Kosztowniak, A. (2024). Markups and CPI. *Journal of International Studies, 17*(2), 262-282. doi:10.14254/2071-8330.2024/17-2/14

Journal of International Studies

Centre of Sociological Research

Scientific Papers

Markups and CPI

Aneta Kosztowniak
Department of Applied Economics,
SGH Warsaw School of Economics,
Poland
aneta.kosztowniak@sgh.waw.pl
ORCID 0000-0001-6088-1899

Abstract. The persistently high inflation since the COVID-19 pandemic, including its strong upward trend in 2020-2023 in Europe and the USA, raises many questions as to the causes for such a situation. Evidently, the problem lies in the persistent inflation expectations of enterprises (in light of the overlapping effects of the energy crises and the outbreak of the war in Ukraine) and increased markups as the response of enterprises to future cost increases. Empirical data indicates that the dynamics of markups in individual economic sections are diversified like never before. All this creates a research gap, which this paper aims to fill. Therefore, the aim of this study is to diagnose the impact of markups on changes in the consumer price index (CPI) in Poland in 2008-2023, identify the markups with the strongest impact, and determine changes in the competitiveness of the economy compared to EU countries. Markups were divided into nine main groups as per NACE classification of economic activity. The impact of markups on CPI changes was assessed using the VAR model. The results indicate that markups in the mining and quarrying (B) and the real estate market service (L) had the greatest pro-inflationary impact on CPI changes and explained about 30% of all CPI changes in Poland. The research results are useful to those formulating the monetary policy, as identifying key sectors whose markup policies explain the changes in CPI is crucial to determining the optimal actions and policy measures.

Keywords: enterprises, sectors, markups, inflation, competitiveness, Poland, EU, VAR

JEL Classification: E51, E58, E63, J31, M21

Received: May, 2023
1st Revision: February, 2024
Accepted: June, 2024

DOI: 10.14254/2071-8330.2024/17-2/14

1. INTRODUCTION

The volatile macroeconomic conditions associated with the COVID-19 pandemic, the Russia-Ukraine conflict, and the energy crisis have caused numerous financial and socio-economic disruptions over the past decade. The decisions of enterprises, however, remain crucial to the real sector of the economy. Of vital importance are the pricing decisions of companies, particularly regarding the markups imposed by producers and trade intermediaries, as they determine the price paid by final consumers. In the EU countries and the USA, many enterprises have reacted to difficulties with increased inflationary expectations. Moreover, enterprises, guided by prudential considerations, have begun to raise markups on goods and services to neutralize cost increases and maintain existing profit levels.

Since markup increases occurred in many countries, they simultaneously triggered quite strong price increase mechanisms. The prices of goods and services increased both inside the country and abroad due to international exchange. In many economies, the practice of transferring the prices of imported goods to domestic prices strengthened. As prices rose in many economies and the real purchasing power of wages fell, the demands for wage increases spread. The increase in wages and the increase in prices of various goods and services, including inventories purchased by enterprises, resulted in an increase in labor costs. Due to the above-mentioned interdependencies of economic processes (changes in inflation expectations, markups, wages, labor costs and inflation), the final effects are noticeable as changes in competitiveness, primarily its deterioration due to the decline in terms of trade and, therefore, economic growth.

Therefore, an important task is to diagnose the impact of changes in markups imposed in the enterprise sector on changes in the levels of goods and service prices. The consequences of high inflation dynamics include the depreciation of disposable income of households and enterprises and the destabilization of exchange conditions and a range of monetary and economic processes in the entire economy. Of course, it should be noted that different types of economic activities have diverse impacts on added value in economies and may influence changes in the prices of the basket of goods and services to different extents. Therefore, the study focused on changes in markup levels from six main types of economic activity.

It should also be emphasized that the strength and scale of the impact of price changes from specific sections on the CPI, and thus on the entire economy, is important. If the importance of a section /type of economic activity is high and has numerous links with many others then spillover effects to many others are potentially more severe. A higher increase in prices (markups) from sections important for the domestic economy and trade (export/import) undermines competitiveness. The decline in competitiveness can be observed, for example, in higher unit labor costs, currency depreciation, deteriorating terms of trade, declining trade balance, capital outflow and many others. Therefore, CPI analyzes at the level of economic activity sections are important.

In terms of the impact of changes in markups on the CPI, important findings are provided by studies on price pressure mechanisms, or disaggregated CPI components at the level of business activities. In these scopes, it is worth mentioning, among others, works by Muntaz and Theodoridis (2023), Hall (2023) and Barkan et al. (2023).

Price pressure mechanism is the effect of inflation expectations and costs in Holl`s opinion (2023). In the mainstream New Keynesian model, the price of a particular product remains fixed until a certain amount of pressure has accumulated to cause a discrete change in the price. A seller in a more volatile environment will adopt policies that involve more frequent adjustments of the seller's price (markups) than in a less volatile environment. Consequently, prices will respond more quickly to driving forces and the relation between inflation and driving forces will be steeper.

The importance of more disaggregated analyzes of CPI changes, not only at the level of main components but also at the level of business sectors or entities, is emphasized by, among others, Barkan et al. (2023). Analyzes at disaggregated levels are advisable because they can explain more about the causes of inflation changes. Barkan et al. (2023) developed a novel hierarchical recurrent neural network (HRNN) model that uses information from higher levels in the CPI hierarchy to improve predictions at more variable lower levels. The disaggregated components are more volatile and more difficult to predict. Moreover, changes in the components of the CPI are more prevalent at lower levels than in the main categories, and therefore allow for more accurate diagnoses of the causes of CPI changes.

With reference to the detailed analyzes of CPI changes, a VAR model was prepared for Poland, considering changes in markups of non-financial enterprises at the level of six sections of activity (NACE) in the years 2008-2023. This means that changes in company markups in these sections cover most determinants of changes in the prices of a goods and service basket. The results of this model are intended to identify the sources of destabilizing changes in the CPI, as well as markups from sections that are stabilizing the overall price level of the basket of goods and services.

The aim of the study is to estimate the relationship between markups of enterprises and consumer price index (CPI) in an error variance decomposition (VAR) model for Poland in the period 2008-2023, indicating changes in the competitiveness of the Polish economy compared to the EU countries.

Responses to impulses were used to examine the positive and negative responses of the CPI to shocks in markups by . The degree of explanation of the CPI on the side of markups was diagnosed using the VAR model.

The following **research hypothesis** was formulated: "Changes in markup dynamics in the sections of significant magnitude for the national economy, which show numerous links to various activities, as well as the sections most sensitive to changes in operating costs have the greatest impact on changes in the CPI, and thus on changes in the economy's competitiveness. This means that an increase of markups in sections crucial to the economy and the most sensitive to changes in operating costs can significantly undermine this competitiveness, and vice versa. Therefore, both the central bank and the fiscal authorities should constantly diagnose the situation in these sections, as part of the so-called policy-mix".

Since the results of the model tests indicated the possibility of using a VAR model, a tool in such a form was used. In addition, it is worth noting that the model is appreciated and has a range of applications in the literature. The VAR-based identification scheme is consistent with a variety of structural models and can be used as a benchmark.

A review of literature in the field of monetary policy and statistical analysis methods based on data published by the National Bank of Poland (NBP), the the Statistics Poland (SP) and Eurostat were used as the methods of research. The impact of markups on CPI changes was assessed using the VAR model, the impulse responses, and the variance decomposition.

A disaggregated analysis of the inflation rate is particularly important for policymakers and market participants. Determinant analysis and inflation forecasting are key tools for adjusting monetary policies around the world (Friedman, 1961). Central banks forecast future inflation trends to justify interest rate decisions and to keep inflation close to their targets. A better understanding of inflation dynamics at the component level can help implement optimal monetary policy (Ida, 2020).

