HOW WELL IS THE RUSSIAN WHEAT MARKET FUNCTIONING? A COMPARISON WITH THE CORN MARKET IN THE USA

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Abstract

Given Russia’s leading position in the world wheat trade, how well its grain markets function becomes very important question to evaluate the state of future global food security. We use a threshold vector error correction model to explicitly account for the influence of trade costs and distance on price relationships in the grain markets of Russia and the USA. In addition, we study impact of market characteristics on regional wheat market integration. Empirical evaluation shows that distance between markets, interregional trade flows, export orientation, export tax and export ban all have a significant impact on the magnitude of wheat market integration.

Keywords

regional market integration, threshold vector error correction model, grain markets, Russia, USA, export ban.

1 Introduction

In recent years Russia has advanced from a grain importing country to one of the primary grain exporting countries. In 2016/17 Russia is forecasted to become the largest wheat exporter in the world.

Russia could further boost its grain production by increasing production efficiency and also by re-cultivating formerly abandoned agricultural land. According to OECD/FAO (2012) global grain production needs to increase by 30% to satisfy global demand for cereals which will reach 3 billion tons by 2050. Russia could play a large role for future global food security (Lioubimtseva and Henebry, 2012). This requires not only Russia’s large additional grain production potential to be mobilized but also that grain markets are functioning well enabling that the grain exporting potential is mobilized as well.

This study aims to address the research question how well the Russian grain market is functioning, a question which has not been addressed in the literature before. Following a price transmission approach we are focusing on the primary grain producing regions and investigate the integration of the regional grain markets. To what degree and how fast are price shocks in one region transmitted to the other regions?

This is an important question given that the Russian grain market is characterized strong production volatility resulting from extreme weather events which are expected to increase with climate change. Favourable production conditions and thus relatively high yields can be observed in some regions but relatively low yields in other regions at the same time. Therefore, interregional grain trade is of high importance to equilibrate grain supply and demand within Russia. Nonetheless, grain market transport and storage infrastructure is deficient in several regions and price peaks are repeatedly observed on regional markets, exceeding even the world market price.

In a well-functioning, efficient market, with a well-developed transport and storage infrastructure, regional prices differ at most by the costs of trade between those regions. Also, price shocks in one region are quickly transmitted to the other regions inducing interregional trade flows when price differences exceed trade costs (Fackler and Goodwin, 2001). Thus, an efficient market could also contribute to cushioning price increasing effects of regional harvest shortfalls and prevent that prices increase beyond the world market price.

However, Russia has a history of restricting the exports of wheat to the world market when domestic wheat prices peak. As our second question, we investigate the effects of the wheat export ban 2010/11 on regional price relationships to shed further light on the domestic price effects of export controls. This is an addition to Götz et al. 2013, 2016b which focus on the export controls' effects on the integration in the world market.

We address both research questions in a price transmission framework. We apply a threshold vector error-correction model (TVECM) to explicitly account for the influence of distance and use a Bayesian estimator suggested by Greb et al. (2013) as an alternative to the conventional maximum likelihood approach (Hansen and Seo, 2002; Lo and Zivot, 2001).

Highly integrated markets characterized by strong price relationships with fast transmission of price changes between the regions are usually interpreted as evidence for well-functioning markets. However, the Russian wheat market is characterized by extremely large distances of up to 4000 km which certainly negatively affects market integration.

To assess how well the Russian market is functioning we conduct a comparative price transmission analysis for the corn market of the USA which is also characterized by large distances, strong variation in regional production and high interregional trade flows. We assume that the corn market of the USA is one of the most efficient grain markets in the world characterized by well-developed transport and storage infrastructure and high market transparency, serving as a benchmark for the Russian wheat market in this study.

The remainder of this paper is organized as follows. Section 2 reviews major literature sources. In Section 3 we discuss methodology and data properties, which is followed by the outcomes of model estimations in Section 4. In the final Section 5, concluding remarks are summarized.

2 Literature review

This paper adds to the strand of literature focusing on spatial price relations between regional agricultural markets.

