

Markup Expansion and Profit-Driven Inflation in the EU: Evidence from the 2022-2025 High-Inflation Period

Sara Brandt Rasmussen Lena Mac Donald Anne Fløe Kauland
Mehmet Ulug (mehmetu@ruc.dk)

Department of Social Sciences and Business, Roskilde University, Denmark

Abstract

This paper examines the relationship between markups and inflation in the European Union during the high-inflation period 2022-2025 and asks to what extent this relationship points to profit-driven inflation. Building on a post-Keynesian, Kaleckian cost-plus pricing framework, in which prices are determined by unit costs and by firms' ability to maintain or expand their markups, we construct country-level markups from firm-level accounting data for large non-financial firms and combine them with quarterly data on consumer prices (HICP), unit labour costs and import prices for a panel of 24 EU countries over 2010-2025. We estimate a Kaleckian price-level equation, in which the HICP is explained by markups, unit labour costs and import prices, using Method of Moments Quantile Regression (MMQR), which allows the coefficients to vary across the conditional distribution of the price level. Because prices rose sharply after 2021, the upper quantiles correspond mostly to the high-inflation years 2022-2025. As a complementary perspective, an Extreme Gradient Boosting (XGBoost) model of annual inflation, interpreted with SHAP values and partial dependence plots, identifies non-linear patterns between inflation, markups and costs. Import prices and unit labour costs are strongly and positively associated with the price level at every quantile and are also the dominant predictors of inflation in the XGBoost model, confirming the importance of cost-push factors. The markup coefficient is insignificant in the lower quantiles, while its point estimate rises across the distribution and becomes significant at the 10% level in the upper quantiles. Together with the descriptive evidence that realised markups kept rising after import price growth had levelled off, the results suggest that firms did not only protect but may also have expanded their markups in 2022-2025. EU price developments in this period therefore cannot be explained by external cost shocks alone; the evidence is consistent with a profit-driven component.

Keywords: profit-driven inflation; sellers' inflation; markups; Kaleckian pricing; method of moments quantile regression; XGBoost

JEL codes: E31, E12, D43, C23

1 Introduction

Inflation in Europe rose sharply after the Covid-19 pandemic and again with the energy crisis that followed Russia's invasion of Ukraine. The dominant explanation in the policy debate has been that inflation was driven mainly by rising energy and input costs, a classic cost-push episode (Lavoie, 2024, p. 232). At the same time, a growing literature asks whether firms with substantial market power used the situation to raise their margins and thereby expand their markups. If so, part of the inflation surge can be

understood as profit-push or *sellers'* inflation (Weber and Wasner, 2023; Nikiforos et al., 2024; Isik et al., 2025).

Most of this literature focuses on the United States or on individual national economies. Relatively few studies examine the EU across countries within a post-Keynesian framework, even though post-2020 inflation hit European economies unevenly and firms' pricing and market structures differ considerably between member states. Moreover, most studies measure profitability through profit shares or aggregate national accounts data, whereas few analyse markups constructed from firm-level data across EU countries.

Figure 1 illustrates the distributional background. Over 1995-2024 the EU labour share is broadly stable at around 52-54% of value added and the profit share at around 32-37%. The main exceptions are the financial crisis of 2008-2009, when the profit share fell and the labour share rose temporarily, and the period 2020-2022, which shows the reverse pattern: the labour share falls by roughly two percentage points in 2021 while the profit share rises correspondingly. After 2023 the shares partly normalise, but the labour share does not fully return to its pre-2020 level.

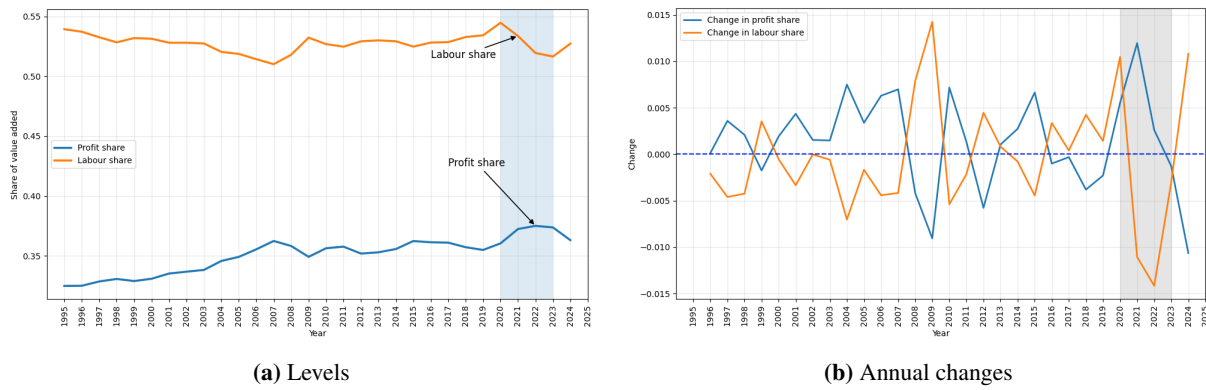


Figure 1: Labour share and profit share of value added in the EU, 1995-2024

Source: Authors' calculations based on Eurostat national accounts data.

In Kalecki's pricing theory, firms do not set prices according to marginal cost but through cost-plus pricing: the price equals unit costs plus a markup, and the markup can be adjusted depending on market structure, competition and macroeconomic conditions (Hein, 2023, p. 139); (Lavoie, 2022, pp. 594-595). If consumer prices rise faster than underlying producer and energy costs in a period of rising input costs, this may indicate markup expansion and hence a redistribution of income from consumers and workers to firms. The question is therefore whether cost-push inflation reflected only higher costs, with firms protecting their markups, or whether firms with market power also exploited the environment to expand them.

This question is difficult to answer with macroeconomic data, since aggregate national accounts allow the analysis of profit margins and profit shares but not of markups directly. We therefore collect firm-level accounting data for large firms in the EU and construct country-specific, sales-weighted markups. This is the main contribution of the paper. We ask:

How does the relationship between markups and inflation evolve during the high-inflation period 2022-2025 in the EU, and to what extent does this indicate profit-driven inflation?

To answer the question we estimate a Kaleckian price-level equation and combine three strands of evidence: (i) Method of Moments Quantile Regression (MMQR; Machado and Santos Silva, 2019),

which allows the association between markups and the price level to differ across the conditional distribution of the price level; (ii) an XGBoost model of annual inflation, interpreted with SHAP values and partial dependence plots, which captures non-linearities and interactions without imposing a functional form and offers a complementary perspective on inflation itself rather than on the price level; and (iii) the descriptive time profile of the variables, which shows that the upper quantiles of the price level fall mostly in the high-inflation years 2022-2025.

The remainder of the paper is organised as follows. Section 2 reviews the debate on profit-led inflation. Section 3 presents the Kaleckian framework. Section 4 describes the data and methods. Section 5 reports the results, Section 6 interprets them and discusses limitations, and Section 7 concludes.

2 Literature review

2.1 The debate on profit-led inflation

The drivers of inflation received renewed attention after the pandemic, and the debate intensified with the war in Ukraine and the energy crisis of 2021-2023. Distributional conflict has again become a central theme, with inflation increasingly interpreted as the outcome of a struggle over income shares between wages and profits.

