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NATIONAL BANK OF SLOVAKIA
EUROSYSTEM

When food bites back

What quarterly firm-level data reveal about food inflation

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Markups for firms operating in food and beverages manufacture and sales sectors have increased in the first half of 2022, suggesting a decoupling between the increase in current production costs and prices. The evolution of markups in the period between the first quarter of 2015 and the second quarter of 2022, a high-inflation environment, shows, on one hand, a very recent dynamic evolution of the price setting behaviour displayed by food-related businesses, and on the other the remarkable stability of markups observed at broad aggregate level in the largest sectors of the Slovak economy.

Introduction

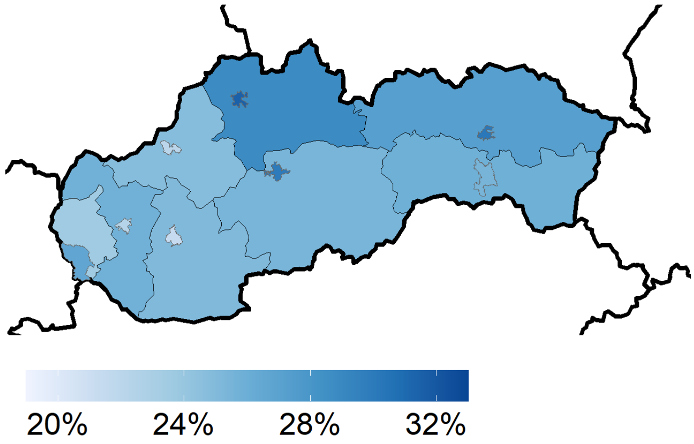
Is the recent acceleration of inflation driven by global cost dynamics or have Slovak manufacturers and retailers been unjustifiably increasing their prices beyond the cost pressures they face? In this policy brief, we examine the price setting behaviour of firms across sectors in Slovakia. The focus on food and beverages sectors stems from their apparent idiosyncrasies as opposed to the economy as a whole. While estimated markups over costs have mostly remained remarkably stable, markups in food and beverages manufacture and retail have showed clear signs of increase, leading food prices to be a key driver of overall inflation in Slovakia in 2022. We provide different interpretations of our findings, among which the possibility of a gradual regime shift in firms' price setting behaviour materializing in an increase in markup volatility.

Context: Food expenditure in Slovakia

Food is a basic necessity. The median Slovak household declares to spend about 26% of their income, almost 10% more than the EA average, to purchase food -with some variation across regions and urban areas, as shown by Chart 1.

Chart 1

Food expenditure as a share of income

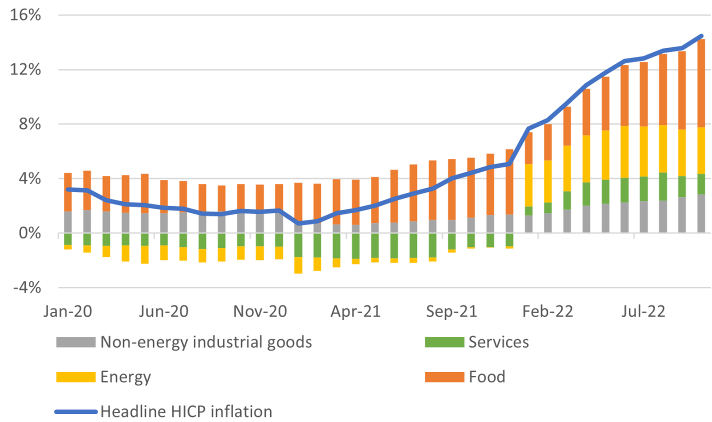


Source: Eurostat, author's calculations based on HFCS 2017.
Notes: Median food expenditure as a share of income at NUTS3 and urban areas level. Food expenditure includes both food expenditures at home and outside. Income is the total household gross income, including interest payments.

Food prices are one of the main drivers of the recent HICP inflation surge, together with the energy component (Chart 2). In October 2022 food prices accounted for almost 45% of the inflation rate, with their contribution being 47% larger than in October 2021.