Goodwin and Piggott (2001) first introduced threshold co-integration in the spatial price transmission literature. They analyse spatial price links between regional corn and soybean markets in North Carolina using a two-regime threshold autoregressive (TAR) model. They find that thresholds are proportionally related to transaction costs, which increase with distance between the markets. Their study confirms the presence of non-linear adjustment of prices to deviations from the long-run price equilibrium between two locations. In particular, price adjustment is hardly confirmed if regional price differences are smaller than transaction costs. On the contrary, large price differentials induce adjustment of regional prices to their price equilibrium, which increases with proximity of the markets. Additionally, the authors utilize a three-regime threshold vector error-correction model (TVECM) to account for changes in the direction of trade flows. However, model results do not find evidence that a reversal in trade direction alters the speed of price adjustments to its spatial price equilibrium.

Our study also contributes to the growing price transmission literature on the domestic price effects of export controls. The effects of wheat export controls in Russia were previously addressed within a price transmission approach by Götz et al. (2016b) and Götz et al. (2013). Both studies focus on the relationship between the world market price and the domestic prices in order to identify the price dampening effect of the export controls. Götz et al. (2013) investigate domestic price effects of the export tax in Russia during 2007/8 within a MSECM approach. They find compared to Ukraine a rather low price dampening effect amounting to 25%. Results of Götz et al. (2016b) suggest a strong heterogeneity of the price dampening effect of the wheat export ban 2010/11 in Russia, varying between 67% and 35% in the major grain producing regions. Differing, this study investigates how the export ban 2010/11 impacts price relationships between the grain producing regions of Russia themselves. A further novelty of our approach is that we use a TVECM in order to capture the possible effects of the export ban on trade costs. Also, we are supplementing the regional price data with interregional trade flow data to facilitate interpretation of our model results.

A regional perspective is also followed by Baylis et al. (2014) which investigate the export ban for wheat and rice implemented in India 2007-2011. They take into account integration between the world and domestic markets, but also explicitly focus on price relations between the regions of India. The analysis is based on regional price data for producing, consuming and port markets and the world market price. Using a linear VECM and a TVECM, they investigate cointegration and integration for the time period when trade was freely possible and compare it to when the export ban was implemented. They find for rice all port markets integrated with the world market during the export ban period as well as when trade is freely possible. Though, no cointegration of the port markets and the world market for wheat is observed during the export ban. However, more domestic market price pairs are integrated during the export ban for rice but less for wheat, when compared to the free trade regime.

3 Methodological framework and data properties

3.1 Methodology and estimation technique

Regionally integrated markets are related through a long-run equilibrium parity, which we characterize by long-run price transmission elasticities estimated in the cointegration equation. Price transmission elasticities characterize how strongly are price shocks transmitted from one region to another. Given wheat prices P_t^1 and P_t^2 for each regional market pair, the respective long-run cointegration relationship can be expressed as follows:

$$P_t^1 = \alpha + \beta P_t^2 + \varepsilon_t \qquad (1)$$

Where P_t^1 and P_t^2 are nonstationary price series expressed in natural logarithm and ε_t denotes stationary disturbance term; α and β are interpreted as intercept and long-run price transmission elasticity, respectively, characterizing the magnitude of the transmission of price shocks from one market to another. Regression equation is estimated by the ordinary least squares method.

Usually, prices diverge from a long-run equilibrium relationship from time to time. Threshold vector error correction model (TVECM) is designed to examine how fast prices converge back to the equilibrium state in the short-run. We adopt a non-linear 3-regime TVECM with 2 thresholds developed by Greb et al. (2013) also to account for the influence of trade costs, which are highly relevant to the Russian wheat market.

A three-regime TVECM is illustrated in equation (2). The vector of dependent variables $\Delta P_t = (\Delta P_t^1,\ \Delta P_t^2)$ denotes the difference between prices in periods t and $t-1$ for both markets in question. As the independent variables, ε_{t-1}, error correction term, or alternatively, lagged residuals from equation (1) is taken to represent the price deviation from the long-run price equilibrium. Additionally, $\sum_{m=1}^{M} \Delta P_{t-m}$ term is the sum of price differences lagged by period *m* to correct residual correlation, and ω_t denotes a white-noise process with expected value $E(\omega_t) = 0$ and covariance matrix $Cov(\omega_t) = \Omega \in (\mathbb{R}^{+})^{2\times 2}$.

