{i,k0} = \left[\log \frac{D_{k,Dec2023}}{D_{k,Dec2020}} - \log \left(\frac{D_{k,Dec2023}}{D_{k,Dec2020}}\right)^*\right] \times D_{k,Dec2020} \times a_{i,k,Dec2017}$$

but in this case the surprise movement in asset income, $\log \frac{D_{k,Dec2023}}{D_{k,Dec2020}} - \log \left(\frac{D_{k,Dec2023}}{D_{k,Dec2020}}\right)^*$, is computed from the surprise movement in asset prices as described in sections 3.3.2 and 3.3.3.

Finally, regarding wage income we compute

$$\begin{aligned}\frac{d\log W_0}{dz_0} \times W_0 = & \left[\log \frac{W_{2021}}{W_{2020}} - \log \left(\frac{W_{2021}}{W_{2020}}\right)^*\right] \times W_{2020} \\ & + \left[\log \frac{W_{2022}}{W_{2020}} - \log \left(\frac{W_{2022}}{W_{2020}}\right)^*\right] \times W_{2020} \\ & + \left[\log \frac{W_{2023}}{W_{2020}} - \log \left(\frac{W_{2023}}{W_{2020}}\right)^*\right] \times W_{2020}\end{aligned}$$

where we assume that the evolution of nominal wages in the absence of shocks is consistent with the 2% inflation target.

D.2 Inflation rates

We take the inflation rate of each of our consumption categories reported in Table C.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 D.1. For Germany, France and Italy, our benchmark estimates are within 0.5 pp of the official measures. Our benchmark rates are somewhat lower in Spain (by 1.5 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).

The discrepancies reported in Table D.1 refer to HICP inflation rates *cumulated* over 2021-23. Discrepancies are smaller for average annual inflation rates, which we use to devalue flows (notably income).

	Italy	Germany	France	Spain
Official	17.5	20.2	14.9	16.1
Our benchmark	17.0	20.5	15.1	14.7
No weight adjustment	17.3	20.7	14.9	14.7

Table D.1: Comparison between cumulated inflation rates for 2021-2023: 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.3 Expenditure shares

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

D.4 The Household Finance and Consumption Survey

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

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

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

D.5 Wages

The evolution of nominal wages in 2021 and 2023 is obtained from data on negotiated wages from National Statistical Agencies. Figures D.1 plots growth rates over this period, whereas D.2 reports their evolution over time starting from 2006, to put this last two years in a historical perspective. Table D.2 summarizes the growth rate of negotiated wages and the minimum wage over the period in the four countries.

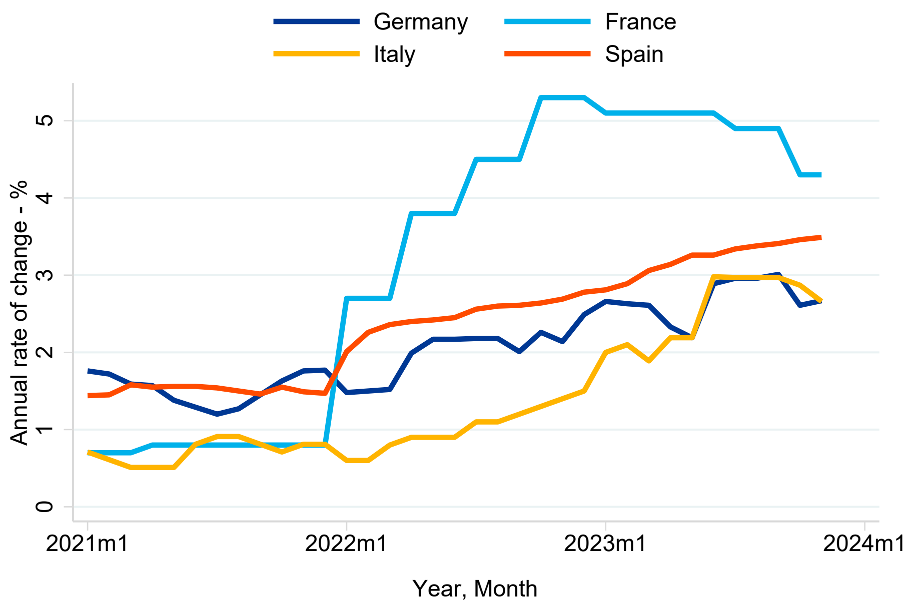

Figure D.1: Average annual rate of change for negotiated wages, monthly data, 2021–2022

Source: National Statistical Agencies.