Results of research into disaggregated inflation rates is important for fiscal authorities, investors, enterprises, and households in addition to monetary authorities, but also for private enterprises who need to anticipate specific components of inflation to forecast their price dynamics and mitigate risk, e.g., when making long-term investments or exporting or importing goods (Goodhart et al., 2023, Kabundi & De Simone, 2022).

In the conditions of supply shocks after the pandemic, which explain inflation changes, the particular importance of the specificity of an economy should be emphasized, mainly:
- its industry structure and connections between sectors,
- the sensitivity of specific industries and entities to exogenous and endogenous shocks,
- the speed and scale of changes in the pricing policy (increase in markups) in the conditions of sustained inflationary expectations.

The analysis presented in the study focuses on these aspects. Its results emphasize the importance of the structure of the economy and its diversified sectoral impact to explaining CPI changes in the Polish economy.

2. LITERATURE REVIEW

In advanced modern economies, the central bank's remit is typically to stabilize inflation at around two percent a year. Nonetheless, many central banks allowed inflation to approach or even exceed 10 percent a year starting in 2021, reaching a maximum in mid-2022. Inflation grew much faster than implied by the models employed by central banks and by most practical macroeconomists.

In Hall's opinion (2023), at times of a high volatility of price determinants – cost and productivity – inflation can jump upward and downward at a high speed, contrary to the uniformly sticky behaviour associated with traditional Phillips curves. Sectors with standard New Keynesian price stickiness are vulnerable to rapid transitions from stickiness to flexibility, as sellers elect to reset their prices and abandon anchoring. The cross-industry volatility of price determinants grew substantially in the inflation episode accompanying the pandemic. Volatility remained elevated even in late 2022. The logic of the New Keynesian model of the Phillips curve links inflation to volatility, because a larger fraction of sellers are pushed out of their regions of inaction when volatility is elevated. The New Keynesian Phillips curve becomes much steeper in volatile times.

The mechanism of enterprise reaction is very well identified, e.g., in the model by Yotzov et al. (2023), which considered the impact of published CPI data on the current perception of inflation by companies and inflation expectations for the next year in England, using the results for approximately 2,500 British companies from January 2019 to January 2023. These data were published in the Decision Marker Panel (DMP). The results from Yotzov et al. (2023) point to the following conclusions. First, the expected increase in corporate prices largely corresponds to the Bank of England's monetary policy decisions. That is, firms analyze the variable responses of price expectations during the periods of low and high inflation. Under the conditions of high inflation, firms change (adjust) prices more often than in the conditions of low inflation. Second, the firms' perception of current inflation was confirmed. Average CPI perceptions were between -0.5 and 0.4 percentage points away from the actual CPI inflation in each month from January 2022 to January 2023. For example, in January 2023 the annual CPI inflation rate was 10.1%, whereas the average CPI perception among DMP respondents was 9.8%. Nevertheless, there is a notable heterogeneity in perceptions at the firm level. Third, studies of the impact of published CPI results on companies' expectations bring mixed results. No significant impact was found on CPI expectations for the next year. The impact on CPI expectations (as an aggregate measure of price growth) depends mainly on changes in energy prices (according to 69% of the respondents). In contrast, there is a significant impact of the published CPI data on companies' own-price expectations (taken as a company-specific measure of price growth), including changes in the labor market situation and other non-energy costs. Confirmed, one-year ahead own-price expectations respond significantly to CPI outturns, with the effects being particularly strong since the start of 2022.

The following results of Yotzov et al. (2023) are worth highlighting: in 2022–23, CPI data releases have a positive and significant effect on firms' own expected price growth in the days following a data release. These results are quantitatively meaningful as well: a 1 percentage point increase in CPI is associated with an almost 1 percentage point increase in expected own-price growth in the days following a release. It should be noted that this strong reaction may decline over time.

Therefore, the nature of expectations formed by firms can have important implications for the path of inflation going forward. Indeed, inflation expectations play a key role in price setting behaviour in most modern macro models (Wernig, 2022, Coibon et. al 2020, Coibon et al. 2023, Binder, 2021).

Moreover, in the fight against inflation, a particularly difficult problem is the impact of dynamic and scale of price growth on the expectations of economic agents as to price dynamics in the future. This element is particularly important when there is a long-term price increase. It may turn out that because of the emergence and then consolidation of inflation expectations, the wage dynamics will "overtake" the price dynamics, eliminating not only the possible positive impact of creeping inflation on changes in real economic categories, but even causing a regression (Binder, 2021, Boissay, 2022, Binder, 2020, Barlevy, Hu, 2023, Glick, 2022, Gomes, 2023, Leduc, Liu, 2023).

It is worth recalling that counteracting the effect of inflation, while consolidating inflation expectations, was particularly difficult, e.g., in the 1970s when, because of the first and the second energy crises (1974-1975, 1979-1980), the rate of economic growth slowed down and unemployment increased. At that time, it was difficult to overcome inflation by the traditional methods of economic policy (Keynes, 1947) and to analyze it scientifically (Friedmam, 1959; 1970; 1984; Modigliani, 1977).

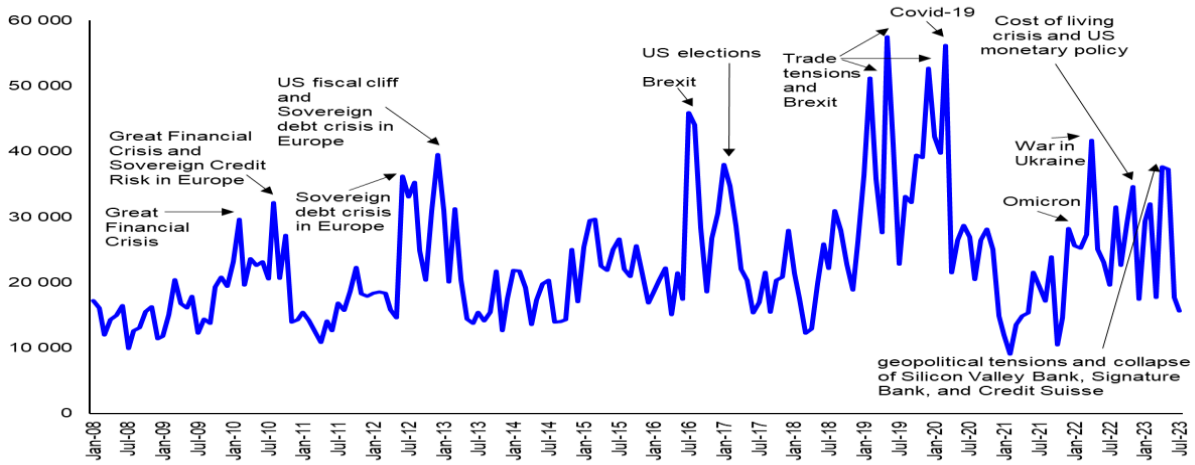


Figure 1.World Uncertainty Index, GDP weighted average in the period from January 2008 to July 2023

Note: This dataset includes the World Uncertainty Index (WUI) for 71 countries since January 2008 at a monthly frequency. Updated on July 28, 2023.

Source: https://worlduncertaintyindex.com/data/

An important study explaining the increase in enterprises' markups the American economy at the turn of 2021-2022 comes from Glover at al. (2023). The activities of a monopolistic enterprise adjusting its operation and pricing policy to increased marginal costs and higher demand were analyzed. The authors pointed out that companies raise prices (markups) because they expect higher costs to replace current inventory as it is sold, or in anticipation of higher marginal costs in the future, wanting to smooth out price increases over time, rather than raising them sharply and abruptly. Generally, a profit-maximizing monopolist chooses a price that equates marginal revenue with marginal cost, and any change in price leads to a loss of profits. Changes in firms' running marginal costs or demand for their products can contribute

to inflation as firms adjust their prices to maximize profits (Kosztowniak, 2023a; 2023b). The total price change can always be understood as the combined effects of changes in the marginal cost of production and changes in a firm's margin.