$$\Delta P_t = \begin{cases} \rho_1 \varepsilon_{t-1} + \sum_{m=1}^{M} \Theta_{1m} \Delta P_{t-m} + \omega_t\,, & if\ \varepsilon_{t-1} \le \tau_1\ (Lower) \\ \rho_2 \varepsilon_{t-1} + \sum_{m=1}^{M} \Theta_{2m} \Delta P_{t-m} + \omega_t\,, & if\ \tau_1 < \varepsilon_{t-1} \le \tau_2\ (Middle\,) \\ \rho_3 \varepsilon_{t-1} + \sum_{m=1}^{M} \Theta_{3m} \Delta P_{t-m} + \omega_t\,, & if\ \tau_2 < \varepsilon_{t-1}\ (Upper) \end{cases} \quad (2)$$

The short-run dynamics are characterized by the speed of adjustment parameter (ρ_k) and the coefficients of the price differences (Θ_{km}) lagged by *m*-periods with *k* referring to a regime. All parameters may vary by regime with *k=1 … 3*.

We employ novel regularized Bayesian technique to identify estimates of threshold parameters, which govern the regime switch, and restricted maximum likelihood method to estimate model variable coefficients (Greb et al., 2013).

Having completed price transmission analysis, next we combine price transmission elasticities with various market characteristics in reduced-form regression analysis to identify causes of the differences in the degree of market integration. We posit that distance, interregional trade flows and export orientation have a significant impact on the degree of market integration.

We to conduct econometric analysis using Tobit model, which is fitted to the data sample of Russia and the USA. Model is given in the following reduced-from equation:

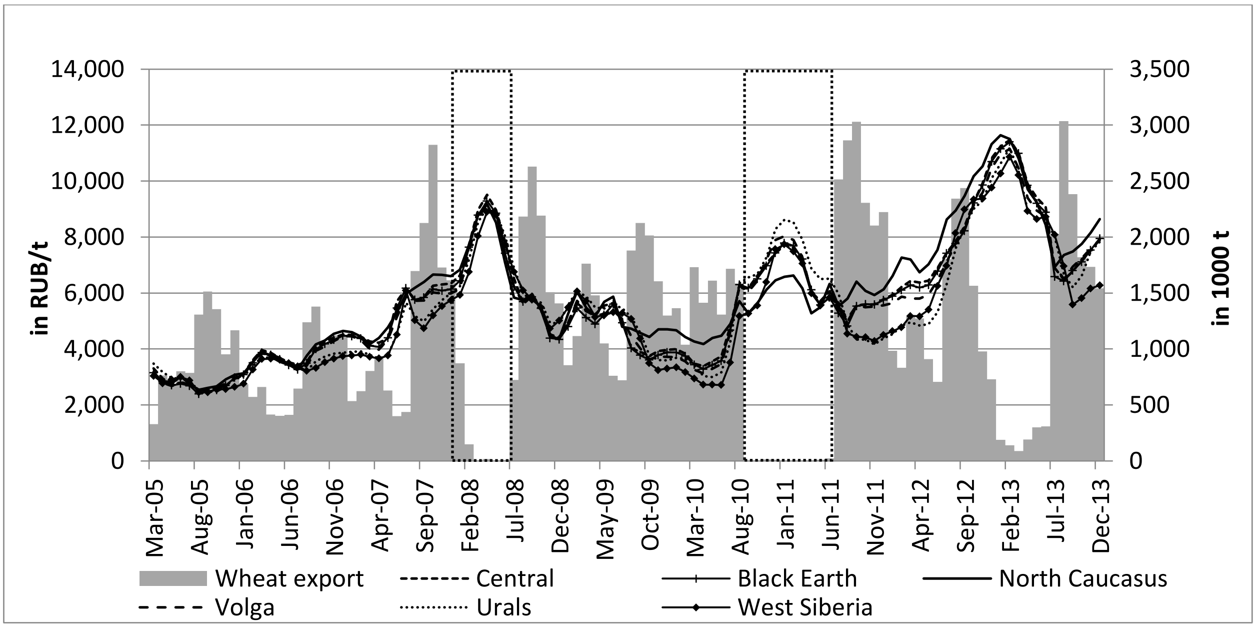
$$\text{Long} - \text{run price transmission elasticity}_i =$$
$$\beta_0 + \beta_1 \text{Volume}_i + \ \beta_2 \text{Distance}_i + \beta_3 \text{Exporter}_i + \ \gamma_0 \text{Russia}_i +$$
$$+ \gamma_1 \text{Volume}_i * \text{Russia}_i + \gamma_2 \text{Distance}_i * \text{Russia}_i + \gamma_3 \text{Exporter}_i * \text{Russia}_i + \varepsilon_{it} \qquad (3)$$

