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The impact of markups and wages on changes in the level of inflation in Poland**

1. Introduction

In order to limit the negative impact of price increases on real economic processes, many central banks treat the fight against inflation as a key priority of their economic policy. Anti-inflation policy evolves from a Keynesian (demand) approach using fiscal policy tools, through a monetarist (supply) approach focused on regulating the amount of money, to comprehensive monetary policy instruments, including mainly interest rates, open market operations, reserve requirements or non-standard instruments of portfolio reduction bonds and others.

Isolating the most effective ways and tools to fight inflation is not easy, taking into account the unprecedented overlapping of numerous events such as the aforementioned COVID-19 pandemic and the energy crisis related to Russia's aggression in Ukraine. These events caused numerous disturbances in the monetary and fiscal spheres, business activity (in the areas of supply chains or investment policy in the domestic sector and foreign trade), as well as in the functioning of households (in the area of employment or income). They were the source of numerous shocks of an exogenous and endogenous nature, on which financial policy in the short and medium term often has a limited impact, resulting in the consolidation of inflation expectations in the economy.

This situation forces us to verify the existing theoretical and empirical studies on the determinants of the CPI and the channels of influence. Identifying whether we are dealing with demand or supply inflation, short- and long-term paths of inflation/disinflation in accordance with the model Philips curve. This situation

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also compels us to model inflation determinants not only focused on changes in the level of core inflation, fuels, energy, food, but more broadly, taking into account inflationary impulses from the enterprise sector and the labor market, e.g. in terms of markups and wages.

Literature information from recent years (after the outbreak of COVID-19) indicates that enterprises are trying to hedge against inflation, e.g. in the form of raising markups and employees in the form of wage increases to compensate for the decline in the purchasing power of nominal wages. The aforementioned increase in markups and wages, resulting from prudential motives, has an impact on the supply and demand side on price growth, making it difficult and extending the time needed to lower inflation.

The aim of the study is to analyze the impact of markups and wages of enterprises on changes in the level of inflation in Poland in the years 2007–2022.

The following research hypothesis was formulated: The increase in inflation expectations and future production costs in the economy stimulated the growth of enterprises' markups, limiting the effectiveness of measures to counteract inflation in Poland between 2007–2022.

Among the research methods available, the analysis of literature studies in the field of monetary policy and statistical analysis methods based on data published by the National Bank of Poland (NBP) and the Central Statistical Office (CSO) were used. The impact of markups and wages on changes in CPI were assessed using the VECM model, the impulse responses and variance decomposition.

2. Literature review

In the process of formulating monetary policy, including the assessment of inflation processes in the economy, central banks use numerous inflation measures, including core inflation indices, which, albeit with varying degrees of precision, allow us to approximate the unobservable trend of increasing the general price level. Core inflation is that part of inflation which is related to inflation expectations and demand pressure and which is not directly dependent on supply shocks. Its advantage is that it approximates the medium- and long-term trend in the growth of prices of consumer goods and services (Consumer Price Index, CPI) in the economy.

Core inflation shows the tendencies of their changes which are less subject to seasonal fluctuations and those resulting from supply shocks, which are most often of a temporary nature. In addition, it indicates the part of inflation which is more closely related to the monetary policy pursued than in the case of other parts and is useful in (ex-post) analyzes of the direction and scale of the impact of the pursued monetary policy on inflation and its measures, which are generally less volatile in than the CPI inflation rate (NBP 2023a, 2023b).

In the fight against inflation, a particularly difficult problem is the impact of price increases 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 as a result of the emergence and subsequent consolidation of inflation expectations, the wage dynamics will “overtake” the price dynamics, not only eliminating the possible positive impact of creeping inflation on changes in real economic categories, but even causing a regression. Counteracting the effect of inflation, while consolidating inflation expectations, was particularly difficult, e.g. in the 1970s and 1980s. As a result of the first and later second energy crisis (1974–1975, 1979–1980), the rate of economic growth slowed down and unemployment increased. At that time, it was difficult to overcome inflation by traditional methods of economic policy (Keynes 1947) and to analyze it scientifically (Friedman 1959, 1970, 1984; Modigliani 1977).

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) showed a clear upward trend. Finally, in Q1 2023 in Poland, these indicators reached the following levels: CPI and core inflation excluding administrative prices will reach 17%, core inflation 15%, mean trimmed 16%, respectively, excluding most volatile prices 15% and food and energy prices 12%. The main components determining the level of CPI inflation were core inflation, prices of food and non-alcoholic beverages and energy prices (CSO 2023; NBP 2023b).

A strong inflation impulse caused by the increase in the cost of energy raw materials affects the increase in the prices of many goods and services, determining the increase in production costs, and in subsequent stages may cause a markup-wage spiral as well as a price-wage spiral (especially from Q2 2021). Thus, these impulses in Poland contribute to fueling inflationary processes, making it difficult to combat. Just like the current energy crisis, the previous energy crises were also a challenge for many monetary institutions, including those in the largest economies such as the USA, Great Britain, France, or Japan (Kosztowniak 2022, 183–210).

In addition to the aforementioned inflation expectations or energy crises, the following are listed among the main causes of inflation in the theoretical and empirical output:

- Demand gap and expansionary budgetary policy stabilizing the economic situation or stimulating (sustaining) an increase in expenditure in the economy (demand-pull inflation), resulting in an unbalanced state of public finances (Okun 1970).

