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SPATIAL INTEGRATION OF VEGETABLE WHOLESALE MARKETS IN POLAND ON THE SELECTED EXAMPLE

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ABSTRACT

This article attempts to verify the phenomenon of price transmission between wholesale markets of carrots in Poland. Determining the level of spatial integration of markets will indicate their efficiency and thus can make it easier for producers to take decisions about where to sell their products. The empirical data includes daily quotations of carrot prices on fruit and vegetable wholesale markets in Bronisze, Kalisz, Poznań, Radom and Sandomierz. The time range of the studies covered the years 2011–2016. This research is based on dynamic econometric methods (sVAR model) and the Granger causality tests. The research carried out using dynamic econometric methods has shown that despite the occurrence of significant variation in the level of carrot prices in the examined markets, their interaction was observed. Moreover, the results of the sVAR model estimation indicate that the changes in carrot prices on a particular market are stronger influenced by the price changes from the same market. This is an autoregressive effect. It also means that the carrot price information coming from other wholesale markets (price transmission effect) has a much weaker effect.

Key words: price transmission, sVAR model, Granger causality test, wholesale market, vegetable prices

INTRODUCTION

The market for agricultural products is subject to the universal laws of market economy. However, it has specific characteristics which in many cases result in atypical market behaviour compared to other markets. Nevertheless, the most important principle shaping the level of prices on the agricultural products market is the law of supply and demand [Hamulczuk et al. 2012]. The price relationship between agricultural markets at the same level in the distribution chain is determined by horizontal price transmission. It consists of spreading, via impulses, of prices of a given product in different locations. This phenomenon is defined as the spatial transmission of prices [Fackler and Goodwin 2001]. In macroeconomic terms, integration is a process of strengthening cooperation and connecting markets, which is made possible by eliminating economic barriers between these markets. Spatial market integration refers to the flow of price impulses and the existence of relationships between individual markets (price transmission). Market integration describes a situation where two conditions are met, namely: commodity prices in spatially separated markets change in parallel and signals and information are transmitted fluently between them.

Prices between two markets that trade with each other vary based on the magnitude of the markets' transaction costs and, in the case of markets between which there is no trade, these differences in prices may not be dependent solely on transaction costs [Tomek and Robinson 1981].

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Spatial integration of markets provides an opportunity to create competitive conditions between markets where prices are mainly differentiated by transaction costs [Barrett and Li 2002]. Measuring market integration can become an essential tool in understanding how markets function [Ravallion 1986].

The fruit and vegetable market is an element of the agricultural market. However is distinguished by the existence of autonomous local markets, a high level of seasonality, a significant share of small, non-organised producers, and a wide range of products which differ in quality levels. In addition, large fluctuations in the level of prices, both in time and spatial cross-section, are an important feature. This leads to asymmetry in price transmission, and leads to lack of integration. Determining the level of spatial integration of markets will indicate their efficiency and thus make it easier for producers to make decisions about where to sell their products. The aim of this article was to assess the degree of spatial integration of wholesale fruit and vegetables markets in Poland on the example of carrot, in which Poland is a significant producer.

Wholesale markets play an important role in wholesale trade, which is the link between producers and retailers [Urban and Olszańska 2015]. One of the most important functions of wholesale markets is the price formation through the interaction of supply and demand forces. These markets and their operators are seen as an important element of trade in the agricultural sector, especially in relation to fruit and vegetables [Gołębiewski and Sobczak 2017]. Wholesale markets in Poland were established in the 1990s. These entities were an alternative to marts that dealt with wholesale trade of agricultural products which dominated the trade between producers and retailers in the first years after the transformation. At the same time, the position of existing entities, i.e. cooperatives, was significantly weakened and eventually their place was taken by new entities specialising in wholesale trade [Chojnacki 1999].

MATERIAL AND METHODS

In order to determine the spatial integration of wholesale markets, we used daily prices of carrots sold at five wholesale markets: Warsaw Agricultural-Food Wholesale Market and Wielkopolska Agro-Horticultural Guild S.A. in Poznań, Sandomierz Horticultura Wholesale Market S.A., Agricultural-Food Wholesale Market Giełda Kaliska Sp. z o.o., Agricultural-Food Wholesale Market in Radom and Sandomierski Horticultural Wholesale Market S.A. The time period of the analysed prices (2011–2016) allowed minimising the impact of extraordinary changes in the supply of this commodity. Data on the price levels of carrots selected fruit and vegetable species were obtained directly from wholesale markets and the Polish Wholesale Markets Association.

