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World prices and domestic food price spikes

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Abstract

In this paper we aim to assess the mechanics of the global food price increases experienced in the recent years, most profoundly during the 2007-2008 food price spikes. At this stage, we aim to test, whether there is an empirically assessable relationship between World agricultural commodity prices, World oil prices and Hungarian producer and consumer food prices. After briefly discussing the background of the food price surge, and some studies empirically assessing it, we estimate a Vector Error Correction Model (VECM) with two long-run relationships, modelling vertical and horizontal price relationships (price transmissions). Preliminary results express (as somewhat expected for a small open economy as Hungary) that global developments have direct and significant effects upon price levels in Hungary regardless whether a vertical or horizontal price dimension is used. Further research will focus on determination of the magnitude, speed of occurrence and duration (needed to return to equilibrium) of the abovementioned global shifters express upon domestic agricultural and food price levels.

Keywords: agricultural prices, crude oil prices, cointegration, vector error correction

JEL classification: Q1

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Világgazdasági terményárrobbanás és a hazai élelmiszerárak

Bakucs Zoltán - Fertő Imre

Összefoglaló

A tanulmány célja a 2007–2008-ban megfigyelt globális agrár-/élelmiszerár-robbanás nyomán annak az elemzése, hogy vajon létezik-e empirikusan kimutatható kapcsolat a globális agrárárak, a nyersolajárak, valamint a magyar agrár-élelmiszeripar termelői és fogyasztói árai között. Miután röviden bemutatjuk az említett árrobbanás hátterét és hatását, vektorhiba-korrekciós modell segítségével két hosszú távú kointegrációs kapcsolatot definiálunk, amelyekben az első a vertikális, míg a második a horizontális ártranszmissziós kapcsolatot modellezi. Eredményeink, figyelembe véve a magyar gazdaság méretét és nyitottságát, nem meglepő módon azt mutatják, hogy a globális folyamatok közvetlen és szignifikáns hatást gyakorolnak a hazai árak alakulására úgy a horizontális, mint a vertikális dimenzió esetében. További kutatást igényel a globális hatások magyar árakra gyakorolt befolyása mértékének, és főképp egy-egy sokkhatás begyűrűzési sebességének, valamint tartósságának az elemzése.