- Supply shocks – in the form of changes in productivity, changes in oil resources, or changes in food resources, caused by weather changes or interruption of supply chains, as at the beginning of the COVID-19 pandemic; changing both the quantities of goods and their prices that are delivered to the market (Dudek 2008, 71–84).
- Demand shocks – reflecting changes in consumer behavior on the demand side as a result of changes in preferences or resulting from consumer decisions (Dudek 2008, 85–92).
- Existing market structures of producers on the market or in the branch producing goods and services (e.g. monopoly, oligopoly or other) – determining the possibility of shaping the price, supply, demand and, as a result, the size of the surplus of producers and consumers on the market (Perry 1982, 197–205; Foster et al. 2008, 394–425; Traina 2018; Dąbrowski 2016, 108–112; De Loecker, Unger 2020; Kosztowniak 2023).
- Import of inflation in the form of purchase of goods and services from abroad (the scale depends on the share of imports in GDP) (Wang et al. 2013).
- Development of the so-called wage-price-push in the conditions of increasing wage demands from employers by employees or competition for the distribution of newly created value, or an increase in wage-price spiral risks in the period after the COVID-19 pandemic (IMF 2022, 51–69; Boissay et al. 2022).

3. Empirical research review

One of the interesting studies explaining the increase in margins by enterprises at the turn of 2021–2022 in the American economy is the study conducted by Glover, Mustre-del-Rio and Ende-Becker (2023, 1–13). The activities of a monopolistic enterprise adjusting its activity and pricing policy to the increase in 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 the demand for their products can contribute to inflation as firms adjust their prices to maximize profits. The total price change can always be understood as the combined effects of changes in the

marginal cost of production and changes in the 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 increases, the markups increase.

The more important findings include the statement that companies raise their markups in the present to mitigate price increases they expect in the future. This means that future costs may increase inflation in the present, through markups.

The empirical research by A. Glover, J. Mustre-del-Rio and A. Ende-Becker (2023, 11) on the American market shows that in 2021 the increase in markups probably contributed to the increase in inflation by over 50%, which was a much higher contribution than in the previous decade. However, they note that the margin itself is held back by a number of unobservable factors, including changes in demand, but also changes in firms' expectations of future marginal costs. The decline in markups in the first half of 2022 (even as inflation hit high levels again) was consistent with companies raising markups in 2021 in anticipation of future cost pressures. They also found that the increase in markups was similar across industries, with very different relative inflation rates in 2021, which was also consistent with the aggregative increase in expected future marginal costs. They also stressed that the increase in markups was likely a signal that price setters expect a steady increase in future production costs.

The risk of the expected wage-price spiral may vary in intensity in individual EU countries. From previous analyzes, Boissay et al. (2022) finds that the correlation between wage growth and inflation has decreased in recent decades, and that other institutional factors, such as a high degree of firm pricing power, declining bargaining power, and declining trade union membership, seem to limit the risk of a wage-price spiral developing.

As regards the growing wage pressure, important conclusions were also presented by the International Monetary Fund (IMF) in the World Economic Outlook report from 2022. It indicated that rising inflation, positive growth in nominal wages, falling real wages and falling unemployment characterized the macroeconomic situation in 2021 in many economies around the world. Although unusual, such conditions are not "unprecedented" because there have been 22 similar episodes in the group of developed economies analyzed over the past 40 years (and in several over the past 60 years).

According to the IMF, many economies have seen price inflation skyrocket since 2021 as adverse "supply shocks" hit the global economy and labor markets were tense in the wake of the severe COVID-19 shock. The Fund notes that the

rise in inflation has raised concerns among some observers that prices and wages may begin to feed each other and accelerate, leading to wage-price dynamics. However, empirical analyzes and models based on real firm costs of historical episodes similar to the current one suggest that they were not usually followed by a wage-price spiral. In fact, on average, inflation then gradually declined, with nominal wages gradually catching up over several quarters. However, in some cases inflation remained high for some time.

The Fund indicated that wage dynamics in 2020 and early 2021 were poorly explained by inflation expectations, and the stagnant labor market situation likely reflected an unusual constellation of shocks caused by the COVID-19 pandemic. Model-based analysis of wages and prices in 2020–2021 shows different underlying shocks, i.e. wages were effectively driven by capacity and labor supply shocks, while private saving was important for price developments. In the second half of 2021, wage growth was relatively well explained by inflation expectations and the workforce. Real wages have been flat or declining on average in all economies. The IMF stresses that this is an important aspect of the current economic climate, as falling real wages can have a disinflationary effect, lowering market slack on average, potentially indicating this gradual shift towards more normal economic dynamics. Of course, this shift is highly dependent on whether earlier shocks “retract” and whether “new” shocks emerge.

In addition, the analyzes indicate the key role of the process of shaping expectations in determining wage and price prospects. When wage and price expectations are more retrograde, monetary policy action needs to be more front-on to minimize the risk of inflation becoming de-anchored. As monetary policy is tightened more aggressively and the fall in real wages helps to reduce price pressures, according to the scenario analysis, the risk of a persistent wage-price spiral in the current period is moderately limited, assuming no more persistent inflationary shocks or structural changes in the formation processes of wages and prices (such as a sharp increase in the shift from prices to wages or vice versa).

Determining the optimal response of monetary policy depends on whether the central bank minimizes the welfare function that balances output and inflation deviations or knows the process of shaping expectations and has full information on future cost shocks (IMF 2022).

4. Changes in markups and wages by sector in Poland

Comparing the dynamics of gross markups in the enterprise sector and the CPI in Poland in 2007–2022, it is noteworthy that the dynamics of markups

are usually higher than inflation (CSO 2023). From Q4 2012, when both indices amounted to 3%, there were reverse trends (increasing markups and falling CPI) to Q4 2019 and Q4 2020, when they amounted to 4%. Since Q3 2022, these trends have reversed, with inflation showing a strong increase accompanied by a decrease in gross markups. The growth period of gross markups was from Q3 2021 (3%) to Q2 2022 (8%), followed by a decline to 6% in Q3 2022. If the restrictive impact of the key NBP interest rates and other conditions anti-inflationary measures start to work, a decrease in CPI is expected (Fig. 1).