In order to examine the stationarity of the time series for selecting the appropriate modelling methodology we have used an augmented Dickey–Fuller (ADF) test. The test (ADF) is based on a regression equation [Maddala 2008]:

$$\Delta y_t = \delta y_{t-1} + \sum_{i=1}^{k} \gamma_i \Delta y_{t-1} + bt + \varepsilon_t \qquad (1)$$

where:

δ, b, γ – structural parameters estimated using the least squares method;
k – number of lags;
t – deterministic trend;
Δy_{t-1} – the first differences of variable y in period $t-1$;
ε_t – residuals.

The null hypothesis for this test states that the y_t series is non-stationary (y_t has a unit root), while the alternative hypothesis states that the y_t series is stationary.

The type of process generating y_t has been also examined on the basis of the autocorrelation function (correlogram), which is in the form of [Box and Jenkins 1970]:

$$r_k = \hat{\rho}_k = \sum_{t+k+1}^{T} \left(x_t - \overline{x}\right)\left(x_{t-k} - \overline{x}\right) / \sum_{t=1}^{T} \left(x_t - \overline{x}\right)^2 =$$

$$= \frac{\sum_{t=k+1}^{T} \left(x_t - \overline{x}\right)\left(x_{t-k} - \overline{x}\right)}{Ts^2} \qquad (2)$$

where:

t – time index;
k – number of lags;
$\overline{x}$ – the average value of x.

In order to analyse the volatility of carrot prices on studied markets and to determine the existence of spatial integration, the structural model VAR (sVAR) was applied:

$$Bx_t = \Gamma_0 D_t + \Gamma_1 x_{t-1} + \Gamma_2 x_{t-2} + ... + \Gamma_k x_{t-k} + \xi_t \quad (3)$$

where:
x_t – vector of the n variables in the model

$$x_t = [x_{1t} \ ... \ x_{nt}]' \quad (4)$$

D_t – vector of deterministic components;
Γ_0 – matrix of parameters for variables in vector D_t;
B – parameter matrix when variables of vector x_t are non-delayed:

$$B = \begin{bmatrix} 1 & b_{12} & ... & b_{1n} \\ b_{21} & 1 & ... & b_{2n} \\ ... & ... & 1 & ... \\ n_1 & b_{n2} & ... & 1 \end{bmatrix} \quad (5)$$

Γ_1 (i = 1, 2, 3, …, k) – parameter matrices with delayed variables;
x_n, ξ_t – random disturbance vector of the structural model [Kusideł 2000].

The selection of lags was based on the Akaike and Schwarz information criterions.

The Granger causality test was used to analyse relations between the studied variables. Testing causality in the Granger sense is based on the following system of equations:

$$Y_t = \beta_0 + \sum_{j=1}^{m} \beta_j Y_{t-j} + \sum_{k=l}^{n} \beta_k X_{t-k} + u_t \quad (6)$$

$$X_t = \beta_0 + \sum_{j=1}^{m} \beta_j X_{t-j} + \sum_{k=l}^{n} \beta_k Y_{t-k} + u_t \quad (7)$$

where:
Y_t – values of the variable Y;
X_t – values of the variable X;
β – structural parameters of the model;
u_t – random component of the model [Granger 1969].

The null hypothesis in the Granger Causality test assumes that all β_k coefficients are equal to zero, which means that there is no causality, while the alternative hypothesis assumes the occurrence of causality in the Granger sense.

RESULT AND EMPIRICAL RESEARCH

This empirical study requires examining the stationarity of time series. The test results for the analysed time series are presented in Table 1. The calculated value of ADF test statistics is less than the critical value at each level of significance. Therefore, the null hypothesis about the non-stationarity of the time series for the examined carrot markets should be rejected.