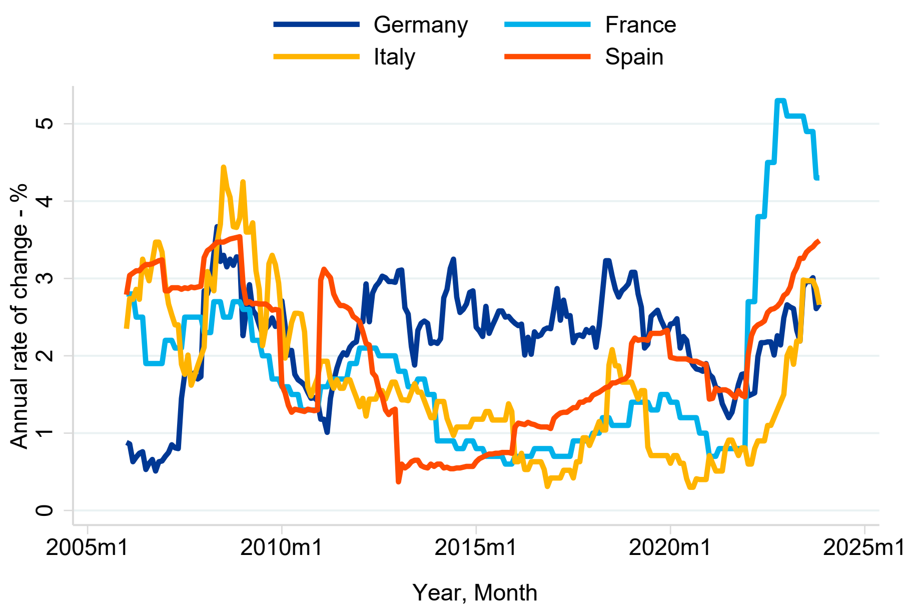

Figure D.2: Average annual rate of change for negotiated wages, monthly data, 2006–2022

Source: National Statistical Agencies.

D.6 Financial data

D.6.1 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 D.3 reports its evolution from 2006. We compiled a list of the

Country	Indicator	Year		
		2021	2022	2023
Germany	Negotiated Wages	1.51	2.60	4.00
	Minimum Wage	1.60	10.76	0
	Pensions	2.50	4.00	5.30
France	Negotiated Wages	0.78	4.03	4.80
	Minimum Wage	0.98	3.12	0
	Pensions	1.00	3.40	4.20
Italy	Negotiated Wages	0.67	1.04	2.90
	Minimum Wage	NA	NA	NA
	Pensions	1.70	3.00	7.20
Spain	Negotiated Wages	1.51	2.80	3.50
	Minimum Wage	0.53	4.71	0
	Pensions	4.20	4.60	9.60

Table D.2: 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. Pensions figures come from the Eurosystem staff macroeconomic projections for the euro area.

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 B.8.[38]

We obtain house prices from the OECD, weighting each EU country according to the geographical distribution of REIT index described above.[39] Figure D.4 traces the evolution over time of our index.

D.7 Inflation surprises

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

[38]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.