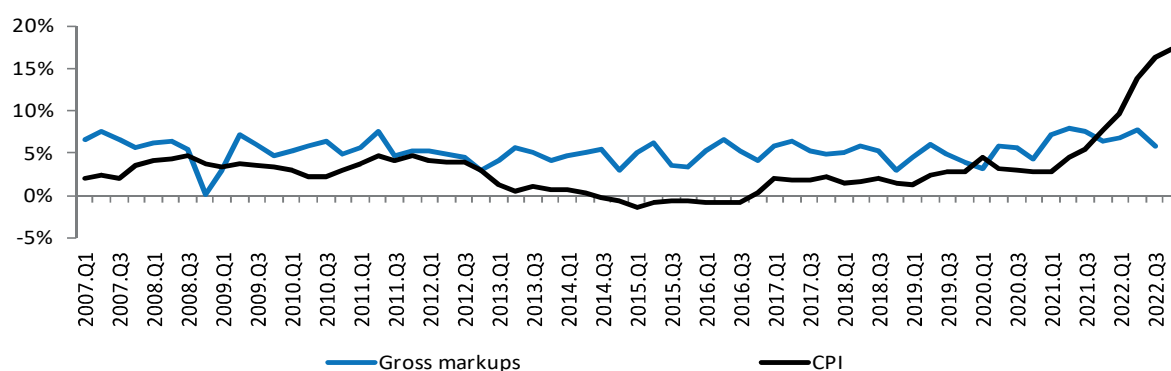


Figure 1. Gross markups in the enterprise sector and CPI in Poland in 2005–2022 [%]

According to the data of the Central Statistical Office for the years 2007–2022, the dynamics of markups in the industry sector (C) in Poland was varied, however, the dynamics of markups in the mining and quarrying section showed the greatest fluctuations. After a decrease in this dynamics in Q2 2020 (–6%), it was later strongly rebounded to 31% in Q2 2022 (which was the effect of the base after the COVID-19 pandemic, as in the situation related to the energy crisis, after the war in Ukraine broke out. Among the other sections of the industry sector, which also achieved high markups, especially in Q2 2021, the following should be noted: water supply, sewage and waste management, reclamation (section E) and generation and supply of electricity, gas, and water (section D) showing a decline in subsequent quarters. Among the other sections, high growth (reaching a maximum of 35% in Q1 2021) was recorded in information and communication activities (section J). In Q1 2022, the imposed markups achieved in construction (F) and real estate market services (L) recorded a decrease, rising again in Q2 2022. The volatility of these markups is likely to persist and will depend on changes in supply and employment costs, after on the side of enterprises and on the side of consumers from their income situation (Fig. 2).

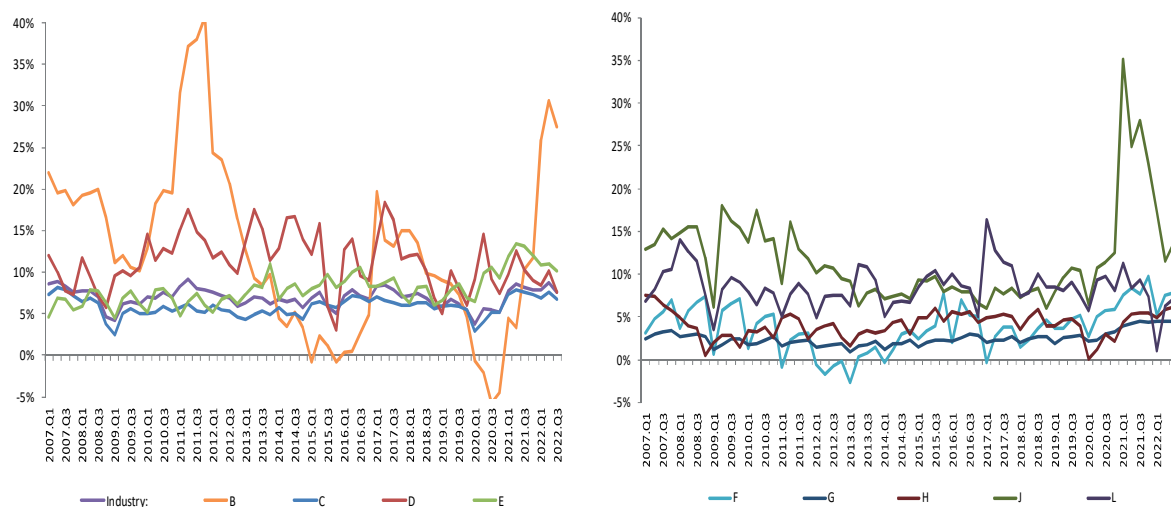


Figure 2. Gross markups in the industry and other sectors in Poland in 2007–2022 [%]

Industry: B – mining and quarrying, C – industrial processing, D – generation and supply of electricity, gas, steam and hot water, E – water supply, sewage and waste management, reclamation and F – construction, G – trade and repair of motor vehicles, H – transport and warehouse management, J – information and communication, L – real estate market service

The growing dynamics of markups was accompanied by an increase in prices for many goods and services, and as a result, it also stimulated an increase in wage pressure in all sectors of the economy. The data of the Central Statistical Office on the dynamics of average monthly gross nominal wages and salaries in Poland in the years 2018–2022 shows that in the case of the enterprise sector, the highest increase in these wages was achieved in the mining and quarrying section (B), i.e. 37% in Q3 2022. The other sections, i.e. industrial processing (C), electricity generation and supply (D) or water supply and sewage and waste management (E), showed significantly lower dynamics. Among the remaining sections, the greatest fluctuations in gross wages and salaries were recorded in health care and social assistance (Q). In the second half of 2022, however, the largest increase in the dynamics of gross fencing was recorded in transport and storage (H), i.e., 27% in Q3 2022 (Fig. 3).

While the dynamics of gross nominal wages in Poland has been increasing since 2017, in 2021–2022, in real terms, their decrease was maintained, a trend clearly discernible from Q3 2021. At that time, the dynamics of real wages in the national economy, as well as in the sector of enterprises employing more than 9 people, amounted to approx. 5%, falling sharply to -1.8% in Q2 2022 in the entire economy and to -4.3% in Q3 2022. The growing disproportion between rapidly growing inflation and falling real wages is noteworthy (Fig. 4).

