Who bears the costs of inflation?
A distributional analysis of euro area households

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Motivation: distributional effects of inflation shocks

- Headline inflation on the rise since 2021 Data
- Key drivers: energy and food prices Data
- Public debate: contrasting arguments
  - Poorer households spend relatively more of energy and food
  - But wealthier households own positive net nominal assets
  - Sluggish adjustment of nominal wages

Our contribution

1. **Conceptual:** Provide comprehensive framework to assess various channels of infl shocks
2. **Empirical:** Quantify size of various channels across EA countries/households

Recent contributions

- Cardoso, Ferreira, Leiva, Nuño, Ortiz, Rodrigo, and Vazquez (2022)
  - Spanish bank account data
  - Quantify role of consumption baskets, net nominal positions and labour market income
- Del Canto, Grigsby, Qian and Walsh (2023)
  - Framework to study welfare impact of inflation
  - Use estimated impulse response functions to oil and monetary shocks
- Curci, Savegnago, Zevi and Zizza (2023)
  - Heterogeneity of household-specific inflation rates and effect of government measures in Italy
- Many other empirical studies, mostly focusing on heterogeneous consumption baskets
  - Battistini, Di Nino, Dossche, Kolndrekaj (2022)
  - Charalampakis, Fagandini, Henkel, Osbat (2022)
  - Menyhert (2022)

Our framework

- Households live for two periods, $t = 0, 1$
- They maximise $V_0 = u(C_0) + \beta u(C_1)$ subject to the budget constraints ($t = 0, 1$):

$$\begin{aligned} C_t P_t &= B_{St} + (1 + \delta Q_{Lt}) B_{Lt} + \sum_{k=1}^{K} (Q_{kt} + D_{kt}) a_{kt} + W_t - T_t \\ &\quad - \rho_t h_t - Q_{St} B_{St+1} - Q_{Lt} B_{Lt+1} - \sum_{k=1}^{K} Q_{kt} a_{kt+1} \end{aligned}$$

B_{St} short-term bonds, B_{Lt} long-term bonds, a_{kt} real assets, W_t nominal wages, T_t nominal government taxes net of transfers, $\rho_t h_t$ rental expenses

Our experiment: one-off increase in inflation (MIT shock)

- Before $t = 0$, all prices are consistent with zero inflation
- At $t = 0$, unexpected one-off "inflation shock" dZ_0 inducing

$$\frac{d \log P_0}{dZ_0} \equiv \frac{\sum_{j=1}^{J} xsh_j \cdot d \log p_{j0}}{dZ_0},$$

- At $t = 1$, price stability restored and monetary neutrality

$$\frac{d \log W_1}{dZ_0} = \frac{d \log \rho_1}{dZ_0} = \frac{d \log D_{k1}}{dZ_0} = \frac{d \log Q_{k1}}{dZ_0} = \frac{d \log P_1}{dZ_0} = \frac{d \log P_0}{dZ_0}$$

Impact on welfare: first-order effects

- Object of interest: impact of the inflation shock dZ_0 on the value function V of each household on individual households.
- Because of the envelope theorem, ignore changes in choice variables: Envelope theorem

$$\frac{dV}{dZ_0} = \frac{d\mathcal{L}}{dZ_0}$$

- Define 'money metric welfare gains' (Fagereng et al., 2022; del Canto et al., 2022):

$$d\mathcal{W} = \frac{dV/u'(C_0)}{dZ_0}$$

Impact on welfare: first-order effects

- Object of interest: impact on welfare of the inflation shock dZ_0 on individual households, scaled with their marginal utility.
- Because of the envelope theorem, ignore changes in choice variables and: Envelope theorem

$$\frac{dV}{dZ_0} = \frac{d\mathcal{L}}{dZ_0}$$

Lagrangean

- Define 'money metric welfare gains' (Fagereng et al., 2022; del Canto et al., 2022):

$$d\mathcal{W} = \frac{dV/u'(C_0)}{dZ_0}$$

- Decompose the effects into:
  - Stage 1: partial equilibrium (no changes in prices)
  - Stage 2: general equilibrium, (changes in wages, rents and asset prices as in the data)