Where $\text{Long run price transmission coefficient}_i$ is an estimate of β coefficient from cointegration equation (1). Volume_i and Distance_i measures total interregional wheat trade and average kilometers covered by the means of railway transport between regions, respectively. Exporter_i is an indicator variable and takes value 1 if a region is an exporter to the world, otherwise equals to 0. Russia_i is a dummy variable that equals to 1 if a market is located in Russia. By introducing interaction terms we test conditional hypothesis that market characteristics have different effect on market integration in Russia compared to the USA.

3.2 Data sets and data properties

To estimate our price transmission model, we use a unique dataset of weekly prices of wheat of class three (Rubel/ton), the most widely traded type of wheat for human consumption in the Russian domestic market. This data is collected by the Russian Grain Union and is not publicly available. The quoted prices are paid by traders to farmers on the basis of ex-works contracts. Our data set comprises regional data for the six economic grain producing regions North Caucasus, Black Earth, Central, Volga, Urals and West Siberia and contains 468 observations (January 2005 until December 2013) (Figure 1). From this database, we construct 15 market pairs in total by combining each market with all other five regional markets in Russia.

Figure 1: Development of regional wheat prices in Russia in 2005-2013



Note: The area with dashed line on the graph covers the period of export tax (Nov 2007 - May 2008) and export ban (Aug 2010 - Jul 2011).

Source: Russian Grain Union, GTI.

To run comparisons with the USA, we employ weekly corn prices for 16 states observed between marketing years 2008 and 2011 (source: USDA, 2016). Overall, this dataset generates 63 market pairs, which we construct by pairing 7 markets from the major producing ‘Corn Belt’ area states with the other 9 markets mostly from net-consumer states. Each price series contain 156 observations on the weekly basis.

Given that wheat markets in Russia were highly turbulent over the recent decade, we notice that the regional price relationships are not stable, but rather differ from marketing year to marketing year. For example, the price of North Caucasus is in some period higher and in other periods lower than in the other regions. Also, the interregional trade flows are highly volatile. This implies that the interregional price relationships, which are depicted in the price transmission model, are highly unstable, and thus parameter estimates may also not be constant. To tackle this issue, we estimate the price transmission model based only on one marketing year sample which is characterized by relatively stable price relationships. There is no need for such treatment for the USA price series.

In particular, we use the price observations of the marketing year 2009/10, when trade was freely possible, as our data base. Also, to investigate the impact of the drought and the export ban, we estimate the price transmission model based on the price data for the marketing year 2010/11 and compare the parameter estimates with those obtained based on the 2009/10 price data. Both data sets comprise 52 observations each.

We apply Augmented Dickey-Fuller test (Dickey and Fuller, 1981) to confirm non-stationary nature of individual price series. We examine existence of long-run relationship between them using three cointegration tests (Johansen, 1988; Hansen and Seo, 2002; Larsen, 2012). Test results, which are all confirmatory, are available from the authors upon request.

In addition, to account for market characteristics, we supplement our dataset with the weekly amounts of grains transported by train between all grain producing regions of Russia as a measure for interregional grain trade flows (source: Rosstat, 2014). From the same dataset we calculate quantity weighted kilometers between two paired regions to account for the distance. Equivalent state-level data for the USA is extracted from Carload Waybill Samples (Source: Surface Transportation Board, 2016).

4 Results

4.1 Parameters of the long-run price equilibrium regression

In this section, we discuss estimation results of price transmission analysis for Russia for the marketing year 2009/10, when trade was freely possible, and in the marketing year 2010/11, when Russian government imposed export ban. Table 1 presents the parameter estimates of the long-run price equilibrium regression. For the marketing year 2009/10 results suggest that the long-run price transmission parameter decreases and the intercept parameter increases with increasing distance between the regions. This corresponds with the Law of One Price according to which markets are perfectly integrated if the intercept of the long-run price equilibrium is equal to zero and the slope parameter is equal to one.