The impact of markups and wages on changes in the level of inflation in Poland

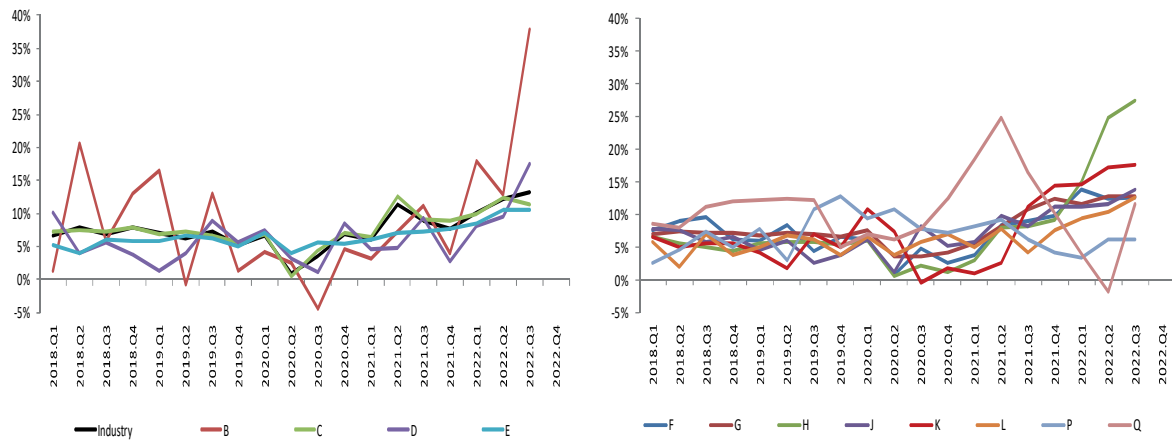


Figure 3. Dynamics of average monthly gross nominal wages in the industry and other sectors in Poland in 2008–2022 [%]

Industry: B – mining and quarrying, C – industrial processing, D – generation and supply of electricity, gas, steam and hot water, E – water supply, sewage and waste management, reclamation and F – construction, G – trade and repair of motor vehicles, H – transport and warehouse management, J – information and communication, L – real estate market service, K – financial and insurance activities, P – education, Q – health care and social assistance

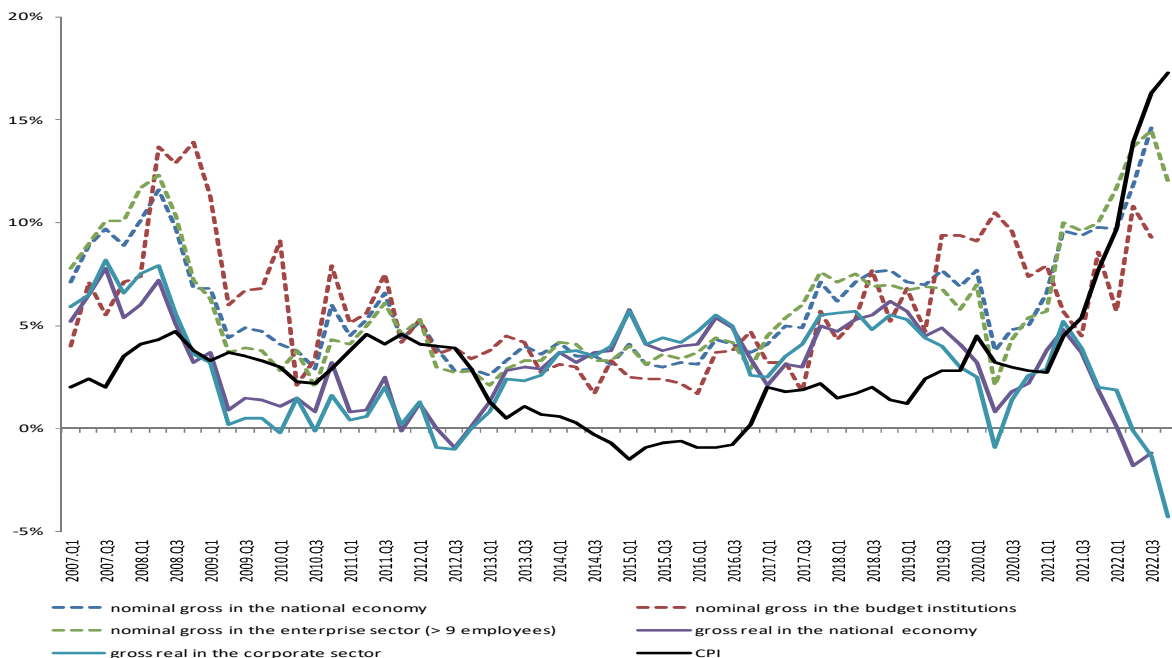


Figure 4. Average monthly nominal and real gross wages and CPI in Poland in 2007–2022 [%]

According to the NBP projections based on the NECMOD (2023) model, in the period 2023–2025 an increase in real wages is expected, with a gradual adjustment of labor costs to the slower rate of economic growth and a moderate increase in unemployment over the forecast horizon.

5. Research methodology

In order to analyze the relationship between changes in CPI and markups and wages in the 2008.Q1-2022.Q4 (60 quarters), a final formula for the CPI function was developed:

$$d_CPI_t = \alpha_0 + \alpha_1 d_Markups_t + \alpha_2 d_Wages_t + \xi_i \quad (1)$$

The explained variable:

d_CPI_t – Consumption Price Index [%].

Explanatory variables:

$d_Markups_t$ – Gross markups in the economy [%],

d_Wages_t – Gross wages in the economy [%],

ξ_i – random component,

t – period.

Dates came from the CSO database sources. All variables expressed in terms of percent points are included in the form of the first differences variables. Empirical analysis was performed using the eViews11.