For the time series investigated, autocorrelation and partial autocorrelation functions were generated. The generated autocorrelation functions have confirmed the stationarity of the carrot price series for selected wholesale markets. In this case, autocorrelation functions are expiring systematically and do not take on a sinusoidal shape (the figure). Studying the shape of the autocorrelation function is considered one of the non-formalised methods of testing the stationarity of time series [Kusideł 2000].

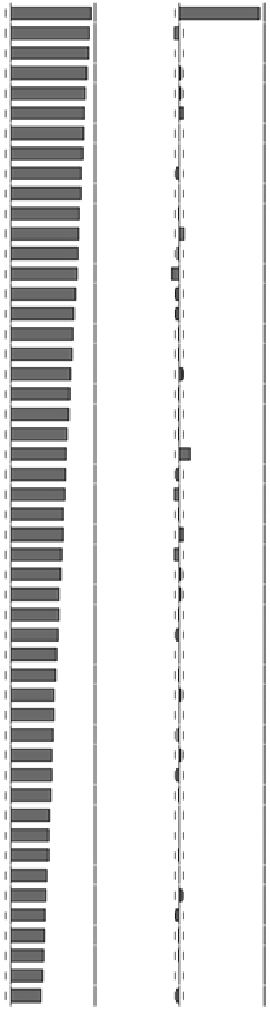
In the sVAR model, restrictions were imposed on pairs of parameters corresponding to wholesale

Table 1. Results of stationarity tests of time series of the examined prices of carrots

Wholesale market	ADF test statistics	The critical value for a p level of significance	
		p for 0.01	p for 0.05
Bronisze	–3.221	–2.568	–2.863
Poznań	–3.313	–2.568	–2.863
Kalisz	–3.169	–2.568	–2.863
Radom	–3.629	–2.568	–2.863
Sandomierz	–4.108	–2.568	–2.863

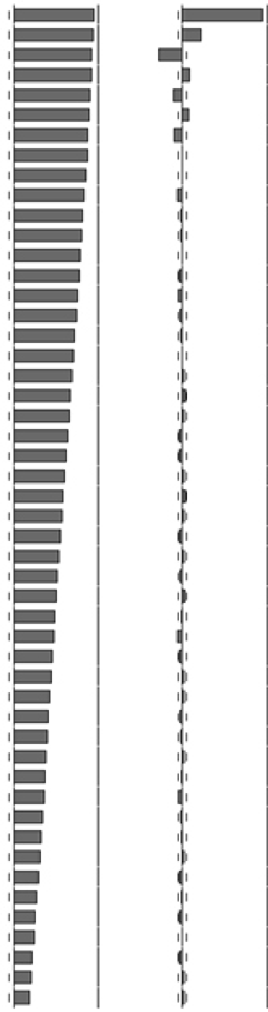
Source: Calculations and author’s elaboration using the EViews program.

Bronisze



1	0.986	0.986	1449.2	0.000
2	0.970	-0.061	2853.6	0.000
3	0.955	-0.004	4214.1	0.000
4	0.940	0.011	5532.9	0.000
5	0.925	0.020	6812.8	0.000
6	0.913	0.043	8058.6	0.000
7	0.900	0.006	9272.0	0.000
8	0.888	-0.002	10454.	0.000
9	0.875	-0.027	11602.	0.000
10	0.863	0.006	12719.	0.000
11	0.850	-0.008	13804.	0.000
12	0.839	0.058	14863.	0.000
13	0.828	-0.017	15894.	0.000
14	0.815	-0.085	16893.	0.000
15	0.801	-0.036	17859.	0.000
16	0.786	-0.033	18789.	0.000
17	0.770	-0.009	19683.	0.000
18	0.755	-0.010	20543.	0.000
19	0.741	0.038	21373.	0.000
20	0.728	-0.015	22173.	0.000
21	0.714	-0.016	22944.	0.000
22	0.700	-0.015	23686.	0.000
23	0.690	0.124	24406.	0.000
24	0.679	-0.026	25105.	0.000
25	0.667	-0.063	25779.	0.000
26	0.655	-0.016	26429.	0.000
27	0.644	0.054	27057.	0.000
28	0.631	-0.061	27662.	0.000
29	0.618	0.017	28243.	0.000
30	0.607	0.017	28802.	0.000
31	0.595	-0.011	29341.	0.000
32	0.583	-0.025	29858.	0.000
33	0.571	0.002	30356.	0.000
34	0.559	-0.012	30832.	0.000
35	0.548	0.018	31290.	0.000
36	0.537	-0.002	31730.	0.000
37	0.526	-0.020	32153.	0.000
38	0.516	0.019	32560.	0.000
39	0.505	-0.030	32951.	0.000
40	0.494	-0.010	33324.	0.000
41	0.483	0.000	33681.	0.000
42	0.472	0.005	34022.	0.000
43	0.461	-0.016	34348.	0.000
44	0.450	0.000	34659.	0.000
45	0.440	0.032	34957.	0.000
46	0.429	-0.042	35240.	0.000
47	0.419	-0.014	35510.	0.000
48	0.408	-0.014	35766.	0.000
49	0.396	-0.002	36008.	0.000
50	0.385	-0.027	36237.	0.000