Chart 2

Headline inflation and its main components

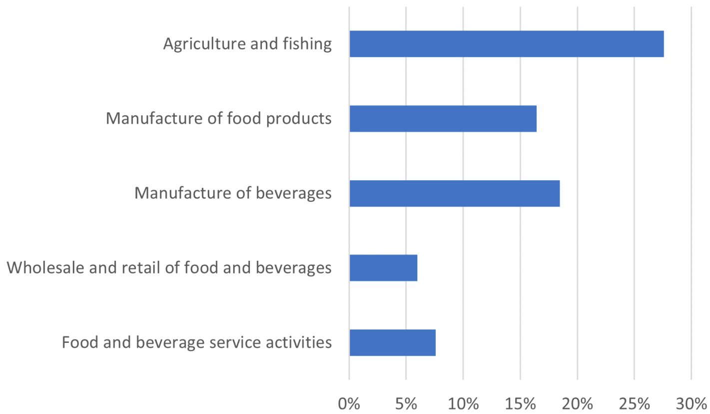


Source: Eurostat and NBS calculations.
Note: The last observations refers to October 2022.

Part of the food prices dynamics is unsurprisingly tied to the recent developments in energy prices. Higher order effects, other than direct impact, pass through intermediate costs to final consumer prices, adding to the inflationary pressure. Chart 3 shows how much of the economic value created by the different stages of the food production chain is directly reliant on energy inputs, including fuels and heat. The highest ranking of agricultural and fishing enterprises is mainly driven by fuel costs, which in Slovakia have so far remained moderate. On the other hand, the heavy electricity consumption of industrial processes explains the relatively higher placement of food and beverages manufacturing firms and substantiates upward price adjustments mirroring the rise in operating costs.

Chart 3

Energy intensity of food-related industrial sectors (percentages)



Source: SSO, author's calculations.
Notes: Results are based on an annual firm-level database of firms with 20 or more employees, computed on 2019 data. Sectors were created pooling firms on the base of their NACE classification. Energy intensity for each sector is the ratio of total energy costs over total gross value added produced, where energy costs include the purchase of fuels, heat, and electricity.

Theory: Market power, prices, and markups

The ability of firms to set a price higher than production costs, that is to charge a markup, is directly correlated with the amount of market power they wield. Market power is a central indicator when considering the efficiency of an economy, since competitive pressure keeps prices close to production costs, to the benefit of consumers. When firms gain market power, and they become able to set higher prices, they do not only claim part of the customers surplus as their own, but also lead to a distorted demand for production factors, stifle marginal productivity, and lower the overall aggregate factor productivity,[1] all of which are commonly regarded as suboptimal outcomes. While it remains true that market entities can exert their market influence in a plethora of ways, looking into their price-setting policy, and therefore markups, is usually the quickest method to detect signs of market power.

The existence of markups per se, however, is not inherently a negative signal, since they are not driven solely by the concentration of market power and a lack of competition. They can also be explained by return on intangible assets (such as investments in R&D), by the need to cover fixed costs or by intertemporal considerations. In this scenario, higher markups can act as an incentive to the technological innovation process, keeping firms incentivized to invest in technology and driving aggregate productivity growth.[2] Sometimes, relatively high markups are a feature of a given industrial sector, where large fix and overhead costs are unescapable, and firms need to charge prices consistently higher than marginal costs to recover them. The existence of subsidies and public regulation schemes imposed on prices can further blur the picture, as a sudden increase of perceived uncertainty about the future can act as a confounding factor and push firms to rise margins to buffer possible future cost hikes.

Any markup analysis needs to start with their accurate measurement, which often proves to be an all but a trivial exercise since true markups are the ratio of price and marginal costs, two variables that are rarely available. Our own database is no exception. Ever since the end of the eighties, industrial organization literature consistently estimated markups multiplying the output elasticity of a variable input by the ratio of revenues over the cost of such variable input, the so-called ratio estimator.[3] The procedure allows for straightforward estimation of markups once given the elasticity, that is given that the parameters of the production function are known.

Our investigation focuses on the evolution of their distribution over time rather than on their level, since our estimates are bound to be biased by the lack of explicit data on prices and quantities. This empirical exercise builds on well-established and seminal contributions to literature,[4] where production function elasticities are estimated using a

[1] C. Hsieh and P. Klenow, "Misallocation and Manufacturing TFP in China and India *", Quarterly Journal of Economics, vol. 124, no. 4, pp. 1403-1448, 2009.