The descriptive statistics of the analyzed variables show that in terms of explained variables, markups showed greater variability (St. dev. 0.116, C.V. 199.19, Skewness 1.421 and Ex. kurtosis 3.131) than wages (Tab. 1).

Table 1
Summary Statistics, using the observations 2008:1–2022:4

| Variable | Mean | Median | Minimum | Maximum |
|--------------|--------------|------------|-----------|--------------|
| d_CPI | 0.0022373 | 0.00000 | −0.016000 | 0.042000 |
| $d_Markups$ | −8.0769e-005 | 0.00041674 | −0.052631 | 0.041484 |
| d_Wages | 0.00077586 | 0.00000 | −0.039000 | 0.031000 |
| Variable | Std. Dev. | C.V. | Skewness | Ex. kurtosis |
| d_CPI | 0.0099805 | 4.4610 | 1.4212 | 3.1310 |
| $d_Markups$ | 0.016088 | 199.19 | −0.25327 | 1.0632 |
| d_Wages | 0.013292 | 17.131 | −0.26853 | 1.0276 |

Table 1 cont.

| Variable | 5% Perc. | 95% Perc. | IQ range | Missing obs. |
|------------------|-----------|-----------|----------|--------------|
| <i>d_CPI</i> | -0.010000 | 0.023000 | 0.010000 | 0 |
| <i>d_Markups</i> | -0.026985 | 0.027678 | 0.020110 | 0 |
| <i>d_Wages</i> | -0.024300 | 0.028100 | 0.014250 | 0 |

Initial data verification concerned the verification of stationarity with the use of several tests. To verify the stationarity of the analyzed time series, the Augmented Dickey-Fuller (ADF) test is used, estimated by means of the regression equation in the following form:

$$\Delta y_t = \mu + \delta_{t-1} + \sum_{i=1}^k \delta_i y_{t-1} + \varepsilon_t \quad (2)$$

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.

ADF test results confirmed the existence of a unit root $a = 1$ in the I(1) process and the stationarity of the series.

The lag order for the VAR/VECM model was determined on the basis of estimation of the following information criteria: the Aikake information criterion (AIC), Schwartz-Bayesian information criterion (BIC), and Hannan-Quinn information criterion (HQC). According to these criteria, the best lag order 4 was accepted.

In order to analyze the stability of the VAR model, a unit root test was applied. The test indicates that in the analyzed model equation roots in respect of the module are lower than one, which means that the model is stable and may be used for further analyzes (Fig. 5).

Co-integration was verified using two tests: the Engle-Granger and Johansen tests (Johansen 1991, 1992, 1995). Their results comprehensively confirmed co-integration for lag 4. This is proved by the values of the test statistic τ_e which are lower than critical values $\tau_{critical}$, levels of asymptotic p -values and integrated processes.

Results of the Johansen test show that at the significance level of 0.05, co-integration to the order of one occurs. Due to the occurrence of unit element in all the time series and the existence of cointegration between the model variables, it was possible to extend and transform the model into vector error correction models (VECM).

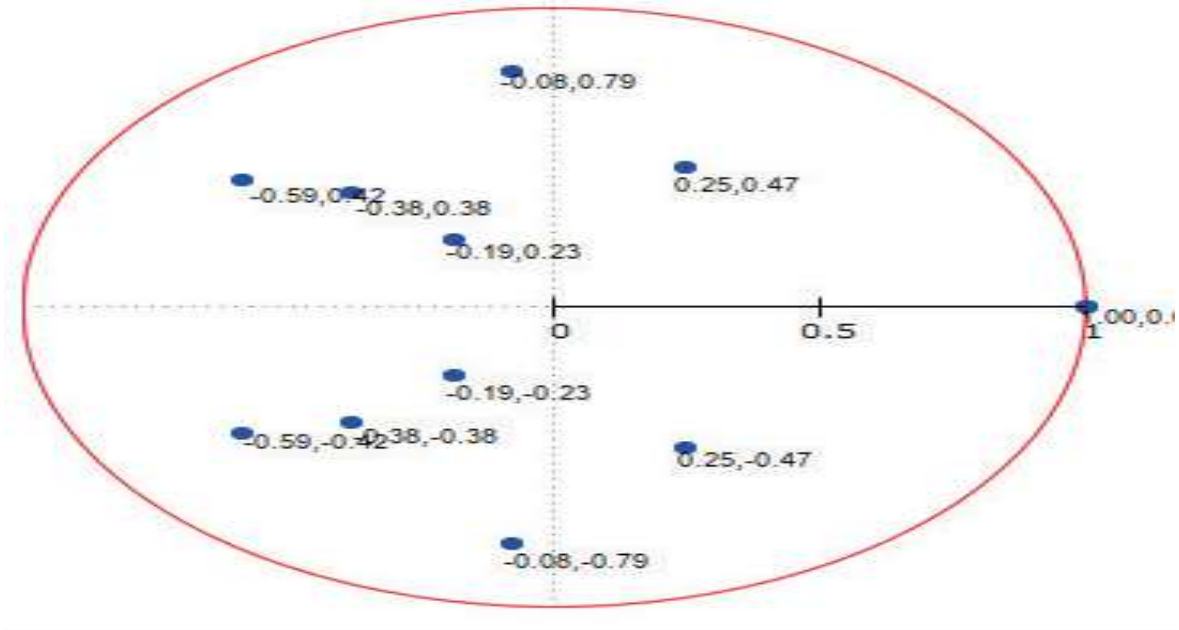


Figure 5. VAR inverse roots in relation to the unit circle

6. Empirical model

6.1. VECM model

Co-integration was verified by means of the Engle-Granger and Johansen tests which confirmed the occurrence of co-integration and thus justified the use of the VECM model for the lag order 1 and co-integration of order 1. In accordance with the Granger representation theorem, if variables y_t and x_t are integrated to the order of $I(1)$ and are co-integrated, the relationship between them can be represented as a vector error correction model (VECM).