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

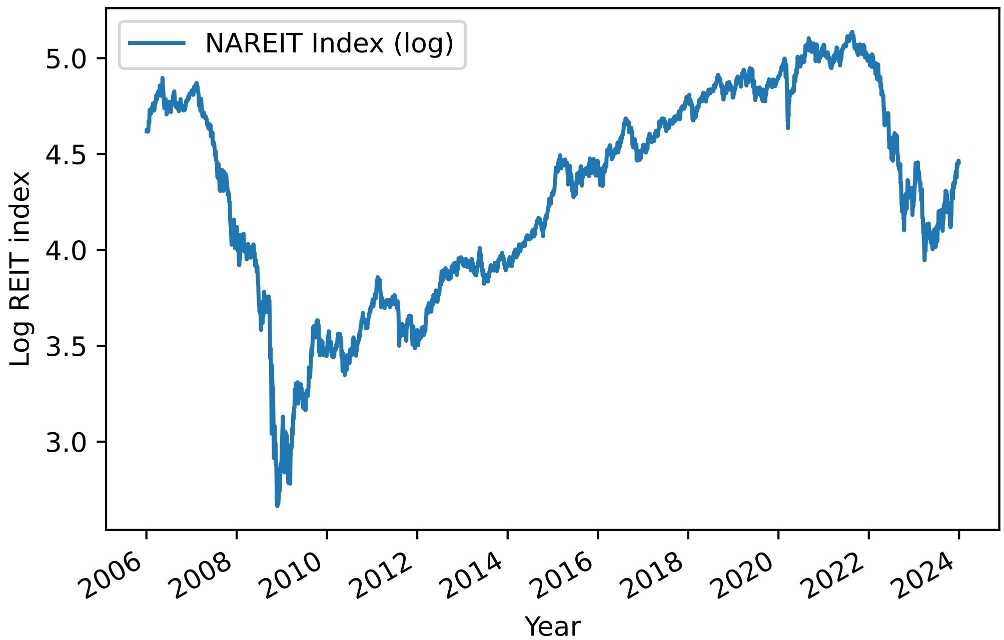

Figure D.3: NAREIT Euro zone Residential Index; in logs.

Source: Bloomberg.

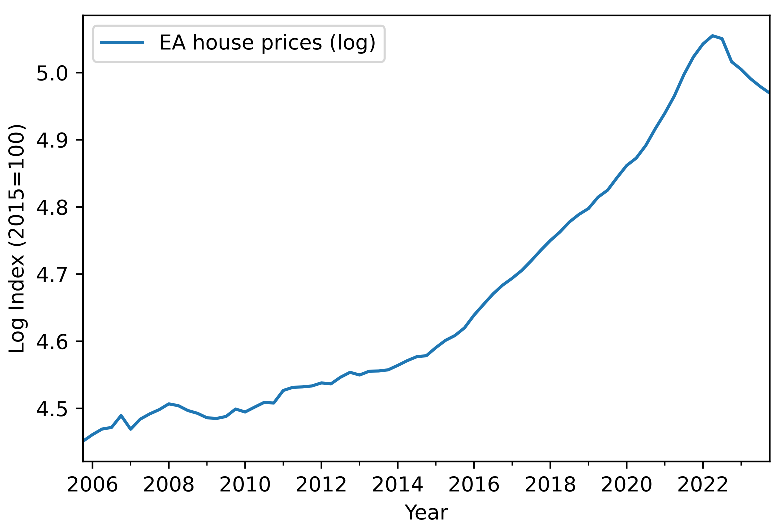

Figure D.4: Euro area house prices, weighted by the share residential REIT index.