Tárgyszavak: agrárárak, nyersolajár, kointegráció, vektorhiba-korrekciós modell

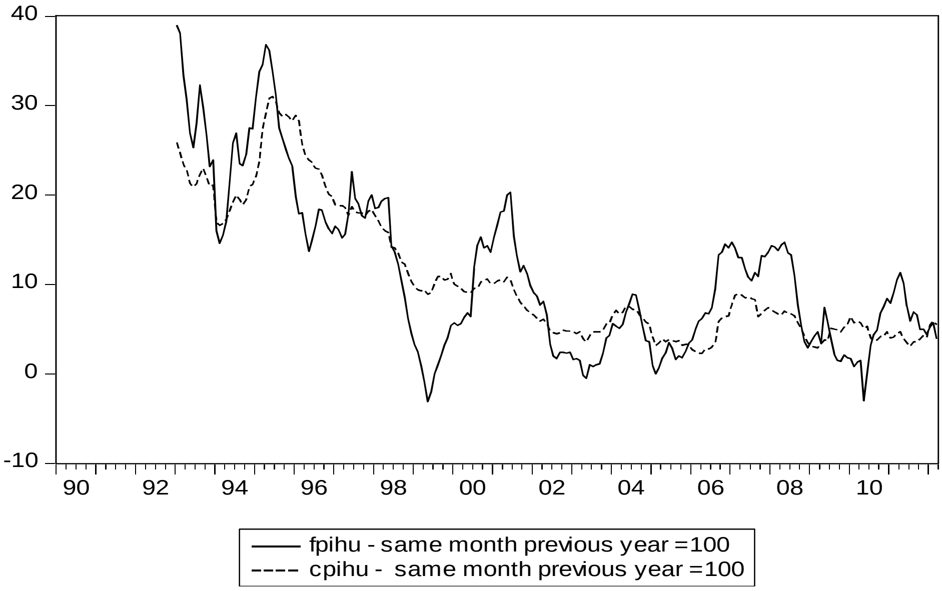
JEL kódok: Q1

1. Introduction

An increasingly rich international literature (e.g. McCalla 2009; Mitchell 2008; Lang 2010 just to name a few) focuses on the World commodity price surge experienced during 2007 – 2008. A number of global and local factors are usually listed as responsible for the food price spikes. Some often cited reasons are climate conditions and government policy interventions (e.g. grain export bans in some BRIC countries). On other hand however, global commodity supply and demand shifts (e.g. biofuels1) are found to have significantly influenced price instability. In this paper, we aim to map the way domestic food price inflation connects to global trends, through a set of macroeconomic variables, meant to simultaneously model horizontal and vertical price transmission. Figures 1 and 2 graphically depict the differences between overall price inflation and food price inflation. The much higher volatility of consumer food prices is evident from the graphs.

Figure 1.

Monthly Hungarian food price and overall consumer price indices



Source: Own calculations, data from Hungarian central Bank

Columns 2 and 3 of tables 1 and 2 present the descriptive statistics of the price index series for the full sample. Columns 4 and 5 present the same statistics for the 'price spike' period of 2007 and 2008.

1From 5% in 2000, by 2010 40% of United States maize production went for energy production, and between 2000 and 2007 ethanol tripled (Davidson et al. 2012).

Table 1.

Comparative descriptive statistics of FPIHU and CPIHU variables (base: same period in previous year)

Descriptive statistics	1993m1-2012m3		2007m1-2008m12	
	FPIHU	CPIHU	FPIHU	CPIHU
Mean	11.38052	10.77229	11.60833	7.020833
Median	9.100000	7.500000	13.05000	6.950000
Maximum	39.00000	31.00000	14.70000	9.000000
Minimum	-3.100000	2.300000	2.900000	3.500000
Std. Dev.	9.219653	7.656490	3.412244	1.418505
Obs.	231	231	24	24

Source: Own calculations

By taking a closer look on the descriptive statistics, it is worth noting that the 1.05 FPIHU/CPIHU full sample mean ratio, is increased to 1.65 for the price spike sample. If the volatility of the index series is considered, the standard deviation ratio of FPIHU and CPIHU variables amounts to 1.2 for the full sample and 2.41 in the sub-sample (table 1.). Similar conclusions may be derived by analysing the sample mean and variance ratios in table 2. Standard price transmission analysis focuses on either horizontal or vertical transmission. In the former, the relationship between geographically distinct prices yet the same market level (e.g. World commodity and national prices), whilst with the latter prices observed in the same geographical region, but different levels (e.g. producer and consumer prices) are the focus of analysis.

Table 2.

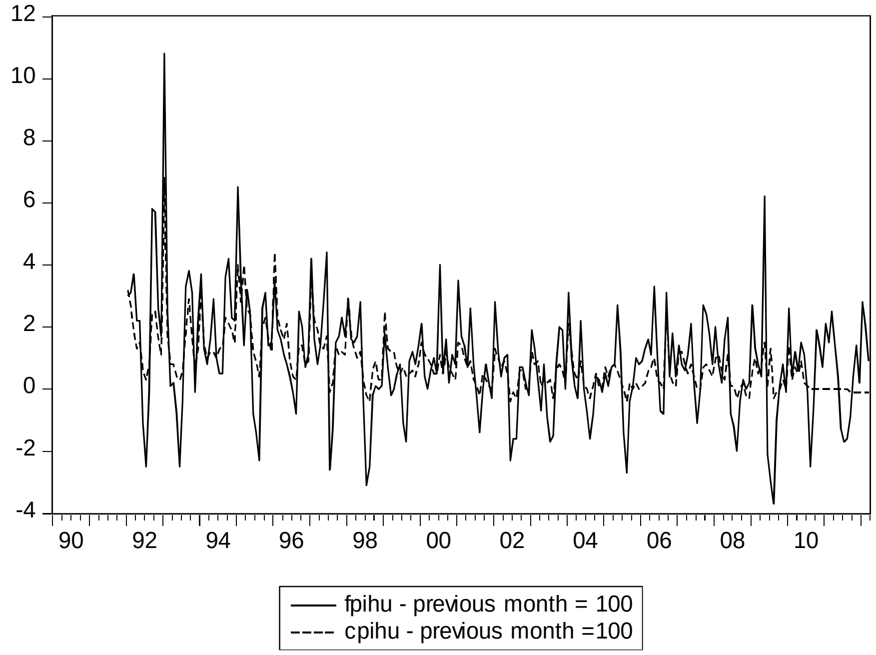
Comparative descriptive statistics of FPIHU and CPIHU variables (base: previous month)