Weber and Wasner (2023) argue that pandemic inflation was not initiated by a classic wage-profit conflict. They describe a four-phase process consisting of an impulse, a propagation, an amplification and a conflict phase. In the impulse phase, commodity price increases, supply bottlenecks and low capacity utilisation trigger the first price rises. In the propagation phase these shocks spread through the economy as firms raise prices to protect their profit margins; profit levels may rise while margins remain constant. In sectors facing bottlenecks or strong demand, firms may use temporary market power to raise prices further and increase margins, which amplifies the initial shocks along the value chain (Weber and Wasner, 2023, pp. 193-195). Distributional conflict arises only later, when workers try to restore lost purchasing power through higher wage demands (Weber and Wasner, 2023, p. 186).

Lavoie (2024) criticises the profit-inflation argument and stresses that the profit share can rise without any increase in markups. Within a post-Keynesian pricing framework, changes in direct and indirect costs, including overhead labour and the prices of imported inputs, can raise prices and shift the income distribution even if the percentage markup is constant. Variations in capacity utilisation over the business cycle can also change unit costs, and hence the profit share, without any change in pricing behaviour (Lavoie, 2024, pp. 235-240). A rising profit share is therefore not in itself evidence of profit inflation (Lavoie, 2024, p. 238).

Nikiforos et al. (2024) and Storm (2023) agree that profit shares can rise without markup changes, but Nikiforos et al. (2024) argue that the business cycle cannot explain the post-pandemic pattern. The profit share rose while the economy was still far from full capacity, it did not fall markedly during the 2020 recession, and a cyclical rise in the profit share is normally disinflationary because it is driven by falling unit costs. They therefore reject a purely cyclical explanation and point to profit-driven inflation dynamics (Nikiforos et al., 2024, p. 344). Lavoie replies that the pandemic was an abnormal situation in which the composition of the economy changed, so deviations from the normal cycle cannot on their own identify rising profits as the cause (Lavoie, 2024, p. 238).

Storm (2023) likewise stresses the need to control for other factors before attributing price changes to markups. Using a counterfactual that removes the markup increase, he nevertheless finds that higher markups account for a large share of the rise in profits, and that firms today protect their margins during inflation shocks far better than during the oil crises of the 1970s (Storm, 2023, pp. 247-250).

Isik et al. (2025) extend this perspective to Turkey. They show that post-pandemic inflation is better explained by cost shocks and rising profit shares than by demand pressure, and that the role of the profit share is stronger in periods of high inflation. Profit-driven inflation thus appears not as a universal mechanism but as a context-dependent one (Isik et al., 2025, pp. 233-236). This insight motivates our use of a quantile approach.

2.2 Measurement, causality and market power

Much of the disagreement in the literature stems from three methodological issues. The first is measurement. The terms markup, profit margin and profit share are often used interchangeably, although they capture different economic quantities (Lavoie, 2024; Storm, 2023). In the Kaleckian tradition the markup is the ratio of price to unit cost and reflects pricing power. The profit margin relates profits to turnover, and the profit share is the part of value added accruing to capital. The three need not move together: the profit share may rise with an unchanged markup, in which case it reflects a change in income distribution rather than in pricing behaviour. Weber and Wasner (2023), Nikiforos et al. (2024) and Isik et al. (2025) rely mainly on profit shares and on the decomposition of nominal gross value added into wages and profits, which reveals who “captures” inflation but does not by itself identify markup changes. Storm (2023) and Lavoie (2024) therefore argue that conclusions about profit inflation require evidence on markups; Storm defines profit inflation strictly as “an increase in the gross output price that is caused by an increase in the profit mark-up” (Storm, 2023, p. 243). Nikiforos et al. (2024), by contrast, argue that inflation can have a profit-driven character even without rising markups, as long as firms maintain their markups in the face of external cost shocks while wages do not adjust. In this view, which Weber and Wasner (2023) share, profit-driven inflation is a distributional rather than a purely pricing phenomenon.

The second issue is causality. The literature documents a strong correlation between profits and inflation, but a clear causal ordering is rarely established, since rising profit shares can be both a cause and a result of inflation. Weber and Wasner (2023, pp. 185-186) support their sequential account by showing that profits contributed more than wages to the growth of nominal value added in the early phase of the surge, about 9.4 against 4.7 percentage points over 2020-2022, and they add qualitative evidence from earnings calls in which firms with market power describe price increases as a strategy to protect or raise margins (Weber and Wasner, 2023, pp. 201-207). Systematic quantitative firm-level evidence, however, is scarce. Lavoie (2024, pp. 241-242) adds that changes in aggregate markups may reflect composition effects rather than changes in pricing behaviour, and Nikiforos et al. (2024, pp. 353-356) find that markup increases are concentrated in particular segments while other firms experience stagnation or decline. Heterogeneity across firms and sectors thus complicates identification and underlines the value of firm-level data.

The third issue is market power. Sellers’ inflation is not possible under perfect competition but arises in concentrated markets where firms act as price makers, and market power is dynamic: shared cost shocks, bottlenecks and legitimising narratives can make it easier for firms to raise prices without losing market share (Weber and Wasner, 2023, pp. 186-192). Storm (2023, pp. 253-255) likewise finds

that markup increases are concentrated among large firms. Lavoie, however, cautions that rising measured markups need not reflect greater market power, since sectoral shifts, demand composition or firm selection can produce the same pattern (Lavoie, 2024, pp. 241-242).

In sum, the literature calls for a clear definition and measurement of markups, attention to heterogeneity across countries and inflation regimes, and caution about causal claims. Our design responds to each: we measure markups directly from firm-level data for large firms, we exploit a cross-country panel, and we estimate relationships that are allowed to differ between low and high price-level states.

3 Theoretical framework

In neoclassical theory perfect competition serves as the benchmark: firms are price takers, the price equals marginal cost, and competition eliminates markups. Under imperfect competition, firms with market power price above marginal cost, constrained by the elasticity of demand, so that the markup emerges endogenously from profit maximisation (Pindyck and Rubinfeld, 2013, pp. 284-287, 357-363). Post-Keynesian theory instead assumes that firms in largely oligopolistic markets set prices through cost-plus pricing on the basis of normal unit costs rather than marginal cost (Lavoie, 2022, pp. 130-134, 165-168, 592-594).

Following Kalecki, the basic price equation is

$$P = (1 + u)C, \quad (1)$$

where P is the price, C unit costs and u the markup (Hein, 2023, p. 139); (Lavoie, 2022, pp. 594-595). The markup is thus

$$u = \frac{P - C}{C} = \frac{P}{C} - 1 \quad (2)$$

and reflects firms' ability to price above costs (Lavoie, 2022, pp. 165-168). Unit costs can be written as

$$C = (1 + j) \frac{w}{y}, \quad (3)$$

where w is the nominal wage, y labour productivity, w/y unit labour costs, and j the ratio of unit material costs to unit labour costs. When j rises, for example because imported raw materials become more expensive, total unit costs increase (Lavoie, 2022, pp. 594-595).