Stage 1, partial equilibrium: measurement

$$d\mathcal{W}^{PE} = \left[\underbrace{-\frac{d\log \bar{P}_0}{dZ_0}}_{\text{average } \pi} - \underbrace{\frac{d\log P_0 - d\log \bar{P}_0}{dZ_0}}_{\text{1. } \pi \text{ differences}} \right] \times$$

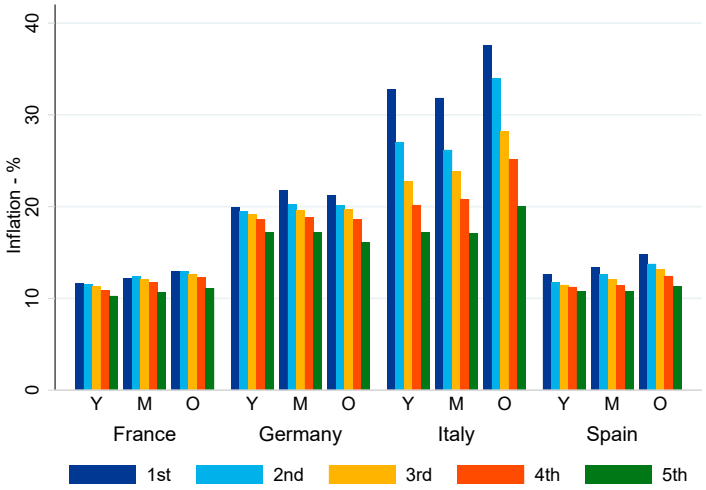
$$\left[\underbrace{W_0 - T_0}_{\text{2. net income}} + \underbrace{B_{S0} + Q_{L0}\delta B_{L0} + B_{L0}}_{\text{3. NNP}} - \underbrace{\rho_0 h_0}_{\text{4. rent}} + \underbrace{\sum_{k=1}^{K} D_{0k} a_{0k} + \sum_{k=1}^{K} Q_{0k}\left(a_{0k} - a_{1k}\right)}_{\text{5. K gains}} \right]$$

Measurement

- Item 1: Hh-level inflation rates (HBS, HICP) net of expectations (Consensus)
- Items 2, 3, 4, 5: Household Finance and Consumption Survey 2017

Why NNPs differ

2021–22 cumulative household-level inflation rates
Large differences in levels and consumption-quintile slopes across countries



Aggregate inflation shock

- FR: 12%
- DE: 18%
- IT: 24%
- ES: 12%

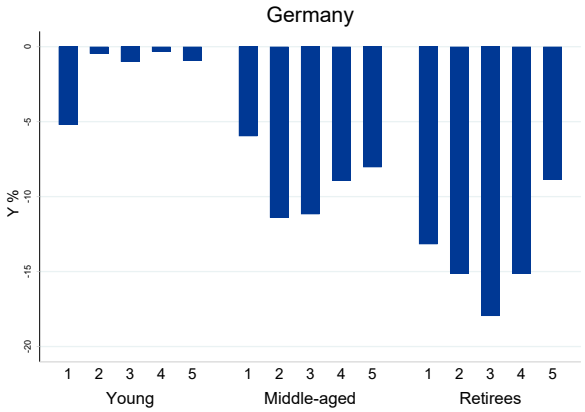
Negative slope over C

- High-C Hhs face lower inflation, by ∼5pp

Differences in size and slope driven by energy prices

Details

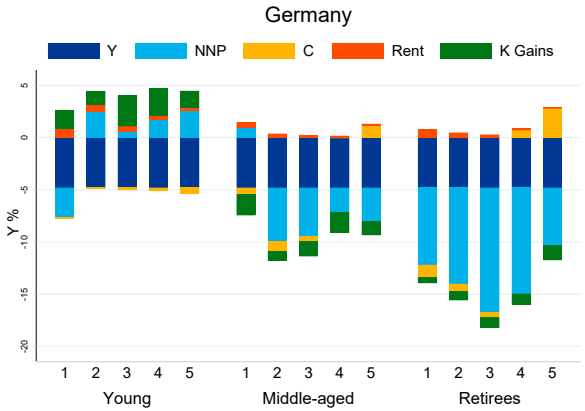
Stage 1 (partial equilibrium): total, net effect Germany