Markups may or may not contribute to inflation: when the monopolist's marginal costs increase, markups decrease; but when the demand for the monopolist's products rises, the markups increase (see also: Perry, 1982, Wang et al. 2013, Traina, 2018, Reich, 2022). More importantly, companies are are believed to raise their markups at present to mitigate price increases they expect in the future. This means that future costs may hike inflation at present, through markups.

Moreover, an empirical study by Glover at al. (2023) of the American market shows that in 2021, the increase in markups probably contributed to raising inflation by more than 50%, which was a much higher contribution than in the previous decade.

Similar questions were formulated for the Polish economy, regarding the degree to which CPI changes are explained by increasing markups, by means of the VAR model and variance decomposition analysis presented in the fifth chapter.

3. CHANGES IN THE COMPETITIVENESS OF ECONOMIES

The level of competitiveness of any economy is significantly influenced by changes in CPI, markups, and wages because they ultimately determine the amount of labor costs and terms of trade.

3.1. Markups, wages, and CPI

In the case of Poland, during the period of increased CPI dynamics (2019-2023), there were also large fluctuations in the markups of individual economic sections. Markups in terms of industry varied, nevertheless, they were highest in section B, mining and quarrying; after falling to -6% in Q2 2020, it later rebounded to 31% in Q2 2022 (which was a base effect). A similarly strong amplitude of fluctuation had occurred in Q4 2010 (41%) before. Other sections that achieved high markups, especially in Q2 2021, were mainly: section E - water supply, sewage, waste management, reclamation (13% in Q2 2021) - and D - electricity, gas and water generation and supply (15% in 2020), showing a decline in the subsequent quarters (5% in Q4 2022). As for the remaining sections, a high growth (reaching a maximum of 35% in Q1 2021) was recorded in section I, information and communication activities. In Q1 2022, the markups imposed in sections F (construction) and L (real estate services) experienced a decline, rising again in Q2 2022. The volatility of these markups is likely to continue and will depend on changes in supply and employment costs, on the business side, and on the consumers' income situation (Figure 2).

The changes in markups present in Poland had a significant impact on price changes in the economy, including mainly energy prices (i.e., sections B and D), prices of transportation services (sections H and G), or prices of industrial goods (section C and others in industry). Thus, changes in these prices influenced changes in the prices of the entire basket of goods and services, determining the dynamics of the CPI.

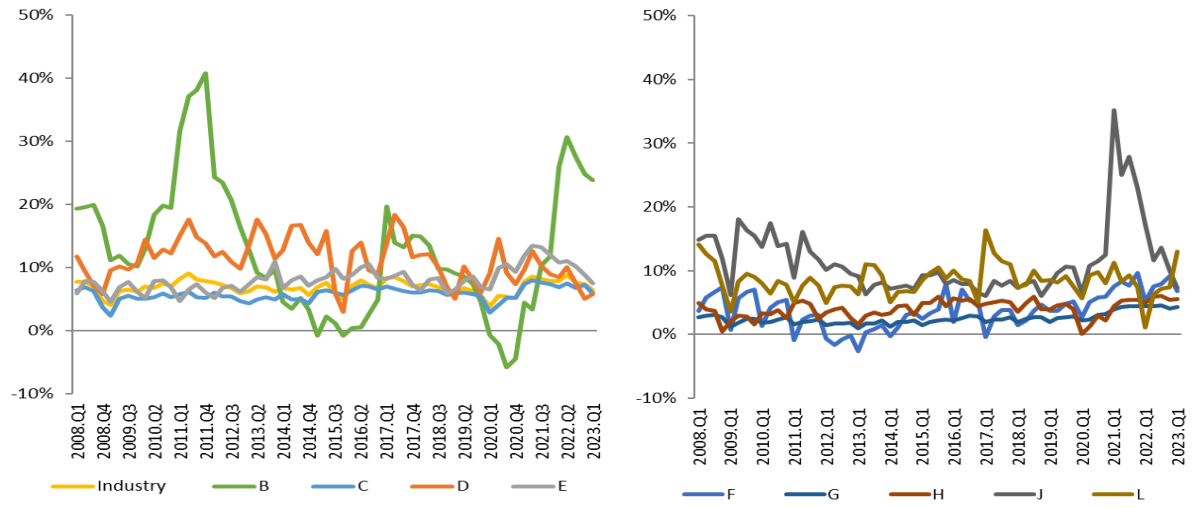


Figure 2. Gross markups in industry and other sections in Poland from 2008 Q1 to 2023 Q1 (%)
Note: Mining and quarrying (B), industrial processing (C), generation and supply of electricity, gas, steam, and hot water (D), water supply; sewage and waste management; reclamation (E), construction (F), trade and repair of motor vehicles (G), transport and warehouse management (H), information and communication (J) and real estate market service (L).
Source: The author's own calculations: SP (2023).

The conclusions of Yotzov et al. (2023) as well as of Hall (2023) regarding the rapid response of own price (markup) changes in case of accelerated CPI dynamics as an adequate prediction of inflation changes in the next 12 months confirm the actual CPI changes for Poland. During the periods of rapid CPI growth (2019-2022), companies were more likely to raise markups as well as wages in nominal terms (Figure 3).

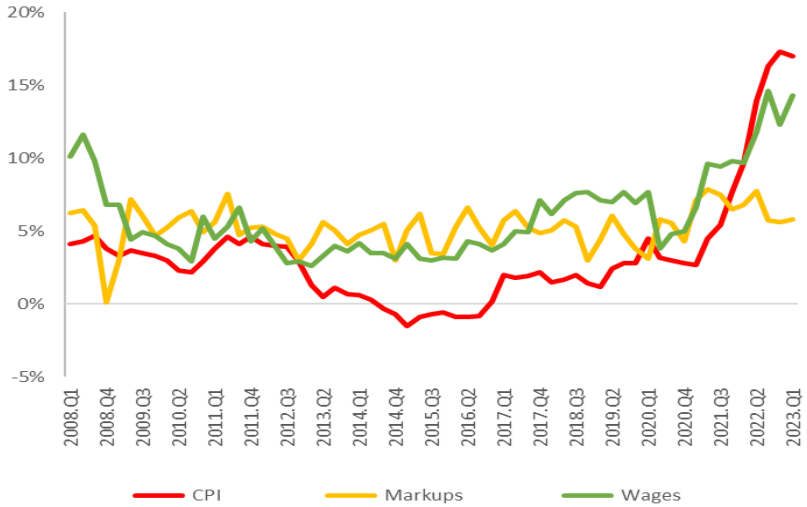


Figure 3. CPI and gross markups and wages in the enterprise sector in Poland in 2008Q1- 2023Q1 (%)
Source: The author's own calculations: SP (2023).

According to NBP's most recent data (2023), in the Q2 2023 CPI and core inflation excluding administrative prices amounted to 13.1%, core inflation to 11.6% excluding the most volatile prices of food (price inflation 18.8%) and energy (9.5%). The chief components determining the level of CPI inflation were: core inflation, prices of food and non-alcoholic beverages, and energy prices.

3.2. Labour cost

The impact of labor costs on inflation changes was studied by Shapiro (2023), who concluded labor-cost growth has a small effect on nonhousing service (NHS) inflation or on inflation overall. Estimates imply the recent surge in the employment cost index explains only about 0.1 percentage point (pp) of current elevated inflation readings, a negligible portion of the 3pp increase in the core PCE measure. Further analysis shows that changes in labor costs affect prices mainly through the supply channel. Namely, businesses tend to raise prices when wages rise because their costs increase, not because demand increases.

The results cast some doubt on the narrative that labor-cost growth is by itself an important driver of NHS price inflation. This leaves open other explanations for the high correlation between labor-cost growth and inflation. For instance, recent evidence shows that wage growth tends to follow inflation, as well as expectations of future inflation (Glick, Leduc, and Pepper 2022). Overall, the results highlight that recent labor-cost growth is likely to be a poor gauge of risks to the inflation outlook (see Barlevy and Hu, 2023).