Equations (1)-(3) imply that price inflation can arise from three sources: nominal wages rising faster than productivity, an increase in the markup, or an increase in the relative weight of material costs (Lavoie, 2022, p. 595). If firms seek to maintain their markup, rising unit labour costs and rising input prices, for instance from energy shocks or supply disruptions, are passed on to prices; this is the cost-push channel. Kalecki further distinguishes between cost-determined prices of finished goods and demand-determined prices of raw materials, which are set on world markets and may be amplified by speculation. Increases in raw material prices feed directly into firms' costs and from there into the general price level (Lavoie, 2022, pp. 595-596).

Inflation can therefore result both from rising costs and from changes in markups, for instance when market power is used to widen margins (Lavoie, 2022, pp. 165-168, 595-596); (Hein, 2023, p. 220). The price and markup equations form the theoretical basis of our empirical model. Equation (1) is a price-

level equation, and we estimate it in that form, relating the price level to markups, unit labour costs and import prices:

$$p = f\left(u, \frac{w}{q}, m\right), \quad (4)$$

where p is the price, u the markup, w/q unit labour costs and m import prices, a proxy for external cost shocks (Isik et al., 2025, p. 235). Methodologically, we adopt a critical realist position: observed co-movements between prices, costs and markups are treated as manifestations of underlying mechanisms, such as pricing power, imported cost shocks and distributional conflict, that operate in an open system and cannot be observed directly (Dow, 2003).

4 Data and methodology

4.1 Firm-level data and markup construction

Firm-level data are taken from the London Stock Exchange Group (LSEG) database (LSEG, 2026). The search covered both listed and private firms, but because of data availability the final sample consists mainly of listed firms. We restrict the sample to active, individual firms headquartered in EU member states and, following the European Commission’s SME definition, to large firms with a turnover of at least EUR 50 million (European Commission, 2026). Large firms are the most likely to possess market power and hence the relevant population for studying markups. Sectors are defined by The Refinitiv Business Classification (TRBC). Financial firms are excluded because they follow different accounting and reporting standards (Nikiforos et al., 2024, p. 353), and real estate is excluded because its revenues depend largely on capital gains and asset prices rather than on the production of goods and services.

From LSEG we collect quarterly *Sales of Goods & Services, Net* and *Cost of Revenues, Total* for 2010-2025, following Nikiforos et al. (2024). Data are collected by fiscal rather than calendar quarter, as firms differ in their reporting periods. The initial extract contains 3,280,320 firm-quarter observations; after removing observations with insufficient information to compute a markup, 60,560 observations on 1,361 firms remain.

The firm-level markup is the ratio of net sales to total cost of revenues. To limit the influence of outliers, we remove the bottom and top 1% of the markup distribution. Country markups are then computed for each quarter as the sales-weighted mean of firm markups, so that large firms, which typically have greater influence on price formation, carry more weight. Because the measure is based on realised sales and costs, it captures *realised* rather than target markups.

4.2 Macroeconomic data and panel construction

Quarterly macroeconomic series are obtained from Eurostat: the Harmonised Index of Consumer Prices (Eurostat, 2026b), nominal unit labour costs (Eurostat, 2026c) and the import price index (Eurostat, 2026a). The country markups are merged with these series by country and quarter. Malta is excluded because firm-level data are available for only 14 quarters. The final dataset is a balanced panel of 24 EU countries over 64 quarters (2010Q1-2025Q4), giving 1,536 observations. Table 1 summarises the variables.

Table 1: Overview of variables

Variable	Symbol	Description	Source	Unit
Price level (HICP)	$hicp(p)$	Consumer price level; dependent variable in the Kaleckian price-level equation.	Eurostat	Index (2015 = 100)
Markup	$markup(u)$	Sales-weighted firm markup; captures the degree of market power in price setting.	LSEG	Ratio
Nominal unit labour cost	$ulc(w/q)$	Labour cost per unit of output; indicator of wage pressure.	Eurostat	Index (2015 = 100)
Import price index	$import(m)$	Prices of imported goods and inputs; proxy for external cost shocks.	Eurostat	Index (2015 = 100)
Annual inflation	π	Four-quarter percentage change of the HICP, computed from the index; target variable of the XGBoost model.	Eurostat	% y/y

Based on Equation (4), the empirical model is

$$hicp_{it} = \alpha_i + \beta_1 markup_{it} + \beta_2 ulc_{it} + \beta_3 import_{it} + \varepsilon_{it}, \quad (5)$$

where i denotes countries and t quarters. Equation (5) is a Kaleckian price-level equation: the dependent variable is the HICP index, that is, the consumer price level, and the coefficients measure how the price level co-moves with markups and with the two cost components. The model is estimated across the conditional distribution of $hicp$, as described below. Since the HICP rises over the sample, and especially after 2021, high conditional quantiles of the price level correspond mostly to the high-inflation years 2022-2025; we use this correspondence, rather than the quantiles themselves, to relate the results to the inflation episode.

4.3 Panel diagnostics

With $N = 24$ and $T = 64$, the data form a panel time series, so cross-sectional dependence, slope heterogeneity and non-stationarity must be addressed (Pesaran, 2015, pp. 750-751). Differences in market structure, wage setting, import dependence, energy exposure and institutions make it unlikely that the relationships of interest are identical across countries.

Cross-sectional dependence. Common unobserved factors and shocks that hit several countries at once can make errors correlated across units. Ignoring such dependence yields unreliable inference and, if the common factors are correlated with the regressors, biased estimates (Pesaran, 2015, p. 750). We use the CD test of Pesaran (2004),

$$CD = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^N \hat{\rho}_{ij}, \quad (6)$$

where $\hat{\rho}_{ij}$ is the pairwise correlation of residuals between units i and j . Under the null of cross-sectional independence the statistic is asymptotically standard normal and has mean zero even in moderately sized panels (Pesaran, 2015, pp. 787-788).

Slope heterogeneity. If slopes differ across units but are restricted to be equal, a common coefficient can mask heterogeneous effects and produce misleading inference (Pesaran, 2015, pp. 703, 710). We apply the test of Pesaran and Yamagata (2008), with null hypothesis $\beta_i = \beta$ for all i . Based on the dispersion statistic $\tilde{S}$ of Swamy (1970), which compares the unit-specific estimates $\hat{\beta}_i$ with a pooled weighted fixed-effects estimate $\tilde{\beta}_{WFE}$, the standardised statistics are

$$\tilde{\Delta} = \sqrt{N} \frac{N^{-1}\tilde{S} - k}{\sqrt{2k}}, \quad \tilde{\Delta}_{adj} = \sqrt{N} \frac{N^{-1}\tilde{S} - k}{\sqrt{2k(T-k-1)/(T+1)}}, \quad (7)$$

where k is the number of regressors. Both are asymptotically standard normal; the adjusted version has better small-sample properties (Pesaran, 2015, pp. 734-738).