[2] P. Aghion, A. Bergeaud, T. Boppart, P. Klenow and H. Li, "A Theory of Falling Growth and Rising Rents", Federal Reserve Bank of San Francisco, Working Paper Series, vol. 2019, no. 11, pp. 01-43, 2022.

[3] R. Hall, "Market Structure and Macroeconomic Fluctuations", Brookings Papers on Economic Activity, vol. 17, no. 2, pp. 285-338, 1986. R. Hall, "The Relation between Price and Marginal Cost in U.S. Industry", Journal of Political Economy, vol. 96, no. 5, pp. 921-947, 1988.

[4] A non-exhaustive list includes: De Loecker, J. Eeckhout and G. Unger, "The Rise of Market Power and the Macroeconomic Implications*", The Quarterly Journal of Eco-

two-stage iterative GMM procedure. We also rely on some recent analysis of markups estimation techniques[5] to deal with our data limitations and choose our econometric specification.

How do we estimate markups?

Our database is a quarterly firm-level dataset produced by the Slovak Statistical Office, covering a sample of about 10.000 firms with 20 employees or more from 1Q2013 to the second quarter of 2022. The variables we use are revenues, total sales, wages, value added, fixed inputs, and flexible inputs; all of them are in euros, expressed in nominal terms. Inputs differentiate between flexible and fixed, according to whether firms are able to adjust them each period with negligible cost. This differentiation is crucial in our analytical approach since the definition of markups relies on flexible inputs. All firms are mapped into their industrial sector and subsector up to NACE4 industry codes.[6]

Industries are mapped into five custom sectors and cover food production from the field to the household and also include eateries and drinking venues. We will mainly present results for this custom aggregation, given our focus on food prices, together with some broad NACE1-level evidence to provide a means of comparison. Table 1 shows the highest NACE level of aggregation mapped into each of our five custom sectors; when possible, we exclude the subsectors exclusively regarding the sale of tobacco products, to keep the analysis strongly focused on alimentary products.[7]

We complement revenues with total sales and calculate firms market share using value added at NACE4 level to account for firms with high domestic intermediate consumption and foreign generated revenues. Materials, energy, goods that are resold, and services accessory to the sale process are treated as flexible inputs, while we regard capital, proxied by fixed tangible assets (broadly, the sum of buildings, land, and transport equipment owned), and labor as the fixed inputs. All the variables are brought to real terms using industry sector-level deflators and all-sectors total deflators for the first two quarters of 2022.

nomics, vol. 135, no. 2, pp. 561-644, 2020. D. Ackerberg, K. Caves and G. Frazer, ”Identification Properties of Recent Production Function Estimators”, Econometrica, vol. 83, no. 6, pp. 2411-2451, 2015. J. Loecker and F. Warzynski, ”Markups and Firm-Level Export Status”, American Economic Review, vol. 102, no. 6, pp. 2437-2471, 2012.

[5] M. De Ridder, B. Grassi and G. Morzenti, ”The Hitchhiker’s Guide to Markup Estimation”, CEPR Press Discussion Paper, no. 17532, 2022.

[6] The NACE (from the French Nomenclature statistique des Activités économiques dans la Communauté Européenne) system is the standard EU industry classification. It has four hierarchical levels, gathering firms in increasingly specific groups.

[7] We check that the numerical consistency of our categories is not varying too wildly across quarters, so that results remain comparable over time.

Table 1: NACE sectors mapping structure

	NACE2	NACE3	NACE4	NACE4 Excluded
Agriculture and fishing	1			
	3			
Manufacture of food products	10			
Manufacture of beverages	11			
Wholesale and retail of food and beverages	46	461	4617	
		463		4635
		471	4711	
	47	472		4726
		478	4781	
Food and beverage service activities	56			

Source: NBS calculations

Note: NACE-level industry sectors mapped into our five custom sectors. Level of aggregation varies due to different level of specificity of each NACE1 industrial sector, and number of available firms. Excluded sectors regard the wholesale and retail sale of tobacco and tobacco products.

The estimation of markups starts with a two-step GMM procedure widely adopted in the industrial organization literature. In the first step we purge measurement error from the observed revenues. The fitted values of revenues are then used to estimate the production function and, straightforwardly, the variable input elasticity needed to estimate firm-level markups.