In particular, long-run price transmission is strongest between the neighbouring regions Central and Black Earth (0.940), the first of which is the major consumption centre and the second is a production region, and lowest between North Caucasus and West Siberia (0.132), the two grain producing regions which are the most distant to each other. Our results also suggest that North Caucasus is the least integrated with the other grain producing regions of Russia. North Caucasus is the only major grain producing region with direct access to the world grain market. Thus, different to the other grain producing regions, North Caucasus is also strongly influenced by the world market conditions explaining its rather low integration in the Russian regional grain markets.

Table 1: Parameters of the long-run price equilibrium regression, 2009/10 and 2010/11

Price pairs			Long-run price transmission elasticities			Intercept parameter	
Dependent variable	**Independent variable**	**Distance (km)**	**2009/10**	**2010/11**	**% change**	**2009/10**	**2010/11**
Central	Black Earth	526	0.940	0.917	-2	0.519	0.733
Central	Volga	801	0.698	0.824	18	2.525	1.538
Central	Urals	2044	0.432	0.670	55	4.699	2.590
Central	West Siberia	3346	0.358	0.589	65	5.346	3.654
North Caucasus	Black Earth	870	0.333	0.573	72	5.672	3.646
North Caucasus	Central	1300	0.346	0.642	86	5.557	3.037
North Caucasus	Volga	1708	0.267	0.543	103	6.225	3.896
North Caucasus	Urals	2682	0.156	0.443	184	7.132	4.752
North Caucasus	West Siberia	3984	0.132	0.392	197	7.340	5.262
Black Earth	Volga	1035	0.740	0.890	20	2.153	0.959
Black Earth	Urals	2027	0.469	0.760	62	4.366	2.052
Black Earth	West Siberia	3329	0.388	0.636	64	5.071	3.248
Volga	Urals	1235	0.677	0.844	25	2.645	1.326
Volga	West Siberia	2537	0.571	0.717	26	3.575	2.553
Urals	West Siberia	1310	0.833	0.834	0	1.452	1.590

Note: All parameters are significant at a level lower than 1%.
Source: Own estimations.

For the marketing year 2010/11, when several regions experienced severe droughts and exports to the world market were forbidden by an export ban, the slope coefficient increases and the intercept parameter decreases compared to 2009/10 for 13 out of the 15 price pairs. Obviously, the domestic Russian grain market is characterized by stronger market integration during the export ban.

4.2 Estimated parameters of the TVECM

Selected parameters of the 3-regime TVECM, which is estimated for the 15 market pairs separately for the marketing years 2009/10 and 2010/11 are presented in Tables 2a and Table 2b in Appendix. It becomes evident that the vast majority of observations are attributed to the middle regime for 12 out of 15 regional price pairs in 2009/10. This means that the error correction term between regional market pairs is usually smaller than the absolute value of the lower and upper threshold, providing evidence for strong market integration. In 2010/11 the number of market pairs for which the majority of observations lays in the middle regime increases to 14 out of the 15 market pairs. This can be interpreted as evidence of the strengthened integration of regional markets during the export ban.

Another attribute to characterize market integration is the size of the band of inaction, difference between the absolute value of the upper and lower threshold. The average size of the band of inaction is significantly lower in the marketing year 2009/10 amounting to 0.07 compared to the marketing year 2010/11 amounting to 0.12. This can be explained by the increase of the size of thresholds, which are proxy for the transaction costs. These results suggest that interregional trade costs increased in 2010/11 compared to 2009/10. Information provided by the Russian Grain Union confirms these results. First, the railway transport costs were increased by 10% by the government in 2010/11 compared to 2009/10. Further, the destinations of interregional grain trade flows changed during the export ban and grain trade flows were even reversed. Traders had to extend their business to other regions and could not make use of their established business contacts. Thus, transaction costs of trade increased strongly by increasing trade risk associated with a high level of fraud and high risk of contract enforcement.

