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Original Paper

The stormy development of butter prices in Slovakia

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ABSTRACT

The development of butter prices in Slovakia has been full of upheavals for a long time. Consumer prices of butter are influenced by many factors, and one of them is pressure along the butter product vertical. This is reflected in the transmission of the price along the supply chain and is subsequently reflected in the price of butter on the consumer's table. The aim of this article is to examine this price transmission more closely and to reveal possible structural changes in the relationship between producer and consumer prices of butter in Slovakia.

KEYWORDS: butter prices, price transmission, producer, consumer

JEL CLASSIFICATION: Q11, Q13, Q18

INTRODUCTION

The price of butter is influenced by various factors and its development is subject to turbulence based on a combination of these elements. Among the most important factors affecting butter prices are the conditions on the dairy market, including the dynamics of supply and demand. Changes in milk production, processing capacities and global demand for dairy products play a major role. For example, the fall in world milk production in 2016, caused by low farm prices, (due to the milk surplus in 2015 following the abolition of quotas in the EU), caused a shock to butter prices (Homola, 2018). At the same time, the cost of fodder for dairy cows has a fundamental influence on milk production, which in turn is influenced by the prices of grain and fodder. Fluctuations in feed prices can indirectly affect butter prices. The quality and quantity of feed is affected by weather conditions. Especially recently, we have witnessed more frequent extreme weather events such as droughts and floods. Due to the occurrence of an enormous drought in 2022, the harvest was significantly below average, mainly corn and alfalfa. Below-average quality and quantity of feed is

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currently reflected in feed costs, which make up approximately 25% of the total direct costs in dairy farming. The lack of fodder, especially corn, must be replaced by the purchase of substitute feed mixtures, which significantly increases costs. Energy costs are also not negligible in dairy farming, the prices of which have increased by almost 2 times on average year-on-year. Currently, cereal prices are already falling due to the assumption of above-average harvests and a significant amount of cheaper cereals imported mainly from Ukraine. However, the reduction in the prices of feed grains has not yet been fully reflected in the drop in the prices of feed mixtures, due to the high energy demand of their production (Repka, 2023). Government policies such as subsidies, import/export regulations, and agricultural support programs can affect butter prices as well. For example, since 2016, the development of consumer prices of milk and butter has also been influenced by the reduced rate of value added tax (Gálik, 2019). In addition, there are global economic conditions, which include the recent Covid-19 pandemic. The Covid-19 pandemic has had several effects on the dairy industry, including butter. Supply chains have been disrupted, lockdowns, restrictions and transport disruptions during the pandemic have affected the entire supply chain. Stockpiling by consumers also put pressure on butter prices (Krajanová, 2022). The disruption of international trade due to the pandemic and war in Ukraine has affected the global supply and demand for dairy products and affected prices along the supply chain too. We will address the issue of price transfer along the supply chain in this article.

MATERIAL AND METHODS

Data used in this study were collected from Agricultural Market Information of Slovakia (ATIS) and the Slovak Statistical Office. Average monthly production and consumer prices of butter in Slovakia were considered for analysis. Selection of these data were made based on availability, as these data are collected by officially appointed authorities and provide better understanding about producers, and consumers within supply chain.