Poznań

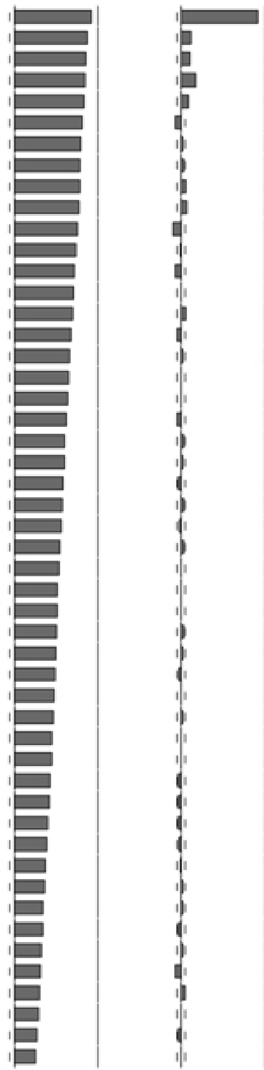


1	0.987	0.987	1453.8	0.000
2	0.981	0.236	2889.5	0.000
3	0.966	-0.292	4283.3	0.000
4	0.957	0.089	5650.6	0.000
5	0.941	-0.114	6975.1	0.000
6	0.931	0.074	8271.6	0.000
7	0.915	-0.105	9524.6	0.000
8	0.903	0.001	10745.	0.000
9	0.887	-0.004	11925.	0.000
10	0.873	-0.062	13068.	0.000
11	0.856	-0.020	14169.	0.000
12	0.841	-0.022	15233.	0.000
13	0.825	-0.000	16255.	0.000
14	0.809	-0.041	17239.	0.000
15	0.791	-0.055	18180.	0.000
16	0.773	-0.030	19080.	0.000
17	0.754	-0.024	19937.	0.000
18	0.736	0.001	20753.	0.000
19	0.717	0.008	21529.	0.000
20	0.700	0.039	22269.	0.000
21	0.683	0.014	22974.	0.000
22	0.665	-0.041	23643.	0.000
23	0.647	-0.042	24277.	0.000
24	0.629	0.010	24877.	0.000
25	0.612	0.041	25445.	0.000
26	0.596	0.023	25984.	0.000
27	0.579	-0.043	26493.	0.000
28	0.563	0.014	26974.	0.000
29	0.546	-0.028	27427.	0.000
30	0.531	0.029	27856.	0.000
31	0.515	-0.009	28259.	0.000
32	0.498	-0.062	28637.	0.000
33	0.481	-0.044	28990.	0.000
34	0.465	0.023	29320.	0.000
35	0.449	0.017	29627.	0.000
36	0.433	-0.030	29913.	0.000
37	0.417	-0.018	30178.	0.000
38	0.401	0.020	30425.	0.000
39	0.385	-0.015	30652.	0.000
40	0.369	-0.051	30861.	0.000
41	0.353	-0.019	31052.	0.000
42	0.337	-0.015	31225.	0.000
43	0.321	0.015	31383.	0.000
44	0.304	-0.036	31526.	0.000
45	0.288	-0.013	31653.	0.000
46	0.271	-0.034	31766.	0.000
47	0.255	-0.001	31866.	0.000
48	0.237	-0.039	31953.	0.000
49	0.221	0.019	32028.	0.000
50	0.204	0.012	32093.	0.000

