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Gliding through space: Regional integration of butter prices

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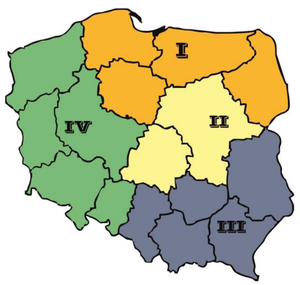
Map 1. Price reporting regions for butter in Poland.



I- Centra ll- Northern III- S-Eastern IV- Western

Introduction

Regional differences in economic development and farming imply a different degree of local economy dependence on farm revenues. According to the NUTS classification ranking all regions in the EU, several regions of the eastern and southeastern Poland are among the least developed regions. Those regions tend to be sparsely populated, for example, the population density of Podlaskie and Warminsko-mazurskie Voivodships is only 48% of the national average, and that of Lubelskie Voivodship equals about 61% (GUS, 2018). The average monthly gross earnings in those three regions ranged from 84% to 88.8% of the national average in 2017. Podlaskie Voivodship is among top three leading dairy producing regions in the country and farming is the backbone of local economies. Parts of Warminsko-mazurskie and northern Lubelskie Voivodships have sizable dairy sectors. Dairy farming and dairy processing plants are important sources of income and employment.

Among dairy products, butter is of particular importance because it is the well-accepted and widely used in the daily diet. Refrigerated or frozen butter can be stored for a period of time (Krause et al., 2008). As a storable item with relatively significant value added, butter helps to address the effect of milk production seasonality. Dairy processing cooperatives take advantage of butter storability in managing their inventories allowing for some flexibility in butter marketing.

Objective

Recognizing the importance of dairy farm incomes to regional economies, this paper aims at understanding the dynamics of butter prices.

Analytical approach

The study basically applies the model proposed by Richardson (1978), which describes the relationship between prices of the same commodity between two markets as (Goodwin et al., 1999):

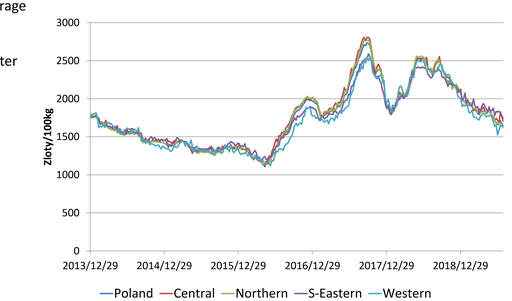
$P^1_{it} = \beta_0 P^2_{it}{}^{\beta 1} T_{it}{}^{\beta 2}$,

where P^1_{it} and P^2_{it} are prices for butter in time t in markets 1 and 2; T_{it} is transfer and transactions costs of butter between the two regional markets. Steps followed were: Unit Root Test - ADF test for stationarity (rejected on the prices); Johansen test of cointegration (found region cointegrated); Application of Granger causality test (found bi-causality); Long Term Regression including milk quota; Two vector error correction were modelled (four regions); Impulse response simulations were used to understand the dynamics (Impulse Responses).

Data

Prices of butter are recorded daily in each voivodship and averaged for each region (Map 1). An average price for the country as a whole is also calculated and recorded by the Central Statistical Office. Price records are for wholesale butter prices and quoted per 100 kg blocks. This study uses 290 weekly observations for the four regions as well as Poland as a whole for the period from December 29, 2013 to July 28, 2019 (Graph 1).

Graph 1. Price reporting regions for butter in Poland and four regions



Selected results

The Granger causality tests of butter price series

Following the test for non-stationarity, the four differentiated series were expressed in logs. Table 1 reports the results of the test on uni- and bidirectional relationships of prices among the four regions (Map 1). Evidence of causality offers insights useful in predicting prices if price forecasting if such is the practical objective of research.

Causality between Northern and Central regions. Test results reject the null that the prices do not cause each other (Table 1). The bidirectional causality implies that the causality runs both ways and prices in each region impact prices in the other region. A change in the wholesale butter price in Northern region, for example, triggers an immediate response in prices in Central region. The result is consistent with the proximity of the concentrated dairy production in both regions and the high dependence on the large urban market in Central region for all butter suppliers in that part of the country. Furthermore, the geographical location of both regions places them at a distance from any potential supplier from outside the country since the bordering countries are either small dairy producers (Lithuania) or not members of the EU (Russia-Kaliningrad area or Belarus).