Descriptive statistics	1992m1 – 2012m3		2007m1 – 2008m12	
	FPIHU	CPIHU	FPIHU	CPIHU
Mean	0.918930	0.837037	0.658333	0.462500
Median	0.800000	0.600000	0.700000	0.450000
Maximum	10.80000	6.800000	2.700000	1.200000
Minimum	-3.700000	-0.400000	-2.000000	-0.300000
Std. Dev.	1.790578	0.945513	1.238132	0.477140
Obs.	243	243	24	24

Source: Own calculations, data from Hungarian Central Bank

Figure 2.

Monthly Hungarian food price and overall consumer price indices

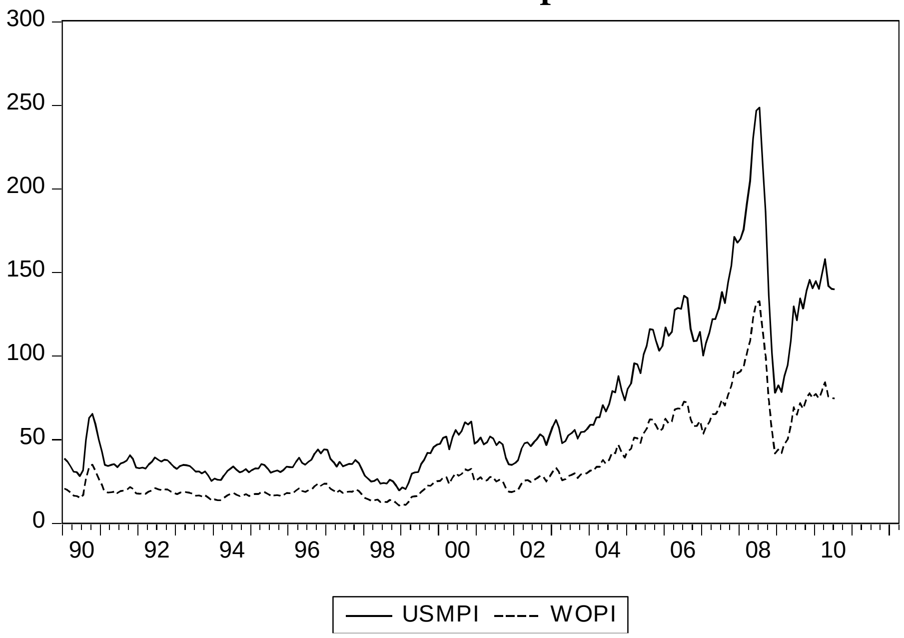


Source: Own calculations, data from Hungarian Central Bank

Figure 3. emphasizes the indirect effect of oil prices upon international raw food prices, induced by biofuel demand, linked to oil prices. The correlation coefficient between oil and US maize prices is close to 1, however the higher volatility of maize prices is shown by a standard deviation statistic double than the one measure for oil prices.

Figure 3.

World oil and US maize price indices



Source: IMF data

Domestic consumer food price spikes can be just as well induced by domestic (vertical transmission) or international, global (horizontal) processes or even both. In their seminal paper, Davidson et al. (2012) assess the causes of UK food price inflation in the recent years by considering horizontal as well that vertical transmission. Authors found that drivers of UK food inflation are raw food world prices and GBP/USD exchange rate. World crude oil prices indirectly influence domestic food price inflation, whilst a set of macroeconomic variables, such as interest rate, unemployment rate etc., were used as proxies for the evolution of national demand.