Fig. The autocorrelation and partial autocorrelation functions for examined time series

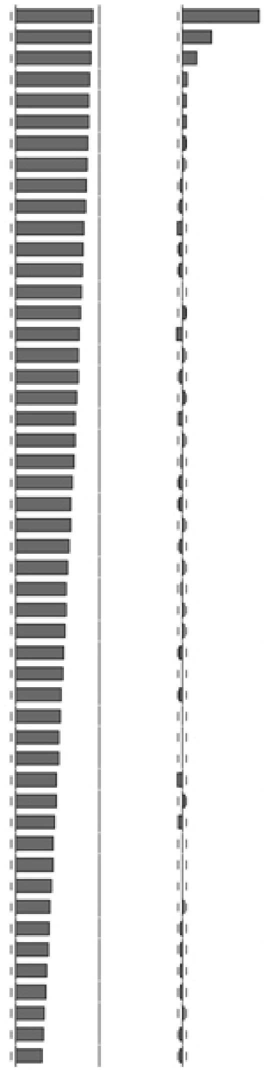
Source: Calculations and author's elaboration using the EViews program.

Radom



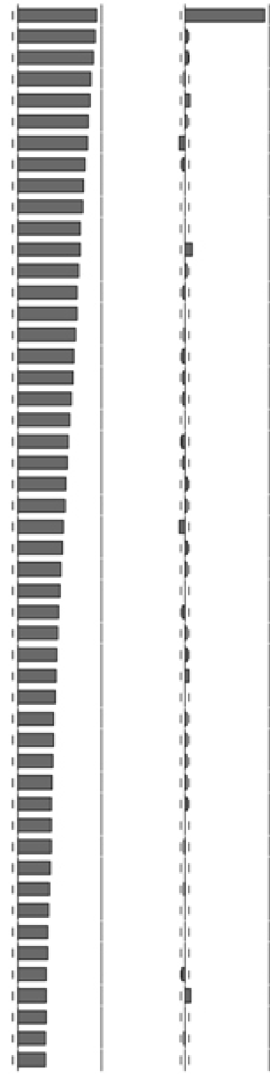
	AC	PAC	Q-Stat	Prob
1	0.952	0.952	1351.2	0.000
2	0.917	0.118	2606.7	0.000
3	0.893	0.109	3796.3	0.000
4	0.882	0.175	4958.8	0.000
5	0.874	0.092	6100.8	0.000
6	0.854	-0.071	7192.1	0.000
7	0.835	0.011	8236.1	0.000
8	0.820	0.028	9242.4	0.000
9	0.812	0.061	10230.	0.000
10	0.807	0.069	11207.	0.000
11	0.789	-0.100	12142.	0.000
12	0.770	-0.016	13033.	0.000
13	0.748	-0.071	13874.	0.000
14	0.732	-0.002	14681.	0.000
15	0.725	0.060	15471.	0.000
16	0.708	-0.054	16227.	0.000
17	0.693	0.014	16952.	0.000
18	0.677	0.005	17643.	0.000
19	0.664	-0.006	18310.	0.000
20	0.649	-0.053	18947.	0.000
21	0.636	0.030	19559.	0.000
22	0.625	0.024	20149.	0.000
23	0.608	-0.042	20708.	0.000
24	0.595	0.029	21245.	0.000
25	0.582	-0.020	21759.	0.000
26	0.572	0.025	22254.	0.000
27	0.561	-0.006	22731.	0.000
28	0.548	-0.001	23187.	0.000
29	0.536	-0.003	23623.	0.000
30	0.526	0.025	24044.	0.000
31	0.517	0.010	24450.	0.000
32	0.506	-0.028	24840.	0.000
33	0.494	0.002	25211.	0.000
34	0.484	0.010	25569.	0.000
35	0.474	0.000	25911.	0.000
36	0.465	-0.004	26242.	0.000
37	0.452	-0.043	26554.	0.000
38	0.436	-0.049	26845.	0.000
39	0.420	-0.039	27114.	0.000
40	0.404	-0.031	27364.	0.000
41	0.391	-0.013	27598.	0.000
42	0.380	0.021	27819.	0.000
43	0.369	0.009	28028.	0.000
44	0.354	-0.033	28220.	0.000
45	0.343	0.020	28400.	0.000
46	0.328	-0.068	28565.	0.000
47	0.318	0.048	28720.	0.000
48	0.307	0.007	28865.	0.000
49	0.292	-0.045	28997.	0.000
50	0.277	0.001	29115.	0.000