We assume that the revenues of the i-th firm at time t depends on both the flexible and the fixed input, and a bundle of other variables. Without making explicit assumptions on the shape of the relationship between inputs and output, denoted as the unknown function Φ, we run a non-parametric regression as:

$$y_{it} = \Phi\left(m_{it}, \Xi_{it}\right) + \varepsilon_{it} \tag{1}$$

where we denote revenues by y, the materials and energy cost with m, and Ξ gathers all the other controls for productivity: fixed costs, market share, and wages. Market share, computed as the share of value added at NACE2 level, is included to control for changes in demand due to price elasticity and oligopoly effects on revenues. Lowercase letters represent log variables. The remainder, our measurement error, is used to purge revenues. While this first step is bound to be biased due to the lack of control variables, among all prices, it has been proved that improves markup dispersion.[8]

In the second step of our estimating procedure, we need to assume a specific functional form for the production function. We choose a translog specification to ease the assumption that output is log linear. In this simplified baseline specification, used for illustrative purposes, revenues are

[8] M. De Ridder, B. Grassi and G. Morzenti, ”The Hitchhiker’s Guide to Markup Estimation”, CEPR Press Discussion Paper, no. 17532, 2022.

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produced by our two inputs, the flexible and the fixed one, which do not interact:

$$\bar{y}_{it} = \beta_m m_{it} + \beta_{mm} m_{it}^2 + \beta_k k_{it} + \beta_{kk} k_{it}^2 + \omega_{it} \tag{2}$$

with ω representing productivity, which we assume independently and identically distributed (i.i.d.), and $\bar{y}$ being the purged revenues from Equation 1. The crucial distinction between flexible and fixed inputs comes now into play: it is well known that estimating this equation is not a trivial effort, since least squares estimation is likely to bias the estimates.[9] We address this issue by instrumenting m_{it} and m_{it}^2 with their respective lags. Since k_{it} is fixed before productivity could be observed, we do not need to instrument the fixed input.

Once the parameters of the production function in Equation 2 are estimated, the input elasticity is immediately available:

$$\theta_{it}^M = \hat{\beta}_m + 2\hat{\beta}_{mm} m_{it} \tag{3}$$

Computing the firm-level markup is now straightforward using the ratio estimator:

$$\mu_{it} = \theta_{it}^M \frac{\bar{Y}_{it}}{M_{it}} \tag{4}$$

In our full specification, other than adding time fixed effects, fixed inputs (capital and labor) are allowed to interact with flexible ones, and the input elasticity in Equation 3 is augmented with the cross-elasticities of flexible and fixed inputs.

As baseline, we estimate markups at NACE1 level of aggregation and we present results on the evolution of markup sectoral distributions for the five largest sectors by gross value added share, namely (C) *Manufacturing*, (G) *Wholesale and retail trade; repair of motor vehicles and motorcycles*, (L) *Real estate activities*, (F) *Construction*, and (M) *Professional, scientific and technical activities*. We then re-estimate the model again on our custom mapping to investigate dynamics and transmission of food prices and present results for *Agriculture and fishing*, *Manufacture of food products*, *Manufacture of beverages*, *Wholesale and retail of food and beverages*, *Food and beverage service activities*. In both cases, markups have been trimmed to a symmetric 1% to limit outliers.