In this research, we employ a similar set of variables, to assess the influence of domestic and global processes on Hungarian consumer food inflation, using vector error cointegration time series methodology. The rest of this paper is organized as follows: section 2 briefly presents the non-stationary time series methodology employed, followed by the presentation of dataset used for empirical analysis in section 3. Empirical analysis and results are presented in section 4, and finally, section 5 concludes.

2. METHODOLOGY

Up to date time series methodology is employed. Unit root tests[2] are used to assess the stationarity properties of time series, followed by cointegration tests and the estimation of a vector error correction model (1), capable to incorporate structural changes within the long-run trends as well as to simultaneously depict the short and long-run dynamics of the system.

$$\Delta Y_t = \alpha \begin{pmatrix} \beta \\ \mu \end{pmatrix}' \begin{pmatrix} Y_{t-1} \\ tE_t \end{pmatrix} + \gamma E_t + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \sum_{i=1}^{p} \sum_{j=2}^{q} \kappa_{j,i} D_{j,t-i} + u_t \tag{1}$$

where Yt is a vector of 5 non-stationary variables (Hungarian agricultural output and food consumer price indices, World agricultural commodity price and oil price indices, HUF/USD exchange rate), p is the lag number, Et =(E1t E2t…Eqt)’ is a matrix of q dummy variables, where Ej,t = 1 if observation t belongs to the jth period and 0 otherwise, Dj,t-i is an impulse dummy that equals 1 if observation t is the ith observation of the jth period, meant to render the corresponding residuals to zero. Γi and Κj,i are short run matrices, α is the speeds of adjustment parameter matrix, β are the long run cointegration coefficients and μ are the long run drift parameters. The ut residuals are supposed to be independently

[2] See Maddala and Kim, 1998 for a detailed discussion of the unit roots in a non-stationary time series econometrics framework.

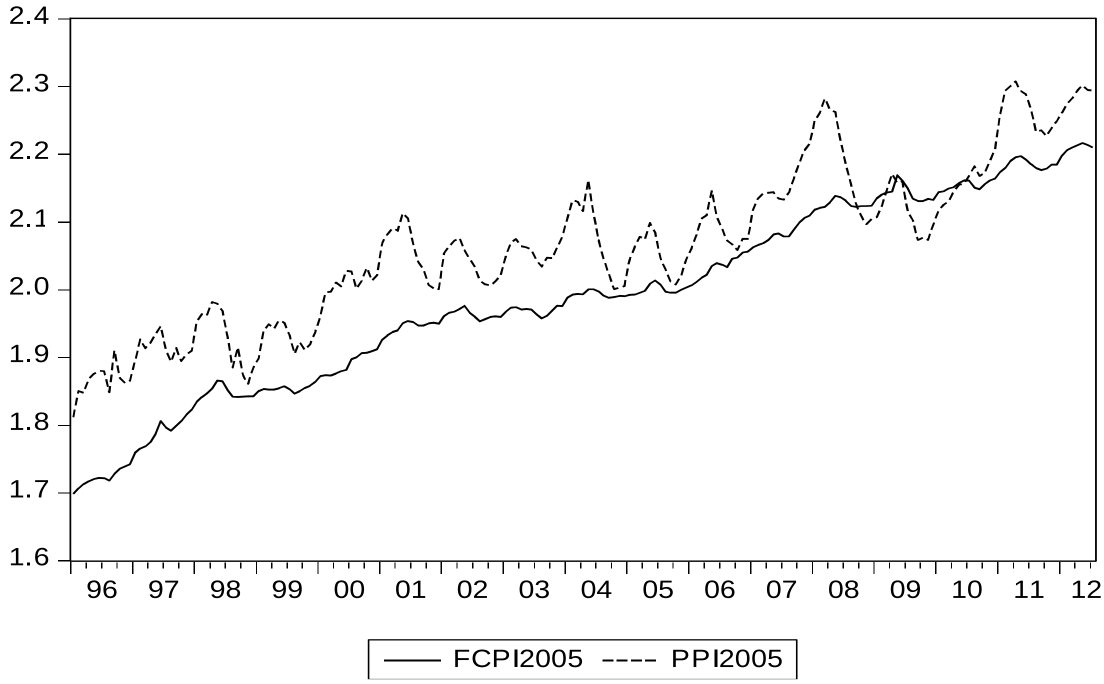
and identically distributed with zero mean and symmetric and positive definite variance-covariance matrix Ω.