In the context of market disturbances caused by the COVID-19 pandemic and the period of war in Ukraine, it is important to lower high inflation expectations and diagnose the causes of changes in other price indices that determine the inflation felt by consumers, since from the beginning of 2021, the core inflation and CPI indices in Poland (as well as in the world) have showed a clear upward trend to 2023.

After a period of relative stability in 2018-2020 and weak dynamics of labor cost changes, the end of 2021 saw the beginning of rapid labor cost changes in many EU countries and around the world. The effects of the above-mentioned price increases of various goods and services and the destabilization caused by the shocks resulted in a period of labor costs increasing in 2020-2021, then shrinking at the end of 2022 and rising again at the beginning of 2023 in Poland, among other places (Figure 4).

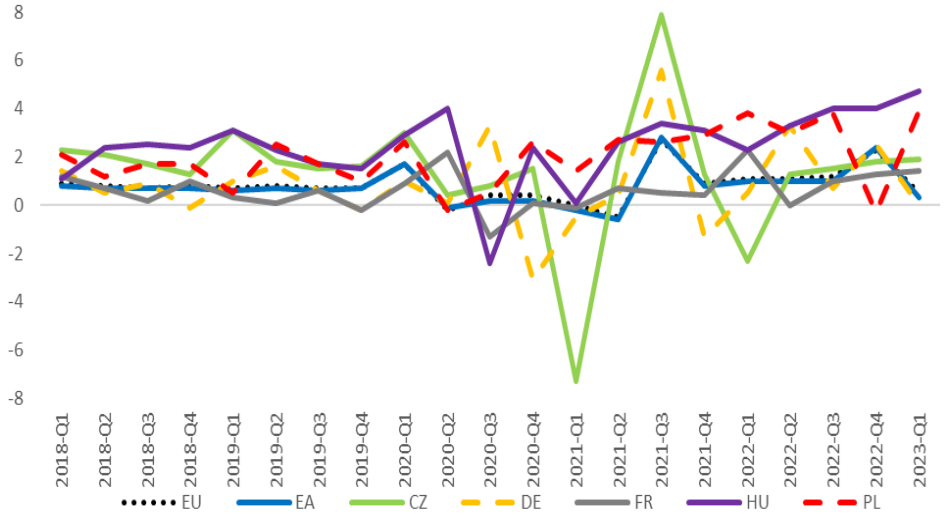


Figure 4. The diversified index of total labor costs in the EU and euro area countries in Q1.2018-Q1.2023
Source: Eurostat (2023), Labour cost index, https://ec.europa.eu/eurostat/databrowser/view/EI_LMLC_Q__custom_7025739/default/table?lang=en

It should be noted the detailed data for Poland regarding changes in the cost index were the result of similar changes both in terms of wages and salaries and other labor costs (pension contributions, sickness benefits, etc.) (Fig. 5).

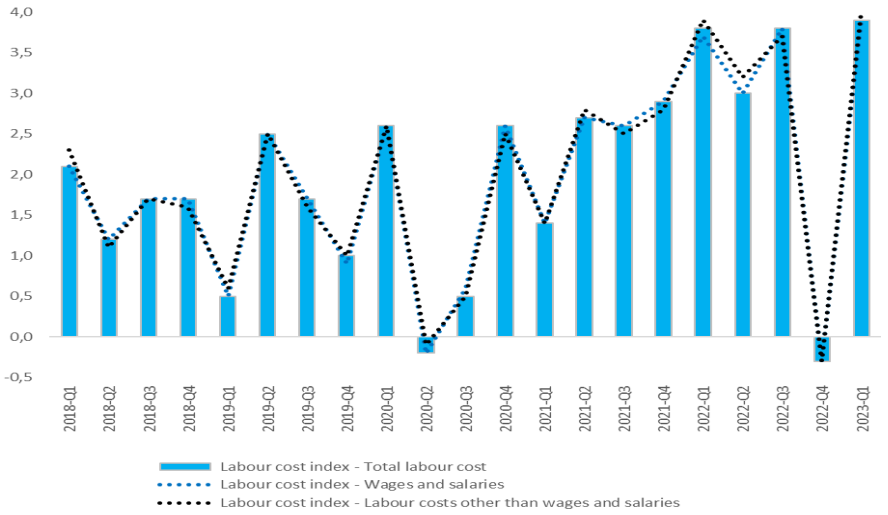
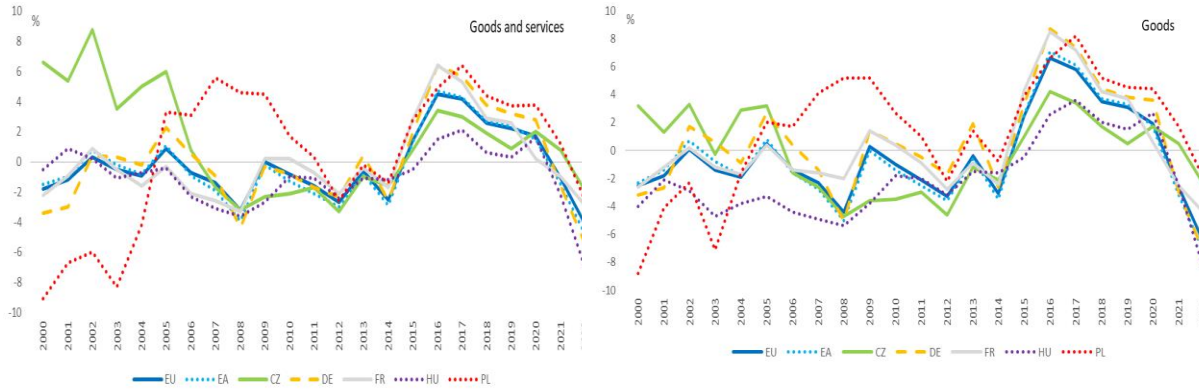


Figure 5. Labour cost indices in Poland divided into components in Q1.2018-Q1.2023
Source: Eurostat (2023), Labour cost index,
https://ec.europa.eu/eurostat/databrowser/view/EI_LMLC_Q__custom_7025739/default/table?lang=en

3.3. Terms of trade

Another indicator informing about the effects of final inflation changes on the economy are changes in the terms of trade. These conditions are important for competitiveness changes as they determine export revenues and affect the costs of importing goods and services. Thus, terms of trade affect the balance of trade and the entire balance of payments (including changes in the inflow/outflow of capital) and ultimately the contribution of trade to creating the added value of the economy. Considering that the share of trade in the GDP of most EU countries is on average 30-45%, terms of trade are an important parameter of competitiveness (Figure 6).



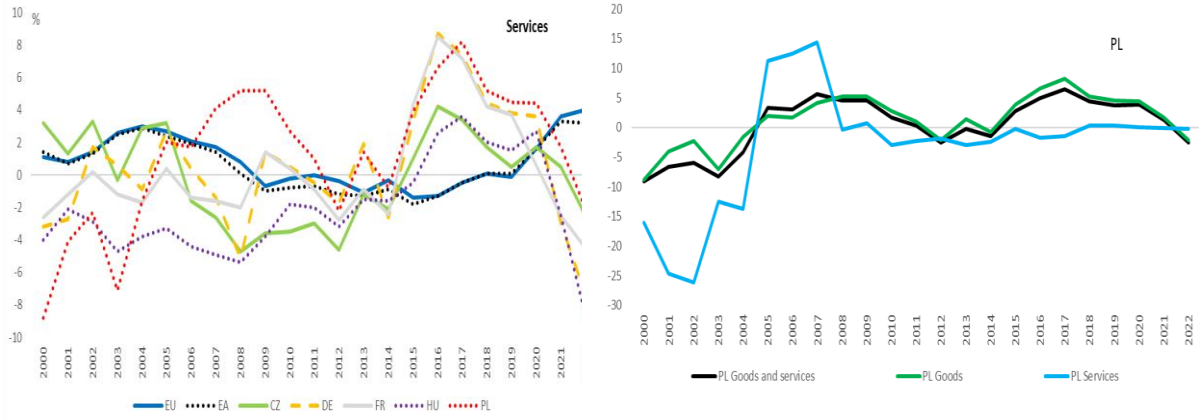


Figure 6. Terms of trade in selected countries in 2000-2022
Note: Terms of trade by items - 5 years % change, price index - t/t-5), based on 2015=100 and national currency.
Source: Eurostat (2023), https://ec.europa.eu/eurostat/databrowser/view/tipsna30/default/table?lang=en

The results of terms of trade changes for countries like the Czech Republic (CZ), Germany (DE), France (FR), Hungary (HU), Poland (PL), and the countries of the European Union (EU) and the euro area (EA) clearly indicate a convergence of changes in trade dynamics, especially in the period 2012-2023. It is worth noting, however, that this convergence concerns the exchange of terms of trade in goods and services (together) as well as goods, due to their dominant share in trade. As far as the terms of trade in services are concerned, especially for Poland, differences should be noted compared to, for example, the dynamics for EU countries and the euro zone.