Source: OECD

D.7.1 Stocks and bond indices

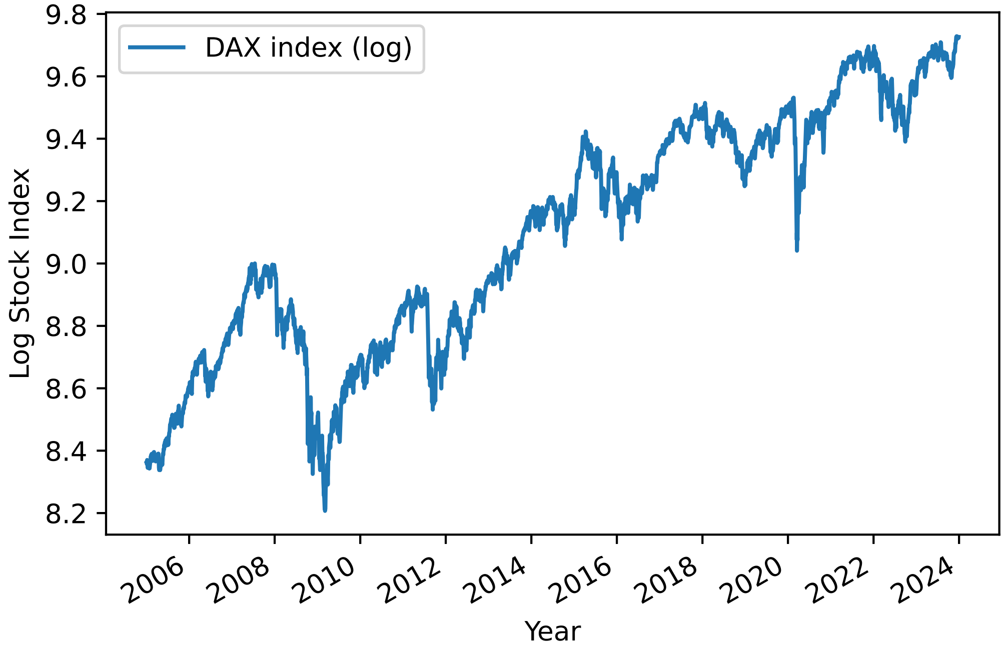

Figure D.5: Value of the DAX Index; in logs.

Source: Bloomberg.

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 D.5 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.

Appendix E Calculation of net income and measurement of fiscal drag

This appendix summarizes how we estimate net income and compute the fiscal drag during the inflation episode. The (nominal) fiscal drag reflects the extra taxes that the households pay and governments receive when the tax system is not indexed to inflation. We quantify the amount of additional taxes by estimating how tax revenues change with inflation, relative to a counterfactual with no inflation surge.

E.1 Estimation of net income

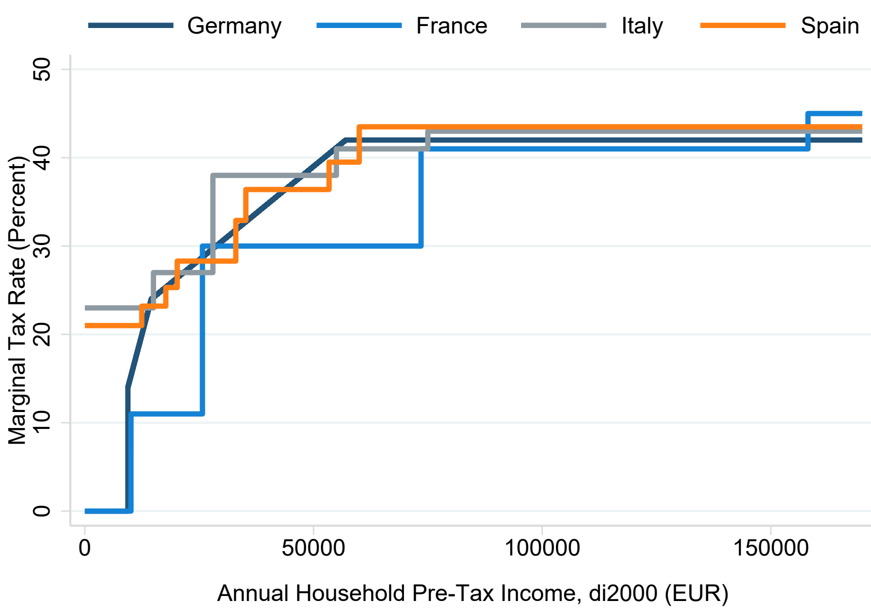

Figure E.1: Marginal tax rates, 2020

Source: OECD Tax Database, https://www.oecd.org/tax/tax-policy/tax-database/; Household Finance and Consumption Survey Note: The figure shows how (statutory) marginal tax rates depend on taxable household income. In Italy, there is the basic employee tax credit of EUR 1880 (not included in taxable income). For Spain, the tax rates shown include both national and regional taxes.

Most of our results in section 4 are reported in percent of household net income prior to the shock. We approximate household net (after-tax) incomes by applying tax schemes of 2020 to taxable incomes and adding nontaxable income, following Slacalek et al. (2020). We calculate taxable income in the HFCS data as: employee income (variable `di1100`) + 2/3×self-employment income (`di1200`) + income from pensions (`di1500`).

After-tax income is the sum of taxable income net of taxes and nontaxable income. Nontaxable income consists of transfers, income from pensions, rental income from real estate property, income from financial assets, income from private business other than self-employment, regular social transfers (except pensions), regular private transfers and income from other sources.