3.DATA

A dataset of five monthly time series variables between January 1996 and July 2007, consisting of 199 observations each are employed in the empirical analysis. Hungarian agrifood sector prices are represented by the Hungarian agricultural output price index (PPI2005) and Hungarian food consumer price index (FCPI2005), presented in figure 4.

Figure 4.

Hungarian agricultural output and food consumer price indices (2005=100)

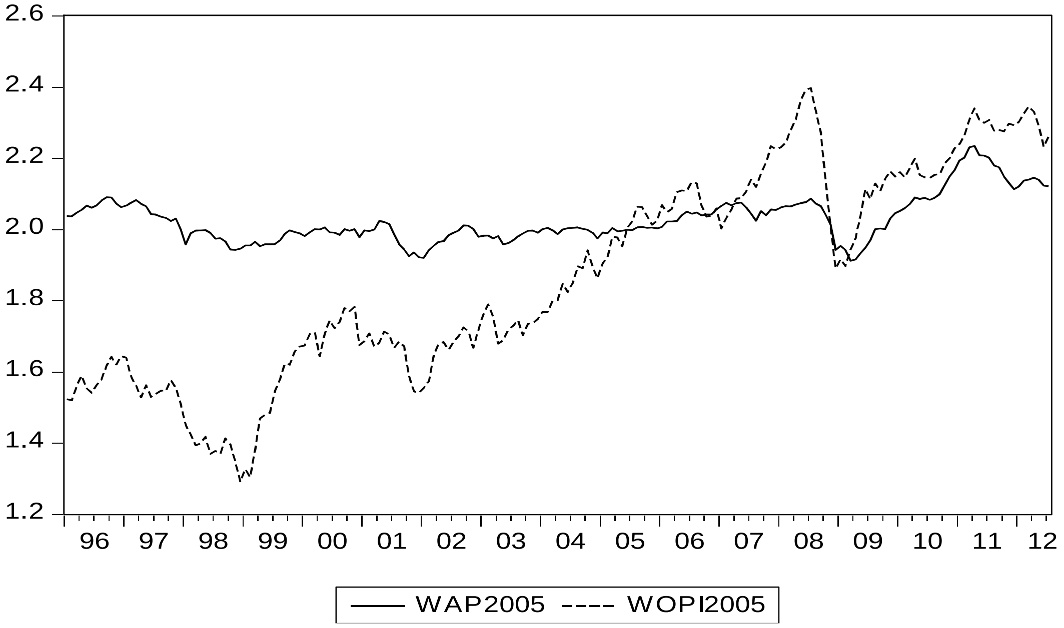


Source: Hungarian Central Statistical Agency

World prices used are World agricultural raw materials price index (WAP2005), and World oil price index (crude petroleum), denoted WOPI2055 and depicted on figure 5. And finally, the connection between World and Hungarian markets is made through the USD/Hungarian forint exchange rate, presented on figure 6.

Figure 5.