Causality between Southeastern and Central regions. The bidirectional causality suggests that price changes in one region prompt price changes in another region (Table 1). The butter producing dairy cooperatives in the Southeastern region are located in voivodships bordering the Central region and include Lubelskie, Świętokrzyskie and Śląskie Voivodships. Some of those cooperatives can supply butter to buyers in their own and Central regions. Opportunities to ship butter to the Western region are constrained by the distance and the existence of numerous dairy cooperatives operating in that region and already competing on the butter market.

Causality between Western and Central regions. The unidirectional causality was confirmed that prices in Central region affect prices in Western region, but the opposite is not true. Consequently, prices from the Central region may be useful in forecasting the prices in Western region. The lack of influence of Western prices on Central region prices contrasts with the effects of prices in Northern and Southeastern regions. Prices behave in Western region distinctly different from the wholesale butter prices in the other three price reporting areas (Map 1).

Causality between Southeastern and Northern regions. The null was rejected (Table 1) implying the bidirectional causality of prices in Southeastern and Northern regions. The regions share the similar natural conditions suitable for dairy production and the proximity of the eastern part of the Northern region and the northern area of the Southeastern region allows for the physical shipments of butter in either direction. Both regions also form the eastern border of the EU restricting shipments from countries located farther east.

Causality between Western and Northern regions. Results of the Granger test established a unidirectional relationship. The wholesale butter prices in Northern region may shape prices in Western region. There is no evidence the opposite is true (Table 1). Northern region, which includes the sparsely populated Podlaskie and Warmińsko-mazurskie Voivodships, but has a competitive diary sector capable of supplying butter to other regions.

Causality between Western and Southeastern regions. In a pattern similar to two other regions, only a unidirectional relationship was established (Table 1). Prices of butter in the Southeastern region influence prices in Western region, but the reverse relationship is not confirmed. The area of Southeastern region that borders Western region includes a number of dairy cooperatives producing butter, which could help to explain the observed linkage.

Results of the Vector Error Correction Estimates show strongly cointegration between butter price in the regions, except the Western region (Table 2). In the VEC model it is possible to estimate the impulse response to a shock for each region in relation to other regions. The results in the central, northern and south-eastern regions showed similar responses, with an increase in the initial 10 to 15 periods (i.e., based on weekly data) to then converge to the equilibrium. In contrast, the Western region showed an opposite (asymmetrical) behavior (Graph 2).

Conclusions. The price of butter and the level of income obtained from its sale by a farm are regionally determined. The differences in integration between regions are due to the potential in dairy production. In the case of Northern region, Pomorskie Voivodship does not have natural conditions favoring dairy farming. In the Southeastern region, Podkarpackie Voivodship witnessed a rapid decline in dairy farming in the last two decades, disallowing any processing plant to maintain the necessary production scale. Dairy farming in that area was mostly for the purpose of self-supply since the average farm size was very small. Additionally, the topography favors sheep grazing rather than cattle operations. In Western region, two voivodships have focus on row crop production, and do not produce butter. Farms there could not compete in dairy farming with Wielkopolskie Voivodship farms, one of the leading dairy-producing areas in Poland. Also, both voivodships border Germany, the largest butter producer in the EU.

Table 1. Granger causality test results of the weekly wholesale butter prices in Central, Northern, Southeaster and Western regions, n=276.

Null hypothesis	F-statistic	Prob.	Decision
Northern does not Granger cause Central	5.8180[a]	8.00E-10	Reject
Central does not Granger cause Northern	3.0441[a]	0.0002	Reject
Southeastern does not Granger cause Central	3.6952[a]	1.00E-05	Reject
Central does not Granger cause Southeastern	2.4097[a]	0.0035	Reject
Western does not Granger cause Central	0.7391	0.7339	Do not reject
Central does not Granger cause Western	4.6415[a]	2.00E-07	Reject
Southeastern does not Granger cause Northern	4.4761[a]	4.00E-07	Reject
Northern does not Granger cause Southeastern	3.3128[a]	7.00E-05	Reject
Western does not Granger cause Northern	1.1704	0.2986	Do not reject
Northern does not Granger cause Western	6.8605[a]	8.00E-12	Reject
Western does not Granger cause Southeastern	1.2787	0.2209	Do not reject
Southeastern does not Granger cause Western	4.1828[a]	1.00E-06	Reject

Table 2. Vector Error Correction Model for butter price in four regions in Poland, n=287 after adjustments.

