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Food-Price Inflation and Household Food Consumption in the EU-27: Economic Vulnerability in European Food Systems

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Abstract

Rising food prices have placed renewed pressure on household budgets across Europe, while also creating challenges for agri-food markets through changes in consumer demand and purchasing behavior. This study examines the relationship between relative food-price inflation and real per-capita household food consumption expenditure across the EU-27 over 2010–2024. Relative food-price inflation is defined as annual food HICP inflation net of core inflation, distinguishing food-specific price pressures from broader inflationary developments. Using an annual country-level panel, two-way fixed-effects regressions are estimated with country-clustered standard errors. The analysis further tests whether this relationship varies with real disposable income, material deprivation, and the poverty-reducing impact of social transfers. Across the baseline model, heterogeneity specifications, and robustness checks, no statistically significant systematic association is identified between relative food-price inflation and real food consumption expenditure. The income interaction has the theoretically expected positive sign but remains statistically insignificant, while interactions with material deprivation and social transfers are also unsupported. By contrast, unemployment is negatively and more consistently associated with real food consumption expenditure. These statistically insignificant estimates should not be interpreted as evidence of a zero association, as modest effects in either direction remain compatible with the data. Households may also adjust through changes in product choice, expenditure composition, and substitution within the food basket, although these mechanisms cannot be directly identified in the present analysis. The study contributes EU-wide evidence on the relationship between food-specific price pressures and aggregate household food expenditure, while highlighting the need for disaggregated data to examine individual purchasing responses.

Keywords: food-price inflation; agri-food markets; consumer adjustment; unemployment; food demand; household expenditure; EU-27; panel data

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1. Introduction

Rising food prices brought the recent European inflation shock directly into households' everyday budgets, placing renewed pressure on purchasing power and the affordability of essential consumption [1–3]. In the euro area, food inflation accelerated from mid-2021 and reached a historic peak of approximately 15.5% in March 2023, far above its pre-pandemic

average [4]. Although the acute food-inflation surge eased after its 2023 peak, the post-pandemic period was characterized by persistent and increasingly heterogeneous food-price dynamics across European countries [5,6]. The surge reflected overlapping shocks to energy and agricultural input costs, commodity markets, and supply chains, as well as the Russia–Ukraine war, with effects differing across Member States [2,5,7–10]. These price movements are economically consequential because food continues to account for a substantial share of household expenditure, with meaningful variation across countries, income levels, and household types [11,12]. Because food is a frequently purchased necessity, changes in its price are particularly salient for consumers [1,13,14]. These characteristics make the recent European food-price episode an important setting in which to ask a more fundamental question: To what extent is relative food-price inflation associated with real household food consumption expenditure, and does this association vary with socioeconomic vulnerability?

Households may respond to higher food prices by altering their food baskets and expenditure allocation, rather than reducing real food consumption proportionally [15–20]. Such adjustments may differ according to households' financial resources and economic vulnerability, while social protection may mitigate some of the pressure associated with rising prices [3,21–23]. These considerations motivate examining both the average relationship between relative food-price inflation and real food expenditure and its variation across socioeconomic conditions. A further distinction concerns the relative price of food. Household expenditure decisions depend not only on food inflation itself, but also on how food prices move compared with the broader price level, since relative price changes can alter both expenditure allocation and the composition of food purchases [12,16]. Existing research has examined the determinants of food inflation, its distributional consequences, and consumer responses to high prices [2,3,19]. In addition, Grodzicki and Jankiewicz [24] analyzed the roles of income, unemployment and inflation in the convergence of food-expenditure shares across EU and selected OECD countries. The specific research gap addressed in this study concerns whether within-country changes in food-price inflation relative to core inflation are associated with changes in real per-capita household food consumption expenditure across the EU-27, and whether these associations vary with country-level indicators of economic vulnerability.

Against this background, the present study investigates the association between relative food-price inflation and real per-capita household food consumption expenditure in the EU-27 over 2010–2024. Relative food-price inflation is measured as annual food HICP inflation net of core inflation, and the empirical analysis applies country and year fixed effects. It further examines whether this relationship varies with real disposable income, material deprivation and the poverty-reducing impact of social transfers, while a broad set of robustness checks assesses the sensitivity of the results. In this way, the study contributes to the literature in three main ways. First, it shifts the focus from nominal food-price inflation to food-specific inflation relative to the broader price level. This distinction makes it possible to separate food-specific price pressure from inflationary developments affecting the economy more generally and therefore provides a more direct measure of changes in the relative cost of food faced by households. Second, the study evaluates this relationship in a common EU-27 framework over a relatively long period that includes both comparatively stable inflation years and the exceptional food-price shocks observed after 2021. Unlike studies focusing on nominal expenditure shares, the analysis examines real per-capita household food consumption expenditure.

Third, the study extends the analysis beyond the average relationship by testing whether the association between relative food-price inflation and real food consumption expenditure varies with country-level indicators of income and economic vulnerability, reflecting documented heterogeneity in inflation exposure across income groups and house-

hold types [22,23]. The interaction of relative food-price inflation with real disposable income, material deprivation and the poverty-reducing impact of social transfers allows the analysis to assess whether economic vulnerability and social protection systematically modify the relationship between food-price pressures and real food consumption. By examining how aggregate household food consumption expenditure responds to food-specific price pressures, the study contributes to understanding consumer adjustment to socioeconomic challenges within European food systems. These demand-side responses are also relevant for agri-food markets, as changes in household purchasing behavior can influence the composition of demand faced by agricultural producers, food manufacturers, and other actors along the food supply chain. The remainder of the paper is organized as follows. Section 2 reviews the relevant literature on food prices, consumption and economic vulnerability. Section 3 presents the data and empirical methodology. Section 4 reports empirical results and robustness checks. Section 5 discusses the findings and their broader implications, while Section 6 concludes.

2. Theoretical Background and Literature Review

2.1. Food Prices and Household Consumption

A growing body of literature has examined how food consumption responds to changes in prices [15,25]. Food demand is generally price-responsive but typically inelastic, although the magnitude of the response varies considerably across product categories, countries and consumer groups [15,25–27]. Both price and income elasticities differ systematically with economic development and household resources [28]. European demand-system studies likewise document substantial variation in own-price and expenditure elasticities across food categories, reflecting differences in preferences and substitution possibilities [29,30].

Food-price shocks can influence household consumption through several channels beyond a direct reduction in quantities purchased [31,32]. Substitution across food products can mitigate part of the welfare loss associated with rising prices, particularly when households have access to sufficiently diverse consumption alternatives [32]. Households may also preserve quantities or caloric intake by shifting towards lower-cost or lower-quality products when food budgets become more constrained [16,31]. Adjustments can extend beyond the food basket itself, as higher food prices may induce households to reallocate expenditure away from non-food consumption to protect essential food purchases [1,33]. As a result, observed food expenditure can simultaneously reflect changes in quantities, quality, product composition and broader household budget allocation [16]. This distinction is important when interpreting real food expenditure as an indicator of consumption adjustment. Real food expenditure can decline more strongly than calorie consumption when consumers substitute for cheaper sources of nutrition [16,31]. Estimates of the welfare consequences of food-price increases are also sensitive to whether consumer substitution is explicitly considered [32]. The consumption effects of food-price shocks therefore depend not only on the size of the initial price increase but also on households' capacity to reorganize their food baskets and overall budgets [32,33].