- Retirees lose, while young break even

Stage 1 (partial equilibrium)—Germany

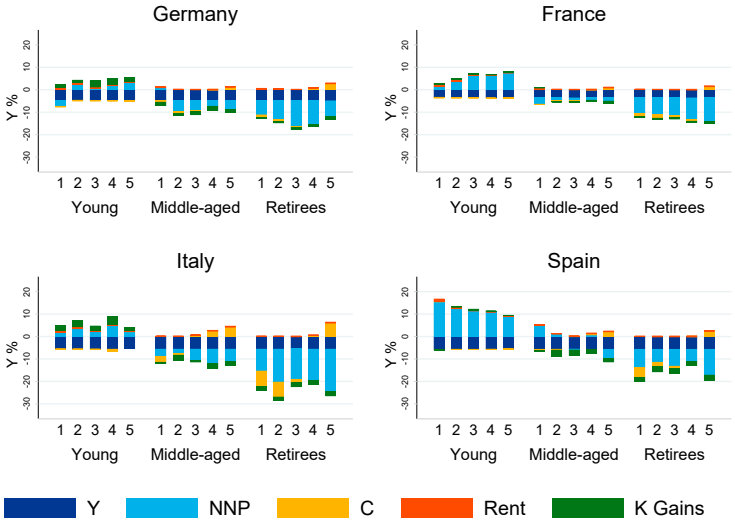
Wage and net nominal positions key; losses higher for older households



- **Net income:** Loss of 5%, even across groups
- **Net nominal positions:** +effect for young, negative for retirees
- **π differences:** Older high-C gain, low-C lose
- **Rent:** Small gains
- **K gains:** Gains for young (potential buyers)
- **Overall:**
  Losses of 5–15% of income, more for retirees

Stage 1 (partial equilibrium): large losses in Italy (large π shock)

Wages and net nom positions key; π differences matter across C quintiles



Y: Net income

NNP: Net nominal positions

C: π differences

Rent

Capital gains

Stage 2, general equilibrium: measurement

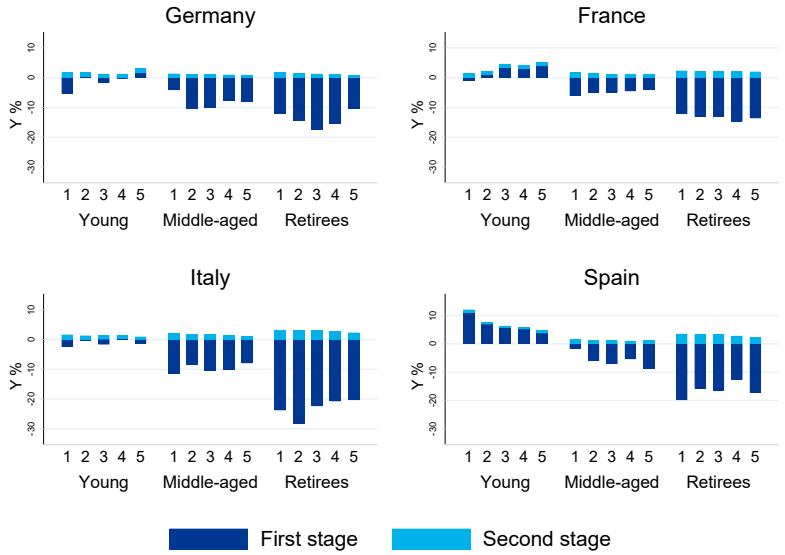
$$
\begin{aligned}
d\mathcal{W}^{GE} = & \underbrace{\frac{d\log W_0}{dZ_0} W_0}_{\text{1. } \Delta\text{wages}} - \underbrace{\frac{d\log T_0}{dZ_0} T_0}_{\text{2. } \Delta\text{minus transfers}} - \underbrace{\frac{d\log \rho_0}{dZ_0} \rho_0 h_0}_{\text{3. } \Delta\text{rent}} + \\
& \underbrace{\frac{d\log Q_{L0}}{dZ_0} Q_{L0} \left(\delta B_{L0} - B_{L,1}\right) - \frac{d\log Q_{S0}}{dZ_0} Q_{S0} B_{S,1}}_{\text{4. } \Delta\text{NNP}} + \\
& \underbrace{\sum_{k=1}^{K} \frac{d\log Q_{k0}}{dZ_0} Q_{k0} \left(a_{k0} - a_{k1}\right) + \sum_{k=1}^{K} \frac{d\log D_{k0}}{dZ_0} D_{k0} a_{k0}}_{\text{5. } \Delta\text{capital gains ('K gains')}}
\end{aligned}
$$