Panel unit roots. Because the first-generation unit root tests assume cross-sectional independence, we use the second-generation CADF and CIPS tests of Pesaran (2007). The CADF regression augments the Dickey-Fuller regression with cross-section averages to proxy the common factor:

$$\Delta y_{it} = a_i + b_i y_{i,t-1} + c_i \bar{y}_{t-1} + d_i \Delta \bar{y}_t + e_{it}, \quad (8)$$

where $\bar{y}_{t-1}$ and $\Delta \bar{y}_t$ are the lagged level and the change of the cross-section mean. The null hypothesis is non-stationarity. The CIPS statistic averages the individual CADF t -ratios, $CIPS = N^{-1} \sum_{i=1}^N t_i(N, T)$, under the null that all series contain a unit root (Pesaran, 2007, pp. 266-269, 289).

4.4 Method of Moments Quantile Regression

Our main estimator is the MMQR of Machado and Santos Silva (2019), which estimates conditional quantiles in panels with individual effects. Unlike mean-based panel estimators, MMQR traces the effect of the regressors across the whole conditional distribution of the dependent variable. This matters for our research question, because the relationship between markups and prices may differ between states with low and high price levels, and in our sample the latter coincide largely with the high-inflation years (see also Isik et al., 2025). The estimator rests on a location-scale model,

$$Y_{it} = \alpha_i + X'_{it}\beta + (\delta_i + Z'_{it}\gamma) U_{it}, \quad (9)$$

where α_i and δ_i are country fixed effects in location and scale, X_{it} is the vector of regressors, Z_{it} a known transformation of X_{it} , and U_{it} an error term normalised to satisfy the moment conditions (Machado and Santos Silva, 2019, pp. 147-148). The conditional quantile function is

$$Q_Y(\tau | X_{it}) = (\alpha_i + \delta_i q(\tau)) + X'_{it}\beta + Z'_{it}\gamma q(\tau), \quad (10)$$

so the effect of a regressor at quantile τ is $\beta(\tau) = \beta + \gamma q(\tau)$: a location effect plus a scale effect that varies with the quantile. We estimate the model for $\tau = 0.1, \dots, 0.9$ and, as a robustness check, for $\tau \in \{0.25, 0.50, 0.75, 0.90\}$.

4.5 Machine learning complement

As a complementary perspective, we estimate an XGBoost model (Chen and Guestrin, 2016) of annual inflation. The target is the four-quarter percentage change of the HICP, $\pi_{it} = 100(hicp_{it}/hicp_{i,t-4} - 1)$, computed from the index for each country, and the features are *markup*, *ulc* and *import*. Because the first four quarters of each country are lost in computing annual inflation, the XGBoost sample covers 2011Q1-2025Q4 (1,440 observations). The two approaches therefore explain different things: MMQR describes how the price level co-moves with markups and costs across its distribution, whereas XGBoost describes how markups and costs are related to the rate of inflation, allowing for non-linearities and interactions. XGBoost is a gradient boosting ensemble in which shallow regression trees are added sequentially, each fitted to the gradient of the loss of the current ensemble, while regularisation limits overfitting (Klosterman, 2021, pp. 163-174). The model is used for exploration rather than causal identification. Hyperparameters, chosen to balance predictive performance and the risk of overfitting, are listed in Table 2. The data are split randomly into 80% training and 20% test observations, and performance is evaluated on the test set with the R^2 , the root mean squared error (RMSE) and the mean absolute error (MAE) (Chicco et al., 2021; Magazzino et al., 2026).

Table 2: XGBoost hyperparameters

Hyperparameter	Value	Function
n_estimators	300	Number of boosting rounds
learning_rate	0.05	Contribution of each tree
max_depth	2	Maximum tree depth
subsample	0.8	Share of observations per tree
colsample_bytree	0.8	Share of features per tree
min_child_weight	3	Restricts complex splits
reg_lambda	1	L2 regularisation
objective	reg:squarederror	Loss function
Train/test split	80/20	Sample split
random_state	42	Reproducibility

We interpret the model with three tools. Feature importance ranks the variables by their contribution to the fitted trees. SHAP (Shapley Additive Explanations) values, based on Shapley values from cooperative game theory, decompose each prediction additively into contributions from each feature, so that the contributions plus a base value equal the prediction (Klosterman, 2021, pp. 183-189); (Van den Broeck et al., 2022). We report mean absolute SHAP values overall and by inflation regime, defined as the bottom 25%, the middle 50% and the top 25% of the distribution of annual inflation. Partial dependence plots (PDPs) show how the average prediction changes as two features vary jointly, revealing thresholds, asymmetries and interactions (Magazzino et al., 2026, pp. 3-7). SHAP values and PDPs are computed on the training sample. All three tools describe how the model uses the data and do not by themselves identify causal effects.

5 Results

5.1 Descriptive evidence

Figure 2 shows the HICP for each country. Prices develop similarly and stably until about 2020 and then rise sharply from 2021 onward. All countries follow the same broad pattern, but the magnitude and speed of the increase differ, which points to heterogeneity across the panel and underlines the need for the diagnostic tests below.

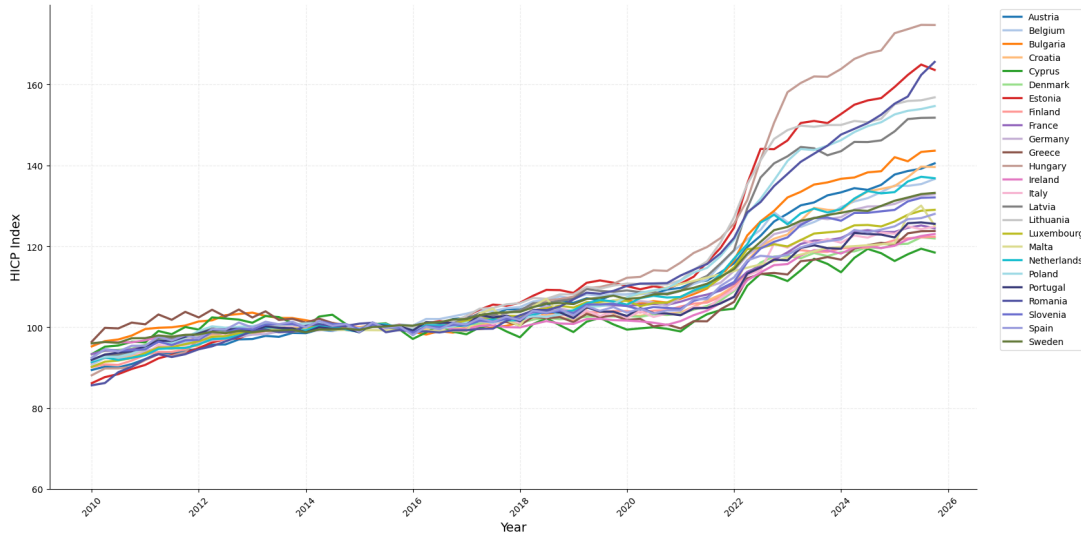


Figure 2: HICP by country, 2010-2025 (index, 2015 = 100)

Source: Authors' calculations based on Eurostat data. The figure also shows Malta, which is excluded from the estimation sample (Section 4).