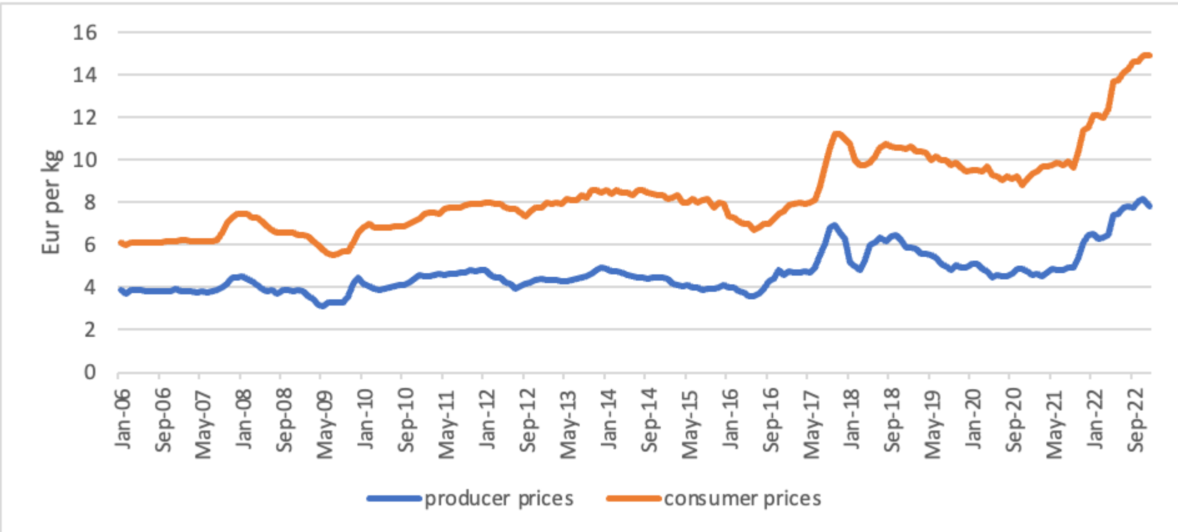

Figure 1 Monthly butter producer and consumer prices in Slovakia
Source: Own elaboration based on data from the Agricultural Market Information of Slovakia (ATIS) and the Slovak Statistical Office

The price series cover the period from January 2006 till December 2022. All the data presented indicate the average monthly price across the entire country, enabling an examination of price transmission within the broader context of the vertical supply chain of butter in Slovakia (Fig. 1).

In the initial phase, it's crucial to examine whether the time series data are stationary. Enders and Granger (1998) recommend to employ unit root tests to ensure that the data remains stationary over time. Specifically, we have employed the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test. The null hypothesis in both of the tests assume random walk of the time series.

As soon as we know that the data are stationary, we can proceed to cointegration testing. To estimate long term relationship between producer and consumer butter prices, it is necesary to apply cointegration test, such as Johansen cointegration test. This approach uses maximum likelihood estimation in a VAR model. By applying the Johansen cointegration test, we can determine the presence and nature of cointegrating relationships among the variables. The test evaluates the null hypothesis: H0: "There is no cointegrating relationship" against the alternative hypothesis H1: "There is a cointegrating relationship." However the presence of the cointegration can be disrupted by the existence of a structural break. To make sure there are no structural breaks in the cointegrating relationship between the time series we conduct the Gregory-Hansen (1996) cointegration test. The standard approach for cointegration (as used by Engle and Granger, 1987) without structural changes is based on a model:

$$y_t = \mu + a_1 x_t + a_2 z_t + \varepsilon_t$$

where x_t, z_t and y_t are I(1), the error term εt is I(0) and the parameters are time invariant. The structural change is manifested by changes in the intersection (μ) and/or changes in the slopes (a1, a2). To model structural change, Gregory and Hansen (1996) defined an indicator variable as follows:

$$\varphi_t = \begin{Bmatrix} 0, if\ t \leq\ [\mathrm{n}\tau] \\ 1, if\ t >\ [\mathrm{n}\tau] \end{Bmatrix}$$

where the unknown parameter τ ∈ (0, 1) indicates the relative timing of the change point. Several models have been proposed to test for cointegration with structural breaks, including: level shift; level shift with trend; and regime shift.

The Momentum Threshold Autoregressive (MTAR) model is aftewards used for capturing the asymmetric reactions within a price series. The MTAR model, as recommended by Enders & Granger (1998) and Enders & Siklos (2001), incorporates the concept of "momentum" to account for the rate of price acceleration, especially in situations where corrections exhibit uneven momentum in different directions. M-TAR model captures asymmetrically sharp movements. General form of TAR model is as follows:

$$\Delta\mu_t = I_t \rho_1 \mu_{t-1} + (1 - I_t)\rho_2 \mu_{t-1} + \Sigma_{i=1}^{k} \beta\, \Delta\mu_{t-i} + \varepsilon_t$$

where μt represents the residual series and I_t is the Heaviside indicator as follows:

$$I_t = \begin{cases} 1\ if\ \Delta\mu_{t-1} \geq \lambda \\ 0\ if\ \Delta\mu_{t-1} < \lambda \end{cases} \quad \text{For M} - \text{TAR model}$$

where μ_{t-1} is the lagged momentum and τ is the threshold.

The null hypothesis can be expressed as: $H0 : \rho1 = \rho2 = 0$. By rejecting null hypothesis we can imply that there exists a notable difference in the autoregressive patterns of the variables when responding to alterations in momentum, thereby indicating the existence of separate regimes or thresholds.

RESULTS AND DISCUSSION

The primary aim of our analysis was to check the price pass through of butter prices along the supply chain. Prior to the price transmission analysis, we had to check the stationarity of time series. The Table 1 and Table 2 outline the results of the Augmented Dickey-Fuller test and Phillips-Perron test conducted for stationarity testing. The tables display test results with constant (Testc) and test with constant and trend (Testct). According to the outcomes of both of the tests, while the price series are non-stationary in levels, after taking first differences, the series became stationary.