Measure adjustments:

- Δwages: National Statistical Institutes (disaggregated data)
- Δrent: HICP
- Δtransfers: Bruegel database on fiscal policy responses to the energy crisis
- ΔNNP, Δcapital gains: elasticities to inflation surprises (high-frequency time series)

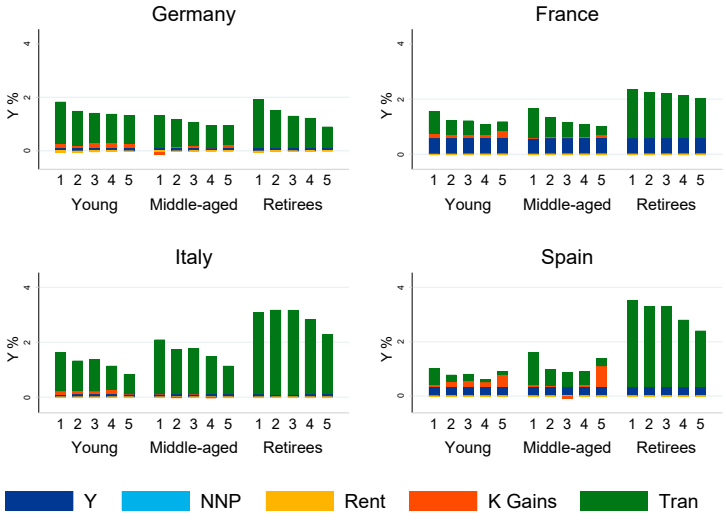
Details

Overall impact: partial (stage 1) > general equilibrium (stage 2) effects



Stage 2: general equilibrium (prices adjust)

Transfers & wages diminish losses, but overall much smaller effect than stage 1



Y: Net income

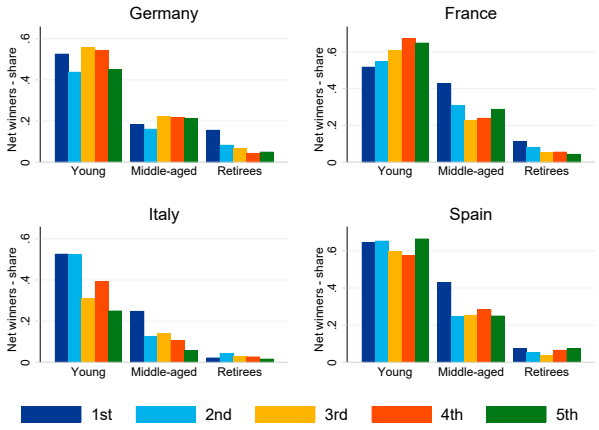
NNP: Net nominal positions

Rent

Capital gains

Transfers

Fraction of winners: about 25%, more among younger (indebted) households



Differences within household groups

- More winners among young due to NNP gains
- More winners in ES, FR (negative NNPs)
- Among young, higher-C households benefit more

Summary and conclusions

- Partial equilibrium effects > general equilibrium effects
- Low-consumption households faced higher inflation due to energy and oil inflation
- Real wages of most households declined (wage stickiness)
- Net nominal positions: Older households lost, while indebted younger benefited
- Overall, substantial negative effects of surprise inflation 2021–22
  - Aggregate loss: 6% of income (similar to Great Recession)
  - 75% of households lost about 5–15% of income; 25% gained
- Next steps: incorporate behavioral responses