The influence of distance is also reflected in the size of the regime-specific speed of adjustment parameters. We find 8 price pairs for 2009/10 and 12 price pairs for 2010/11 out of the 15 price pairs each for which the speed of adjustment parameters and the total adjustment is higher in at least one of the outer regimes (lower and upper regime) compared to the middle regime. This confirms the theory underlying threshold models applied in spatial price transmission, according to which the speed at which deviations from the long-run price equilibrium are corrected, is higher if the price deviations exceed the thresholds. The regime-specific speed of adjustment parameters are increasing for at least one regime in 13 out of 15 cases in 2010/11 compared to 2009/10, confirming once again that the integration of the regional wheat markets was strengthened during the export ban.

4.3 Comparison with the corn market in the USA

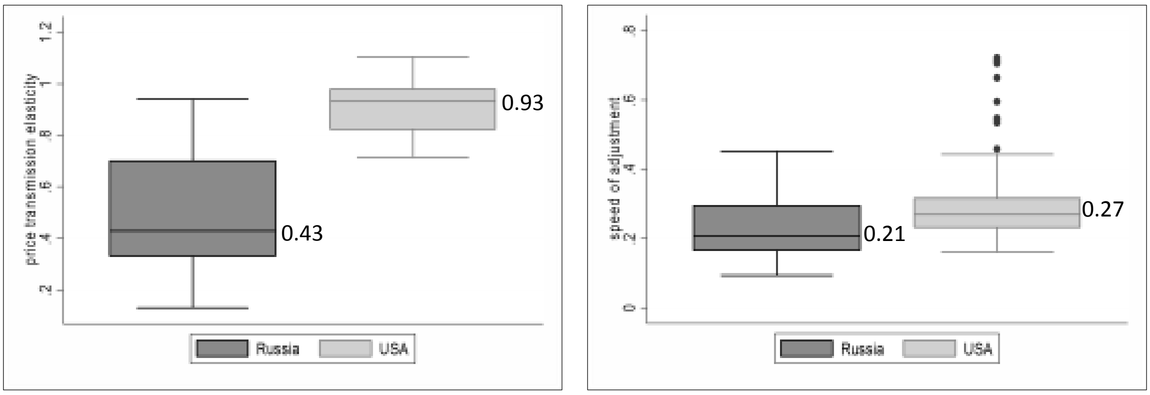
To assess how well the regional wheat markets functions in Russia, we conduct an analysis of the integration of the corn markets in the main grain producing regions of the USA. In general, compared to Russia, transportation logistics function more efficiently and delivery costs are much lower in the USA.

We depict all comparisons concerning the price transmission analysis on Figure 2.

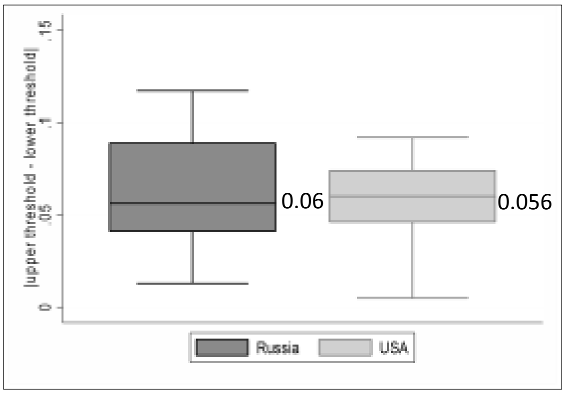
For the sake of comparability, we consider results of price transmission analysis for Russian markets in the marketing year 2009/10 to compare it with the USA. Box-plot of long-run price transmission elasticities on Panel a, Figure 3 shows that price transmission is typically lower in Russia compared to the USA. Median coefficient is 0.43 in Russia and 0.93 in the USA, respectively. In addition, price transmission coefficients are more heterogeneous ranging between 0.13 and 0.97 in Russia, while it has modest variation in the USA changing from 0.72 to 1.10.

Figure 2: Boxplot comparisons of price transmission coefficients for Russia and the USA

a) Long-run price transmission elasticities **b) Speed of adjustment**



c) Band of inaction



Source: Own estimations.