Kalisz



	AC	PAC	Q-Stat	Prob
1	0.956	0.956	1362.0	0.000
2	0.945	0.360	2693.5	0.000
3	0.935	0.175	3999.2	0.000
4	0.924	0.058	5273.5	0.000
5	0.914	0.042	6522.3	0.000
6	0.906	0.045	7749.8	0.000
7	0.898	0.037	8957.3	0.000
8	0.890	0.022	10145.	0.000
9	0.880	-0.019	11306.	0.000
10	0.869	-0.033	12440.	0.000
11	0.856	-0.063	13540.	0.000
12	0.844	-0.040	14609.	0.000
13	0.830	-0.044	15644.	0.000
14	0.819	-0.002	16653.	0.000
15	0.811	0.039	17642.	0.000
16	0.794	-0.077	18592.	0.000
17	0.785	0.022	19521.	0.000
18	0.772	-0.027	20420.	0.000
19	0.762	0.026	21295.	0.000
20	0.746	-0.057	22135.	0.000
21	0.735	0.012	22952.	0.000
22	0.722	-0.010	23740.	0.000
23	0.707	-0.043	24497.	0.000
24	0.692	-0.040	25222.	0.000
25	0.680	0.009	25924.	0.000
26	0.665	-0.032	26594.	0.000
27	0.654	0.020	27242.	0.000
28	0.639	-0.014	27863.	0.000
29	0.628	0.016	28462.	0.000
30	0.617	0.023	29040.	0.000
31	0.600	-0.049	29588.	0.000
32	0.588	-0.003	30114.	0.000
33	0.572	-0.038	30613.	0.000
34	0.559	0.003	31089.	0.000
35	0.545	-0.008	31542.	0.000
36	0.533	0.008	31976.	0.000
37	0.516	-0.061	32383.	0.000
38	0.505	0.027	32773.	0.000
39	0.488	-0.053	33137.	0.000
40	0.474	-0.007	33482.	0.000
41	0.460	-0.004	33806.	0.000
42	0.447	0.008	34112.	0.000
43	0.434	0.016	34401.	0.000
44	0.420	-0.020	34672.	0.000
45	0.405	-0.024	34924.	0.000
46	0.391	-0.018	35158.	0.000
47	0.375	-0.022	35375.	0.000
48	0.363	0.017	35578.	0.000
49	0.347	-0.030	35763.	0.000
50	0.332	-0.028	35933.	0.000

