Spatial Price Transmission in Kazakh Wheat Markets

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1 Introduction[1]

Exploring whether markets function is of special importance to the transition economies, which struggle in moving towards market economy. In this perspective, Kazakhstan grain sector is a good example of a transition economy with a number of new market institutions established after the collapse of the USSR. There were several studies reporting casual evidence of markets functioning in the country. (e.g. Ahmad and Braslavskaya, 2003)

The purpose of this study is to contribute to better knowledge of markets functioning in transition economies. We were thus motivated to conduct a thorough, empirically based and statistically backed assessment of market integration in Kazakhstan grain sector based on price transmission analysis.

The paper continues with a section describing the model. The data source, the steps of analysis and the results are described in section 3. The paper concludes with a summary of empirical and methodological findings and implications derived from them.

2 A three-regime error correction model with asymmetric adjustment

There were major developments since Engle and Granger in 1987 presented a theory of linear adjustments within a system of variables towards equilibrium, Linear ECM, based on the long-run cointegration relationship between the series. Since then Balke and Fomby (1997) summarized and categorized those developments and introduced a family of non-linear cointegration processes (and ECM), which differ from each other depending on assumptions researchers might take regarding the equilibrium point. One of the assumptions sets equilibrium point in zero, which mathematically is easy to apply and empirically was shown in many studies including this one (Goodwin and Piggott, 2001; Meyer, 2003; etc.)[2]

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[1] This poster paper was limited in space and many methodological aspects were left out of description. For more detailed study please contact either of authors.

[2] See Balke and Fomby (1997) and Hansen and Seo (2002) for a theoretical review of non-linear VECM.

We start with estimating linear error correction model. For that we apply Johansen approach:

$$\begin{bmatrix} \Delta P_t^Y \\ \Delta P_t^X \end{bmatrix} = \begin{bmatrix} b_Y \\ b_X \end{bmatrix} + \sum_{i=1}^{n} \begin{bmatrix} \delta_i^{Y,Y} & \delta_i^{Y,X} \\ \delta_i^{X,Y} & \delta_i^{X,X} \end{bmatrix} \begin{bmatrix} \Delta P_{t-i}^Y \\ \Delta P_{t-i}^X \end{bmatrix} + \begin{bmatrix} \alpha_Y \\ \alpha_X \end{bmatrix} (ECT_{t-1}) + \begin{bmatrix} v_Y \\ v_X \end{bmatrix} \qquad (1)$$

where $\Delta P_t^{\cdot} = P_t^{\cdot} - P_{t-1}^{\cdot}$, is the change (first difference) in price at location Y and X, respectively; b_Y and b_X are constants; $\Delta P_{t-i}^{\cdot}$ – is the *i*-lagged change in price at location Y and X, respectively. A system of time series is in equilibrium if $ECT_{t-1} = \beta_c + \beta_t t + \beta_Y p^Y + \beta_X p^X = 0$ with $\boldsymbol{\beta} = [\beta_c\, \beta_t\, \beta_Y\, \beta_X]'$ being the cointegrating vector. This specification of a cointegration relationship may be restricted by setting the constant β_c and/or the trend parameter β_t to zero. Parameters α_Y and α_X describe the adjustment of the price series as a response to deviation from price equilibrium.

After estimating linear VECM we proceed with estimating non-linear VECM. Non-linear VECM assumes two or many regimes where different adjustment processes occur. The critical question is how many regimes or thresholds should be included. In our study we use a more flexible specification of two- threshold (three regime) TECM, as proposed by GOODWIN and PIGGOTT (2001). The economic rationale for the thresholds is transaction costs which prevent any adjustment through arbitrage trade unless price imbalances exceed a threshold. What we did is set equilibrium point equal to zero, and then as the next step we were looking for thresholds on each side from zero by minimizing likelihood function.[3] We thus have three regimes, two regimes where adjustment process to changes in prices is activated, and one regime (neutral) where no significant adjustment process occur.

The model we use in our study allows for asymmetry of the threshold values, denoted γ_1 and γ_2, as well as for the adjustment parameters α_1 and α_2 on different sides of the equilibrium. Hence the complete error correction model is as follows:

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[3] We applied Hansen and Seo (2002) procedure.