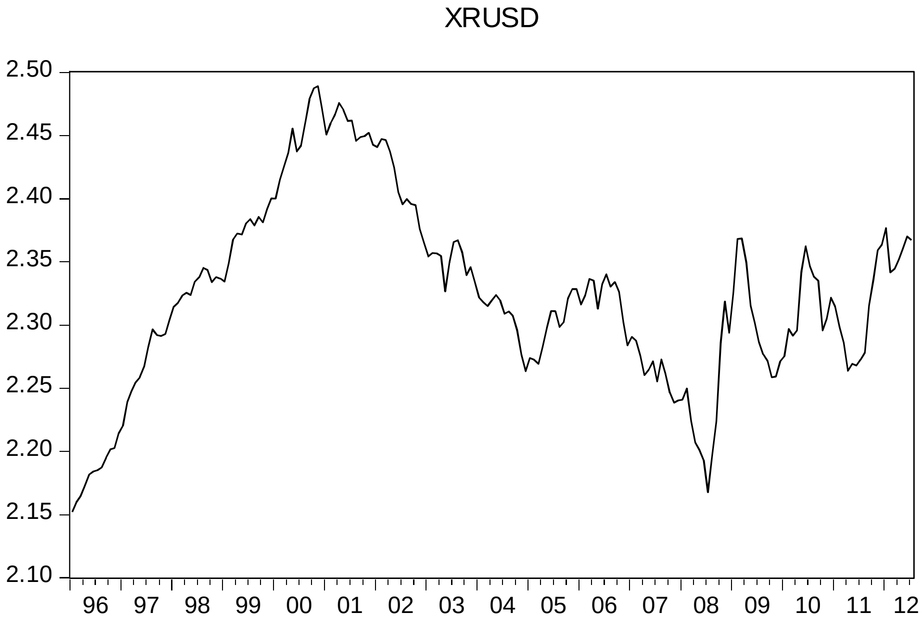
World agricultural raw material price and World oil price indices index (2005=100)



Source: IMF Data

Figure 6.

USD/Hungarian forint exchange rate



Source: Hungarian Central Bank

4. RESULTS AND DISCUSSION

The logged variables presented in previous section were used in estimation. Standard ADF unit root tests[3] were used to assess time series properties of data. Results revealed, as expected, that all 5 series employed contain one unit root each, i.e. they are integrated of order one, I(1). Consequently, cointegration procedure is used to discover whether there are any common long-run trends between series, known as cointegrating vectors (CI). Johansen trace and maximum Eigen-value tests were applied to data after a careful assessment of various information criteria resulted that 5 lags in first difference were sufficient to result white nose residuals in cointegration test models. Trace and Max-Eigen value results are presented in table 3.

Table 3.

Johansen Trace and Max-Eigen value cointegration tests

No. of CI vectors	Trace Statistic	P- value	Max-Eigen Statistic	P-value
None	126.6565	0.0000	63.38936	0.0000
At most 1	63.26717	0.0061	37.14534	0.0032
At most 2	26.12183	0.3351	14.51620	0.4159
At most 3	11.60563	0.4848	6.408537	0.7409
At most 4	5.197097	0.2625	5.197097	0.2625

Note: with respect to deterministic specification of the test, we followed the 'simple-to-general' Pantula principle, by starting with the most simple realistic specification, and moving towards more complex ones, should the null of no cointegration not being rejected. Thus the test procedure above includes a single deterministic term, a long-run intercept (but no trend) included in the CI relations.

Both test statistic uniformly reject the null of 'at most one cointegrating vector' however cannot reject the 'at most 2 cointegrating vectors' null hypothesis, thus we may conclude the existence of two stable long-run relationships between Hungarian food consumer price index, agricultural producer (output) price index, World agricultural price index, World oil price index and Hungarian forint/ USD exchange rate. Identifying are required to establish unique CI relationships. Since these restrictions are somewhat arbitrary, and because we wish to simultaneously focus on vertical (from home producer to consumer) and horizontal (from world markets to home producer prices) price relationships, while accounting for exogenous effects, we impose the following binding restrictions (table 4.), and use a likelihood ratio test, to check their appropriateness. Likelihood ratio test reveal, the restrictions cannot be rejected ($\chi 2(1)=0.241$, $p=0.623$), thus we estimate the fully identified VECM presented in table 5.

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3 Not presented here, to save space, but available from authors upon request.

Table 4.

Restrictions on the β

CI/Variable	FCPI2005	PPI2005	WAP2005	WOPI2005	XRUSD
CI 1	1	*	0	*	*
CI 2	0	1	*	*	*

Note: * represents no imposed restriction on the β

Table 5.