Thank you

Stage 3: estimate substitution across goods using consumption shares

- Define current actual consumption shares, 2019: $w_j = \dfrac{q_j p_j}{\sum_i q_i p_i}$
- Following inflation shock, compare next period's consumption shares, 2022

$$w'_j = \frac{q'_j p'_j}{\sum_i q'_i p'_i}$$

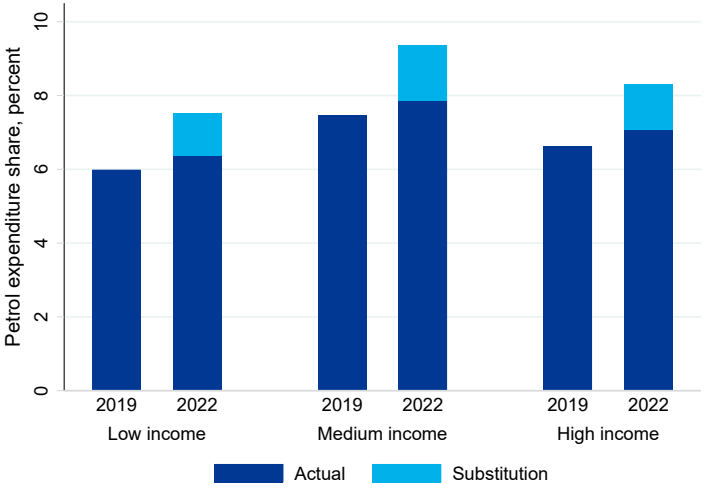
with counterfactual consumption shares in absence of substitution across goods:

$$\hat{w}'_j = \frac{q_j p'_j}{\sum_i q_i p'_i} = \frac{w_j(1+\pi_j)}{\sum_i w_i(1+\pi_i)},$$

where π_j is inflation rate for good j (from HICP)

- Difference b/w actual w'_j and counterfactual $\hat{w}'_j$ 2022 shares reflects substitution

Actual and counterfactual petrol expenditure shares in German credit card data



- Credit card data, "Fable"
- Even across households

Headline inflation rising strongly since 2021

HICP inflation and the HICP price level

(left: annual percentage changes, right: index: Dec-1998 = 100)

Sources: Eurostat.
Notes: The right panel is based on seasonally adjusted data.

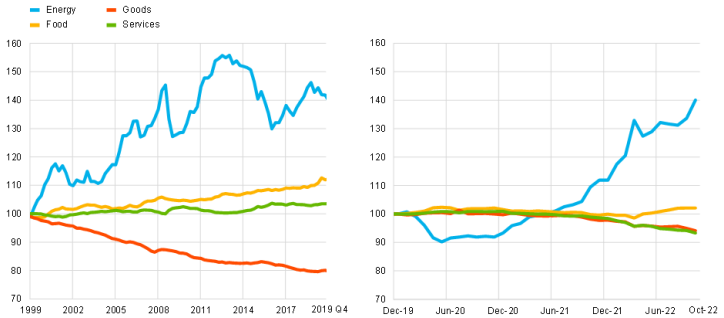
The latest observations are for October 2022.

Source: Lane (2022) Back

Key drivers: energy and food prices

Price developments relative to HICP for different subcomponents

(left: index: 1998 Q4 =100, right: index: December 2019 = 100)



Sources: Eurostat.
Note: Seasonally adjusted data for HICP, food, goods and services. Seasonally adjusted series for energy are not available. The goods category here only includes non-energy industrial goods (NEIG).
The latest observations are for October 2022.

Source: Lane (2022) Back

A reminder of the envelope theorem

- Consider the problem $\max_x f(x,z)$ s.t. $g(x,z)=0$, where z is an exogenous variable
- The maximum value function is $V(z)=f\left(x^*(z),z\right)$. We are interested in

$$\frac{\partial V}{\partial z}=f_x\frac{\partial x^*(z)}{\partial z}+f_z,$$

  which depends on the derivative $\partial x^*(z)/\partial z$
- Construct Lagrangean $\mathcal{L}=f(x,z)+\lambda g(x,z)$, differentiate it w.r.t. z and use the FOCs for an interior optimum to obtain:

$$\frac{\partial \mathcal{L}}{\partial z}=f_z+\lambda g_z=\frac{\partial V}{\partial z}$$

- To assess the change in welfare induced by z we only need to take the partial derivative of the Lagrangean w.r.t. z. **We can ignore changes induced on choice variables**