What we find

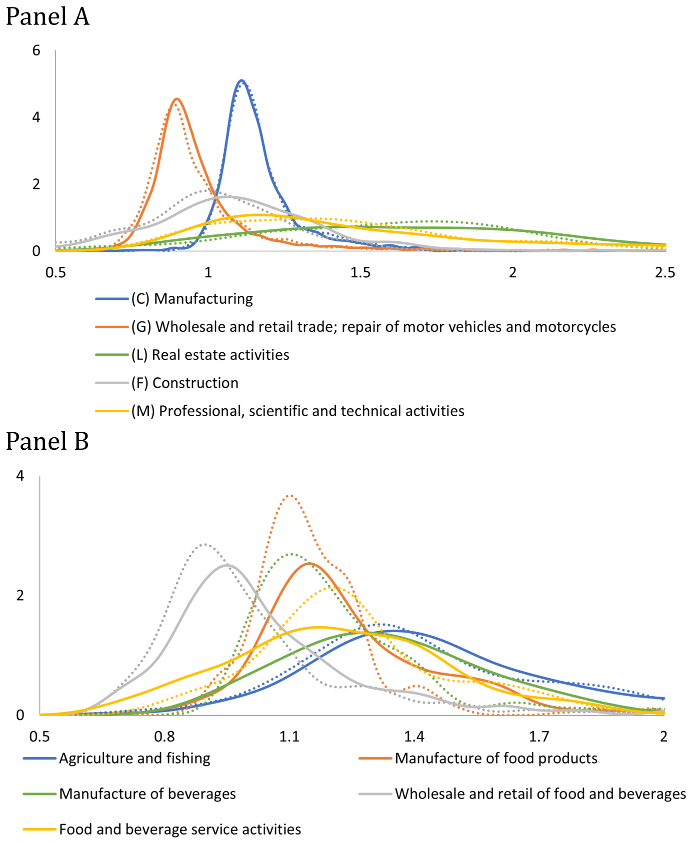
Changes in the empirical density distribution of the markup estimates between the first two quarters of 2015 and 2022 at the more constant NACE1 level hide a more dynamic evolution of the food-related sectors (Chart 4). It is easy to see in Panel A how very little changed in

[9] T. Klette and Z. Griliches, "The inconsistency of common scale estimators when output prices are unobserved and endogenous", Journal of Applied Econometrics, vol. 11, no. 4, pp. 343-361, 1996.

the distribution of markups between 2015 and 2022, with the most notable, albeit still nearly irrelevant, changes happening in the flatter curves characterized by a higher dispersion. The food sectors displayed in Panel B show a more dynamic evolution, with sizable changes between the two periods and an overall shift of the markup distribution in all services to the right. Furthermore, the distributions look generally flatter than their 2015 counterparts, indicating an increased degree of heterogeneity across firms in the same sector.

Chart 4

Estimated markups kernel density
(probability density; dotted stands for 2015 and solid for 2022)



Source: SSO, author's calculations.
Notes: Empirical density estimates of quarterly firm-level markup values of the first two quarters of 2015 and 2022. Data are limited to the five largest industry sectors by GVA share (ignoring the public sector and the Defense) in Panel A, and to our custom mapping in Panel B. Markups are trimmed to a symmetric 1%. Dotted lines refer to 2015 and solid represent 2022 values. Ordinate scale is cut for better readability.

The overall results suggest that firms operating in different areas of the broad food industry have exhibited a pro-cyclical behaviour in 2022, building up a positive contribution to the overall inflationary pressure coming from the food cost component. In the manufacture and the sale sectors the 1H 2022 value added-weighted average markup is higher than the same period average over past years, signalling that revenues have grown more in real terms than the increase in costs would justify (Table 2). We weight for value added to give more weight to larger firms, thus mirroring their larger impact in terms of setting consumer prices and their wider importance in the whole economy and retrieve results overall consistent with the evolution of the unweighted distributions depicted in Chart 4.[10]

Table 2: GVA-weighted average markup and its percentage variation

	2015-2019	2022	Variation
Agriculture and fishing	1.67	1.70	2.11%
Manufacture of food products	1.25	1.46	17.17%
Manufacture of beverages	1.24	1.44	15.79%
Wholesale and retail of food and beverages	1.05	1.29	22.59%
Food and beverage service activities	1.45	1.43	-1.74%

Source: SSO, author's calculations.
Note: The average for the years from 2015 to 2019 has been computed over the first two quarters of every year to match the quarters available in 2022. We disregard the years 2020 and 2021 to void any influence of Covid19-related measures. Sectors consist in a custom mapping of firms at different levels of NACE classification. The T-test null hypothesis of equal means in the two intervals is rejected at 1% confidence levels for all sectors, except Food and beverages service activities, where the test fails to reject at all. Markups are trimmed to a symmetric 1%.