Sandomierz



	AC	PAC	Q-Stat	Prob
1	0.976	0.976	1362.3	0.000
2	0.955	0.027	2665.2	0.000
3	0.935	0.041	3916.5	0.000
4	0.915	-0.015	5116.1	0.000
5	0.899	0.062	6273.5	0.000
6	0.883	0.008	7390.9	0.000
7	0.863	-0.079	8459.9	0.000
8	0.843	-0.029	9480.1	0.000
9	0.823	-0.002	10454.	0.000
10	0.804	-0.003	11383.	0.000
11	0.786	0.008	12271.	0.000
12	0.772	0.090	13129.	0.000
13	0.759	0.014	13959.	0.000
14	0.744	-0.023	14759.	0.000
15	0.730	0.006	15529.	0.000
16	0.716	-0.015	16269.	0.000
17	0.700	-0.029	16977.	0.000
18	0.685	-0.017	17655.	0.000
19	0.670	-0.018	18304.	0.000
20	0.654	-0.001	18925.	0.000
21	0.638	-0.045	19514.	0.000
22	0.621	-0.019	20073.	0.000
23	0.605	0.031	20604.	0.000
24	0.590	0.016	21109.	0.000
25	0.572	-0.074	21585.	0.000
26	0.556	0.026	22036.	0.000
27	0.542	0.014	22462.	0.000
28	0.527	0.002	22867.	0.000
29	0.512	-0.031	23249.	0.000
30	0.498	0.020	23611.	0.000
31	0.486	0.025	23955.	0.000
32	0.476	0.044	24286.	0.000
33	0.466	-0.003	24603.	0.000
34	0.456	0.015	24907.	0.000
35	0.447	0.011	25200.	0.000
36	0.439	0.015	25482.	0.000
37	0.431	0.009	25755.	0.000
38	0.425	0.026	26020.	0.000
39	0.419	0.006	26277.	0.000
40	0.413	-0.012	26527.	0.000
41	0.406	-0.003	26769.	0.000
42	0.398	-0.016	27002.	0.000
43	0.390	-0.002	27227.	0.000
44	0.383	-0.001	27443.	0.000
45	0.376	0.006	27652.	0.000
46	0.368	-0.035	27852.	0.000
47	0.363	0.067	28046.	0.000
48	0.358	0.001	28236.	0.000
49	0.352	-0.009	28419.	0.000
50	0.346	-0.006	28596.	0.000

Fig. – cont.

markets with an insignificant exchange of goods. The estimated parameters of the sVAR model indicated the existence of carrot prices integration between all wholesale markets specified in the econometric model (Table 2). Most of the parameters of the sVAR model were statistically significant indicating that price changes in individual wholesale markets may not be independent (although this issue in VAR models cannot be considered on the basis of the t-Student test alone). Results of the estimation of parameters of the sVAR model showed that the price changes in the examined wholesale markets have positive correlation (for all statistically significant parameters). The exception was the dependency between carrot prices in Sandomierz and Poznań. It was observed that changes in carrot prices on a one of these markets are most sensitive to time delayed price changes occurring on the same market (Table 2). On the other hand, carrot price changes recorded on spatially remote wholesale markets show a significantly lower impact on the level of carrot prices on a particular wholesale market. The results of the estimated sVAR model suggest that the volatility of carrot prices on the examined wholesale markets may be subject to spatial dependencies (price transmission) and autoregressive dependencies (the impact of historical prices on a particular wholesale market on its current value). As mentioned previously, the t-Student statistic is not a reliable test for statistical significance of parameter estimates in VAR and sVAR models. Thus, further testing using the Granger causality test was conducted.

Application of Granger causality test allowed us for characterising the dependencies in carrot price

Table 2. The parameters sVAR model estimates

Breakdown	Bronisze	Poznań	Kalisz	Radom	Sandomierz
Bronisze (–1)	0.963058	0.000901	0.077695	0.088304	0.018879
	(0.00819)	(0.00777)	(0.,01720)	(0.01645)	(0.01087)
	[117.604]	[0.11598]	[4.5161]	[5.3687]	[1.7370]
Poznań (–1)	0.010626	0.954720	0.061378	0.082486	0.028025
	(0.00781)	(0.00701)	(0.01640)	(0.01485)	(0.01037)
	[1.36072]	[136.200]	[3.74183]	[5.55557]	[2.70182]
Kalisz (–1)	0.021183	0.021860	0.819543	0.036165	0.014687
	(0.00757)	(0.00734)	(0.01590)	(0.01554)	(0.01004)
	[2.79896]	[2.97990]	[51.5425]	[2.32748]	[1.46270]
Radom (–1)	0.008179	0.025491	0.043700	0.807311	–0.005437
	(0.00770)	(0.00746)	(0.01617)	(0.01580)	(0.01021)
	[1.06271]	[3.41757]	[2.70251]	[51.0999]	[–0.53243]
Sandomierz (–1)	–0.011941	0.000000	–0.009901	0.000000	0.931445
	(0.00635)	–	(0.01333)	–	(0.00850)
	[–1.87905]	–	[–0.74263]	–	[109.607]
R^2	0.972	0.976	0.917	0.909	0.955

Small approximation errors are displayed on grey background; standard deviation of results of t-Student statistics' are given in square brackets.

Source: Calculations and author's elaboration using the EViews program.