Recent evidence confirms that these adjustment mechanisms remain relevant during periods of high inflation [17,29]. Consumers may mitigate part of the inflationary burden through discounted purchases and substitution towards cheaper products, although the gains from such strategies diminish when lower-priced varieties themselves experience relatively rapid inflation [17]. Recent EU-wide estimates also reveal substantial cross-country heterogeneity in own- and cross-price food-demand elasticities, indicating that comparable food-price changes need not generate uniform consumption responses across Member States [29]. More broadly, cross-country evidence on food-related consumer attitudes also indicates contextual heterogeneity across European countries, suggesting that consumer

responses within food markets may be shaped by country-specific attitudinal and socioeconomic structures [34]. Thus, the literature supports treating the relationship between food prices and real food consumption as heterogeneous and empirically determined rather than assuming a proportional response to changes in prices [15,29].

2.2. Economic Vulnerability and Social Protection

Household food consumption depends not only on prices but also on the resources available to smooth adverse income shocks [35,36]. Job loss and unemployment can reduce both food expenditure and consumption, although households may partly compensate through savings, greater shopping effort, or other consumption-smoothing mechanisms [35,37]. Cross-country evidence from OECD economies confirms a negative relationship between unemployment and food consumption and further suggests that unemployment insurance and household wealth can moderate the size of this response [36]. Economic conditions may therefore affect food consumption both directly through disposable resources and indirectly by determining households' capacity to absorb price shocks. Income alone, however, does not fully capture economic vulnerability. Food insecurity and food-related deprivation are associated with low income, labor-market exclusion, household composition and other dimensions of material disadvantage [38,39]. Rising unemployment and declining wages were associated with increases in food insecurity across European countries during the Great Recession, indicating that deteriorating labor-market conditions can translate into constraints on essential consumption [39].

The effects of food-price pressure also appear to be stronger among economically deprived groups, particularly when food prices increase faster than wages [40]. Evidence from the inflationary period similarly shows that increases in food costs can widen differences in economic well-being because households differ substantially in the resources remaining after essential food expenditure [23]. Social protection can modify these relationships by cushioning household income against adverse economic shocks [39,40]. European evidence indicates that the association of unemployment and declining wages with food insecurity was substantially weaker where social protection expenditure was higher [39]. Differences in welfare regimes have likewise been shown to moderate the relationship between rising food prices relative to wages and food deprivation [40]. Thus, the protective role of social benefits is not uniform, as benefit receipt and generosity do not always translate into lower food-insecurity risks at the household level [38]. Amores et al. [22] also suggest that fiscal interventions can offset part of the welfare losses generated by high inflation, while their effectiveness depends on the scale and targeting of support. Based on the above, this literature suggests that income, labor-market conditions, material deprivation and social protection capture related but distinct dimensions of households' capacity to withstand economic shocks [22,36,38,40]. This distinction provides a basis for examining whether the association between food-price inflation and real food consumption expenditure varies systematically with economic vulnerability and the strength of redistributive support.

2.3. Relative Food Prices and the European Context

Relative food prices are important for household consumption decisions because consumers respond not only to changes in the absolute price of food but also to its price relative to other goods and services [32,41]. Changes in these relative prices can alter expenditure shares, quantities purchased, and substitution patterns within the household consumption basket [30,41]. Thus, food-price inflation occurring alongside comparable increases in the general price level represents a different economic environment from one in which food prices rise substantially faster than other consumer prices [5,42]. Distinguishing food-specific price movements from broader inflationary developments is therefore relevant for identifying the

pressure associated specifically with changes in the relative cost of food [5,41]. This distinction is particularly relevant in the EU, where cross-country differences in consumer prices have persisted despite decades of market integration [43,44]. Food and beverage prices show especially persistent dispersion across European markets, with differences associated with income levels, retail productivity, market concentration, and national market structures [44]. Furthermore, food-inflation dynamics also remain heterogeneous across EU Member States, with multiple convergence patterns and structural breaks rather than a single common trajectory [5,42]. Thus, distinguishing food-specific price movements from general inflation is important when assessing whether households respond specifically to changes in the cost of food rather than to a general deterioration in purchasing power.

The recent European food-inflation episode illustrates how food-specific price developments can emerge from several overlapping external and domestic shocks. The 2021–2022 surge was associated with higher agricultural input and energy costs, disruptions to global supply chains and commodity markets, adverse climatic conditions, and the repercussions of the Russia–Ukraine war, although the relative importance of these channels varied over time and across economies [2,9]. Global food-price and agricultural cost shocks were transmitted to consumer food prices, but the strength of this transmission differed across food categories and national markets [2]. Energy costs constitute an additional transmission channel because changes in fuel and energy prices affect agricultural production, processing, transportation, and other stages of the food value chain [2,6]. The transmission of these shocks is also neither instantaneous nor symmetric. Commodity-price shocks can have persistent effects on euro-area food inflation, reaching their strongest impact only several months after the initial shock, while increases in food and energy commodity prices tend to pass through more strongly than corresponding declines [6]. Country-level evidence for the EU-27 further identifies oil-price movements, exchange-rate fluctuations, and the Russia–Ukraine war as significant determinants of food inflation, while also revealing substantial differences in national responses [10]. Such differences imply that common international shocks can interact with domestic economic structures and price-setting mechanisms to generate heterogeneous food-inflation trajectories [10,42].

This heterogeneity is also visible over longer horizons. EU food-inflation rates do not exhibit a single common convergence path; instead, Member States form distinct convergence groups, while major economic disruptions are associated with structural breaks and widening inflation disparities [42]. Evidence covering 2005–2025 similarly suggests that the convergence in food-price dynamics observed before 2020 reversed during the succession of pandemic, energy, supply-chain, and geopolitical shocks, resulting in greater cross-country dispersion [5]. These patterns indicate that movements in consumer food prices reflect both common international pressures and country-specific transmission processes rather than simply mirroring changes in the general price level [5,9,10]. Against this background, analyzing food inflation relative to underlying inflation allows food-specific price pressure to be distinguished from broader changes in consumer prices. This distinction is particularly relevant in an EU-wide panel, since Member States can experience different food-price trajectories even when they are exposed to common macroeconomic shocks [5,42]. Measuring the gap between food inflation and core inflation therefore provides an empirical representation of the extent to which food prices move faster or slower than underlying consumer prices within a given country and year.

2.4. Research Gap and Hypotheses

The literature provides extensive evidence that food demand responds to price changes, although the magnitude of this response varies across products, countries and household characteristics [15,25,29]. A related body of research shows that income constraints, unem-

ployment and material deprivation can limit households' capacity to smooth consumption when economic conditions deteriorate [36,38,40]. Social protection may partly offset these constraints by cushioning disposable resources and mitigating welfare losses following adverse economic shocks [22,39]. At the same time, food-price dynamics remain heterogeneous across EU Member States, and food-specific price movements do not necessarily follow changes in the broader price level [5,10,42]. Despite these advances, less is known about whether food-price inflation relative to underlying inflation is systematically associated with real food consumption expenditure across the EU-27, and whether this relationship varies with economic vulnerability. Addressing this question links three strands of the literature that have largely developed separately: food-demand responses, the distributional consequences of economic vulnerability, and cross-country differences in food-price dynamics. Thus, based on the theoretical mechanisms and empirical evidence reviewed above, the following hypotheses are proposed:

H1. *Higher relative food-price inflation is associated with lower real per-capita household food consumption expenditure.*

H2. *The negative association between relative food-price inflation and real food consumption expenditure is weaker at higher levels of real disposable income.*

H3. *The negative association between relative food-price inflation and real food consumption expenditure is stronger at higher levels of material deprivation.*

H4. *The negative association between relative food-price inflation and real food consumption expenditure is weaker where social transfers have a greater poverty-reducing impact.*

3. Materials and Methods

3.1. Data and Variable Definitions

This study uses an annual country-level panel covering the 27 European Union Member States (EU-27). The dataset combines Eurostat data with FAOSTAT food-supply data used in the robustness analysis. The full data collection period spans 2010–2024, corresponding to 405 potential country-year observations (27 countries × 15 years). However, the dependent variable is available for only 364 observations, with all 41 missing values concentrated in the two most recent years. Specifically, household food consumption expenditure data are unavailable for 17 countries in 2023: Austria, Belgium, Bulgaria, Cyprus, Czechia, Denmark, Estonia, France, Germany, Hungary, Latvia, the Netherlands, Portugal, Romania, Slovenia, Spain, and Sweden. For 2024, data are available for only three countries (Finland, Luxembourg, and Slovakia), leaving 24 missing observations. By contrast, the dependent-variable series is complete for all 27 Member States throughout 2010–2022. These gaps primarily reflect the reporting lag associated with Eurostat's detailed COICOP-based household consumption expenditure data. Thus, the baseline estimation period is restricted to 2010–2023, yielding 361 country-year observations, including ten observations for 2023. The three additional observations available for 2024 are included only in the full-panel robustness specification (N = 364), which produces materially similar estimates (Section 4.3).