Further, eliminating of short-run price disequilibrium is more time-consuming in Russia compared with the USA (Panel b). In terms of median values, markets in the USA eliminate 27% of any disequilibrium in one week, while just 21% is corrected in Russia. For comparison, maximum observed speed of adjustment in the USA is 0.72 between California and Iowa, the leading consumption centre and the largest production region, respectively. Whereas the highest speed of adjustment in Russia (0.38) is obtained between two neighbouring regions Central and Black Earth, which is the main supplier of wheat to Moscow in Central region.

A similar pattern is observed when comparing threshold estimates between Russian and the USA price pairs (Panel c). Even though median values are very similar (0.06 in Russia and 0.056 in USA) difference in the spread of threshold values are much more noticeable for Russia. Band of inaction values are higher and range in between 0.01 and 0.11 in Russia, whereas it varies from 0.005 to 0.09 in the USA.

4.4 Determinants of market integration

Results of a formal analysis of market characteristics are given in Table 3. The analysis shows that in Russia, markets which are enrolled into the intensive trade with each other tend to be more integrated than markets which lack such linkages. In particular, increase in railway traded wheat volumes by 100 thousand tonnes is associated with the increase in long-run price transmission parameter by 0.032. Though interregional grain trade positively contributes to enforcing market integration in Russia, parameter estimate on traded volumes is highly statistically insignificant in the USA, suggesting that information flows are more important for market integration in the USA than in Russia, where wheat market participants in general lack a practice in using modern technologies to get information on alternative market opportunities throughout the country and beyond.

Table 3: Tobit regression results: analysis of the determinants of market integration[1]

Dependent variable:		**Russia** [a)]		**USA** [b)]	
Long-run price transmission elasticity		**Coef.**	**b. SE**	**Coef.**	**b. SE**
Traded volume	*100 '000 tonnes*	0.032***	0.007	-0.001	0.001
Distance	*100 km*	-0.014***	0.003	-0.010***	0.001
Exporter	*to the world markets*	-0.363***	0.040	0.073***	0.015
Constant		0.826***	0.062	0.999***	0.016
Observations		78			
F-test (8, 70)		3486.54*** (Prob > F = 0.000)			

Note: [a)] data sample refers to 2009/10 marketing year when trade was freely possible and includes data on 15 regional market pairs in total. [b)] data sample refers to 2008/11 marketing year and includes 63 observations. *, **, *** indicate statistical significance at 10, 5 and 1%, respectively. b. SE is bootstrap standard error.
Source: Own estimations.

The estimations also show that distance has negative and statistically significant influence on price transmission in Russia. Closer markets are more strongly integrated in Russia than markets that are far away from each other. For instance, if we consider capital city Moscow in the Central region as a point of reference and compare two markets in terms of proximity to Moscow, then the one which is located 100 km closer to the capital city will show greater magnitude of price transmission by 0.014 points than another market which is more distant from Moscow. The impact of distance is less pronounced in the USA. Increase of distance between markets by 100 km translates into decreased price transmission coefficient only by 0.10 points.

If a market in Russia exports to the world this leads higher isolation of that exporting region from domestic price developments compared to other regions that could not access the world markets. As expected, exporting region North Caucasus, which accounts for the lion’s share of total Russian wheat export, demonstrates very low level of market integration (on average by 0.27 points) compared to other regions in Russia. Contrary, if a region exports to the world markets in the USA, this strengthens integration of that region with the other domestic markets by 0.073

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[1] Due to more convenient illustration, we present total effect of each variable separately for Russia and the USA in this table instead of showing main effects of the variables (for the USA) and their interaction with Russia.

points. We interpret this result as an indicator that in the USA market participants having easier access to the world markets consider price in exporting region as an opportunity cost and use this information as a reference price to negotiate their own trade transactions.

Comparing Russian regional markets with the USA, model estimation shows that constant term, accounting for country effects, suggests that regional price transmission is lower in Russia by 0.173 compared to the USA. Lower integration of wheat markets in Russia parallels fundamental differences between Russia and the USA that exist due to the different market structures and efficiency to function their grain markets.

5 Conclusions

In this paper we have investigated the regional price relationships between the primary grain production regions of Russia to assess the efficiency of the Russian wheat market and have compared them to results for the corn market of the USA.