Figure 3 reports yearly cross-country averages of the four model variables. The HICP (panel a) is roughly flat until 2021 and then shifts markedly upward, rising 46.5% over 2010-2025; the highest price levels, and most of the inflation, are concentrated at the end of the sample. The markup (panel b) fluctuates moderately, declining from its 2016 peak until 2020, which suggests weakening pricing power over those years. It then rises again during the high-inflation period, from 1.58 in 2022 to 1.63 in 2025, indicating that firms on average were able to raise prices relative to their costs. Import prices (panel c) jump between 2020 and 2022 and then stabilise and fall slightly (126.8 in 2022, 124.2 in 2025). Unit labour costs (panel d) grow slowly before the pandemic, are nearly flat in 2020-2021, and then accelerate strongly (from 123.1 in 2022 to 149.3 in 2025). The key descriptive observation is that *markups and unit labour costs continue to rise after import prices have stabilised*.

5.2 Diagnostic tests

Table 3 reports the diagnostic tests. The CD test rejects cross-sectional independence at the 1% level for all variables, so countries are strongly interdependent. The slope homogeneity test rejects at the 1% level as well, meaning that the effects of the regressors on the price level vary across countries, consistent with the heterogeneity visible in Figure 2.

Given cross-sectional dependence and slope heterogeneity, we test for unit roots with the CIPS and CADF tests. Table 4 shows that all variables are stationary at the 1% or 5% level, with and without a

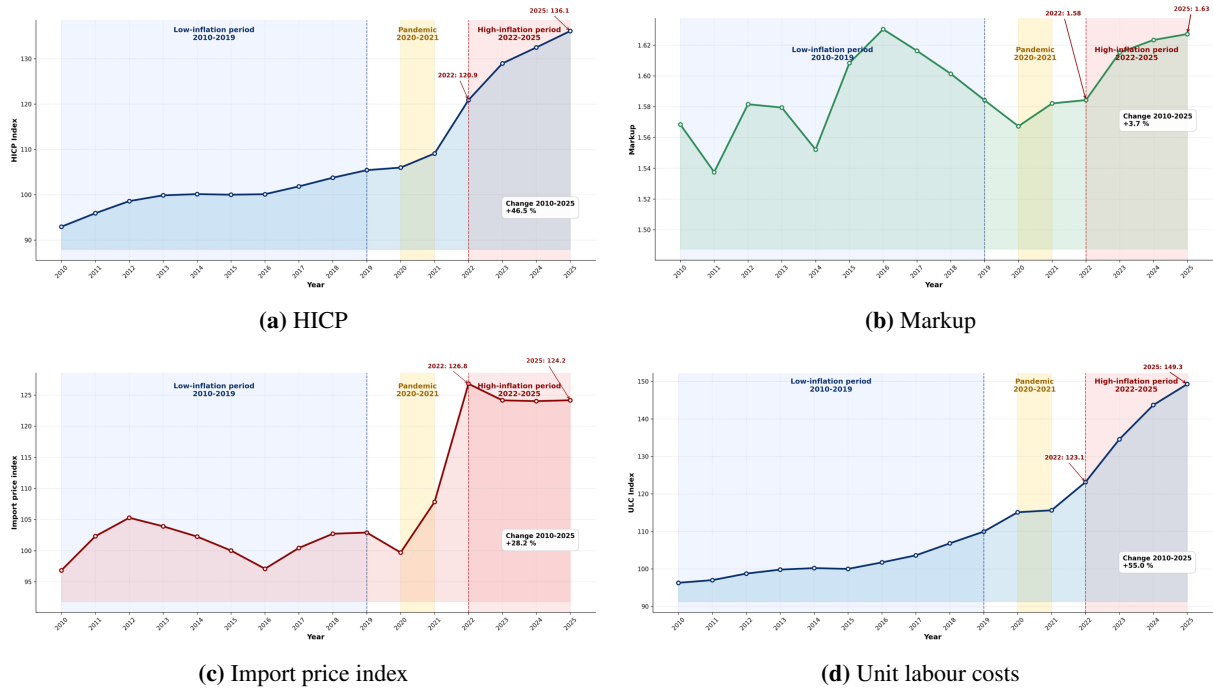


Figure 3: Cross-country averages of the model variables, 2010-2025

Source: Authors' calculations based on LSEG and Eurostat data.

Table 3: Cross-sectional dependence and slope heterogeneity tests

<i>Panel A: Cross-sectional dependence test (Pesaran, 2004)</i>				
	<i>hicp</i>	<i>markup</i>	<i>ulc</i>	<i>import</i>
CD statistic	130.659***	4.725***	87.438***	121.609***
<i>p</i> -value	0.000	0.000	0.000	0.000
<i>Panel B: Slope heterogeneity test (Pesaran and Yamagata, 2008)</i>				
	Statistic	<i>p</i> -value		
$\tilde{\Delta}$	49.283***	0.000		
$\tilde{\Delta}_{adj}$	51.328***	0.000		

Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels. The null hypothesis of the CD test is cross-sectional independence; the null of the Pesaran-Yamagata test is homogeneous slope coefficients.

trend. Together, these results support a heterogeneity-robust estimator applied to the variables in levels, and hence the MMQR.

Table 4: Second-generation panel unit root tests

Variable	CIPS		CADF	
	Constant	Constant + trend	Constant	Constant + trend
<i>hicp</i>	−2.528***	−3.566***	−2.179**	−3.244***
<i>markup</i>	−3.863***	−4.486***	−3.012***	−3.589***
<i>ulc</i>	−3.057***	−5.976***	−3.385***	−4.640***
<i>import</i>	−4.417***	−4.107***	−2.480***	−3.586***

Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels. The null hypothesis of the CIPS test is homogeneous non-stationarity; the null of the CADF test is non-stationarity.

5.3 MMQR results

Table 5 presents the MMQR estimates. Unit labour costs and import prices are positive and significant at the 1% level at every quantile: higher labour costs and higher import prices are associated with a higher price level, and both coefficients increase monotonically along the distribution. Import prices display the stronger association of the two.

Table 5: MMQR estimates, quantiles 0.1 to 0.9

Variable	Q0.1	Q0.2	Q0.3	Q0.4	Q0.5	Q0.6	Q0.7	Q0.8	Q0.9
<i>markup</i>	0.520	0.741	0.907	1.051	1.224	1.380*	1.525*	1.702*	1.911*
<i>ulc</i>	0.316***	0.333***	0.346***	0.358***	0.371***	0.383***	0.395***	0.409***	0.425***
<i>import</i>	0.523***	0.543***	0.557***	0.570***	0.585***	0.598***	0.611***	0.626***	0.645***
Constant	9.025***	6.758***	5.064**	3.590*	1.812	0.218	−1.270	−3.083	−5.222*

Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels. Dependent variable: *hicp*. Country fixed effects in location and scale.

The markup behaves differently. Its coefficient is insignificant in the lower half of the distribution but becomes significant at the 10% level from the 0.6 quantile upward, and its point estimate rises from 0.520 at Q0.1 to 1.911 at Q0.9, almost a fourfold increase. The association between markups and the price level is thus larger in high price-level states. Figure 4 visualises these patterns: the markup coefficient steepens across quantiles, whereas the cost coefficients increase more gradually.