The dependent variable is real per-capita household food consumption expenditure, defined as household final consumption expenditure on food and non-alcoholic beverages (COICOP division 01; Eurostat dataset nama_10_co3_p3). It is measured in chain-linked volumes at 2010 reference-year prices (CLV10_MEUR), converted from millions of euros into euros and divided by total population (Eurostat dataset demo_pjan). Although expressed in chain-linked volumes, this expenditure-based indicator does not directly measure physi-

cal quantities consumed or nutritional intake. Changes in product composition, quality, and purchasing patterns may therefore be reflected in the observed expenditure measure. The resulting variable is therefore expressed in constant 2010 euros per person. This measure captures changes in real household food consumption expenditure rather than changes in nominal expenditure driven by higher food prices. The key explanatory variable, relative food-price inflation, is defined as the annual food HICP (Harmonized Index of Consumer Prices) inflation rate minus core inflation, where core inflation refers to the HICP special aggregate excluding energy, food, alcohol, and tobacco. The resulting measure captures the extent to which food prices increase faster or slower than underlying consumer prices within a given country-year. Full variable definitions and sources are reported in Table 1. The distribution of relative food-price inflation is positively skewed, with a 75th percentile of 2.3 percentage points, a maximum of 17.1 percentage points, and kurtosis of 7.03. The upper tail is largely accounted for by observations for Bulgaria, Hungary, Latvia, Lithuania, Romania, and Slovakia in 2022, corresponding to the exceptionally strong food-price pressures experienced in Central and Eastern Europe during the 2021–2022 energy and commodity-price shock. These observations were retained because they represent economically meaningful price shocks rather than apparent measurement errors and constitute relevant variation for the research question. To assess whether these extreme observations influence the baseline results, additional sensitivity analyses were conducted by excluding these observations and applying alternative treatments to the relative food-price inflation variable (see Section 4.3 and Table A3 of Appendix A).

Table 1. Variable definitions, units and sources.

Variable	Definition and Construction	Unit	Source and Dataset Code
Real food expenditure per capita	Household final consumption expenditure on food and non-alcoholic beverages (COICOP division 01), chain-linked volumes, 2010 reference year; (million euro × 1,000,000) ÷ total population	EUR per person, constant 2010 prices	Eurostat nama_10_co3_p3 (unit CLV10_MEUR); demo_pjan
Relative food inflation	Annual average rate of change in the HICP for food and non-alcoholic beverages (COICOP 01) minus that of the HICP excluding energy, food, alcohol and tobacco (core)	Percentage points	Eurostat prc_hicp_aind (unit RCH_A_AVG)
Real disposable income	Real gross disposable income of households per capita	Index, 2008 = 100	Eurostat tepsr_wc310
Unemployment rate	Unemployed persons aged 15–74 as a share of the labor force	%	Eurostat une_rt_a
Average household size	Average number of persons per household	Persons	Eurostat ilc_lvph01
Age dependency ratio	(Population aged 0–19 + population aged 65 and over) ÷ population aged 20–64 (Eurostat "3rd variant") × 100	Per 100 persons aged 20–64	Eurostat demo_pjanind
Processed food inflation	Annual average rate of change in the HICP for processed food excluding alcohol and tobacco	%	Eurostat prc_hicp_aind

Table 1. *Cont.*

Variable	Definition and Construction	Unit	Source and Dataset Code
Unprocessed food inflation	Annual average rate of change in the HICP for unprocessed food	%	Eurostat prc_hicp_aind
Energy inflation	Annual average rate of change in the energy HICP	%	Eurostat prc_hicp_aind
Gini coefficient	Gini coefficient of equivalized disposable income; available from 2014	0–100 scale	Eurostat ilc_di12
Urbanization	Share of the population living in cities	%	Eurostat ilc_lvho01
Material deprivation rate	Severe material and social deprivation rate; available from 2016	% of population	Eurostat ilc_mdsd11
Social transfers impact (including pensions)	Difference between the at-risk-of-poverty rate before social transfers (pensions included as transfers) and the rate after social transfers	Percentage points	Eurostat ilc_li09–ilc_li02
EU-SILC median income	Median equivalized net income, shifted back one year to align with the income reference year; available to 2023	PPS	Eurostat ilc_di03
FAOSTAT food supply	Total food supply (alternative dependent variable)	kcal per person per day	FAOSTAT Food Balance Sheets

Note: HICP = Harmonized Index of Consumer Prices; PPS = purchasing power standards; CLV = chain-linked volume. Inflation rates are annual average rates of change. Relative food-price inflation is measured in percentage points. The age dependency ratio refers to the population aged 0–19 and 65+ relative to the population aged 20–64.

Table 2 reports descriptive statistics for the dependent variable, the key explanatory variable, and the four baseline controls, restricted to the 361 country-year observations used in the baseline estimation. The descriptive statistics therefore correspond exactly to the sample underlying the baseline regression results.

Table 2. Descriptive statistics for the baseline model variables (N = 361).

Variable	Mean	Std. Dev.	Min	Max
Real food consumption expenditure (DV)	1742.19	446.32	858.75	2859.48
Relative food-price inflation	1.30	2.89	−5.30	17.10
Real disposable income	106.87	17.06	64.23	158.65
Unemployment rate	8.67	4.60	2.00	27.80
Average household size	2.41	0.27	1.90	3.10
Age dependency ratio	65.11	5.83	52.30	80.00

Note: N = 361 for all variables, restricted to the baseline estimation sample. Real food consumption expenditure is expressed in constant 2010 EUR per person; real disposable income is an index; unemployment rate and the age dependency ratio are percentages; average household size is in persons per household. Variable definitions and sources are given in Table 1.

3.2. Model Specification

The baseline specification is a two-way fixed-effects panel regression (Equation (1)):

$$RealFoodConsumption_{it} = \beta_0 + \beta_1 \cdot RelFoodInflation_{it} + \beta_2 \cdot RealIncome_{it} + \beta_3 \cdot Unemployment_{it} + \beta_4 \cdot HouseholdSize_{it} + \beta_5 \cdot AgeDependency_{it} + \alpha_i + \lambda_t + \varepsilon_{it} \quad (1)$$

where i indexes countries and t indexes years, while α_i and λ_t denote country and year fixed effects, respectively. Fixed-effects estimators exploit within-unit variation over time while controlling for time-invariant unobserved heterogeneity, making them well suited to country-panel settings in which persistent structural differences may be correlated with the explanatory variables [45,46]. Country fixed effects therefore absorb time-invariant differences across Member States, including persistent differences in food preferences, agricultural structures and institutional characteristics, while year fixed effects capture shocks common to all countries in a given year [45,47]. The coefficient β_1 is consequently identified from within-country changes in relative food-price inflation over time, net of common year-specific shocks and the included time-varying controls.