Table 1 Augment Dickey-Fuller test

	Price levels		1^{st} Differences	
	$Test_c$	$Test_{ct}$	$Test_c$	$Test_{ct}$
Producer price	-0.226	-1.588	-8.660***	-8.750***
Consumer price	0.092	-1.857	-6.018***	-6.152***

Note: Testc stands for stationarity test with a constant and Testct stands for stationarity test with a constant and trend, *** indicate 1% significance level
Source: Estimated by author

Table 2 Phillips-Perron test

	Price levels		1^{st} Differences	
	$Test_c$	$Test_{ct}$	$Test_c$	$Test_{ct}$
Producer price	-0.752	-2.114	-9.203***	-9.207***
Consumer price	0.949	-0.797	-9.791***	-9.917***

Note: Testc stands for stationarity test with a constant and Testct stands for stationarity test with a constant and trend, *** indicate 1% significance level
Source: Estimated by author

To check the long-run relationship between different price series, we have performed a Johansen cointegration test. The outcomes of Johansen's cointegration test are shown in Table 3. According to our results, there is no long-run relationship between producer and consumer prices of butter.

Table 3 Johansen cointegration test results

Maximum rank	Eigenvalue	Trace statistics	Critical value 5%	Critical value 1%
0		7.3803***	12.53	16.31
1	0.02254	2.8895	3.84	6.51
2	0.01456			

Note: *** indicate 1% significance level
Source: own elaboration

However, the nonexistence of the cointegration can be caused by the presence of a structural break. Therefore, in the next step we admit the existence of a structural break using the Gregory-Hansen cointegration test. Based on the results we find there is a cointegrating relationship with a structural break between producer and consumer butter prices. The test detects two structural breaks significant at more than 5% significance level. The beginning of 2020 was marked by rising butter production. Butter production in the Slovak Republic increased by 19% year-on-year, which was reflected in a drop in prices. Compared to the first half of 2019, the price of butter decreased by 8.5% (Repka, 2020). However, the most significant structural break was observed in the beginning of the year 2016. The estimated date of the structural break is February 2016, which we can see in Table 4. This structural break could be caused by the drop in VAT from 20 to 10%, which was imposed on selected types of goods from January 1, 2016, as well as the lack of milk on European markets.

Table 4 Gregory-Hansen cointegration test results

Model	Gregory –Hansen ADF(t) statistics	Break date
Change in level	-4.52*	August 2018
Change in level and trend	-5.66***	February 2016
Change in regime	-5.00**	January 2020
Change in regime and trend	-6.26***	February 2016

Note: *** indicate 1% significance level, ** 5% significance level, *10% significance level
Source: own elaboration

Threshold cointegration

The results of the autoregressive threshold model estimating the relationship between producer and consumer prices can be found in Table 5. The rejection of the symmetry hypothesis and the significant F-statistics in both F-joint (Phi) and F-equal provide strong evidence of asymmetry in the relationship between producer and consumer prices of butter. The negative values of $\rho 1$ and $\rho 2$, particularly above and below the threshold, indicate the direction and magnitude of the asymmetrical responses. The threshold value of -0.011 signifies the critical point at which this asymmetry becomes apparent. These findings offer valuable insights into the nuanced dynamics of price movements between producers and consumers in the butter market.

Table 5 Momentum threshold autoregression model

Threshold value	Above threshold (ρ1)	Below threshold (ρ2)	F-joint (Phi): (ρ1= ρ2=0)	F-equal: (ρ1= ρ2)
-0.011	-0.105	-0.251	12.063**	4.334**

Note: ** indicate 5% significance level; MTAR stands for the momentum threshold autoregressive test method
Source: own elaboration

CONCLUSIONS

The supply chain for dairy products, such as butter, involves primary producers, processors, distributors, and retailers. Each stage in the supply chain may add its own costs and markups, affecting the final consumer price. In our work, we focused on the transfer of prices within the butter food supply chain. We focused on the purchase and consumer prices of butter. The data was collected on a monthly basis from January 2006 to December 2022. Based on the results of the analysis, we found that there is no long-term linear relationship between the purchase and consumer prices of butter. This result may be a consequence of the existence of a structural break. If we accept the existence of a structural break, we can also say that there is a cointegrating relationship also in the case of butter prices. The structural break occurred in February 2016 and this break could be caused by factors such as the drop in VAT from 20 to 10%, which was imposed on selected types of goods from January 1, 2016, as well as the lack of milk on European markets. The results of the threshold autoregressive models of producer and consumer prices show that there is cointegration, but the symmetry hypothesis is rejected, so that positive and negative consumer price shocks do not affect purchase prices to the same extent. These results provide valuable insight into the behaviour of price transmission between the individual stages of the butter supply chain.

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