4. METHODOLOGY

4.1. Data and model specification

To analyze the relationship between changes in CPI and markups in Q1.2008-Q1.2023 (61 quarters), a formula for the CPI function was developed:

$$d\_CPI_t = \propto_0 + \propto_1 d\_B_t + \propto_2 d\_C_t + \propto_3 d\_D_t + \propto_4 d\_E_t + \propto_5 d\_F_t + \propto_6 d\_G_t + \propto_7 d\_H_t + \propto_8 d\_J_t + \propto_9 d\_L_t + \xi_i \quad (1)$$

The explained variable: d_CPI_t – Consumption Price Index (%).

The nine explanatory variables as gross markups for activities by NACE sections (%):

d_B_t – mining and quarrying (%)
d_C_t – industrial processing (%)
d_D_t – generation and supply of electricity, gas, steam, and hot water (%)
d_E_t – water supply; sewage and waste management; reclamation (%)
d_F_t – construction (%)
d_G_t – trade and repair of motor vehicles (%)
d_H_t – transport and warehouse management (%)
d_J_t – information and communication (%)
d_L_t – real estate market service (%)
ξ_i – random component

t – period

Data came from the SP (2023) database. All the variables expressed in terms of percent points are included in the form of the first differences variables. Empirical analysis used e-Views. The descriptive statistics of the analyzed variables show that in terms of explained variables, markups from B section showed a greater variability (St. dev. 0.10645, C.V. 0.83468, Skewness 0.61312), than from the section J and D (Table 1).

Table 1

Summary statistics, using the observations 2008:1 - 2023:1

Variable	Mean	Median	Minimum	Maximum	Std. Dev.	C.V.	Skewness
CPI	0.033146	0.028000	-0.015000	0.17300	0.040250	1.2143	2.1182
B	0.127540	0.11127	-0.057453	0.40746	0.10645	0.83468	0.61312
C	0.057885	0.058873	0.024293	0.07942	0.010766	0.18600	-0.60010
D	0.111550	0.114190	0.030212	0.18401	0.035026	0.31399	-0.037291
E	0.081235	0.079866	0.045299	0.13429	0.019516	0.24024	0.65782
F	0.038815	0.038317	-0.026892	0.09698	0.028952	0.74589	-0.16086
G	0.025232	0.023452	0.0098462	0.04497	0.008978	0.35581	0.90363
H	0.040335	0.043793	0.0008148	0.06103	0.014006	0.34724	-0.76666
J	0.115240	0.097409	0.059998	0.35149	0.055285	0.47972	2.06610
L	0.084989	0.083347	0.010661	0.16397	0.025242	0.29701	0.27161

Source: The author's own calculations: eViews.

Stationarity was initially verified with the use of several tests (Table 3-4). To verify the stationarity of the analyzed time series, the Augmented Dickey-Fuller (ADF) test is used, estimated by means of the following regression equation:

$$\Delta_{yt} = \mu + \delta_{t-1} + \sum_{i=1}^{k} \delta_i y_{t-1} + \epsilon_t \quad (2)$$

The value of the test statistic: $ADF = \frac{\hat{\delta}}{S_{\hat{\delta}}}$

where $\hat{\delta}$ means the parameter evaluation and $S_{\hat{\delta}}$ is the parameter estimate error.

The results of the ADF test were inconclusive: some variables were non-stationary and others stationary, although for all there was a unit root appears a=1, process (1) (Table 2).

Table 2

Stationarity test results on the basis of the Augmented Dickey–Fuller (ADF) test, lag 10

Variable	Null hypothesis: unit root appears	with constant		constant and trend	
		test statistic: τ_ct (1)	asymptotic *p*-value	test statistic: τ_ct (1)	asymptotic *p*-value
d_CPI_t	a = 1; process I (1)	-1.13238	0.7052	-2.00042	0.6005
d_B_t		-6.62963	3.542e-007	-6.64438	2.971e-006
d_C_t		-7.82251	6.393e-009	-7.76621	6.966e-008
d_D_t		-10.6301	3.065e-021	-4.74748	0.0005386
d_E_t		-3.86745	0.002298	-3.77737	0.01765
d_F_t		-2.71694	0.07108	-3.47529	0.04203
d_G_t		-2.17966	0.2139	-3.64173	0.02639
d_H_t		-3.36577	0.01222	-3.31761	0.06333
d_J_t		-10.5792	6.889e-012	-10.4856	5.838e-011
d_L_t		-5.60783	9.913e-007	-5.50609	1.619e-005

Source: The author's own calculations: eViews.

To verify the conclusions based on the ADF test, the Kwiatkowski–Philips–Schmidt–Shin (KPSS) stationarity test is carried out, where the null hypothesis assumes sequence stationarity, whereas the alternative hypothesis assumes the occurrence of the unit root. The initial test model can take the following form:

$$\gamma t = \beta t + rt + \xi t \qquad (3)$$

where: $r_t = r_t–1 + u_t$, with ξ_t and u_t a stationary and a white-noise random component, respectively. On the other hand, the KPSS test statistic is calculated with the use of the formula:

$$KPSS = T^{-2} \sum_{t=1}^{T} (\sum_{t=1}^{t} e_i) / \hat{\delta}^2 \qquad (4)$$

where ei denotes residuals, and $\hat{\delta}^2$is a long-term variance estimator (Kufel, 2011).

An ultimate verification of stationarity requires an additional test, e.g., KPSS. Most variables showed stationarity, as the test statistic was below the critical values, although for different levels of probability (Table 3).

Table 3

The KPSS stationary test results

Variables	d_CPI	d_B	d_C	d_D	d_E	d_F	d_G	d_H	d_I	d_L
Test statistic	0.566136	0.106455	0.0492639	0.0747809	0.0934187	0.123053	0.298399	0.0840072	0.0537113	0.1309
Critical values	0.351 (10%), 0.462 (5%), 0.728 (1%)									

Note: T = 60, Lag truncation parameter = 3. Source*:* Own research.

Cointegration was verified using two tests, Engle-Granger and Johansen (Johansen 1991, 1992, 1995). Their results confirmed the absence of cointegration. This is evidenced by the values of the test statistic τ_e, which are below the critical values of τ_critical, i.e., the ranks are stationary in the absence of cointegration and at very low levels of asymptotic p-values (Table 4, Table 5).

Table 4

The results of the Engle–Granger co-integration test

Variable	Unit root appears	test statistic: τ_*ct* (1)	Asymptotic *p*-value
d_CPI_t	*a* = 1; process I (1)	-3.2049	0.01973
d_B		-4.3184	0.0004077
d_C		-6.81758	1.019e-009
d_D		-10.6301	3.065e-021
d_E		-9.39507	2.784e-017
d_F		-8.08694	2.775e-013
d_G		-7.38166	2.955e-011
d_H		-7.41291	2.416e-011
d_J		-5.92208	1.841e-007
d_L		-7.32663	4.208e-011

Source: The author's own calculations: eViews.