To estimate taxes, we use tax brackets and marginal tax rates from the OECD Tax Statistics, https://www.oecd-ilibrary.org/taxation/data/oecd-tax-statistics_tax-data-en; tables 'Central government personal income tax rates and thresholds' and 'Sub-central personal income tax rates-progressive systems'.

E.2 Estimation of fiscal drag

The fiscal drag is the variation in income tax revenues caused by the inflation shock because of the lack of, or imperfect, indexation of tax brackets.[40]

Denote the actual tax paid by household h in year $t \in \{2021, 2022, 2023\}$ and as $T_{h,t}$ and the counterfactual tax that would have been paid absent the inflation shock as $T^*_{h,t}$. The fiscal drag, measured in euros, is the difference

$$drag_{h,t} = T_{h,t} - T^*_{h,t}.$$

For each household, we apply the actual tax brackets and marginal tax rates from the OECD Tax Statistics to compute the actual tax burden $T_{h,t}$. While tax brackets in Italy and Spain did not change in 2020–23, in France they are automatically adjusted to inflation annually and in Germany every two years. Consequently, in France and Germany, we take into account this upward adjustment in tax brackets due to inflation indexation.

To compute counterfactual taxes, we start from actual gross nominal labour income in 2020, $W_{h,2020}$. We assume that, absent the inflation shock, gross taxable income in each year would have grown with (gross) expected inflation over the corresponding horizon, $\mathbb{E}\pi_{2020,2021}, \ldots, \mathbb{E}\pi_{2020,2023}$. The expected inflation in Consensus Economics data for our four countries ranges between 0.4% and 1.7% per year.

We therefore estimate counterfactual gross nominal income growth in years 2021–2023 as $W^*_{h,2021} = \mathbb{E}\pi_{2020,2021} \cdot W_{h,2020}$, $W^*_{h,2022} = \mathbb{E}\pi_{2020,2022} \cdot W_{h,2020}$ and $W^*_{h,2023} = \mathbb{E}\pi_{2020,2023} \cdot W_{h,2020}$, respectively. We apply counterfactual tax brackets and marginal tax rates to compute $T^*_{h,y}$. For Italy and Spain, these are the tax brackets observed in 2020. For Germany and France, we assume that tax brackets in 2021–23 would have grown at the inflation rate expected at the start of 2021. For Italy and Spain tax brackets remain unchanged.

Figure E.2 (included in the top panel of Figure 5) shows the average fiscal drag over 2021–23 in percent of initial triennial net (disposable) income:

$$\frac{d \log T^{AUT}_{i,0}}{dz_0} T^{AUT}_{i,0} = -100 \times \frac{1}{3} \times \left(\frac{drag_{i,2021}}{Y^n_{i,2020}} + \frac{drag_{i,2022}}{Y^n_{i,2020}} + \frac{drag_{i,2023}}{Y^n_{i,2020}} \right),$$

where i denotes an age/quintile group in each country.

Note that the fiscal drag is produced by inflation-induced changes in the tax schedule and/or in the household's income level. The estimates of the direct effect of the shock shown in Figure 3 are based on an unchanged (pre-shock) tax schedule and therefore abstract from the fiscal drag. Also note that the fiscal drag can be positive, for example, if tax brackets grow with the inflation rate while nominal incomes grow less than inflation.

[40] There is a literature investigating the inflation-induced bracket creep. For a discussion of indexation of the tax system to inflation and empirical evidence, see Aaron (1976) and Immervoll (2005), respectively. Deutsche Bundesbank (2022) discusses the set-up in Germany and provides estimates of the size of inflation-induced bracket creep.