MMQR quantiles are not defined chronologically, and the upper quantiles are high price-level states rather than inflation regimes as such. Because the HICP trends upward, however, Figures 2 and 3 show that the highest price levels occur in 2020-2025 and especially in 2022-2025. The upper-quantile results therefore pertain mainly to observations from the post-pandemic high-inflation period.

Robustness. Table 6 re-estimates the model at the 0.25, 0.50, 0.75 and 0.90 quantiles. The results for unit labour costs and import prices are stable, while the markup again becomes significant only at the upper quantiles (0.75 and 0.90), in line with Table 5.

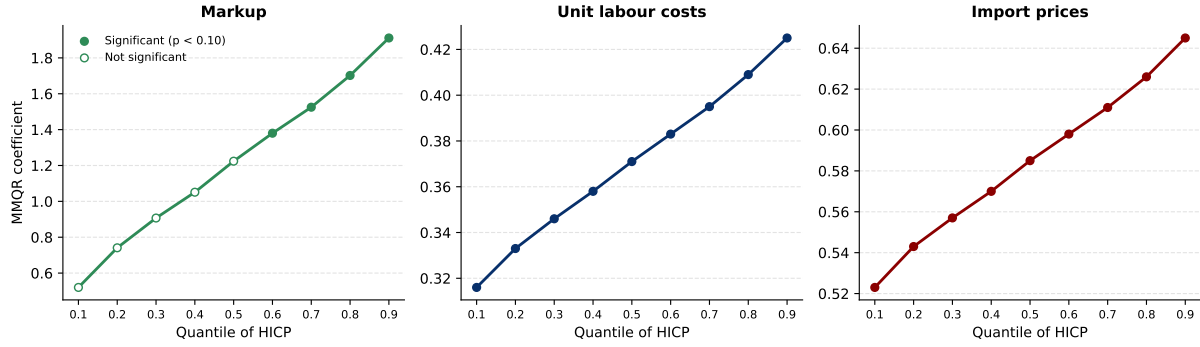


Figure 4: MMQR coefficients across quantiles of the HICP

Source: Authors' estimations. Filled markers denote coefficients significant at the 10% level or better (Table 5).

Table 6: Robustness: MMQR estimates at alternative quantiles

Variable	Q0.25	Q0.50	Q0.75	Q0.90
<i>markup</i>	0.831	1.224	1.613*	1.911*
<i>ulc</i>	0.340***	0.371***	0.402***	0.425***
<i>import</i>	0.550***	0.585***	0.619***	0.645***
Constant	5.842**	1.812	-2.173	-5.222*

Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels. Dependent variable: *hicp*.

5.4 Machine learning results

The XGBoost model explains about 35.1% of the variation in annual inflation in the test set, with an RMSE of 2.492 and an MAE of 1.610 percentage points (Table 7). This moderate predictive performance is adequate for the model's exploratory purpose, which is to examine how the variables contribute to predicted inflation rather than to forecast it.

Table 7: Out-of-sample performance of the XGBoost model of annual inflation

Metric	Value	Interpretation
R^2	0.351	Share of the variance of annual inflation explained in the test set
RMSE	2.492	Root mean squared prediction error (percentage points)
MAE	1.610	Mean absolute prediction error (percentage points)

Notes: Target: annual inflation, $100(hicp_{it}/hicp_{i,t-4} - 1)$. Features: *markup*, *ulc* and *import*. Sample 2011Q1-2025Q4 (1,440 observations), randomly split into 80% training and 20% test observations; metrics are computed on the test set.

Figure 5 shows that import prices are the most important feature (importance score 0.586), followed by unit labour costs (0.259) and markups (0.155). The mean absolute SHAP values give the same ranking: 1.52 percentage points of predicted inflation for import prices, 0.48 for unit labour costs and 0.30 for markups. External cost shocks thus dominate the model's predictions of inflation, consistent with a cost-push interpretation.

Splitting the SHAP values by inflation regime (Figure 6) adds a state-dependent dimension. In the high-inflation regime (top 25% of annual inflation), the contribution of all three variables increases, most visibly for import prices, and the contribution of markups roughly doubles compared with the low- and medium-inflation regimes. Because XGBoost models inflation while MMQR models the price level, this

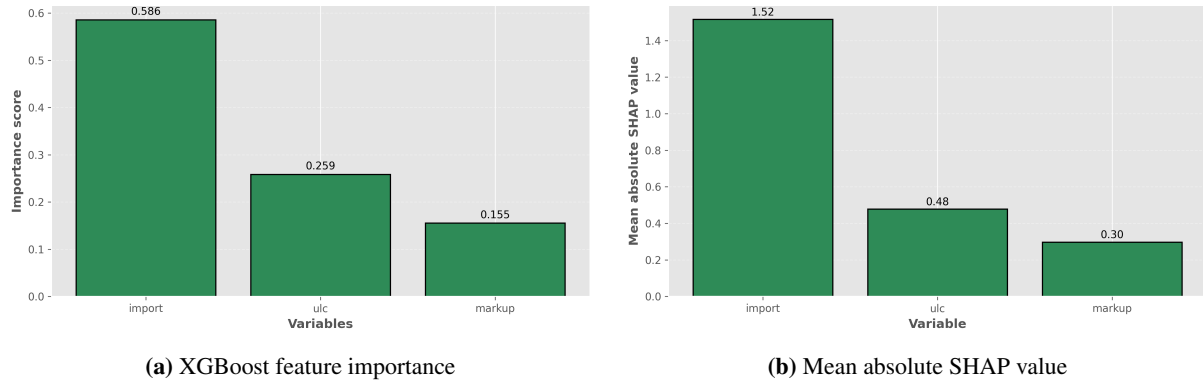


Figure 5: Variable importance in the XGBoost model of annual inflation
Source: Authors' calculations.

is not a replication of the MMQR result but a complementary finding pointing in the same direction: markups matter more for predicted inflation when inflation is high. The importance of import prices dips slightly in the medium regime, which suggests that moderate inflation reflects an interplay of several factors.

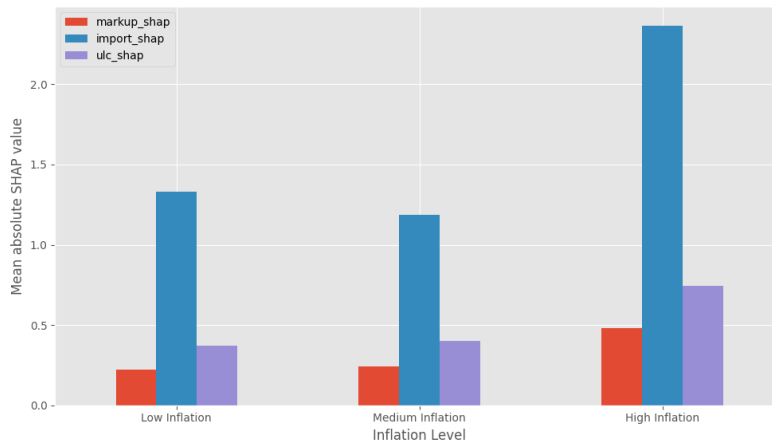


Figure 6: Mean absolute SHAP values by inflation regime (bottom 25%, middle 50% and top 25% of annual inflation)

Source: Authors' calculations.