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Our analysis

- Lagrangean:

$$\mathcal{L} = \sum_{t=0}^{1} \beta^t u\left(C_t\right) + \sum_{t=0}^{1} \lambda_t \beta^t \left[B_{St} + \left(1 + \delta Q_{Lt}\right) B_{Lt} + \sum_{k=1}^{K} \left(Q_{kt} + D_{kt}\right) a_{kt} \right.$$
$$\left. + W_t - T_t - C_t P_t - \rho_t h_t - Q_{St} B_{S,t+1} - Q_{Lt} B_{L,t+1} - \sum_{k=1}^{K} Q_{kt} a_{k,t+1} \right]$$

- Note: $B_{S0}, B_{L0}, a_{k0}, h_0$ all predetermined

- Take $\dfrac{d\mathcal{L}}{dZ_0}$ and decompose effects in two parts, partial eq and general eq:

$$d\mathcal{W} = d\mathcal{W}^{PE} + d\mathcal{W}^{GE}$$

Derivative of the Lagrangean | Welfare metric

Derivative of the Lagrangean for stages 1 and 2

$$d\mathcal{W}_0 = -C_0 P_0 \frac{d\log P_0}{dZ_0} + \frac{d\log W_0}{dZ_0} W_0 + \frac{d\log Q_{L0}}{dZ_0} Q_{L0}\delta B_{L0} + \sum_{k=1}^{K} \frac{d\log Q_{k0}}{dZ_0} Q_{k0}\left(a_{k0} - a_{k1}\right)$$
$$+ \sum_{k=1}^{K} \frac{d\log D_{k0}}{dZ_0} D_{k0} a_{k0} - \frac{d\log \rho_0}{dZ_0}\rho_0 h_0 - \frac{d\log Q_{S0}}{dZ_0} Q_{S0} B_{S1} - \frac{d\log Q_{L0}}{dZ_0} Q_{L0} B_{L1}$$
$$d\mathcal{W}_1 = Q_{S0}\Bigg[- C_1 P_1 \frac{d\log P_1}{dZ_0} + \frac{d\log W_1}{dZ_0} W_1 + \frac{d\log Q_{L1}}{dZ_0} Q_{L1}\delta B_{L1} + \sum_{k=1}^{K} \frac{d\log Q_{k1}}{dZ_0} Q_{k1} a_{k1}$$
$$+ \sum_{k=1}^{K} \frac{d\log D_{k1}}{dZ_0} D_{k1} a_{k1} - \frac{d\log \rho_1}{dZ_0}\rho_1 h_1 \Bigg]$$

since $b_2 = B_2 = a_{k2} = 0$ because $t = 1$ is the terminal period. Back

Partial equilibrium effects: NNPs

- Why are net nominal assets affected differently from other assets?

$$
\begin{aligned}
d\mathcal{W}_0^{PE} &= -\frac{d\log P_0}{dZ_0} \times \Big[\left[B_{S0} + (1+\delta Q_{L0})\, B_{L0}\right] - \left(Q_{S0}B_{S1} + Q_{L0}B_{L1}\right) \\
&\qquad + \sum_{k=1}^{K} Q_{0k}\left(a_{0k} - a_{1k}\right) + \sum_{k=1}^{K} D_{0k}a_{0k} + W_0 - \rho_0 h_0\Big] \\
d\mathcal{W}_1 &= -\frac{d\log P_0}{dZ_0}\left[Q_{S0}B_{S1} + Q_{L0}B_{L1}\right]
\end{aligned}
$$

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Consumption Categories

Consumption Categories			
Class	Label	Class	Label
01	Food	07.22	Fuels
02	Alcohol and tobacco	07.23	Vehicle maintenance
03	Clothing	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	11.1	Restaurants
07.1	Vehicles	11.2	Hotels
07.21	Spare parts	12	Miscellaneous