Cointegrating Eq:	CointEq1			
CENTRAL_L(-1)	1			
NORTHERN_L(-1)	-0,794563			
	-0,09982			
	[-7.96028]			
S_EASTERN_L(-1)	-0,353673			
	-0,12771			
	[-2.76929]			
WESTERN_L(-1)	0,136916			
	-0,08121			
	[1.68604]			
Intercept	0,076766			
Error Correction:	D(CENTRAL_L)	D(NORTHERN_L)	D(S_EASTERN_L)	D(WESTERN_L)
CointEq1	-0,240301	0,139008	0,130586	-0,05357
	-0,07224	-0,05632	-0,06982	-0,08153
	[-3.32622]	[2.46808]	[1.87022]	[-0.65707]
D(CENTRAL_L(-1))	-0,241947	0,065618	0,031487	0,113816
	-0,08088	-0,06305	-0,07817	-0,09127
	[-2.99158]	[1.04070]	[0.40282]	[1.24704]
D(CENTRAL_L(-2))	-0,042092	0,137547	0,035812	0,204706
	-0,06988	-0,05448	-0,06754	-0,07886
	[-0.60232]	[2.52464]	[0.53021]	[2.59571]
D(NORTHERN_L(-1))	0,355824	0,093977	0,390067	0,431443
	-0,09033	-0,07043	-0,08731	-0,10194
	[3.93896]	[1.33441]	[4.46770]	[4.23224]
D(NORTHERN_L(-2))	0,290755	0,020393	0,181057	0,213556
	-0,08485	-0,06615	-0,08201	-0,09575
	[3.42674]	[0.30829]	[2.20784]	[2.23031]
D(S_EASTERN_L(-1))	0,234069	0,33319	-0,209535	0,144224
	-0,07036	-0,05485	-0,068	-0,0794
	[3.32691]	[6.07452]	[-3.08142]	[1.81649]
D(S_EASTERN_L(-2))	0,113727	0,190149	-0,106358	-0,009557
	-0,07243	-0,05647	-0,07001	-0,08174
	[1.57009]	[3.36729]	[-1.51926]	[-0.11692]
D(WESTERN_L(-1))	0,041255	-0,0167	-0,013223	-0,294357
	-0,05577	-0,04348	-0,0539	-0,06293
	[0.73976]	[-0.38410]	[-0.24533]	[-4.67725]
D(WESTERN_L(-2))	0,014323	-0,111883	0,00385	-0,25192
	-0,05467	-0,04262	-0,05284	-0,06169
	[0.26200]	[-2.62518]	[0.07286]	[-4.08352]
Intercept	-2,98E-06	-0,000364	0,000129	-0,000334
	-0,00127	-0,00099	-0,00122	-0,00143
	[-0.00235]	[-0.36896]	[0.10573]	[-0.23357]
R-squared	0,334247	0,362668	0,16484	0,250167
Adj. R-squared	0,312616	0,34196	0,137704	0,225804
Sum sq. resids	0,127454	0,077465	0,119057	0,162313
S.E. equation	0,02145	0,016723	0,020732	0,024207
F-statistic	15,45223	17,51379	6,074757	10,26837
Log likelihood	700,5104	771,9628	710,2899	665,8161
Akaike AIC	-4,81192	-5,309845	-4,880069	-4,570147
Schwarz SC	-4,684411	-5,182337	-4,752561	-4,442639
Mean dependent	-0,000146	-0,000325	-2,77E-05	-0,000341
S.D. dependent	0,025872	0,020615	0,022326	0,027511
Determinant resid covariance (dof adj.)		1,68E-14		
Determinant resid covariance		1,46E-14		
Log likelihood		2942,832		
Akaike information criterion		-20,20092		
Schwarz criterion		-19,63989		
Number of coefficients		44		

Graph 2. Impulse response estimates for butter prices in four regions in Poland.