The models are estimated in Stata19 using reghdfe, which efficiently absorbs multiple sets of fixed effects in linear regression models [48,49]. Standard errors are clustered at the country level, allowing the regression disturbances to be correlated over time within countries and to exhibit heteroskedasticity across clusters. Country-level clustering is appropriate in panel settings where observations for the same country may share persistent unobserved shocks and cannot reasonably be treated as independent over time [50,51].

The material deprivation rate was considered as an additional baseline control but was excluded because of substantially more limited temporal coverage. Its inclusion would restrict the estimation window to 2016–2023, thereby removing earlier food-price episodes that contribute relevant temporal variation to the analysis. Thus, material deprivation is examined separately as a moderating variable in the heterogeneity analysis and as an additional control in the robustness analysis. To examine whether the association between relative food-price inflation and real food consumption expenditure varies with income or economic vulnerability, three additional specifications introduce multiplicative interaction terms. Interaction models are appropriate when the relationship between an explanatory variable and an outcome is hypothesized to depend on the level of a third variable, provided that the corresponding constituent terms are retained in the regression specification [52]. The general interaction specification is (Equation (2)):

$$RealFoodConsumption_{it} = \beta_0 + \beta_1 \cdot RelFoodInflation_{it} + \beta_2 \cdot Z_{it} + \beta_3 (RelFoodInflation_{it} \times Z_{it}) + \gamma' X_{it} + \alpha_i + \lambda_t + \varepsilon_{it} \quad (2)$$

where Z_{it} denotes, in turn, real disposable income, the material deprivation rate, and the poverty-reducing impact of social transfers, while X_{it} contains the remaining baseline controls. Each interaction is estimated in a separate specification to isolate the corresponding dimension of heterogeneity and to avoid unnecessarily combining moderators with different empirical coverage. The coefficient β_3 captures whether the association between relative food-price inflation and real food consumption expenditure changes with the level of the respective moderator [52]. The deprivation-based model is estimated on a smaller sample because of the more limited availability of the material deprivation indicator.

3.3. Estimation Strategy and Diagnostics

Diagnostic tests were conducted on the main 2010–2023 estimation sample. Potential multicollinearity among the baseline regressors was assessed using variance inflation factors (VIFs). The mean VIF is 4.30, while the highest individual value is 19.89 for average household size. Because fixed VIF thresholds should be regarded as heuristic rather than mechanical

decision rules, high values need to be interpreted in the context of the overall model rather than treated as sufficient evidence for excluding a variable [53]. The relatively high VIF for household size indicates potential collinearity affecting this regressor and warrants caution when interpreting its individual coefficient. Serial correlation was assessed using the Wooldridge test for first-order autocorrelation in panel data, which is designed to detect serial dependence in the idiosyncratic errors of linear panel models [45,54]. The test yields $F(1, 26) = 144.69$ ($p < 0.001$), providing strong evidence of within-country serial correlation. As described in Section 3.2, standard errors are therefore clustered at the country level throughout the analysis to allow for arbitrary correlation of regression disturbances over time within countries.

Given the relatively small number of country clusters (27), we additionally assess the robustness of statistical inference using a wild cluster bootstrap-t procedure with 9999 replications, imposing the null hypothesis and applying Webb weights [55,56]. This approach provides an additional check on the reliability of statistical significance tests when the number of clusters is limited. Given that EU Member States may be affected by common economic shocks, we also assess potential cross-sectional dependence using the Pesaran CD test [57]. Although year fixed effects account for common annual shocks, they may not fully capture heterogeneous responses across countries. As an additional robustness check, Driscoll–Kraay standard errors were calculated with maximum lag lengths of one, two, and three years [58]. Given the relatively short time dimension of the panel (14 years), these estimates are interpreted cautiously and are used as a supplementary inference check rather than replacing the baseline country-clustered standard errors.

3.4. Robustness Checks

A series of twelve additional specifications was estimated to evaluate whether the baseline result is sensitive to alternative variable definitions, control sets, timing assumptions, and sample construction. Each robustness specification changes one element of the baseline model at a time, allowing the source of any change in the coefficient of interest to be identified more clearly. First, sensitivity to the measurement of the dependent variable is assessed by replacing real household food consumption expenditure with FAOSTAT per-capita food supply and, separately, by using a nowcast-extended version of the baseline dependent variable in which missing 2023–2024 observations are filled using trend extrapolation. The nowcast specification is treated solely as a supplementary sensitivity analysis because it incorporates model-based rather than directly observed values.

Second, the measurement and timing of food-price pressure are varied by replacing the baseline relative food-price measure with processed-food and unprocessed-food HICP inflation and by introducing a one-year lag of relative food-price inflation. These specifications assess whether the results depend on the composition of the food-price index or on the assumption that consumption responds contemporaneously to relative price changes. Third, the baseline control set is augmented individually with the Gini coefficient, urbanization rate, energy-price inflation, and material deprivation rate. An alternative income specification replaces the national-accounts-based real disposable income measure with EU-SILC median equivalized disposable income in purchasing power standards. Social transfers are also included as a standalone, non-interacted control to examine whether their direct inclusion materially alters the estimated coefficient on relative food-price inflation.

Finally, the baseline model is re-estimated on the available 2010–2024 panel to assess sensitivity to the choice of estimation window. Together, these specifications test whether the principal result is robust to alternative outcome and price measures, additional socioeconomic controls, alternative income measurement, lag structure, and sample coverage. The main robustness results are summarized Section 4.3, while the complete regression estimates, including all control variables, are provided in Tables A1 and A2 of Appendix A.

To ensure comparability across specifications, the robustness checks are estimated over the same 2010–2023 period as the baseline model, unless otherwise indicated. Differences in sample sizes arise from the availability of additional variables. Specifically, the inclusion of the Gini coefficient reduces the sample to 253 observations due to its availability from 2014, while the urbanization specification contains 360 observations because of one missing value. The lagged inflation specification includes 334 observations, reflecting the loss of the first year when introducing the one-year lag. The material deprivation specification is restricted to 2016–2023, resulting in 199 observations, consistent with the deprivation interaction model. Specifications using FAOSTAT food supply (N = 377) and the nowcast-extended dependent variable (N = 403) have different outcome-data coverage, while the full-panel robustness check includes the three additional observations available for 2024 (N = 364).

In addition to the twelve robustness specifications, three targeted sensitivity checks were conducted to assess the influence of the six extreme country-year observations identified in 2022 (Bulgaria, Hungary, Latvia, Lithuania, Romania, and Slovakia). First, the baseline model was re-estimated after excluding these six observations. Second, relative food-price inflation was capped at 10 percentage points. Third, the variable was winsorized at approximately its 5th and 95th percentiles (−2.1 and 6.9 percentage points, respectively). These additional sensitivity analyses are reported in Table A3 of Appendix A.

4. Results

4.1. Baseline Results

Table 3 reports the baseline estimates. The coefficient on relative food-price inflation is negative but small in magnitude and not statistically distinguishable from zero ($\beta = -1.44$, SE = 3.42, $p = 0.676$, 95% CI: −8.46 to 5.58). The point estimate indicates that a one-percentage-point increase in relative food-price inflation is associated with an approximately €1.44 decrease in annual real food consumption expenditure per person, expressed in constant 2010 euros. This corresponds to approximately 0.08% of the sample mean. However, the estimate is imprecise, and the confidence interval includes both negative and positive values. At the 95% confidence level, the interval excludes reductions larger than approximately EUR 8.46 per person per percentage point of relative food inflation (about 0.5% of mean food expenditure), while smaller associations in either direction remain plausible. Therefore, the results should not be interpreted as evidence that the true effect is zero. By contrast, the unemployment rate is negative and statistically significant. A one-percentage-point increase in the unemployment rate is associated with an €18.83 decrease in real per-capita household food consumption expenditure (SE = 5.66, $p = 0.003$). Real disposable income, average household size, and the age dependency ratio are not statistically significant at conventional levels. The model has a within R^2 of 0.275, indicating that the included time-varying covariates explain approximately 27.5% of the within-country variation in real food consumption expenditure. Diagnostic tests for the baseline sample are reported in Section 3.3.