Adjustment regimes:

$$\begin{bmatrix} \Delta P_t^Y \\ \Delta P_t^X \end{bmatrix} = \begin{bmatrix} b_1^Y \\ b_1^X \end{bmatrix} + \sum_{i=1}^{n} \begin{bmatrix} \delta_i^{Y,Y^1} & \delta_i^{Y,X^1} \\ \delta_i^{X,Y^1} & \delta_i^{X,X^1} \end{bmatrix} \begin{bmatrix} \Delta P_{t-i}^Y \\ \Delta P_{t-i}^X \end{bmatrix} + \begin{bmatrix} \alpha_1^Y \\ \alpha_1^X \end{bmatrix} (ECT_{t-1}) + \begin{bmatrix} v_t^{Y^1} \\ v_t^{X^1} \end{bmatrix} \quad if\ ECT_{t-1} \le \gamma_1$$

$$\begin{bmatrix} \Delta P_t^Y \\ \Delta P_t^X \end{bmatrix} = \begin{bmatrix} b_2^Y \\ b_2^X \end{bmatrix} + \sum_{i=1}^{n} \begin{bmatrix} \delta_i^{Y,Y^2} & \delta_i^{Y,X^2} \\ \delta_i^{X,Y^2} & \delta_i^{X,X^2} \end{bmatrix} \begin{bmatrix} \Delta P_{t-i}^Y \\ \Delta P_{t-i}^X \end{bmatrix} + \begin{bmatrix} \alpha_2^Y \\ \alpha_2^X \end{bmatrix} (ECT_{t-1}) + \begin{bmatrix} v_t^{Y^2} \\ v_t^{X^2} \end{bmatrix} \quad if\ ECT_{t-1} \ge \gamma_2 \qquad (2)$$

Non-adjustment regime:

$$\begin{bmatrix} \Delta P_t^Y \\ \Delta P_t^X \end{bmatrix} = \begin{bmatrix} b_3^Y \\ b_3^X \end{bmatrix} + \sum_{i=1}^{n} \begin{bmatrix} \delta_i^{Y,Y^3} & \delta_i^{Y,X^3} \\ \delta_i^{X,Y^3} & \delta_i^{X,X^3} \end{bmatrix} \begin{bmatrix} \Delta P_{t-i}^Y \\ \Delta P_{t-i}^X \end{bmatrix} + \begin{bmatrix} \alpha_3^Y \\ \alpha_3^Y \end{bmatrix} (ECT_{t-1}) + \begin{bmatrix} v_t^{Y^3} \\ v_t^{X^3} \end{bmatrix} \quad if\ \gamma_1 < ECT_{t-1} < \gamma_2$$

3. Empirical procedure and results

For our empirical study we used data on weekly elevator-level wheat prices in three elevator spots of Kazakhstan, Petropavlovsk (PET), Kokshetau (KOK), and Karaganda (KAR). Data had been compiled from the online database of "AgroInfrom" initiative program. Observations were available for the period from March 1998 to December 2004.

ADF tests of the individual price series (in levels and first differences) indicated that each series is I(1), or integrated of order one. (Table 1)

(Insert Table 1 here)

Next we proceeded with estimating cointegration equations for three pairs using the Johansen procedure. Results from the vector error correction model (VECM) (1) yielded close-to-zero and statistically insignificant estimates for the constants b, which led us to impose several restrictions on deterministic trends in both the cointegration space and the dynamic VECM. We have tried three general cases of dynamic models (Harris, 1995: 96). Eventually we imposed the restriction that the constant and time trend enter only the cointegration space, and neither constant nor time trend enters the dynamic linear VECM. Both Johansen trace and maximal eigenvalue tests were in favour of cointegration for only two pairs of series, Petropavlovsk—Kokshetau, and Kokshetau—Karaganda.

(Insert Table 2 here)

Next, we analyze the two pairs of locations with cointegrated prices for whether the adjustment process is sufficiently characterized by a universal ECT parameter in each equation or whether different adjustment parameters must be assumed for different ranges of the ECT. First, we split the vector of the ECT, obtained in the Johansen procedure, into positive and negative sub-samples. Then, on each of these sub-samples we searched for the threshold parameters applying the modification of Hansen and Seo procedure suggested by Meyer (2003).