The fiscal drag produces corresponding effects also on governments' revenues. The change in government revenues in country c is the sum of the fiscal drag experienced by all households, or:

$$drag_{c,yt} = -\sum_{h \in c} drag_{h,t}.$$

Table 4 shows our estimates of the total change in fiscal revenues due to the fiscal drag in percent of triennial GDP, i.e.:

$$drag_c = \frac{drag_{c,2021} + drag_{c,2022} + drag_{c,2023}}{3 \times GDP}.$$

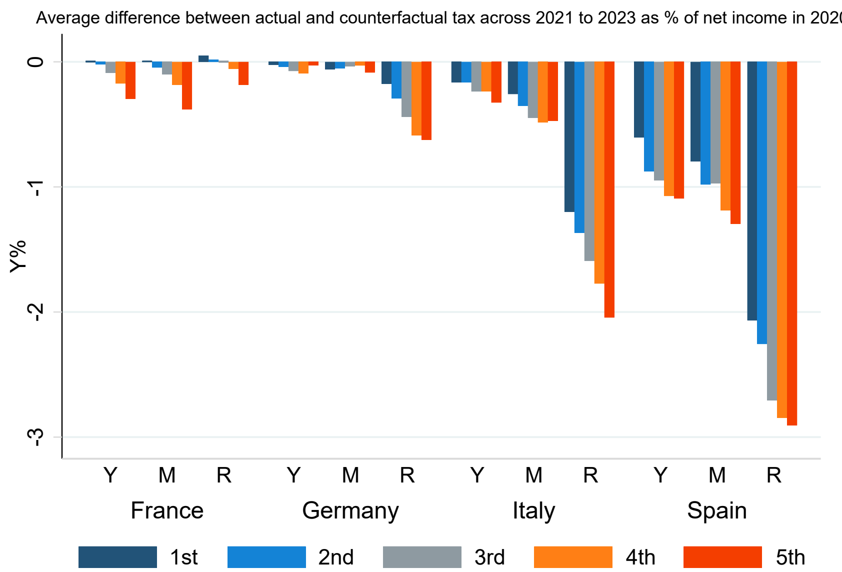

Figure E.2: Fiscal drag in percent of triennial disposable income, by age class and nondurable consumption quintile.
Note: The figure shows how the fiscal drag is distributed across households by age class and consumption quintiles within each age class. The groups Y, M and R denote ages of less than 45 years, 45–64 years and older than 64 years.
Source: OECD Tax Database, https://www.oecd.org/tax/tax-policy/tax-database/; Household Finance and Consumption Survey 2017

Appendix F 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.

F.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 F.1).

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 F.1, assuming full pass through to households.

The resulting evolution of actual and counterfactual petrol prices (EUR/L) is plotted in Figure F.1. 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), and mostly ceased being active early in 2023.

F.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, and extend it to 2023 using data from the French Energy Regulatory Commission (CRE). 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

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 F.1: Subsidies to petrol and other transportation fuels. Source: Sgaravatti et al. (2021)