Table 5

Johansen test

Rank	Eigenvalue	Trace test	p-value	Lmax test	p-value	Trace test p-value
0	0.89124	722.82	[0.0000]	130.90	[0.0000]	722.82 [0.0000]
1	0.87043	591.93	[0.0000]	120.57	[0.0000]	591.93 [0.0000]
2	0.83605	471.36	[0.0000]	106.68	[0.0000]	471.36 [0.0000]
3	0.76994	364.67	[0.0000]	86.696	[0.0000]	364.67 [0.0000]
4	0.69893	277.98	[0.0000]	70.825	[0.0000]	277.98 [0.0000]
5	0.62955	207.15	[0.0000]	58.589	[0.0000]	207.15 [0.0000]
6	0.60755	148.56	[0.0000]	55.185	[0.0000]	148.56 [0.0000]
7	0.52806	93.379	[0.0000]	44.303	[0.0000]	93.379 [0.0000]
8	0.44344	49.076	[0.0000]	34.573	[0.0000]	49.076 [0.0000]
9	0.21793	14.503	[0.0001]	14.503	[0.0001]	14.503 [0.0002]

Note: Number of equations = 10, Lag order = 1, Estimation period: 2008:3 - 2023:1 (T = 59). Case 3: Unrestricted constant, Log-likelihood = 1927.04 (including constant term: 1759.6) Corrected for sample size (df = 48).
Source: The author's own calculations: eViews.

Despite the many modelling tools available (e.g. panel or probit models), the Vector Autoregression Model (VAR) was used in this study. The choice of the VAR model was determined by the lack of cointegration between the model variables; this fact determined that it was not possible to extend and transform the structural VAR into a Vector Error Correction Model (VECM). The VAR model has the advantage of allowing you to analyse interdependences between variables (causality) and response to impulses and to forecast phenomena in terms of variance decomposition . However, it lacks a division into exogenous and endogenous variables.

The lag order for the VAR model was determined by estimating the following information criteria: the Akaike information criterion (AIC), Schwartz-Bayesian information criterion (BIC), and Hannan-Quinn information criterion (HQC). According to these criteria, at maximum lag order 2, the best lag order 1 was accepted (Table 6).

Table 6

Values of the respective information criteria (AIC, BIC and HQC) VAR system

Lag	loglik	p(LR)	AIC	BIC	HQC
1	1728.82990		-55.821721*	-51.913984*	-54.299578*
2	1803.51743	0.00101	-54.948877	-47.488652	-52.042969

Source: The author's own calculations: eViews.

To analyze the stability of the VAR model, a unit root test was applied. The test indicates equation roots in respect of the module are lower than one, which means that the model is stable and may be used for further analyses.

The general form of the VAR can be written as (Kufel, 2011):

$$Y_{1t} = a_{10} + \sum_{i=1}^{p} a_{11i} Y_{1\,t-1} + \sum_{i=1}^{p} a_{12i} Y_{2\,t-1} + \ldots + \sum_{i=1}^{p} a_{1ki} Y_{kt-1} + \varepsilon_{1t},$$

$$Y_{2t} = a_{20} + \sum_{i=1}^{p} a_{21i} Y_{1\,t-1} + \sum_{i=1}^{p} a_{22i} Y_{2\,t-1} + \ldots + \sum_{i=1}^{p} a_{2ki} Y_{kt-1} + \varepsilon_{2t}, \quad (5)$$

$$Y_{kt} = a_{k0} + \sum_{i=1}^{p} a_{k1i} Y_{1\,t-1} + \sum_{i=1}^{p} a_{k2i} Y_{2\,t-1} + \ldots + \sum_{i=1}^{p} a_{kki} Y_{kt-1} + \quad \varepsilon_{kt}\,.$$

The VAR is a multi-equation econometric model consisting of k equations. There are no simultaneous correlations (interdependencies), and the set of explanatory variables consists of time-delay processes. In addition, the order of the lag is assumed to be the same in all processes and is p. The right-hand side of the model is the same in each equation, i.e., in our case, the explanatory variables are the CPI dynamics and the explanatory variables on the left-hand side are markups by NACE sections. Furthermore, the analysis uses the VAR model recommended for zonal (in our case quarterly) data, as the assumption of no contemporaneous relationship between quarterly data holds true for many economic categories.

To analyze the causal relationship between changes in markups and CPI dynamics in Poland in the period Q1.2008-Q1.2023, the VAR was used (Table 8). The following formula can be represented as:

$$CPI_t = \sum_{k=1}^{p} \alpha_k CPI_{t-k} + \sum_{k=1}^{p} \beta_k MARKUPS\ B_{t-k} + \cdots . + \sum_{k=1}^{p} \beta_k MARKUPS\ L_{t-k} + \mu_t \quad (6)$$

where:

CPI - average inflation rate in Poland, measured by the consumer price index,

$MARKUS$ - markups for analysed NACE sections (B, C, D, E, F, G, H, J, L),

μ - residual component,

t - analysis period,

k - number of variable lags.

In the subsequent steps, the verification of the consistency of the VAR model parameters involved an autocorrelation test (portmanteau Ljung-Box, to 4th lags), a reliability quotient test (the significance of successive lags of all variables in each equation), a normality test of the residuals distribution (Jargue-Bera), and causality tests in the Granger sense. The results of the tests confirmed the validity of the use of the VAR model, the choice of variables, lags, and restrictions.

The results of the VAR model indicate that the highest contribution to explaining changes in the CPI came from the company's own previous CPI changes, followed by markups from the real estate (L) and mining and quarrying (B) sections. The model's R^2 explanation rate was 47.44%, with an adjusted R^2 of 36.49% and DW = 2,177 (Table 7).

Table 7

The VAR system

Determinant of covariance matrix = 5.8974262e-039 AIC = -55.9187; BIC = -52.0453; HQC = -54.4067			Portmanteau test: LB(14) = 1428.88, df = 1300 [0.0069]		
Equation 1: d_CPI	***Coefficient***	***Std. Error***	***t-ratio***	***p-value***	
const	0.00084896	0.0010787	0.7870	0.4352	
d_CPI_1	0.439887	0.126381	3.481	0.0011	***
d_B_1	0.0645287	0.0265653	2.429	0.0189	**
d_C_1	0.174748	0.186327	0.9379	0.3530	
d_D_1	−0.024034	0.0352119	−0.6826	0.4982	
d_E_1	0.0379985	0.0957396	0.3969	0.6932	
d_F_1	−0.024160	0.0694050	−0.3481	0.7293	
d_G_1	0.1430020	0.315686	0.4530	0.6526	