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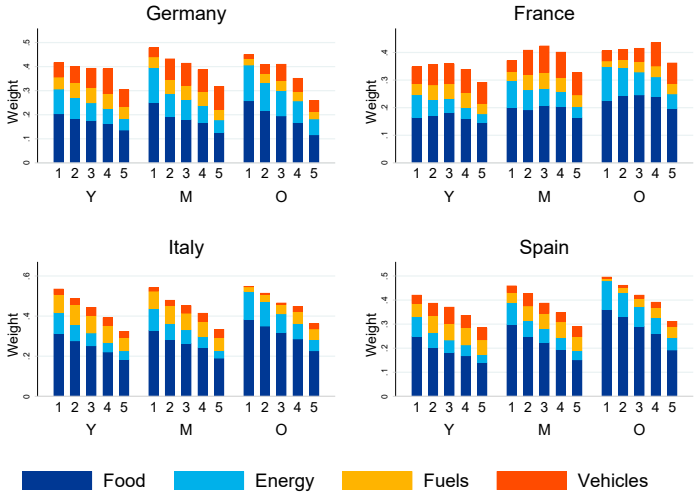
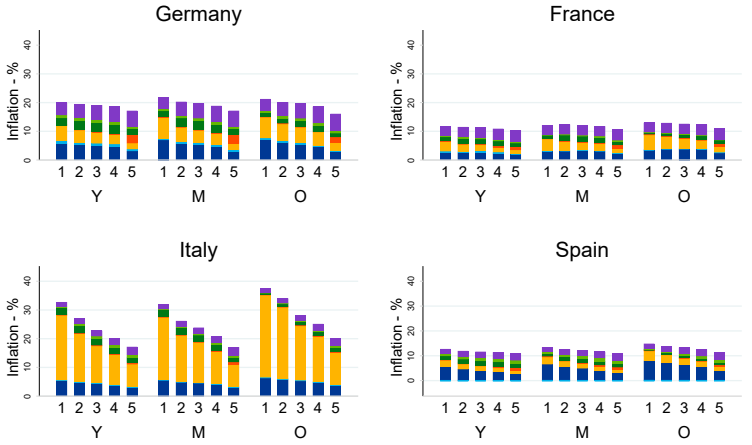
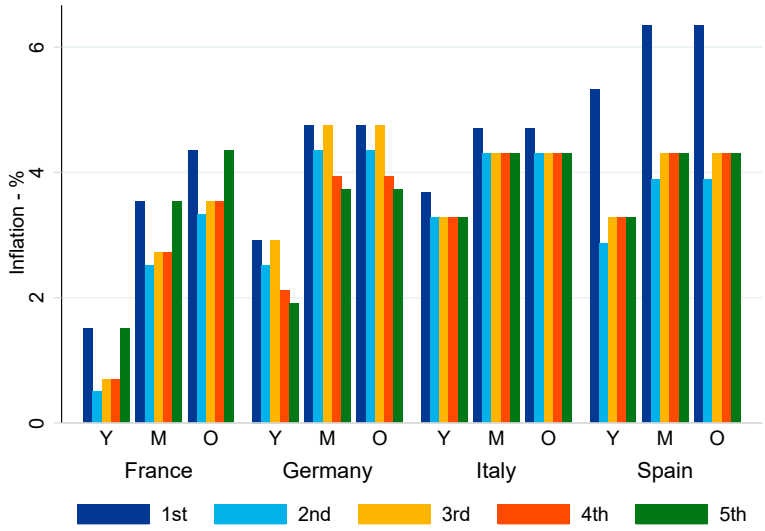
Structure of consumption expenditures
Lower-consumption households have higher food & energy expenditure shares



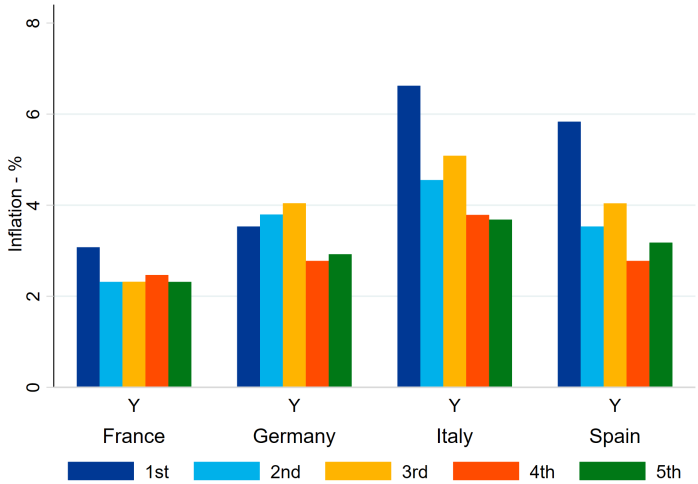
Decomposition of household-level inflation rates
Bulk of inflation driven by energy and food - Back