Table 3. Granger causality test results for carrot

Wholesale market	Bronisze	Poznań	Kalisz	Radom	Sandomierz
Bronisze	– –	X (0.1049) X (0.1976)	→ (6.E-08) ← (9.E-07)	→ (1.E-17) ← (0.0009)	→ (0.0002) X (0.8528)
Poznań	X (0.1976) X (0.1049)	– –	X (0.1445) → (4.E-05)	← (0.0184) X (0.0028)	→ (0.021) X (0.955)
Kalisz	← (9.E-07) → (6.E-08)	→ (4.E-05) X (0.1445)	– –	→ (2.E-08) ← (0.0002)	→ (5.E-06) X (0.5105)
Radom	→ (0.0009) ← (1.E-17)	→ (0.0028) ← (0.0184)	→ (0.0002) ← (2.E-08)	– –	→ (0.0003) X (0.7109)
Sandomierz	X (0.8528) ← (0.0002)	← (0.955) X (0.955)	← (0.5005) X (0.5105)	← (0.7109) X (0.7109)	– –

p-value for the relevant test statistic, indicating acceptance or rejection of the null hypothesis for the Granger causality test are given in brackets; X means no causality in the Granger sense; ←, → show directions of causality in the Granger sense.

Source: Calculations and author's elaboration using the EViews program.

formation. Results of the Granger causality tests for carrot prices (Table 3) show the interaction of prices in most of the examined wholesale markets. Only in cases of the Warsaw Agricultural-Food Wholesale Market and Wielkopolska Agro-Horticultural Guild S.A. in Poznań, there was no dependency between carrot prices on these markets in 2011–2016.

CONCLUSIONS

The research based on dynamic econometric methods has shown that there are dependencies in the studied wholesale markets for carrot prices. This indicates the existence of price transmission between the analysed markets, thus suggesting that the analysed wholesale carrot markets were spatially integrated. This research indicates that the largest Warsaw Agro-Food Wholesale Market S.A. in Bronisze influences the formation of carrot prices on all wholesale markets examined, with the exception of the Poznań market (Table 3). At the same time, it was stated that Sandomierz Horticultura Wholesale Market S.A. has the lowest degree of integration with other mentioned wholesale markets. In most cases it is only a "recipient" of carrot price information from other wholesales markets. Moreover, the results of the sVAR model estimation indicate that the changes in carrot prices on a particular market are stronger influenced by the price changes from the same market (autoregressive effect). It also means that the carrot price information coming from other wholesale markets (price transmission effect) has a much weaker effect.

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INTEGRACJA PRZESTRZENNA RYNKÓW HURTOWYCH WARZYW W POLSCE NA WYBRANYM PRZYKŁADZIE

STRESZCZENIE

W artykule podjęto próbę weryfikacji zjawiska występowania transmisji cen między rynkami hurtowymi w Polsce na rynku marchwi. Określenie poziomu przestrzennej integracji rynków wskaże ich efektywność, a tym samym może ułatwić producentom podejmowanie decyzji o tym, gdzie sprzedawać swoje produkty. Dane empiryczne obejmują dzienne notowania cen marchwi na rynkach hurtowych owoców i warzyw w Broniszach, Kaliszu, Poznaniu, Radomiu i Sandomierzu. Zakres czasowy badań obejmował lata 2011–2016. Do analizy wykorzystano metody ekonometrii dynamicznej (model sVAR) oraz przeprowadzono testy przyczynowości Grangera. Badania przeprowadzone z wykorzystaniem dynamicznych metod ekonometrycznych wykazały, że pomimo wystąpienia istotnych różnic w poziomie cen marchwi na badanych rynkach zaobserwowano ich wzajemne oddziaływanie. Ponadto wyniki oceny modelu sVAR wskazują, że na zmiany cen marchwi na danym rynku silniej wpływają zmiany cen z tego samego rynku (efekt autoregresyjny). Oznacza to również, że informacje o cenie marchwi pochodzące z innych rynków hurtowych (efekt transmisji ceny) mają znacznie słabszy efekt.

Słowa kluczowe: transmisja cen, model sVAR, test przyczynowości Grangera, rynki hurtowe, ceny warzyw