The general form of the VECM can be written as:

$$\begin{aligned}\Delta Y_t &= \Gamma_1 \Delta Y_{t-1} + \Gamma_2 \Delta Y_{t-2} + \dots + \Gamma_{k-1} \Delta Y_{t-k+1} + \pi Y_{t-k} + \varepsilon_t = \\ &= \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-i} + \pi Y_{t-k} + \varepsilon_t\end{aligned}\quad (3)$$

where:

$$\Gamma_i = \sum_{j=1}^i A_j - I, \quad i = 1, 2, \dots, k-1, \quad \Gamma_k = \pi = -\pi(1) = -\left(I - \sum_{i=1}^k A_i\right)$$

and I is a unit matrix.

Table 2
VECM system

| | beta (cointegrating vectors, standard errors in parentheses) | | alpha (adjustment vectors) | |
|-----------------------------------|-----------------------------------------------------------------|--------------------|-------------------------------|-----------------|
| <i>d_CPI</i> | 1.0000 | (0.00000) | -0.038392 | |
| <i>d_Markups</i> | -19.858 | (3.3527) | 0.12188 | |
| <i>d_Wages</i> | -4.1164 | (1.8425) | -0.0070512 | |
| Equation 1: <i>d_d_CPI</i> | Coefficient | Std. Error | <i>t</i> -ratio | <i>p</i> -value |
| const | 0.000802175 | 0.00122416 | 0.6553 | 0.5158 |
| EC1 | -0.0383920 | 0.0201011 | -1.9100 | 0.0628* |
| R-squared | 0.369592 | Adjusted R-squared | 0.222985 | |
| rho | -0.049353 | Durbin-Watson | 2.081440 | |
| Equation 2: <i>d_d_Markups</i> | Coefficient | Std. Error | <i>t</i> -ratio | <i>p</i> -value |
| const | 0.000917658 | 0.00140464 | 0.6533 | 0.5170 |
| EC1 | 0.121885 | 0.0230648 | 5.2840 | <0.0001*** |
| R-squared | 0.825057 | Adjusted R-squared | 0.784373 | |
| rho | -0.071169 | Durbin-Watson | 2.028696 | |
| Equation 3: <i>d_d_Wages</i> | Coefficient | Std. Error | <i>t</i> -ratio | <i>p</i> -value |
| const | 0.00124978 | 0.00190912 | 0.6546 | 0.5162 |
| EC1 | -0.00705120 | 0.0313486 | -0.2249 | 0.8231 |
| R-squared | 0.591495 | Adjusted R-squared | 0.496494 | |
| rho | -0.006118 | Durbin-Watson | 1.938970 | |

Note: Lag order 4, maximum likelihood estimates, observations 2009:2-2022:3 ($T = 54$), cointegration rank = 1; * $p < 0.1$, *** $p < 0.01$.

The evaluation of the vector correction model component (EC1) representing the mechanism of short-term adjustments which serves the attainment of the long-term model balance (Tab. 2). Evaluation of the EC1 indicates that the strongest correction of the deviation from long-term equilibrium occurs in the case of the markups. Here, around 1.2% of the imbalance from the long-term growth path is corrected by a short-term adjustment process. Weaker deviation adjustments occur for CPI from wages (-0.7%). The values of the coefficient of determination R^2

reveal adjustment matching of the VECM model equations to empirical data, i.e., for CPI (22.3%), markups (78.4%) and wages (49.6%).

To verify the correctness of the VECM model results, the ARCH test was carried out verifying occurrence of autocorrelation. The ARCH test results indicate that in the examined model of the residual-based process (three variables), the ARCH effect was not observed because LM test statistics are lower than the levels of χ^2 . This means that there is no autoregressive changeability of the conditional variance and there is no need to estimate model parameters by means of weighted least squares method. Thus, the results of this test confirm the credibility of the VECM model and allow for conclusions to be drawn on their basis.

6.2. The impulse response functions and the variance decomposition

Analysis of CPI responses to shocks derived from markups and wages reveal that CPI responses are the strongest to impulses from markups and weaker from wages. However, CPI responds positively to both shocks. The responses of CPI were strongest from own past shocks, stabilizing after period 4. The impact of markups on CPI responses weakened 0.27% in period 2 to 0.11% in period 20 and increasing in response to wage changes (0.03% and 0.07%). The reaction of the CPI impulse response was longer on the side of markups (stabilizing after 15 periods) and shorter and weaker on the part of wages (stabilizing after 7-10 periods) (Fig. 6).