The evolution over time of markups and net revenues of firms in food production and sale chain highlights a certain degree of heterogeneity regarding the increase in margins and the upwards decoupling between price and overall costs (Chart 5). Panel A displays the evolution over time of sectoral average markups, complementing the findings reported in Table 2, and shows how markups in the food manufacture and sales sector have known a positive trend in the first half of 2022. This further confirms that firms over-corrected their prices more than the increase in costs could induced, among others, by the energy factor could justify. Despite the lack of consistent data on profits at quarterly level, Panel B shows estimates of first semester of each year of the total net revenues (as the difference between revenues and total costs) for each food-related sector. Higher markups directly translated in higher net revenues for the food manufacture and the sale sectors, with a more moderate increase for the manufacture of beverages. The agricultural and fishing sector, on the other hand, registered an increase in net revenues not backed by an increase in margin. This result appears to be driven by a substantial increase in both costs and revenues in the first semester of the 2022 (+96% on 1H 2021), rather than by a change in sales volume or in the subsidy structure.[11]

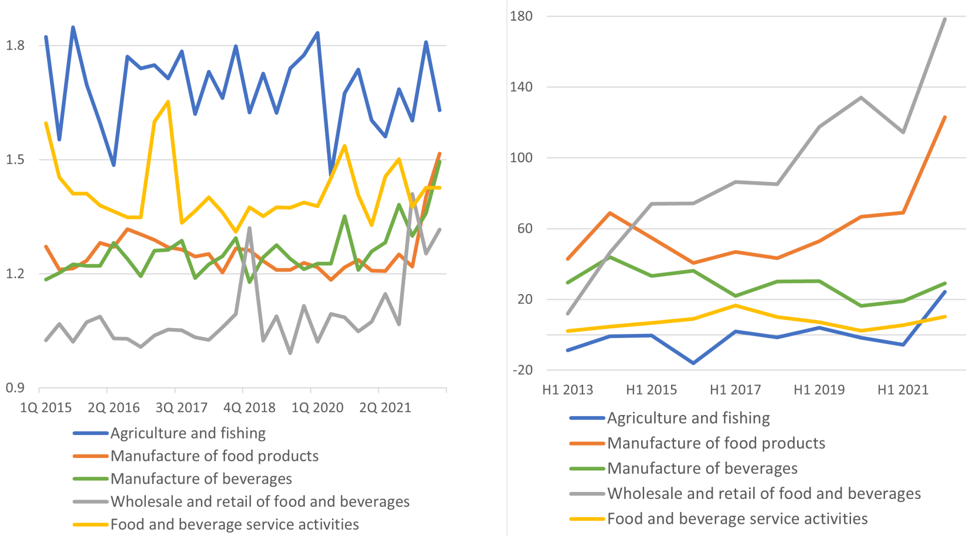
[10] Intuitively, a similar result can be achieved weighting the results by revenues. This approach, however, is at direct risk of "double counting" since the size of the markup itself is directly proportional to the amount of revenues (see Equation 4).

[11] The Report on Agriculture and Food Sector in the Slovak Republic for 2020 - Green Report estimates that the share of the total subsidies in revenues is as high as 30.1%.

Chart 5

GVA-weighted average markups and total net revenues

Panel A Panel B



Source: SSO, author's calculations.
Notes: (Panel A) Quarterly gva-weighted average markup estimate for each sector (a custom mapping of firms at different levels of NACE classification). Markups are trimmed to a symmetric 1%. (Panel B) Total net revenues, computed as the difference between total revenues and total costs, for the first two quarters of each year.

Discussion and policy implications

We presented evidence that markups of firms operating in industrial sectors related to the food production and sales chain have grown during the first half of 2022, thus accelerating the food prices component of the HICP inflation.

It would be premature to conclude that firms have liberally pursued a higher degree of market power. Preliminary data for 3Q2022 as well as individual consultations with firms operating in these sectors suggest that intertemporal considerations may have started to play a greater role in their pricing behaviour. In an environment with higher actual and anticipated inflation, compounded by a deep uncertainty about the integrity of supply chains, not only the frequency but also the magnitudes of price increases may have changed relative to past practice. This can manifest itself as higher volatility in markups.

The new environment calls for a stronger commitment to price stability to prevent such pricing behaviour to entrench in the economy, and higher markups volatility to spill over into higher inflation instability. At the same time, a concerted effort by all regulatory and surveillance actors is needed to preclude the structural underlying sources of the volatility from resulting in long-term scars to the efficiency of the economy and to consumer welfare.