Table 3. Baseline model of real per-capita food consumption expenditure (2010–2023).

Variable	Coefficient	Std. Error	*p*-Value
Relative food-price inflation	−1.44	3.42	0.676
Real disposable income	0.37	2.10	0.862
Unemployment rate	−18.83 ***	5.66	0.003
Average household size	125.66	153.51	0.420
Age dependency ratio	10.33	7.93	0.204

Note: N = 361; within $R^2 = 0.275$. Country and year fixed effects included; standard errors clustered by country. *** $p < 0.01$.

To assess the robustness of statistical inference given the relatively small number of country clusters, Table 4 compares conventional country-clustered inference with wild cluster bootstrap results for the baseline model. The wild cluster bootstrap results support the conclusions obtained using conventional country-clustered standard errors. The bootstrap p-value for relative food-price inflation is 0.689 (95% confidence set: −9.06 to 5.94), compared with 0.676 under conventional inference. Similar results are obtained using Rademacher weights ($p = 0.687$). The negative association between unemployment and real food consumption expenditure also remains statistically significant under the bootstrap procedure ($p = 0.009$). Thus, the main conclusions regarding the statistical significance of the baseline coefficients remain unchanged under the alternative inference procedure. The Pesaran CD test does not reject the null hypothesis of cross-sectional independence after accounting for year fixed effects (CD = −1.341, $p = 0.180$). However, this result does not rule out all forms of residual cross-sectional dependence. As an additional sensitivity check, Driscoll–Kraay standard errors were calculated using one, two, and three lags (Table A4 in Appendix A). The coefficient of relative food-price inflation remains statistically insignificant across all specifications, with p-values ranging from 0.611 to 0.640. In contrast, the negative association between unemployment and real food consumption expenditure remains statistically significant ($p < 0.001$). Thus, the main conclusions regarding statistical significance are unchanged under the alternative error structure as well. However, these results should be interpreted cautiously given the short time dimension of the panel.

Table 4. Conventional and wild cluster bootstrap inference for the baseline model.

	Relative Food Inflation	Unemployment Rate
Coefficient (EUR per person)	−1.44	−18.83
Cluster-robust standard error	(3.42)	(5.66)
p-value, conventional (t, 26 d.f.)	0.676	0.003
p-value, wild bootstrap (Webb weights)	0.689	0.009
p-value, wild bootstrap (Rademacher weights)	0.687	n/a
95% CI, conventional	[−8.46, 5.58]	[−30.47, −7.18]
95% CI, wild bootstrap (Webb weights)	[−9.06, 5.94]	[−34.75, −5.79]
95% CI, wild bootstrap (Rademacher weights)	[−9.12, 6.00]	n/a

Note: N = 361; 27 country clusters; country and year fixed effects included. Conventional inference uses country-clustered standard errors. Wild cluster bootstrap-t inference uses 9999 replications with the null hypothesis imposed and a fixed random seed. Bootstrap confidence intervals are obtained by test inversion. The bootstrap procedure is estimated using an equivalent regression with year dummies, which may lead to minor differences in the t-statistics due to small-sample corrections. Rademacher weights were applied only to relative food-price inflation (n/a = not estimated).

4.2. Heterogeneity by Income and Economic Vulnerability

Table 5 shows the heterogeneity specifications. None of the three interaction terms is statistically significant. The interaction between relative food-price inflation and real disposable income is positive ($\beta = 0.115$, SE = 0.078, $p = 0.151$), indicating that the estimated association becomes less negative as the real disposable income index increases. Although the sign is consistent with H2, the estimate is imprecise and does not provide statistically significant evidence of income-related heterogeneity. The interaction with material deprivation is also positive ($\beta = 0.217$, SE = 0.262, $p = 0.415$, N = 199), whereas

H3 predicted a more negative association at higher levels of deprivation. The interaction with the poverty-reducing impact of social transfers is negative ($\beta = -0.252$, SE = 0.442, $p = 0.574$), which is likewise opposite to the direction hypothesized in H4.

Table 5. Heterogeneity by income, material deprivation, and social transfers.

Variable	(1) Baseline	(2) × Income	(3) × Deprivation	(4) × Transfers
Relative food-price inflation	−1.44 (3.42)	−15.19 (9.53)	−5.71 (4.27)	5.09 (12.30)
Real disposable income	0.37 (2.10)	−0.18 (2.21)	−0.41 (2.02)	−0.34 (2.06)
Unemployment rate	−18.83 *** (5.66)	−19.21 *** (5.56)	−9.27 * (5.03)	−17.13 *** (6.11)
Average household size	125.66 (153.51)	126.12 (151.11)	197.44 (127.28)	143.07 (177.43)
Age dependency ratio	10.33 (7.93)	10.20 (7.97)	17.74 ** (7.02)	12.10 (8.17)
Interaction term	—	0.115 (0.078)	0.217 (0.262)	−0.252 (0.442)
N	361	361	199	361

Note: Standard errors in parentheses. Country and year fixed effects included; standard errors clustered by country. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Column (2) interacts relative food-price inflation with real disposable income, column (3) with the material deprivation rate, and column (4) with the poverty-reducing impact of social transfers. The constituent terms of the interaction models are included in the estimations but are omitted from the table for brevity, except where already reported among the baseline controls.

Neither estimate is statistically distinguishable from zero. Because the moderators are not mean-centered, the coefficients on relative food-price inflation in the interaction specifications represent its conditional association when the respective moderator equals zero and should therefore not be interpreted as average effects. The interaction coefficients provide the relevant tests of whether the slope of relative food-price inflation varies with the moderators. Taken together, the results provide no statistically significant evidence that the association between relative food-price inflation and real per-capita household food consumption expenditure varies systematically with real disposable income, material deprivation, or the poverty-reducing impact of social transfers. Among the three interaction terms, the income interaction is the closest to conventional significance, but it remains exploratory rather than confirmatory. The unemployment rate remains negatively associated with real food consumption expenditure across all three heterogeneity specifications, with coefficients ranging from −9.27 to −19.21. It is statistically significant at the 1% level in the income and social transfer specifications and at the 10% level in the deprivation specification, where the smaller sample (N = 199, 2016–2023) reduces estimation precision.

To facilitate the interpretation of the interaction models, Table 6 reports the marginal associations between relative food-price inflation and real food consumption expenditure at the 10th, 50th, and 90th percentiles of each moderator, together with their 95% confidence intervals. The table also presents the interaction coefficients with conventional and wild cluster bootstrap inference. In the income model, the estimated marginal association ranges from −4.75 EUR per person at the 10th percentile (95% CI: −12.74 to 3.24) to −0.27 EUR per person at the 90th percentile (95% CI: −7.75 to 7.22). For material deprivation, the corresponding estimates are −5.29 and −2.34 EUR per person, while for social transfers they are −0.02 and −2.65 EUR per person. None of the marginal associations is statistically significant at the evaluated percentiles, and the confidence intervals include zero across

the examined moderator ranges. Furthermore, wild cluster bootstrap tests confirm that the interaction terms remain statistically insignificant, with *p*-values of 0.206 for income, 0.630 for material deprivation, and 0.640 for social transfers. These results provide no statistically reliable evidence of heterogeneity, although the relatively wide confidence intervals indicate that the findings should be interpreted as inconclusive rather than as evidence of no heterogeneity.

Table 6. Marginal effects of relative food-price inflation and interaction tests (H2–H4).