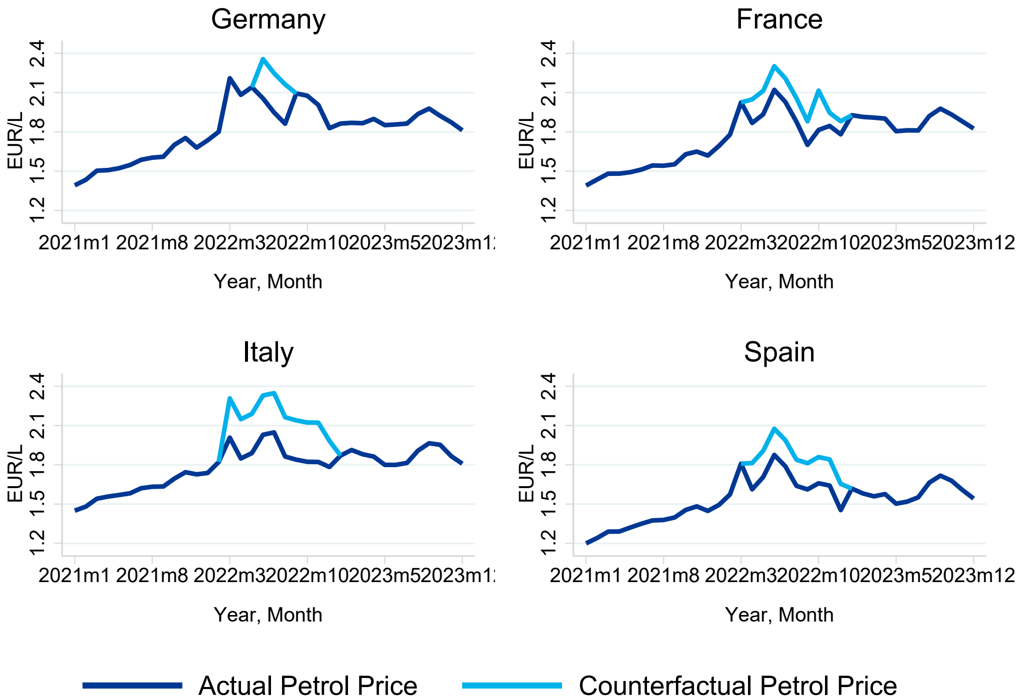

Figure F.1: Actual and Counterfactual prices for petrol in Germany, France, Italy, and Spain; EUR
Source: Eurostat, Insee, Statista, myLPG.eu, mise.gov.it and Sgaravatti et al. (2021).

that bottlenecks in supply systems and other trading frictions can generate differences in prices across countries.

Figure F.2 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%).

F.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, and extend it to 2023. We show the series in the left panel of Figure F.3.

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

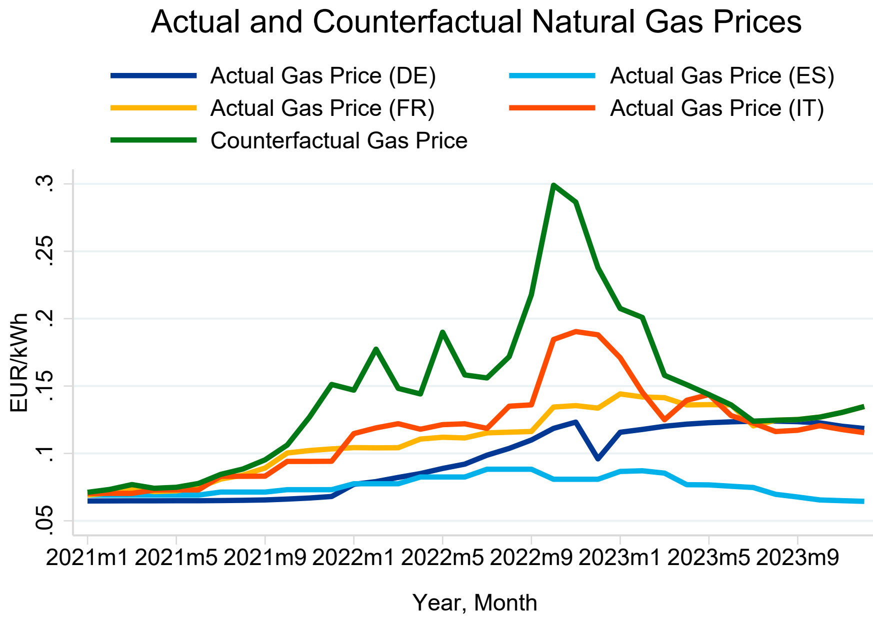

Figure F.2: Actual and Counterfactual prices for natural gas in Germany, Spain, France, and Italy; EUR Source: Eurostat and Dao et al. (2023).

and counterfactual wholesale electricity prices for 2021 and 2023 from the electricity operator OMIE (EPData, 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:

$$P_t^{\text{retail,actual}} = a + b \cdot P_t^{\text{wholesale,actual}}. \tag{F1}$$

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:

$$\hat{P}_t^{\text{retail,count}} = a + b \cdot P_t^{\text{wholesale,count}}. \tag{F2}$$

The right panel of Figure F.3 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). However, in Spain these interventions stopped being active around February 2023, given the large drop in international gas prices. In France, instead, the data on counterfactual electricity prices provided by the French Energy Regulatory Commission (CRE) suggests that, absent interventions, electricity prices would have remained elevated for much of 2023.