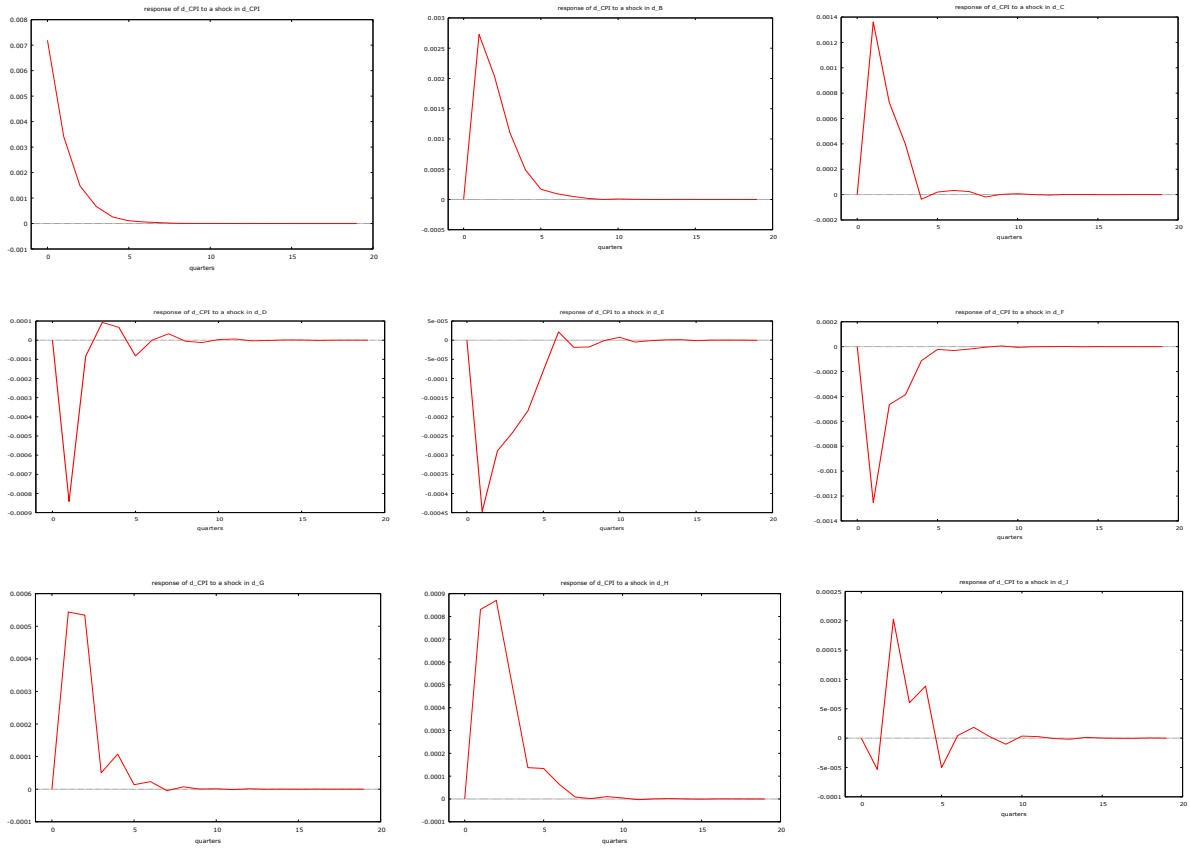
d_H_1	0.1530600	0.128661	1.190	0.2400	
d_J_1	0.0004506	0.0313263	0.01438	0.9886	
d_L_1	−0.1430160	0.0467669	−3.058	0.0036	***
Mean dependent var	0.002153		S.D. dependent var	0.010004	
Sum squared resid	0.003050		S.E. of regression	0.007972	
R-squared	0.474469		Adjusted R-squared	0.364983	
F(10, 48)	4.333610		P-value(F)	0.000246	
rho	−0.094192		Durbin-Watson	2.177152	

Note: Lag order 1, Maximum likelihood estimates, observations 2008:3-2023:1 (T = 59); * $p< 0.1$, ** $p< 0.05$, *** $p< 0.01$. *Source:* The author's own calculations: eViews.

5. EMPIRICAL RESULTS AND DISCUSSION

5.1. Impulse response functions

An analysis of the CPI's response to its own CPI-derived shocks indicates positive and declining impulses after the 5th quarter forecast. CPI responses to shocks derived from markups reveal that these responses are positive for the markups of B, C, G, H and J sections, but negative for impulses from D, E, F, and L sections. The positive CPI response was strongest to shocks originating from the H and G sections, i.e. activities including services and fuel price (as during the COVID-19 pandemic). The responses of the CPI to the markup shocks surveyed indicate that their impact was short-time, although sharp around the 2nd-3rd quarters of the analysis, declining very quickly in the 4-5th quarters, and stabilising in the 6th quarter. This means that the impact of markup changes on the CPI can be felt for about one year (Figure 7).



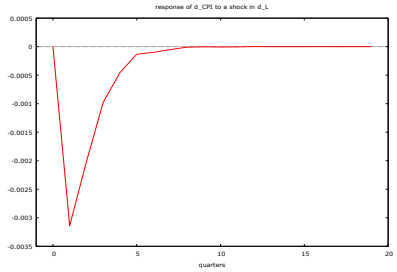


Figure 7. Impulse responses to a one-standard error shock in CPI and markups
Source: The author's own calculations: eViews.

5.2. Variance decomposition

CPI and markups were analyzed by means of variance decomposition in the forecast horizon of 20 quarters (5 years). The results of CPI decomposition indicate that, in the short-term perspective of the 1st period, these changes are fully (100%) accounted for with their own forecast errors. In the 2nd period, their own changes decline (to 3.7%) and there was a growing degree of clarification from the section markups, especially L (11.5%), B (8.7%) and (2.1%). However, in the long-term, it`s in the 20th period CPI's own changes decrease (to 64.6%) and the degree of its explanation by total markups rises (35.4%), including mainly the part of markups in sections: L (14.8%), B (12.8%), C (2.5%) and F (1.9%) These four sections were the pillars of explanations of CPI changes, in total close to 32%. Moreover, only two sections, i.e., L (real estate market service) and B (mining and quarrying), explained about 27.6% of CPI changes. The lowest level of explanation of CPI changes was shown by markups in sections: J, G, E, D (below 1%) (Table 8).

Table 8

The decomposition of variance for CPI in the 20 periods

	d_CPI	d_B	d_C	d_D	d_E	d_F	d_G	d_H	d_J	d_L
1	100	0	0	0	0	0	0	0	0	0
2	73.6929	8.6607	2.1561	0.8245	0.2324	1.8242	0.3438	0.8023	0.0033	11.4598
3	66.6901	11.7845	2.4236	0.7284	0.2881	1.8163	0.5908	1.4724	0.0447	14.161
4	65.0014	12.6007	2.503	0.7136	0.3359	1.9053	0.5744	1.6735	0.0468	14.6453
5	64.6828	12.7606	2.4895	0.7138	0.3670	1.9063	0.5824	1.6821	0.0542	14.7613
6	64.6355	12.7771	2.4876	0.7198	0.3728	1.9051	0.582	1.6980	0.0567	14.7653
7	64.6202	12.7825	2.488	0.7196	0.3732	1.9055	0.5824	1.7015	0.0567	14.7706
8	64.6153	12.784	2.4883	0.7206	0.3735	1.9057	0.5824	1.7014	0.0570	14.7718
9	64.6146	12.7842	2.4886	0.7207	0.3738	1.9056	0.5824	1.7014	0.0570	14.7717
10	64.6143	12.7842	2.4886	0.7208	0.3738	1.9057	0.5824	1.7015	0.0571	14.7717
11	64.6142	12.7842	2.4887	0.7208	0.3738	1.9057	0.5824	1.7015	0.0571	14.7717
12	64.6141	12.7842	2.4887	0.7209	0.3738	1.9057	0.5824	1.7015	0.0571	14.7717
13	64.6141	12.7842	2.4887	0.7209	0.3738	1.9057	0.5824	1.7015	0.0571	14.7717
14	64.6141	12.7842	2.4887	0.7209	0.3738	1.9057	0.5824	1.7015	0.0571	14.7717
15	64.6140	12.7842	2.4887	0.7209	0.3738	1.9057	0.5824	1.7015	0.0571	14.7717
15	64.6140	12.7842	2.4887	0.7209	0.3738	1.9057	0.5824	1.7015	0.0571	14.7717
17	64.6140	12.7842	2.4887	0.7209	0.0373	1.9057	0.5824	1.7015	0.0571	14.7717
18	64.6140	12.7842	2.4887	0.7209	0.3738	1.9057	0.5824	1.7015	0.0571	14.7717
19	64.6140	12.7842	2.4887	0.7209	0.3738	1.9057	0.5824	1.7015	0.0571	14.7717
20	64.6140	12.7842	2.4887	0.7209	0.3738	1.9057	0.5824	1.7015	0.0571	14.7717

Source: The author's own calculations: eViews.