Figure 7 presents two-way partial dependence surfaces, where the vertical axis and colour scale show predicted annual inflation. The surface for unit labour costs and import prices (panel a) rises steeply when both are high, showing that domestic cost pressure and external cost shocks reinforce each other. In the markup-import surface (panel b), predicted inflation rises mainly with import prices, and import prices can push inflation up even at stable markup levels. In the markup-ULC surface (panel c), higher labour costs dominate, but predictions vary somewhat across markup levels, hinting at non-linear interactions between cost structure and margins. The uneven slopes of the surfaces indicate that interactions between the variables differ across inflation levels, a feature that a linear specification cannot capture.

Overall, the two approaches offer complementary perspectives. The MMQR results concern the price level, and the XGBoost results concern annual inflation. Both point to import prices and labour costs as the main drivers, and both indicate that markups matter more in high states: high price-level states in MMQR and high-inflation regimes in XGBoost, which in both cases fall mostly in 2022-2025. Taken in isolation, markups have a limited direct effect on predicted inflation; their relevance is state-dependent.

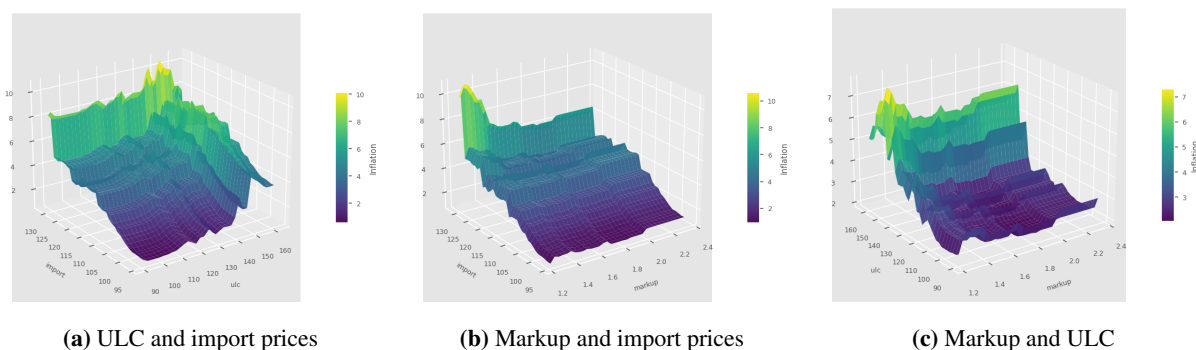


Figure 7: Two-way partial dependence plots from the XGBoost model (predicted annual inflation, %)
Source: Authors' calculations.

6 Discussion

6.1 The role of markups in 2022-2025

All the studies reviewed regard the post-pandemic period as economically unusual. Weber and Wasner (2023) and Nikiforos et al. (2024) argue that inflation dynamics departed from historical patterns and from a classic wage-price spiral, while Lavoie (2024) holds that the period was structurally atypical, so that deviations from normal cyclical patterns cannot prove the nature of inflation. We take Lavoie's point seriously: our results are not presented as proof of a single mechanism but as empirical regularities in a historically atypical period shaped by several simultaneous forces. What distinguishes our evidence is that the markup variable is constructed directly from firm-level data and therefore measures pricing outcomes rather than the functional distribution of income.

The finding that the association between markups and prices is larger in high price-level states, which are concentrated in the high-inflation years 2022-2025, suggests that the economic environment changed firms' scope for passing on and adding to cost increases. Markups do not exist in isolation from macroeconomic conditions. When prices are adjusted more often and by larger amounts, firms can pass on rising costs with less risk of losing market share. If pricing were merely a passive cost pass-through mechanism, one would expect a stable relationship between markups and prices across the distribution.

Import prices play a central role, which is consistent with the theoretical expectation that the initial impulse came from large external cost shocks: global bottlenecks, energy prices, transport disruptions and geopolitical uncertainty. However, the dynamics change over 2022-2025. Import price growth levels off, while unit labour costs and markups keep rising, suggesting that inflation became less dependent on the original external shock and was increasingly propagated through domestic price and cost dynamics. Because the MMQR estimates are based on the full 2010-2025 panel, the strong significance of import prices does not imply that they dominated throughout; a close link between import prices and inflation is to be expected in open economies. Our reading is not that import prices lost importance, but that their role changed: external shocks provided the initial impulse, while pricing and domestic cost dynamics carried inflation forward. This sequence closely resembles the four-phase process of Weber and Wasner (2023).

Lavoie (2024) notes that after large import and energy shocks prices typically rise first and wages follow with a lag, which is consistent with the continued rise in unit labour costs after 2022 (Figure 3d). Lagged wage adjustment can mechanically raise profit shares, which is the core of Lavoie's critique,

also acknowledged by Storm (2023) and Nikiforos et al. (2024). Our markup measure, however, is the ratio of sales to cost of revenues. Rising labour costs increase the denominator and should, other things equal, push the realised markup down; if firms merely passed on higher costs proportionally, the markup would remain stable. The fact that the realised markup kept rising while import price growth slowed and labour costs accelerated implies that firms' sales prices grew faster than both direct production costs and labour costs. This pattern is consistent with large firms with market power expanding their target markups during the exceptional conditions of 2022-2025.

6.2 Can the inflation be classified as profit-driven?

In the post-Keynesian framework, firms set prices *ex ante* through a markup, while profits are realised *ex post* depending on actual demand and turnover. The question is therefore how profit-driven inflation should be identified empirically. Storm (2023) and Lavoie (2024) require an actual increase in markups, whereas Weber and Wasner (2023), Nikiforos et al. (2024) and Isik et al. (2025) adopt a broader, distributional view in which inflation can be profit-driven even if firms only protect existing markups through price pass-through.

This distinction guided our design. Because rising profit shares do not necessarily imply rising markups, we measured markups directly. Our results indicate that realised markups increased in 2022-2025 and that their association with the price level is larger in the high price-level states that characterise these years. The evidence is therefore hard to reconcile with pure cost-push or with stable markup protection alone, and it is consistent with a profit-driven component of inflation under both the broader distributional definition and the narrower markup-based definition.

6.3 Limitations

Causality is difficult to establish in any macroeconometric setting, since inflation and markups may influence each other, giving rise to simultaneity and endogeneity. MMQR identifies conditional associations across the distribution of the price level, not causal effects (Machado and Santos Silva, 2019, pp. 145-146), and it does not exploit the temporal ordering of the data in the way dynamic time-series models do (Machado and Santos Silva, 2019, pp. 146-149). It therefore cannot tell whether rising markups caused inflation or rose as a consequence of it. Likewise, XGBoost, SHAP values and PDPs describe how a predictive model uses the data, and since the XGBoost model explains inflation rather than the price level, its results complement rather than replicate the MMQR estimates; they depend on hyperparameter choices and distributional assumptions and do not reveal causal mechanisms (Chen and Guestrin, 2016; Van den Broeck et al., 2022; Magazzino et al., 2026). The coefficient on markups is also estimated with more uncertainty than those on costs, being significant only at the 10% level. In the location-scale decomposition, the scale coefficient on markups is not statistically significant, so the rise of the markup coefficient across quantiles should be read as indicative rather than as a formally established difference. Finally, because the model is specified in levels, the quantiles describe price-level states; they coincide largely, but not exactly, with periods of high inflation. Re-estimating the model in inflation rates (year-on-year changes of all variables) is a natural extension.