Further, we tested the significance of the threshold found in each of the sub-samples against the null of no thresholds using the Hansen and Seo SupLM test. According to this test linearity is not rejected for the pair of Petropavlovsk and Kokshetau. For the pair Kokshetau – Karaganda the null of no thresholds on each side of the ECT was rejected and threshold parameters of -0.043 and 0.001 were estimated and proved to be statistically significant. (Table 3)

(Insert Table 3 here)

We define three regimes: regime I (adjustment regime for negative ECT), where the deviation from the equilibrium is greater than (in absolute terms) the negative threshold, ECT $\leq$ -0.043; regime II (adjustment regime for positive ECT), where the deviation from the equilibrium is greater than the value of the positive threshold, ECT $\geq$ 0.001; and regime of no adjustments, where the deviation from the equilibrium is in between the two thresholds, -0.043 < ECT < 0.001.[4]

Threshold values in the pair Kokshetau—Karaganda in the positive and negative regimes of price adjustment differ from each other significantly, thus suggesting that allowing for asymmetry is justified. The asymmetry of threshold values refers to the question, how much the price e.g. in Kokshetau should be above or below its equilibrium level to trigger any

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[4] Though the value of the positive threshold value is very close to zero, the LM test indicates that the error correction mechanism is significantly different on both sides of this threshold.

adjustment process. Findings suggest that small positive deviations of this price from its equilibrium level are sufficient while much larger negative deviations are needed to trigger any adjustments (in both locations). In dollar terms this means that the prices have to be as much as 3.84 USD/ton below their equilibrium level to set off price changes due to the error correction mechanism. On the other hand, negligible positive deviations (0.08 USD/ton) from equilibrium will already cause adjustments.[5]

An important finding is that in total 94 percent of the observations from the sample of prices in Kokshetau and Karaganda were in adjustment regimes (26% in Regime I and 68% in Regime II). This number is relatively high when compared to findings from earlier studies on the case of developed economies (Goodwin and Piggott (2001) found in 4 out of 6 pairs less than 20% of observations falling into the regimes of adjustment). This has an important implication about spatial market integration in Kazakhstan. We can conclude that during the observed period of time prices in both markets were often deviated from the equilibrium to an extent that triggers adjustment processes.

The three-regime TVECM with Eicker-White standard errors in the brackets is reported below in (3). The speed of adjustment parameters (ECT parameters) for Karaganda equation(s) of the VECM are statistically significant at the 5% level. Results indicate very inelastic response of prices in Karaganda. However, the ECT parameters in the Kokshetau equations of the VECM are statistically insignificant in all regimes.

(3) Kokshetau – Karaganda

Adjustment Regime I – ECT ≤ -0.043

Share of observations – 26%

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[5] The threshold price γ^{USD} in USD/t was computed as $\gamma^{USD} = \left(\exp\left(\gamma^{P}\right) - 1\right) * \overline{p}^{Kar}$, with γ^{P} the threshold parameter, and $\overline{p}^{Kar}$ the mean (over time) price in Karaganda.

$$\begin{bmatrix} \Delta P_t^{Kok} \\ \Delta P_t^{Kar} \end{bmatrix} = \begin{bmatrix} 0.008 \\ (0.008) \\ 0.025 \\ (0.012) \end{bmatrix} \left[ECT_{t-1} \right] + \begin{bmatrix} 0.235 & 0.053 \\ (0.068) & (0.050) \\ 0.365 & 0.256 \\ (0.149) & (0.076) \end{bmatrix} \begin{bmatrix} \Delta P_{t-1}^{Kok} \\ \Delta P_{t-1}^{Kar} \end{bmatrix} + \begin{bmatrix} e_t^{Kok} \\ e_t^{Kar} \end{bmatrix}$$