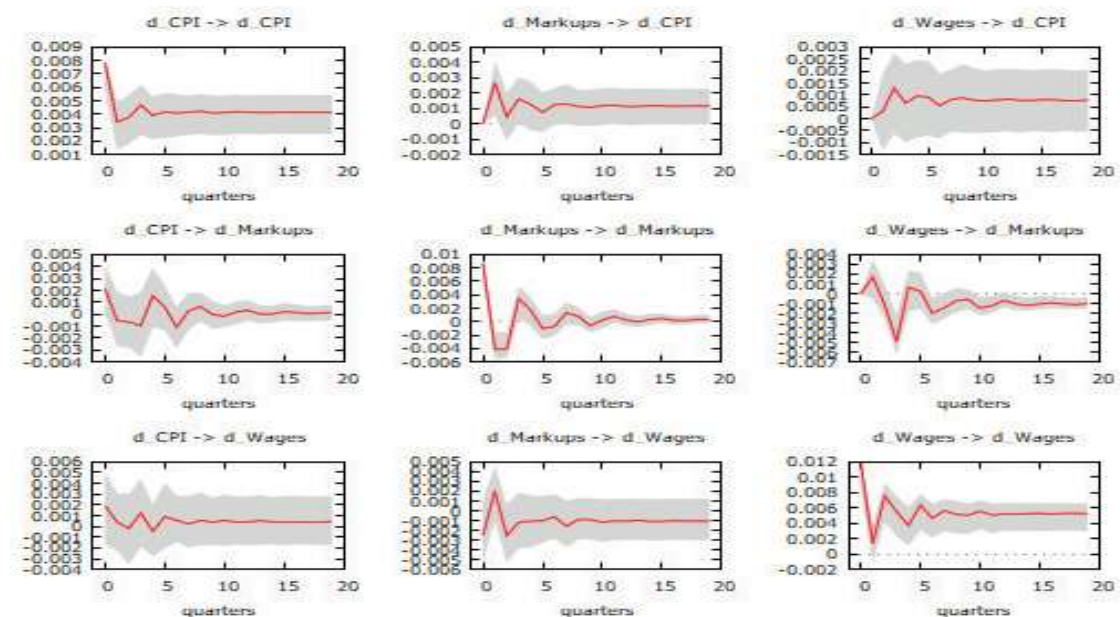


Figure 6. Impulse responses to a one-standard error shock in CPI, markups, and wages

CPI, markups, and wages were analyzed by means of variance decomposition in the forecast horizon of 20 quarters (5 years). Results of CPI decomposition indicate that in the period 1 these changes are fully accounted for with their own forecast errors. In period 2, their own changes lose (91.0%) and such markups (8.9%) and wages (0.1) grow in significance. In the period 20 CPI's own changes decrease to 89.7% and increase the degree of its explanation by markups (7.4%) and wages (2.9%).

The importance of markups in explaining changes in CPI decreases over time (from 8.9% in period 2 to 7.4 in period 20) and increases in wages (from 0.1% in period 2 to 2.9% in period 20). It is worth noting that over the forecast period, the degree of explanation of CPI on the part of markups remains 2–3 times higher than wages. However, the degree of explanation of CPI depended mainly on own shocks, although they show a certain decrease (100.0% and 89.7%).

The decomposition results for markups and wages indicate that their changes depend on their previous own changes. However, during the change of markups, it depends more on wages (from 2.8% in period 2 to 25.5% in period 20) than results of wages decomposition on the part of markups (from 4.3% in period 1 to 5.1% in period 20) (Tab. 3).

Table 3

Decomposition of variance for CPI, markups, and wages in the 20 periods

| pe- riod | for d_CPI | | | for $d_Markups$ | | | for d_Wages | | |
|-------------|--------------|---------------|------------|------------------|---------------|------------|----------------|---------------|------------|
| | d_CPI | $d_Mark-ups$ | d_Wages | d_CPI | $d_Mark-ups$ | d_Wages | d_CPI | $d_Mark-ups$ | d_Wages |
| 1 | 100.0000 | 0.0000 | 0.0000 | 5.7638 | 94.2362 | 0.0000 | 2.4625 | 4.3182 | 93.2193 |
| 2 | 91.0013 | 8.8825 | 0.1163 | 4.8801 | 92.2917 | 2.8283 | 2.4741 | 6.7836 | 90.7424 |
| 3 | 90.5639 | 7.6235 | 1.8126 | 4.4923 | 92.0865 | 3.4212 | 1.7691 | 7.7933 | 90.4376 |
| 4 | 89.9924 | 8.2168 | 1.7908 | 4.0182 | 77.8132 | 18.1686 | 2.1547 | 7.3058 | 90.5395 |
| 5 | 89.4622 | 8.3272 | 2.2107 | 5.3610 | 76.8578 | 17.7812 | 2.1093 | 7.3186 | 90.5721 |
| 6 | 89.8565 | 7.6826 | 2.4609 | 5.5400 | 76.8040 | 17.6560 | 2.0829 | 6.6618 | 91.2553 |
| 7 | 89.8656 | 7.7622 | 2.3723 | 6.0523 | 74.4948 | 19.4529 | 2.0422 | 6.3256 | 91.6322 |
| 8 | 89.6911 | 7.8389 | 2.4700 | 5.9596 | 73.8235 | 20.2169 | 1.8652 | 6.4160 | 91.7187 |
| 9 | 89.6957 | 7.7113 | 2.5929 | 6.1394 | 73.5214 | 20.3392 | 1.8140 | 6.1627 | 92.0233 |
| 10 | 89.7555 | 7.5980 | 2.6465 | 6.1143 | 73.4313 | 20.4543 | 1.7336 | 5.9762 | 92.2902 |
| 11 | 89.7511 | 7.5813 | 2.6677 | 6.0506 | 72.4998 | 21.4496 | 1.6775 | 5.8494 | 92.4731 |
| 12 | 89.7200 | 7.5777 | 2.7023 | 5.9976 | 71.9640 | 22.0385 | 1.6175 | 5.7462 | 92.6364 |
| 13 | 89.7276 | 7.5155 | 2.7569 | 6.0348 | 71.7340 | 22.2312 | 1.5588 | 5.6419 | 92.7993 |

Table 3 cont.

| pe- riod | for d_CPI | | | for $d_Markups$ | | | for d_Wages | | |
|-------------|--------------|---------------|------------|------------------|---------------|------------|----------------|---------------|------------|
| | d_CPI | $d_Mark-ups$ | d_Wages | d_CPI | $d_Mark-ups$ | d_Wages | d_CPI | $d_Mark-ups$ | d_Wages |
| 14 | 89.7474 | 7.4718 | 2.7809 | 5.9973 | 71.2886 | 22.7141 | 1.5247 | 5.5172 | 92.9581 |
| 15 | 89.7413 | 7.4607 | 2.7980 | 5.9456 | 70.7295 | 23.3249 | 1.4803 | 5.4445 | 93.0753 |
| 16 | 89.7328 | 7.4414 | 2.8258 | 5.9241 | 70.3244 | 23.7515 | 1.4417 | 5.3747 | 93.1837 |
| 17 | 89.7397 | 7.4103 | 2.8500 | 5.9065 | 69.9831 | 24.1103 | 1.4093 | 5.2945 | 93.2962 |
| 18 | 89.7447 | 7.3888 | 2.8665 | 5.8717 | 69.5624 | 24.5660 | 1.3791 | 5.2284 | 93.3924 |
| 19 | 89.7417 | 7.3770 | 2.8812 | 5.8322 | 69.1041 | 25.0638 | 1.3516 | 5.1717 | 93.4767 |
| 20 | 89.7408 | 7.3608 | 2.8985 | 5.8083 | 68.7307 | 25.4609 | 1.3247 | 5.1191 | 93.5562 |

7. Conclusion

The analysis of the theoretical and empirical literature indicates various determinants of inflation which may be of a supply and demand nature. A decrease in the supply of non-wage inputs causes costs to increase. However, increases in aggregated demand cause an growth in demand for: goods and services, inputs and labor affect on demand-pull inflation.