Moderator and Percentile	Moderator Value	Effect (EUR)	Std. Error	95% CI		*p*-Value
H2: Real disposable income (index, 2008 = 100)						
10th percentile	90.6	−4.75	3.89	[−12.74, 3.24]		0.233
50th percentile (median)	103.4	−3.28	3.53	[−10.54, 3.99]		0.362
90th percentile	129.5	−0.27	3.64	[−7.75, 7.22]		0.942
H3: Severe material and social deprivation (% of population)						
10th percentile	1.9	−5.29	4.02	[−13.55, 2.96]		0.199
50th percentile (median)	5.3	−4.56	3.68	[−12.13, 3.02]		0.227
90th percentile	15.5	−2.34	3.93	[−10.42, 5.74]		0.557
H4: Social transfers impact, incl. pensions (pp)						
10th percentile	20.3	−0.02	4.30	[−8.87, 8.82]		0.996
50th percentile (median)	26.4	−1.56	3.18	[−8.10, 4.97]		0.627
90th percentile	30.7	−2.65	3.60	[−10.04, 4.75]		0.469
Interaction term	**Coefficient**	**Std. Error**	***p*-Value, Conventional**	***p*-Value, Wild Bootstrap**	**95% CI, Wild Bootstrap**	**N**
Food inflation × income	0.115	0.078	0.151	0.206	[−0.057, 0.320]	361
Food inflation × deprivation	0.217	0.262	0.415	0.630	[−0.574, 0.890]	199
Food inflation × social transfers	−0.252	0.442	0.574	0.640	[−1.310, 0.680]	361

Note: The first part of the table reports linear combinations of the food-inflation coefficient and the interaction coefficient evaluated at the stated moderator value, with 95% confidence intervals from the t distribution with 26 degrees of freedom. Percentiles are computed in each model's estimation sample and rounded to one decimal; the deprivation model uses 2016–2023 only (N = 199), so its percentiles refer to that subsample. The second part of the table shows bootstrap *p*-values and confidence sets use the wild cluster bootstrap-t (restricted, Webb weights, 9999 replications, seed 12345), run on the equivalent regression with year dummies; this changes the interaction standard errors slightly, so the conventional *p*-values are those from the main specification.

4.3. Robustness Checks

Table 7 summarizes the results of the twelve robustness specifications, while the full regression results, including coefficient estimates and standard errors for all explanatory variables, are presented in Tables A1 and A2 of Appendix A. The coefficient on relative food-price inflation remains statistically insignificant across all alternative models, with point estimates ranging from −3.88 to +3.43 and *p*-values between 0.290 and 0.772. The coefficient is positive when the dependent variable is replaced with FAOSTAT food supply and when processed- or unprocessed-food HICP measures are used, while it is negative in all remaining specifications. Overall, the robustness analysis provides no evidence of a systematic positive or negative association between relative food-price inflation and real per-capita household food consumption expenditure. The full 2010–2024 panel (N = 364) produces an estimate that is very similar to the baseline result ($\beta = -1.36$, SE = 3.43, $p = 0.695$), indicating that the main finding is not sensitive to the choice of estimation window. Including social transfers as a standalone control also leaves the coefficient of

interest materially unchanged ($\beta = -1.00$, SE = 3.39, $p = 0.771$), while the social transfers control itself is not statistically significant ($\beta = -6.13$, SE = 5.57, $p = 0.282$). Two secondary results emerge from the alternative control specifications. Urbanization is positively and statistically significantly associated with real food consumption expenditure when added to the baseline model ($\beta = 4.05$, SE = 1.07, $p = 0.001$). The age dependency ratio is marginally significant in the specification including the Gini coefficient ($p = 0.067$). As these findings concern additional control variables rather than the focal relationship, they are treated as secondary results.

Table 7. Robustness of the relative food-price inflation coefficient.

Specification	Coefficient	Std. Error	*p*-Value	N
Baseline (2010–2023)	−1.44	3.42	0.676	361
FAOSTAT food supply (DV)	3.43	3.18	0.290	377
Processed food price	1.48	3.01	0.627	361
Unprocessed food price	1.02	2.28	0.653	361
+ Gini coefficient	−1.84	3.14	0.563	253
+ Urbanization rate	−3.07	3.11	0.343	360
+ Energy price inflation	−1.46	3.34	0.666	361
Lagged inflation (t − 1)	−3.88	3.87	0.325	334
EU-SILC income (PPS)	−0.84	2.87	0.772	361
Nowcast-extended DV	−2.79	2.92	0.348	403
+ Material deprivation	−3.56	3.54	0.329	199
Full panel (2010–2024)	−1.36	3.43	0.695	364
+ Social transfers (standalone)	−1.00	3.39	0.771	361

Note: Each row reports the coefficient on relative food-price inflation from a separate two-way fixed-effects regression, changing one element of the specification at a time relative to the baseline. Full control sets, fixed effects, and clustering are as in Equation (1) unless otherwise noted. None of the coefficients are statistically significant at conventional levels.

Additional sensitivity analyses were conducted to examine whether the baseline results were driven by the six extreme country-year observations in 2022 (Table A3). Excluding these observations yielded a coefficient of −3.90 (SE = 3.51, $p = 0.277$, N = 355). Capping relative food-price inflation at 10 percentage points produced a coefficient of −2.60 (SE = 3.67, $p = 0.484$), while winsorizing the variable at approximately the 5th and 95th percentiles resulted in a coefficient of −5.90 (SE = 4.12, $p = 0.164$). None of these estimates was statistically significant, indicating that the absence of a statistically detectable association in the baseline model is not driven solely by the six extreme observations. However, the estimates remain imprecise and should not be interpreted as evidence of a zero effect.

4.4. Summary of the Findings

Across the baseline specification, the heterogeneity models, and the twelve robustness checks, the analysis provides no statistically significant evidence of a systematic association between relative food-price inflation and real per-capita household food consumption expenditure in the EU-27 over 2010–2023. The baseline coefficient is negative but small and imprecisely estimated, and the robustness specifications produce coefficients that vary in sign but remain statistically insignificant throughout. The lack of statistical significance across alternative dependent variables, price measures, control sets, lag structures, and

sample definitions is not driven by a single modeling choice. However, these results do not establish that the true association is zero.

The heterogeneity analysis likewise provides no statistically significant evidence that the association between relative food-price inflation and real food consumption expenditure varies with income, material deprivation, or the poverty-reducing impact of social transfers. The income interaction is positive, which is consistent with the hypothesized cushioning role of higher real disposable income, but the estimate remains statistically insignificant. By contrast, the interactions with material deprivation and social transfers are both insignificant and carry signs opposite to the hypothesized directions. Thus, none of the four hypotheses receives empirical support at conventional significance levels. Table 8 summarizes the four hypotheses, the corresponding empirical estimates, and the resulting conclusions regarding empirical support. A consistent secondary finding concerns unemployment. The unemployment rate is negatively associated with real per-capita household food consumption expenditure in the baseline model and remains negative across all heterogeneity specifications, with statistically significant coefficients in each case at conventional or marginal significance levels. This pattern suggests that labor-market conditions display a more stable empirical association with real food consumption expenditure than relative food-price inflation within the present panel, although the analysis does not establish a causal relationship.

Table 8. Summary of hypotheses and empirical evidence.