Our strategy is therefore not to prove a single causal mechanism but to assess whether several independent pieces of evidence, namely quantile regressions, machine learning diagnostics and the time profile of the variables, jointly align with the theory of profit-driven inflation. Firm-level markups reduce

the composition problems associated with aggregate profit shares (Lavoie, 2024), although the sample is dominated by listed firms and measures realised rather than target markups. Future research could exploit the time dimension more directly, for example with dynamic quantile or local projection methods, and examine heterogeneity across sectors.

7 Conclusion

This paper examined whether the EU inflation surge of 2022-2025 reflected only cost shocks or also had a profit- and markup-driven character. Our main contribution is the construction of country-level, sales-weighted markups from firm-level data for 24 EU countries, which allows conclusions about markups rather than about aggregate profit shares.

Diagnostic tests revealed strong cross-sectional dependence and slope heterogeneity, and second-generation unit root tests showed that all variables are stationary, supporting the use of MMQR. In a Kaleckian price-level equation estimated by MMQR, import prices and unit labour costs are positively and significantly associated with the price level at all quantiles, with coefficients increasing along the distribution and import prices showing the stronger association. Markups, by contrast, are insignificant in the lower half of the distribution, while their point estimate is markedly larger, and significant at the 10% level, in the upper quantiles. These upper quantiles are high price-level states that fall mostly in 2022-2025. The XGBoost model of annual inflation offers a complementary perspective: import prices and labour costs dominate its predictions, and the contribution of markups roughly doubles in the high-inflation regime.

Taken together, the results indicate that rising import prices and other cost shocks were the primary initial drivers of inflation after the pandemic, but that the association between markups and prices is larger in the high price-level states of the energy-crisis period. Realised markups continued to rise even after import price growth had slowed and while labour costs were rising, meaning that sales prices outpaced direct production costs. Interpreted through a Kaleckian lens, this suggests that firms with market power used the exceptional conditions to pass on and amplify price increases. EU inflation in 2022-2025 can therefore, to a certain extent, be characterised as profit-driven, under both a broader distributional and a narrower markup-based definition. For policy, this implies that monetary tightening aimed at demand may be an incomplete response to inflation episodes in which pricing power amplifies cost shocks, and that competition policy and the monitoring of markups deserve a place in the anti-inflation toolkit.

References

- Tianqi Chen and Carlos Guestrin. XGBoost: A scalable tree boosting system. In *Proceedings of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining*, pages 785–794, 2016. doi: 10.1145/2939672.2939785.
- Davide Chicco, Matthijs J. Warrens, and Giuseppe Jurman. The coefficient of determination R-squared is more informative than SMAPE, MAE, MAPE, MSE and RMSE in regression analysis evaluation. *PeerJ Computer Science*, 7:e623, 2021. doi: 10.7717/peerj-cs.623.
- Sheila C. Dow. Critical realism and economics. In Paul Downward, editor, *Applied Economics and the Critical Realist Critique*. Routledge, London, 2003.

- European Commission. SME definition. https://single-market-economy.ec.europa.eu/smes/sme-fundamentals/sme-definition_en, 2026.
- Eurostat. Gross domestic product (GDP) and main components (output, expenditure and income), quarterly data [namq_10_gdp]. Eurostat Data Browser, 2026a.
- Eurostat. HICP, monthly data (index) [prc_hicp_midx]. Eurostat Data Browser, 2026b.
- Eurostat. Labour productivity and unit labour costs, quarterly data [namq_10_lp_ulc]. Eurostat Data Browser, 2026c.
- Eckhard Hein. *Macroeconomics after Kalecki and Keynes: Post-Keynesian Foundations*. Edward Elgar, Cheltenham, 2023.
- S. Isik, M. Mert, and M. Ulug. Profit produced by post-pandemic inflation: Evidence from an emerging economy. *Structural Change and Economic Dynamics*, 72:233–244, 2025. doi: 10.1016/j.strueco.2024.10.002.
- Stephen Klosterman. *Data Science Projects with Python*. Packt Publishing, Birmingham, second edition, 2021.
- Marc Lavoie. *Post-Keynesian Economics: New Foundations*. Edward Elgar, Cheltenham, second edition, 2022.
- Marc Lavoie. Questioning profit inflation as an explanation of the post-pandemic inflation. *European Journal of Economics and Economic Policies: Intervention*, 21(2):232–247, 2024. doi: 10.4337/ejeep.2024.0139.
- LSEG. London stock exchange group: Data and analytics. <https://www.lseg.com/en/about-us>, 2026.
- José A. F. Machado and J. M. C. Santos Silva. Quantiles via moments. *Journal of Econometrics*, 213(1):145–173, 2019. doi: 10.1016/j.jeconom.2019.04.009.
- C. Magazzino, A. E. Caglar, M. Ulug, and T. Gattone. Rewiring R&D, clean energy, and the road to net zero: A machine learning analysis for France. *Renewable Energy*, 263:125240, 2026. doi: 10.1016/j.renene.2026.125240.
- Michalis Nikiforos, S. Grothe, and J. D. Weber. Markups, profit shares, and cost-push-profit-led inflation. *Industrial and Corporate Change*, 33(2):342–362, 2024. doi: 10.1093/icc/dtae003.
- M. Hashem Pesaran. General diagnostic tests for cross section dependence in panels. Working Paper 1229, CESifo, 2004.
- M. Hashem Pesaran. A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, 22(2):265–312, 2007. doi: 10.1002/jae.951.
- M. Hashem Pesaran. *Time Series and Panel Data Econometrics*. Oxford University Press, Oxford, 2015. doi: 10.1093/acprof:oso/9780198736912.001.0001.

- M. Hashem Pesaran and Takashi Yamagata. Testing slope homogeneity in large panels. *Journal of Econometrics*, 142(1):50–93, 2008. doi: 10.1016/j.jeconom.2007.05.010.
- Robert S. Pindyck and Daniel L. Rubinfeld. *Microeconomics*. Pearson, Boston, eighth edition, 2013.
- Servaas Storm. Profit inflation is real. *PSL Quarterly Review*, 76(306):243–259, 2023. doi: 10.13133/2037-3643/18217.
- P. A. V. B. Swamy. Efficient inference in a random coefficient regression model. *Econometrica*, 38(2): 311–323, 1970. doi: 10.2307/1913012.
- Guy Van den Broeck, Anton Lykov, Maximilian Schleich, and Dan Suciu. On the tractability of SHAP explanations. *Journal of Artificial Intelligence Research*, 74:851–886, 2022. doi: 10.1613/jair.1.13283.
- Isabella M. Weber and Evan Wasner. Sellers’ inflation, profits and conflict: Why can large firms hike prices in an emergency? *Review of Keynesian Economics*, 11(2):183–213, 2023. doi: 10.4337/roke.2023.02.05.