The VECM model: long-run cointegration relationship and error correction (t-stats in brackets)

Cointegrating Eq:	CointEq1	CointEq2			
FCPI2005(-1)	1.000000	0.000000			
PPI2005(-1)	-0.494624	1.000000			
	[-3.80601]				
WAP2005(-1)	0.000000	-0.468256			
		[-3.82479]			
WOPI2005(-1)	-0.241025	-0.311281			
	[-4.87622]	[-11.8136]			
XRUSD(-1)	0.000000	-0.340225			
		[-3.93136]			
C	-0.588782	0.208525			
	[-3.08619]	[0.59096]			
Error Correction:	D(FCPI2005)	D(PPI2005)	D(WAP2005)	D(WOPI2005)	D(XRUSD)
CointEq1	-0.031593	0.102862	0.031035	-0.089749	-0.006736
	[-3.16894]	[2.74647]	[1.12410]	[-1.17354]	[-0.22559]
CointEq2	-0.026593	-0.221125	-0.050946	0.056249	-0.052063
	[-2.45273]	[-5.42899]	[-1.69678]	[0.67630]	[-1.60319]
R-squared	0.479608	0.413640	0.276871	0.213525	0.200784
Adj. R-squared	0.398101	0.321800	0.163610	0.090343	0.075606
F-statistic	5.884248	4.503935	2.444542	1.733404	1.603983
Log likelihood	777.7036	522.2621	581.1156	384.4736	565.9804
Akaike AIC	-7.779312	-5.132249	-5.742131	-3.704390	-5.585289
Schwarz SC	-7.322873	-4.675811	-5.285692	-3.247951	-5.128851

Note: short- run dynamics represented by first difference of variables up to the fifth lags were included in the VECM estimation. Since at these stage of the analysis they are not relevant, were omitted from the table.

The first CI vector captures the vertical dimension of the price relationship. Since data are in logs, estimated coefficients may be interpreted as elasticities. As expected, coefficients show inelastic estimates with the right sign (negative in vector, positive in equation specification). Thus the vertical price transmission equation can be interpreted as follows.

1% increase in domestic agricultural producer prices, World oil prices, results 0.49% and 0.24% increase in Hungarian food consumer price index respectively. With respect to horizontal transmission, 1% increase in World agricultural commodity price index, World oil prices index induce a 0.46% and 0.31% increase in Hungarian agricultural producer prices respectively. The World oil prices index is a common explanatory variable in both identified long-run equations. Thus it would be reasonable to expect to have a similar impact upon Hungarian food consumer and Hungarian agricultural producer price indices.

Table 6.

Restricted long-run cointegrating relationships (t-stats in brackets)

Cointegrating Eq:	CointEq1	CointEq2
FCPI2005(-1)	1.000000	0.000000
PPI2005(-1)	-0.290698	1.000000
	[-4.67869]	
WAP2005(-1)	0.000000	-0.425354
		[-3.87843]
WOPI2005(-1)	-0.312785	-0.312785
	[-12.7161]	[-12.7161]
XRUSD(-1)	0.000000	-0.303511
		[-4.07206]
C	-0.886487	0.038245
	[-7.72606]	[0.11978]

This hypothesis can be built into the VECM estimation and use a likelihood ration test to assess its appropriateness. The resulting χ2(2)=0.854 (p=0.653) is not significant, concluding the statistical equality of WOPI2005 coefficient in the two long-run equations. And finally, 1% increase in the USD/HUF exchange rate results in 0.34% increase in domestic agricultural producer prices. Re-estimating the model with the WOPI2005 variable's coefficient equality restriction induces only some minor magnitude changes in the estimated values of other variables (table 6.).

5. Conclusions

Preliminary results emphasise the major role international raw agricultural commodity and oil prices prices play in the determination of domestic producer and, more importantly consumer prices. Considering that Hungary is a small open economy, where significant agricultural exports are driven by international trends, the effect of exchange rate in the horizontal price transmission is emphasised. In further reserahc Vector error correction models will be very useful to assess the implications (magnitude as well as duration) of an unexpected shock to one of the integrated time series variables. Thus impulse response functions able to graphically depict the influence and pass-through of oil, macroeconomic (e.g. income or unemployment) and world raw food prices upon domestic consumer food prices can be employed in further analysis.

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