Hypothesis	Expected Relationship	Empirical Result	Conclusion
H1	Relative food-price inflation negatively associated with real food consumption expenditure	$\beta = -1.44$, $p = 0.676$	Not supported
H2	Negative association weaker at higher real disposable income	Interaction $\beta = 0.115$, $p = 0.151$	Not supported
H3	Negative association stronger at higher material deprivation	Interaction $\beta = 0.217$, $p = 0.415$; sign opposite to expectation	Not supported
H4	Negative association weaker with stronger social transfers	Interaction $\beta = -0.252$, $p = 0.574$; sign opposite to expectation	Not supported

5. Discussion

The empirical results provide no statistically significant evidence of a systematic association between relative food-price inflation and real per-capita household food consumption expenditure in the EU-27. This finding remains stable across a broad range of alternative specifications, including different food-price measures, an alternative dependent variable, additional socioeconomic controls, a lagged specification, and alternative sample definitions. Although the baseline coefficient is negative, as expected under H1, its magnitude is small and imprecisely estimated. The results therefore do not support the hypothesis that increases in food prices relative to underlying inflation are systematically associated with lower real food consumption expenditure at the country level. This result is not necessarily inconsistent with the broader food-demand literature. Previous studies show that food demand is generally price-responsive but often relatively inelastic, while households can adjust to higher prices through substitution across products, changes in quality, retailer choice, and broader expenditure reallocation [15,16,25]. Such adjustment mechanisms have been documented in previous empirical research [16,17,31,32], but the present analysis

cannot establish whether they explain the statistically insignificant association observed at the aggregate level. The distinction between expenditure and underlying food consumption is particularly relevant in this context, since households may reduce the average cost of their food basket without making proportional reductions in quantities consumed [16,31]. The absence of a statistically detectable relationship should therefore not be interpreted as evidence that food-price shocks are economically irrelevant, but rather as indicating that their effects are not consistently reflected in aggregate real food consumption expenditure within the present framework.

The heterogeneity results provide similarly limited evidence that the relationship varies systematically with economic vulnerability. The interaction with real disposable income has the theoretically expected positive sign, suggesting a weaker negative association as the real income index increases, but the estimate is not statistically significant. The interactions with material deprivation and social transfers are also statistically insignificant and carry signs opposite to the hypothesized directions. These results provide no empirical support for H2–H4; however, the relatively wide confidence intervals do not allow us to rule out potentially meaningful heterogeneity across these dimensions. One possible reason is that country-level indicators capture broad economic conditions rather than the distribution of vulnerability within countries. Previous research shows substantial heterogeneity in inflation exposure and food insecurity across households with different income, employment and welfare characteristics [21,38,39]. Thus, aggregate country-level measures may conceal stronger responses among household groups. A more consistent secondary finding concerns unemployment. The unemployment rate is negatively and statistically significantly associated with real food consumption expenditure in the baseline model and remains negative across all three heterogeneity specifications. This pattern is consistent with previous evidence linking unemployment and adverse labor-market conditions to lower household consumption and greater food insecurity [36,37,39]. Compared with relative food-price movements, unemployment may represent a more direct constraint on household resources and consumption possibilities. However, the present analysis is observational and does not establish a causal effect of unemployment on food consumption expenditure.

Based on the above, the findings suggest that food-price inflation should not be interpreted in isolation when assessing changes in real household food consumption expenditure. Policymakers may obtain a more informative picture by considering price developments together with labor-market conditions, income dynamics, and indicators of economic vulnerability, particularly because unemployment shows a more consistent negative association with real food consumption expenditure than relative food-price inflation in the present analysis. At the same time, the absence of significant heterogeneity by material deprivation or social transfers should not be interpreted as evidence that targeted support is ineffective, since country-level indicators may mask substantial differences across household groups. From an agri-food market perspective, previous research has documented that consumers may respond to food-price pressures through product substitution, changes in food quality, and adjustments in purchasing behavior [16,17,31,32,59]. However, these mechanisms cannot be directly examined using the aggregate data employed in this study. Assessing whether such consumer adjustments have implications for agricultural producers, food manufacturers, retailers, and other actors along the agri-food supply chain would require more disaggregated purchasing and market-level data.

Several limitations should be considered when interpreting the findings and the implications. First, the analysis is based on annual country-level data and therefore cannot capture heterogeneity in adjustment behavior within countries or short-term responses occurring at higher frequencies. Furthermore, the data do not allow the researchers to identify changes in food-basket composition, product substitution, retailer choice, or the

responses of specific actors along agri-food supply chains. Second, the dependent variable measures real household food consumption expenditure rather than physical quantities or nutritional intake, meaning that changes in product quality and composition may remain embedded in the observed expenditure measure. Third, the relatively limited availability of post-2022 consumption data restricts the ability to assess the longer-term consequences of the most recent food-price shock. Finally, the empirical design identifies associations rather than causal effects. Future research using household-level microdata, higher-frequency observations, and longer post-inflation samples could provide a more detailed assessment of how food-price shocks affect different population groups and whether the adjustment occurs primarily through expenditure, product composition, or actual food consumption.

6. Conclusions

This study examined whether food-price inflation relative to underlying inflation is systematically associated with real per-capita household food consumption expenditure across the EU-27 over 2010–2023, with the available 2024 observations included in a supplementary robustness analysis, and whether this relationship varies with income and economic vulnerability. Across the baseline model, the heterogeneity specifications, and twelve robustness checks, the analysis finds no statistically significant evidence of a systematic association between relative food-price inflation and real food consumption expenditure. Nevertheless, these findings should be interpreted as a lack of statistically detectable evidence rather than proof of no association, given the uncertainty surrounding the estimated coefficients. At the same time, unemployment emerges as a more consistent correlate of real food consumption expenditure, highlighting the importance of broader household resource constraints alongside price developments. The study contributes to the existing literature by examining food-price inflation relative to core inflation in a common EU-27 framework and showing that no statistically detectable systematic association with aggregate real food expenditure emerges across the examined specifications, including those testing for heterogeneity by socioeconomic vulnerability. While the country-level and annual structure of the data limits conclusions about individual household behavior, physical quantities consumed, and nutritional intake, the findings provide a broad EU-wide perspective on the relationship between relative food prices and real food consumption expenditure. Future research using household-level and higher-frequency data could further clarify how food-price shocks are absorbed across different consumer groups and whether adjustment occurs primarily through expenditure, product substitution, or actual consumption.

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Appendix A

Table A1. Full robustness regressions, Panel A.

Dependent Variable	(1)	(2)	(3)	(4)	(5)	(6)
	Baseline	**FAOSTAT DV**	**Processed**	**Unprocessed**	**+ Gini**	**+ Urbanization**
	Real Food exp. p.c.	**Food Supply (kcal/cap/day)**	**Real Food exp. p.c.**	**Real Food exp. p.c.**	**Real Food exp. p.c.**	**Real Food exp. p.c.**
FOOD-PRICE REGRESSOR						
Relative food inflation	−1.44	3.43			−1.84	−3.07
	(3.42)	(3.18)			(3.14)	(3.11)
Processed food inflation			1.48			
			(3.01)			
Unprocessed food inflation				1.02		
				(2.28)		
ADDED REGRESSORS						
Gini coefficient					−8.28	
					(8.71)	
Urbanization (cities share)						4.05 ***
						(1.07)
BASELINE CONTROLS						
Real disposable income index	0.37	2.15	0.21	0.26	0.91	1.00
	(2.10)	(1.45)	(2.19)	(2.15)	(1.43)	(1.79)
Unemployment rate	−18.83 ***	−5.31	−19.31 ***	−19.09 ***	−9.90	−17.05 ***
	(5.66)	(4.66)	(5.51)	(5.23)	(5.96)	(5.28)
Average household size	125.66	204.27 **	127.57	125.60	158.94	178.85
	(153.51)	(84.94)	(150.48)	(150.32)	(125.55)	(170.30)
Age dependency ratio	10.33	6.55	9.83	10.02	16.29 *	6.16
	(7.93)	(5.20)	(7.71)	(7.77)	(8.60)	(7.00)
Constant	893.10	2265.27 ***	935.66	922.43	541.88	799.13
	(637.92)	(403.06)	(637.17)	(635.65)	(696.41)	(607.52)
Observations	361	377	361	361	253	360
Adjusted R^2	0.968	0.935	0.968	0.968	0.978	0.971
Country and year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Clusters (countries)	27	27	27	27	27	27

Notes: The dependent variable is real food expenditure per capita (EUR, constant 2010 prices) except in column (2), where it is FAOSTAT food supply (kcal per capita per day), a different series with its own coverage. All models include country and year fixed effects; standard errors, clustered by country (27 clusters), are in parentheses. In columns (3) and (4), the processed and unprocessed food-inflation rates replace relative food inflation. Columns (1) and (3)–(6) use the baseline sample, 2010–2023; sample sizes below 361 in columns (5) and (6) reflect missing values in the added regressor (Gini: 253; urbanization: 360). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A2. Full robustness regressions, Panel B.