Adjustment Regime II – ECT ≥ 0.001

Share of observations – 68%

$$\begin{bmatrix} \Delta P_t^{Kok} \\ \Delta P_t^{Kar} \end{bmatrix} = \begin{bmatrix} 0.005 \\ (0.010) \\ 0.033 \\ (0.010) \end{bmatrix} \left[ECT_{t-1} \right] + \begin{bmatrix} 0.031 & 0.153 \\ (0.107) & (0.076) \\ 0.006 & 0.152 \\ (0.095) & (0.064) \end{bmatrix} \begin{bmatrix} \Delta P_{t-1}^{Kok} \\ \Delta P_{t-1}^{Kar} \end{bmatrix} + \begin{bmatrix} e_t^{Kok} \\ e_t^{Kar} \end{bmatrix}$$

Regime of No Adjustments – 0.043 < ECT < 0.001

Share of observations – 6%

$$\begin{bmatrix} \Delta P_t^{Kok} \\ \Delta P_t^{Kar} \end{bmatrix} = \begin{bmatrix} -0.057 \\ (0.255) \\ 0.455 \\ (0.162) \end{bmatrix} \left[ECT_{t-1} \right] + \begin{bmatrix} 0.324 & -0.719 \\ (0.114) & (0.188) \\ -0.113 & -0.518 \\ (0.078) & (0.218) \end{bmatrix} \begin{bmatrix} \Delta P_{t-1}^{Kok} \\ \Delta P_{t-1}^{Kar} \end{bmatrix} + \begin{bmatrix} e_t^{Kok} \\ e_t^{Kar} \end{bmatrix}$$

The insignificance of the ECT parameters in the no-adjustment regime is justified as it is reasonable to associate the threshold parameter with transaction costs and conclude that no arbitrage trade and hence no price adjustment occurs unless that threshold is exceeded. Still, we fail to explain the insignificance of the ECT parameters for the Kokshetau equation in all regimes.

Conclusions

In this study we have investigated one aspect of the quality of marketing and trade opportunities in the Kazakh wheat sector, that is the nature of integration among regional wheat markets. We applied threshold VECM techniques to assess the co-movement between time series of elevator prices at three grain-trading [and producing] spots in the northern and central parts of the country.

From available data it was possible to examine three pairs of wheat markets. Results give a picture that the degree and nature of integration differs between the three considered pairs of locations. These results motivate to focus research on relationships with poorly integrated markets, where impediments to arbitrage trade could be identified and possibly mitigated by appropriate policy.

Though earlier studies have suggested that asymmetry in spatial price transmission is not likely, our findings suggest that this is not necessarily the case, at least for transition countries. We find empirical evidence for price adjustment with asymmetric thresholds in the spatial grain markets of Kazakhstan. Clearly this is an important finding, yet another research question arises at this point as to the concrete policy implications/advises in order to ease delays in price transmission. Further analysis can be extended to a careful examination of factors affecting spatial price transmission.

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Table 1: Results of ADF test for unit roots in Kazakh price series in levels and first differences, AR(2) with constant.

Series	t	
	Level	1st difference
Petropavlovsk	-1.72	-12.45*
Kokshetau	-1.10	-11.47*
Karaganda	-1.49	-10.26*

* - statistically significant at 1% level. Critical value is –3.43. In total 355 observations were available for analysis. Gaps in the data due to missing values were replaced using linear interpolation.
Source: own computations

Table 2: Test for cointegration and estimated long-run linear cointegration relationship.

Pair	λ_{max}	λ_{trace}	Long-run cointegration relationship
Petropavlovsk – Kokshetau	36.95*	40.36*	Price (Petrop) = -0.51 + 1.10*Price(Koksh) + 0.02*t
Kokshetau – Karaganda	16.82*	20.08*	Price (Koksh) = -0.87 + 1.17*Price(Karag) + 0.08*t

* - statistically significant at 5%. Critical values (Osterwald-Lenum, 1992) at 5% for (n-r) = 2 the Maximal Eigenvalue test is 15.67; and for the trace test is 19.96.
Source: own computations

Table 3: Threshold parameter estimates and Hansen's SupLM test results.

Pair	Positive Threshold	Hansen's SupLM test	Negative Threshold	Hansen's SupLM test
Petropavlovsk – Kokshetau	0.001	13.87	-0.154	15.06
Kokshetau – Karaganda	0.001	15.94*	-0.043	23.99*

Critical values for Hansen's SupLM test were derived using bootstrap at residual level with 5000 replications.
Source: own computations based on data of AgroInform, 2005