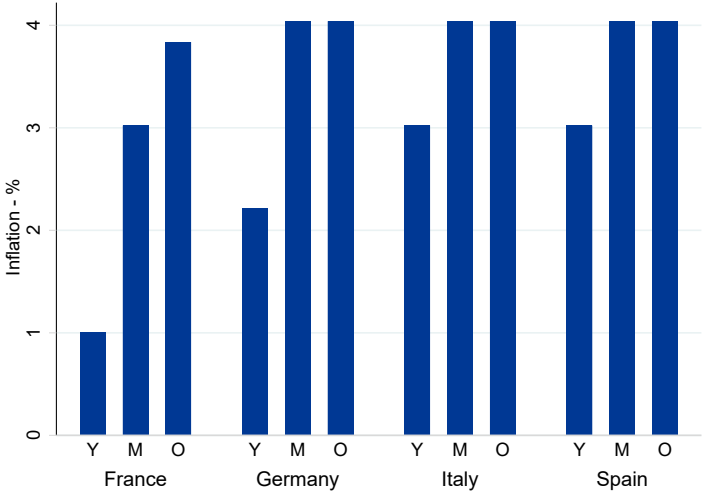
CES inflation expectations by age and income quintile, January 2021
Younger households expect somewhat lower inflation



Household-level inflation rates by income quintile, CES, January 2021
Expectations somewhat higher for low-income households



Household-level inflation rates by age, CES, January 2021
Expectations lower for young households



High-frequency identification

1. REIT returns $R(Q_t)$ on inflation-linked swap ($\Delta ILS_{1Y,t}$) in days when HICP is relased:

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

2. Housing excess returns $R(H_t)$ on lagged REITs excess returns $R(Q_{t-1})$ (quarterly):

$$R(H_t) - R_f = \alpha + \delta\big[R(Q_{t-1}) - R_f\big] + \tilde{\gamma}\big[R(S_t) - R_f\big] + \text{controls} + \varepsilon_t, \tag{2}$$

- House price elasticity to inflation shocks is $\beta\delta$
- Same regression as (1) for stock returns and bond returns Results - step 1 Results - step 2 Back

Effects of inflation surprises on asset return: step 1

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

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Effects of inflation surprises on asset return: step 2

Step 2: $R(H_t) - R_f = \alpha + \delta\big[R(Q_{t-1}) - R_f\big] + \tilde{\gamma}\big[R(S_t) - R_f\big] + \text{controls} + \varepsilon_t$

	House returns
$R(Q_{t-1}) - R_f$	0.015^*
	(0.018)
$R(S_t) - R_f$	0.012
	(0.018)
Obs	64
Adj. R^2	0.630
F-stat	23.316

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Actual and counterfactual exp shares in German credit card data, Fable

	Category	Actual_19	Predicted_22	Actual_22	Inflation	Substitution
0	Food	10.57	11.06	15.99	15.00	44.58
1	Alcohol and tobacco	0.40	0.37	0.60	2.20	62.16
2	Clothing	12.10	11.45	12.15	4.00	6.11
3	Housing, Electricity	0.87	1.20	1.02	51.20	-15.00
4	Furnishings	4.35	4.28	4.26	8.30	-0.47
5	Health	2.63	2.44	2.96	2.10	21.31
6	Transport	21.62	23.60	19.87	20.00	-15.81
7	Communication	0.95	0.82	0.79	-5.40	-3.66
8	Recreation	26.71	24.90	22.78	2.50	-8.51
9	Education	0.33	0.30	0.46	-0.40	53.33
10	Restaurants and Hotels	16.73	17.01	16.68	11.80	-1.94
11	Miscellaneous	2.74	2.58	2.44	3.50	-5.43