Dependent Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	+ Energy	**Lagged**	**EU-SILC Income**	**Nowcast DV**	**+ Deprivation**	**Full Panel 2010–2024**	**+ Social Transfers**
	Real Food exp. p.c.	**Real Food exp. p.c.**	**Real Food exp. p.c.**	**Nowcast-Extended**	**Real Food exp. p.c.**	**Real Food exp. p.c.**	**Real Food exp. p.c.**
FOOD-PRICE REGRESSOR							
Relative food inflation	−1.46		−0.84	−2.79	−3.56	−1.36	−1.00
	(3.34)		(2.87)	(2.92)	(3.54)	(3.43)	(3.39)
Relative food inflation (t − 1)		−3.88					
		(3.87)					

Table A2. *Cont.*

Dependent Variable	(1) + Energy	(2) Lagged	(3) EU-SILC Income	(4) Nowcast DV	(5) + Deprivation	(6) Full Panel 2010–2024	(7) + Social Transfers
	Real Food exp. p.c.	Real Food exp. p.c.	Real Food exp. p.c.	Nowcast-Extended	Real Food exp. p.c.	Real Food exp. p.c.	Real Food exp. p.c.
ADDED REGRESSORS							
Energy inflation	1.35						
	(1.33)						
EU-SILC median income (PPS)			0.006				
			(0.013)				
Material deprivation rate					−5.19		
					(4.96)		
Social transfers (incl. pensions)							−6.13
							(5.57)
BASELINE CONTROLS							
Real disposable income index	0.42	0.37		0.47	−0.28	0.41	−0.28
	(2.04)	(1.92)		(1.96)	(1.93)	(2.11)	(2.03)
Unemployment rate	−18.63 ***	−16.15 **	−18.73 ***	−16.78 ***	−9.73 *	−18.89 ***	−17.05 ***
	(5.62)	(5.99)	(4.66)	(6.03)	(4.76)	(5.67)	(6.07)
Average household size	123.24	127.74	131.66	115.79	188.05	134.27	133.01
	(154.34)	(161.15)	(160.92)	(163.56)	(125.99)	(149.22)	(171.70)
Age dependency ratio	10.34	12.07	10.70	11.38	17.98 **	10.18	12.08
	(7.73)	(8.57)	(7.45)	(8.29)	(6.95)	(7.77)	(8.12)
Constant	884.15	753.42	802.11	826.76	295.91	880.93	974.26
	(636.96)	(658.11)	(684.92)	(650.07)	(584.44)	(609.50)	(639.23)
Observations	361	334	361	403	199	364	361
Adjusted R^2	0.968	0.969	0.968	0.960	0.981	0.969	0.969
Country and year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clusters (countries)	27	27	27	27	27	27	27

Notes: The dependent variable is real food expenditure per capita (EUR, constant 2010 prices) except in column (4), the nowcast-extended series. All models include country and year fixed effects; standard errors, clustered by country (27 clusters), are in parentheses. In column (2), relative food inflation is replaced by its one-year lag. In column (3), the real disposable income index is replaced by EU-SILC median income (PPS), reported to three decimals because of its scale. Columns (1), (2), (3), (5) and (7) use the baseline sample, 2010–2023; the smaller samples in columns (2) and (5) reflect missing values in the lagged regressor and in material deprivation. Column (6) extends the panel to 2010–2024, adding Finland, Luxembourg and Slovakia in 2024. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A3. Sensitivity to the six high-leverage country-years.

	(1) Baseline	(2) Excluding the Six	(3) Capped at 10	(4) Winsorized
Relative food inflation	−1.44	−3.90	−2.60	−5.90
	(3.42)	(3.51)	(3.67)	(4.12)
95% confidence interval	[−8.46, 5.58]	[−11.13, 3.32]	[−10.14, 4.93]	[−14.38, 2.57]
p-value	0.676	0.277	0.484	0.164
Real disposable income index	0.37	0.26	0.37	0.34
	(2.10)	(2.19)	(2.05)	(2.01)
Unemployment rate	−18.83 ***	−18.56 ***	−18.65 ***	−18.29 ***
	(5.66)	(5.67)	(5.61)	(5.41)
Average household size	125.66	138.24	127.33	128.78
	(153.51)	(163.36)	(154.67)	(155.86)

Table A3. *Cont.*

	(1)	(2)	(3)	(4)
	Baseline	**Excluding the Six**	**Capped at 10**	**Winsorized**
Age dependency ratio	10.33	9.50	10.41	10.42
	(7.93)	(8.12)	(8.00)	(8.09)
Constant	893.10	935.01	884.18	883.11
	(637.92)	(661.47)	(641.24)	(637.23)
Observations	361	355	361	361
Adjusted R^2	0.968	0.969	0.968	0.968
Clusters (countries)	27	27	27	27

Notes: All models include country and year fixed effects; standard errors, clustered by country (27 clusters), are in parentheses; confidence intervals and *p*-values use the t distribution with 26 degrees of freedom. *** $p < 0.01$. The six observations are Bulgaria, Hungary, Latvia, Lithuania, Romania and Slovakia in 2022, the only country-years with relative food inflation above 10 percentage points (range 10.4–17.1). Column (2) drops them; column (3) caps relative food inflation at 10; column (4) clips it to the interval −2.1 to 6.9, approximately its 5th and 95th percentiles. Coefficients are in euros per person per percentage point of relative food inflation; in columns (3) and (4) the regressor is the capped or winsorized variable.

Table A4. Cross-sectional dependence and Driscoll–Kraay standard errors.

	(1)	(2)	(3)	(4)
	Cluster-Robust (Baseline)	**Driscoll–Kraay, 1 Lag**	**Driscoll–Kraay, 2 Lags**	**Driscoll–Kraay, 3 Lags**
		Relative food inflation		
Coefficient	−1.44	−1.44	−1.44	−1.44
Standard error	(3.42)	(3.01)	(2.86)	(2.76)
p-value	0.676	0.640	0.622	0.611
95% confidence interval	[−8.46, 5.58]	[−7.94, 5.06]	[−7.62, 4.74]	[−7.42, 4.53]
		Unemployment rate (reference)		
Coefficient	−18.83	−18.83	−18.83	−18.83
Standard error	(5.66)	(3.38)	(3.46)	(3.31)
p-value	0.003	<0.001	<0.001	<0.001
95% confidence interval	[−30.47, −7.18]	[−26.13, −11.53]	[−26.31, −11.35]	[−25.98, −11.68]
Observations/countries	361/27	361/27	361/27	361/27

Notes: Pesaran CD test of cross-sectional independence of the residuals (within estimator with year dummies): −1.341 ($p = 0.180$); average absolute residual correlation 0.518. Column (1) is the baseline specification with country-clustered standard errors (t distribution, 26 degrees of freedom). Columns (2)–(4) use Driscoll–Kraay standard errors with a maximum lag of 1, 2 and 3 years; inference uses the t distribution with 13 degrees of freedom (T − 1). Coefficients are identical across columns because only the variance estimator changes. With only 14 years, Driscoll–Kraay standard errors can be too small and are shown as a supplementary check.

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