The growing various effects of the COVID-10 pandemic, the outbreak of war in Ukraine and the aftermath of the energy crisis are responsible for both supply- and demand-type stimuli, making it difficult to lower both inflation and inflation expectations. Enterprises try to hedge against inflation, e.g., in the form of raising markups and employees in the form of wage increases to compensate for the decline in the purchasing power of nominal wages.

The results of empirical and econometric analyzes allowed the formulation of the following conclusions for Poland.

1. In the years 2007–2022, markups showed a higher dynamic of change than wages.
2. In terms of the dynamics of markups and wages, the highest dynamics was achieved by the industry sector, including the mining and quarrying section (B). High dynamics of markups, apart from mining, was shown in the section of water supply, sewage and waste management, reclamation (section E) and electricity, gas and water production and supply (section D). Among the remaining sections, activity in the field of information and communication

- (section J) recorded a high increase. In the case of wage dynamics, sections of transport and storage (H) and health care (Q) were characterized by high dynamics.
3. Analysis of CPI responses to shocks derived from markups and wages reveal that CPI responses are the strongest to impulses from markups and weaker from wages. However, CPI responds positively to both shocks. The responses of CPI were strongest from own past shocks, stabilizing after period 4. The impact of markups on CPI responses was weakening (0.27% in period 2 to 0.11% in period 20) and increasing in response to wage changes (0.03% and 0.07%). The response of the CPI impulse response was longer on the part of markups (stabilizing after 15 periods) and shorter and weaker on the part of wages (stabilizing after 7–10 periods)
 4. Results of CPI decomposition indicate that these changes are fully accounted for with their own forecast errors in period 1. In period 2, their own changes lose (91.0%) and such markups (8.9%) and wages (0.1) grow in significance. In period 20, the CPI's own changes decrease to 89.7% and increase the degree of its explanation by markups (7.4%) and wages (2.9%). Moreover, the importance of markups in explaining CPI changes decreases over time (from 8.9% in period 2 to 7.4 in period 20) and increases in wages (from 0.1% in period 2 to 2.9% in period 20). Moreover, in the forecast period (20 periods, 5 years), the degree of CPI explanation on the part of markups remains 2–3 times higher than wages.
 5. The results of the decomposition for markups and wages indicate, in the forecast period (20 periods), that their changes mainly depend on their own earlier changes. However, over time, markups changes may depend more on wages (from 2.8% in period 2 to 25.5% in period 20) than results of wages decomposition on the part of markups (from 4.3% in period 1 to 5.1% in period 20). This means the expected increase in the importance of wages.

The disproportion between rising inflation and falling real wages presented in Figure 4 means that in the short and medium term the need to rebuild the real purchasing power of wages will be accompanied by wage pressure. The wage pressure will continue, at least until the upward dynamics of inflation stops. In addition, it is worth emphasizing that unfavorable demographic changes in Poland (low birth rate, fewer and fewer new people entering the market at working age) may contribute to maintaining the upward trend in wages.

Summing up, the presented results of empirical research indicate a positive verification of the hypothesis and allow us to conclude that “The increase in inflation expectations and future production costs in the economy stimulated the growth of enterprise markups, limiting the effectiveness of anti-inflation measures in Poland at the turn of 2007–2022, with the expected stronger impact of wages in subsequent years, in accordance with the variance decomposition.”

8. Study limitations and directions for the further research

The study has some limitations. First, the period of maintaining exogenous shocks and their intensification at the time of destabilizing efforts of anti-inflation policy in Poland and in the world. The second, the consolidation of inflation expectations at a high level, both on the side of enterprises deciding, for example, to change markups or employees who pass wage increases. The third, the effects of the fight against inflation are determined by the total decisions made as part of fiscal policy. Thus, it requires complementary decisions within the policy mix, especially in the period of problems with fighting high inflation.

In future surveys, an important issue is the study of the impact of monetary policy tightening on changes in inflation expectations as well as the effects of changes in the distribution of income in the economy, i.e. socio-economic consequences. The effects of high inflation are more pronounced for low-income households. The global negative price shock following the Russian aggression in Ukraine had heterogeneous inflationary effects across EU countries and households.

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Summary

This paper analysis of the impact of markups and wages of enterprises on changes in the level of inflation in Poland in the years 2007–2022. The impact of markups and wages on changes in CPI were assessed using the VECM model, the impulse responses, and the variance decomposition. The results indicate that industrial sector, including the mining and quarrying section, showed the highest dynamics of changes in markups and wages. In the years 2005–2022, the impact of markups on changes in CPI was stronger, although it was losing importance, with a weaker but growing impact of wages. Forecasts of the degree of clarification of the CPI in Poland indicate a greater importance of markups, with the impact of wages weaker by half, but growing over time. The paper extends the state of theoretical and empirical studies on the determinants of the CPI and the inflation expectations. It also considers the context of persistent exogenous and endogenous shocks from the COVID-19 pandemic and the war in Ukraine, and changes in demand and supply impulses. The results of this study may be valuable as a contribution to the literature on inflation and its forecasts, and for monetary policy makers.

JEL codes: E52, E58, E63, E66

Keywords: *inflation expectations, inflation, markups, wages*