DISCUSSION

Changes in enterprise markups significantly affect the level of inflation and competitiveness changes in the economy. What matters are the strength and scale of the impact of markup changes, especially in business sectors related to industry (construction, transport, mining, and quarrying). Spillover effects then become visible in the economy and may be more severe. A higher increase in prices (markups) from sectors important for the domestic economy and trade (export/import) impairs competitiveness. The rising markups of enterprises, often hedging themselves against the expected inflation increases, and desiring to improve profits (2021-2023), resulted in greater labor costs in Poland and many other European countries, poorer terms of trade in goods and services, as well as exchange rates fluctuations (depreciation). The impact channel of the markup increase was significant due to the scale of influence on numerous macroeconomic conditions, including the eventual deterioration of payment balances.

In Poland, the rise in enterprise inflation expectations was due to expected increases of production costs, including the cost of raw materials and services, and rising wage demands, especially in 2020-2022. The precautionary motivations of enterprises determined the growth of markups in various sections, depending on market demand and the competitive structure in the industry and market, like in other developed countries, as highlighted by Coiben et al. (2023), Werning (2022), Binder, (2021) or Coiben et. al (2020).

As indicated by the results of the NBP's survey of companies' expectations in Poland in 2008-2023 regarding future inflation (in a 12-month perspective), these expectations are very accurate when verified against real inflation. This means that entrepreneurs are rationally undertaking their adjustment measures. As indicated by statistical data for Poland and a number of studies in the period 2021-2023, high inflation dynamics are also accompanied by a rapid response of mark-up raising by enterprises (e.g. Shapiro, 2022, Barnichon, Shapiro, 2022, Yotzov et al. 2023, as well as Hall, 2023, Coibion et al., 2023). In addition, companies operating in monopoly or oligopoly structures can afford to raise markups faster because the low level of competition allows them to do so (as emphasized e.g. by Glover, Mustre-del-Río and Ende-Becker, 2023, Reich, 2022, Traina, 2018, Wang et al. 2013, Perry, 1982). Moreover, during the COVID-19 pandemic, the war in Ukraine, and the energy crisis, rocketing fuel and commodity prices and disrupted supply chains further stimulated margin expansion in the hardest hit industries.

Among the implications of growing markups for in real-time processes in the conditions of increasing inflation expectations, it is worth indicating some more important consequences for economic entities, consumers, as well as monetary and fiscal policy.

First of all, for enterprises raising markups, their growth means short-eyed profits or covering the costs of operations, but also the pressure of stocks before another increase in prices of services, works or raw materials and the uncertainty of new investments. For entities cooperating with companies raising markups, this means higher operating costs, liquidity problems or payment grinders.

Secondly, for consumers, e.g. households, it means rising maintenance costs, shopping pressure from subsequent expensive increases in markups, as well as an expected falling consumer demand in the future.

Thirdly, growing markups drive employees' payroll demands, which causes the effects of pay-price push, i.e. an increase in production on the part of employers.

Fourth, interest rates increases by the central bank to combat CPI hikes loan interest rate in commercial banks, i.e. an increase in the costs of their service on the side of borrowers (enterprises and households), and finally shrinking investments and consumer demand.

Fifth, it changes the valuation and profitability of bonds, financial and material assets, which has long-term consequences and makes it difficult to combat inflation with monetary policy.

Sixth, the competitiveness of exported goods and services collapses, which means falling income of exporting enterprises and revenues to the state budget from taxes (CIT, custom duties, and others).

Thus, there are many effects of markup growth. The problem arises when enterprises boost their markups at present to alleviate expensive price increases they expect in the future, but the dynamics and frequency of this markup growth are significant in the short run because the expected costs increase inflation at present, through markups. The mechanism of a self-propelled price spiral is set in motion, hard to fight, since it consolidates the inflation expectations of all market participants and makes it difficult for the monetary authorities to reduce CPI. An overly restrictive monetary policy can lead to higher unemployment and the need of financing benefits from the state budget and local authorities, which finally slow down economic growth.

Therefore, the question should be formulated, what should decision- and policymakers do in this situation? Considering the complex foundations of the subsequent crises of pandemia, energy and war conflict driving production costs up, the various tools of policy mix should be used. As far as monetary policy is concerned, the information policy on interest rates changes and the period of reaching the inflationary goal is important. As for fiscal policy, it will be important to support enterprises in reducing their operating costs (purchases of raw materials, energy prices, periodic exemptions from taxes, payments for employee remuneration, and others). In the market economy, policymakers may not directly shape the price policy of enterprises (decisions in the field of markups) but may affect business conditions in the monetary and fiscal dimensions.

Moreover, this study focused on the impact of markup growth on CPI, but inflation changes can arise for a number of reasons, most importantly, the demand gap and expansive budget policy stimulating expenditure in the economy, i.e. demand inflation, supply shocks caused by changes in the productivity of enterprises (in addition to energy shocks causing changes in gas, energy, and other prices, the market structures of producers (De Loecker, 2018; Reich, 2022), demand shocks caused by changes in consumer behavior, or import of inflation through the purchase of goods and services from abroad (Wang et. al., 2013).

5. CONCLUSION

The results of these empirical and econometric analyzes suggest the following conclusions for Poland. In 2020-2023, most enterprises in Poland, like in the USA or EU countries, increased their markups (Hall, 2023). In the case of Polish enterprises, the highest dynamics of markups were recorded for the energy sections (B, the mining and quarrying section, and D electricity, gas and water production and supply), transport services (H transport and storage and G, trade and repair of motor vehicles) and the industrial section (C).

The analysis of impulse responses indicates that own shocks had the largest share in explaining CPI responses. This impact was positive but declining after the 5th quarter of the forecast, with a stabilizing trend in the subsequent periods. CPI responses to overhead shocks reveal that CPI responses are positive to markup impulses from sections B, C, G, H, and J, while these responses are negative to impulses from sections D, E, F, and L. The strongest positive CPI response occurred in the case of shocks from sections H and G, i.e., activities involving services and sensitive to fuel prices and interrupted supply chains (similar to the COVID-19 pandemic). CPI reactions to the shocks of the markups surveyed indicate that their impact was short-time, the strongest around the 2nd-3rd quarters of the analysis, falling in the 4th-5th quarters, and stabilizing in the 6th quarter. This means that the impact of individual markup changes on CPI is felt for about one year.

The results of CPI decomposition indicate that in the 1st period, these changes are fully (100%) accounted for with their own forecast errors. In period 2, their own changes decline (73.7%) and there is a growing degree of clarification from the section markups, especially L (11.5%), B (8.7%) and (2.1%). In the 20th period, CPI's own changes decrease (to 64.6%) and the degree of its explanation by total markups improves (35.4%), including mainly the part of markups in sections: L (14.8%), B (12.8%), C (2.5%) and F (1.9%) These four sections were the pillars of explanations for CPI changes, in total close to 32%. Moreover, only two sections, L (real estate market service) and B (mining and quarrying), explained about 27.6% of CPI changes. That means sections L and B are the most pro-inflationary, least stable. The lowest level of explanation of CPI changes was shown by markups in sections: J, G, E, D (below 1%), that is, these sections are the least pro-inflationary, most financially stable.

In general, these results of empirical research indicate a positive verification of the hypothesis that "Changes in markup dynamics in the sections of significant magnitude for the national economy, which show numerous links to various activities, as well as the sections most sensitive to changes in operating costs have the greatest impact on changes in the CPI, and thus on changes in the economy's competitiveness. This means that an increase of markups in sections crucial to the economy and the most sensitive to changes in operating costs can significantly undermine this competitiveness, and vice versa. Therefore, both the central bank and the fiscal authorities should constantly diagnose the situation in these sections, as part of the so-called "policy-mix".

As the results concerning the contribution of markup changes at the section level to CPI changes have practical significance, future research should focus on even more disaggregated data. Therefore, an analysis of CPI changes at the level of business activity markups, i.e., of 4 NACE, could bring interesting results.

ACKNOWLEDGEMENT

The authors are thankful to the SGH Warsaw School of Economics for financial support to carry out this research within the project No. KZiF/ S24:1.31 "Transformation processes of sustainable banking in the EU under ESG, climate policy and macroprudential policy changes".

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