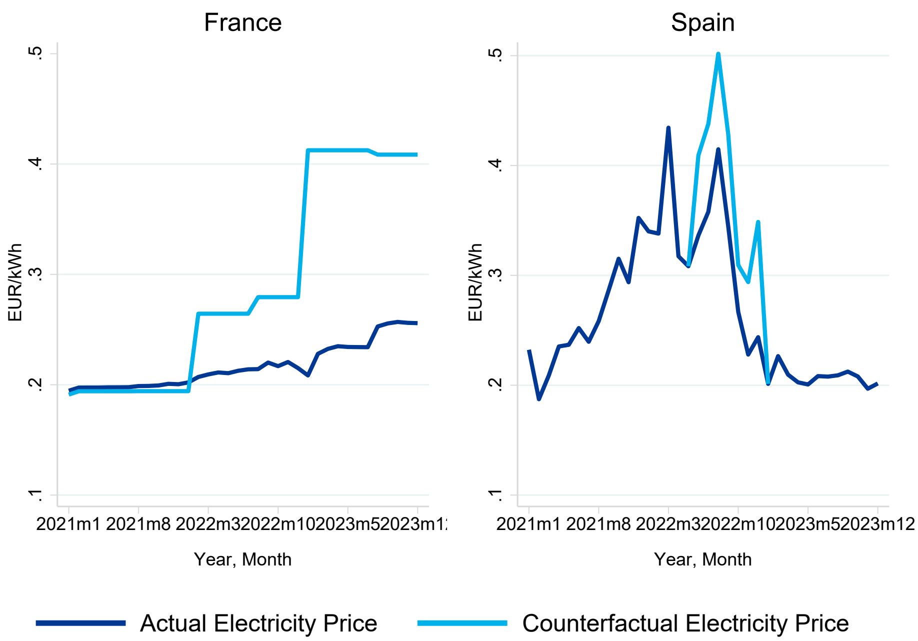

Figure F.3: Actual and Counterfactual prices for electricity in France and Spain; EUR
Source: Eurostat, OMIE and Dao et al. (2023).

Appendix G Summary of 2021–23 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 F describes how we account for direct interventions in energy markets (e.g., temporary reductions of VAT rates, excise duties, price caps).

G.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 600 (in 2023)
- EUR 100 subsidy to unemployed people (in 2022 and 2023)
- EUR 200 subsidy for recipients of social security (in 2023)

G.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 (in 2022); the measure was updated for 2023 folllowing the latest indication of the government: https://www.service-public.fr/particuliers/actualites/A15056?lang=en
- One time energy bonus of EUR 200 for for households whose annual reference tax income per consumption unit is strictly less than EUR 10,800 euros and EUR 100 for those where it is above EUR 10,800 and below EUR 20,000

G.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 and pensioners 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 and 2023)
- 2% increment for pensioners with income lower than EUR 35,000 (in 2022 and 2023)

G.4 Spain

- EUR 200 subsidy for low incomes (in 2022)

Appendix H Computing losses from energy prices for the government

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 (e.g., the electricity bill paid by public hospitals) and the energy content of all of the goods included in government consumption, based on input-output tables. Thus, we proceed in two steps: first, we estimate the share of energy in government spending; 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 spending. 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 downstream to government purchases. 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). 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.

More specifically, 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 π_{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 triennial GDP.

Appendix I Reconciling micro and macro data on direct nominal positions of households

Table I.1 compares the aggregated direct net nominal positions for households from the HFCS with those recorded in aggregate financial account data. From this latter source, we compute direct nominal net positions (DNNP) as defined in Section 5.1.1 because this is the closest counterpart to our measure from the HFCS microdata.

	Micro data (HFCS)			Aggregate data (Financial Accounts)		
Country	DNNP	Nominal assets	Liabilities	DNNP	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 I.1: Direct nominal positions in micro and aggregate data, EUR per capita, 2017

Aggregated positions in surveys are substantially lower than those in financial account 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, while 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). On the survey side, the first one is under-coverage: households often under-report their assets and liabilities. The second problem with surveys is related to the difficulty to interview extremely wealthy households, which account for a disproportionate share of total wealth and its components, assets especially (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). On the side of financial accounts, measurement issues can arise because they sometimes treat households as a residual when allocating assets and liabilities across economic sectors.

All in all, Table I.1 suggests that our results in Section 4 might underestimate the loss suffered by certain households through the devaluation of their net nominal positions. A plausible conjecture is that significant downward bias is only present for individuals at the top of the wealth distribution.