In general, the results of the price transmission analysis for Russia demonstrate high variation in the level of market integration across regions. Price pairs involving North Caucasus, the exporting region with direct access to the world markets, are characterized by particularly low long-run price transmission elasticity, speed of adjustment parameters and total adjustment. This suggests that the Russian grain market can be divided in two clusters: the exporting region next to the Black Sea which is strongly influenced by world market conditions and the other grain production regions which are almost isolated from the exporting region and also the world market which are mainly influenced by domestic market conditions.

In a large country like Russia, distance between the grain producing regions has strong influence on their price relationships. This is reflected in a band of inaction and an upper and lower threshold increasing with distance between the regions, whereas the long-run price transmission elasticity, the speed of adjustment parameter and the total adjustment decrease with distance. Thus, we find the highest speed of adjustment parameters and total adjustment for neighbouring regions.

Our results suggest that the integration of the regional wheat markets strengthened during the wheat export ban in 2010/11. In particular, price transmission elasticities and regime-specific speed of adjustment parameters increased in 2010/11 compared to 2009/10 for many price-pairs. Further, we find that the size of thresholds and the band of inaction increasing in 2010/11 compared to 2009/10. We trace this back to increasing transport costs and also increasing trade risk of interregional grain transactions. The increasing trade risks results from the change in export destinations requiring to involve new trade partners. These results confirm that in general the risk of business is particularly high in Russia due to a high degree of fraud and the difficulties to enforce contracts.

The comparison of the Russian wheat market with the corn market of the USA makes evident that the efficiency of the Russian wheat market is significantly lower. In particular, the Russian market is characterized by a high heterogeneity in the degree of price transmission compared to the USA. Furthermore, TVECM estimations show that thresholds are larger and it takes more time for price shocks to be corrected in Russia compared to the USA.

Our analysis on the determinants of market integration show that the volume of direct grain trade between regions is of high importance for market integration in Russia, but is not significant for the USA. This suggests that market integration in USA is rather the results of information flows between regions. It is striking that in the USA, grain is transported via smaller distances compared to Russia. This can be explained with a different market structure: in the USA livestock and ethanol production plants are located very close to corn production regions.

The analysis further confirms a lower influence of distance in the USA. Further, the exporting region is particularly strongly integrated with other regions in the USA whereas the integration of the exporting region in the other domestic markets is particularly low in Russia.

Our study offers several important implications in terms of trade policy and food security. First, strengthening market integration between the grain production regions could contribute to decrease price volatility within the regions of Russia. If price signals were faster transmitted from deficit to surplus regions, and the transaction costs of trade were decreased, incentives for interregional trade from surplus to the actual deficit regions would be strengthened and contribute to cushion the price increasing effects of regional production shortfalls. This in turn would reduce the incentives for the government to implement export controls on grain market which in the long-run strongly negatively affect the further development of the grain sector.

Second, the grain export potential in Russia can be increased as long as this results from an increase in grain production in the exporting region which is well integrated in the world market. However, the mobilization of grain export potential in other grain production regions will require substantial investments in grain market infrastructure to improve their integration in the export market and thus in the world grain market, which might cause substantial additional costs. Ultimately world market price conditions will determine if this is efficient. As an alternative the wheat supply chain might be restructured in those regions. Livestock production might settle in the more remote grain production regions and instead of grains meat and meat products will be exported to the world market.

References

BAYLIS, K., C. JOLEJOLE-FOREMAN and M. MALLORY (2014): Impact of wheat and rice export ban on Indian market integration. Contributed Paper, IAMO-Forum 2014 “The rise of the “emerging economies”: Towards functioning agricultural markets and trade relations?”, June 25-27, Halle (Saale), Germany.

DICKEY, D. A. and W. A. FULLER (1981): Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. In: Econometrica 49 (4): 1057-1072.

FACKLER, P. and B. GOODWIN (2001): Spatial price analysis. In: Gardner, B. and G. Rausser (eds.): Handbook of Agricultural Economics. Elsevier, Amsterdam: 971-1024.

GOODWIN, B. K. and N. PIGGOTT (2001): Spatial market integration in the presence of threshold effects. In: American Journal of Agricultural Economics 83 (2): 302-317.

GÖTZ, L., T. GLAUBEN and B. BRÜMMER (2013): Wheat export restrictions and domestic market effects in Russia and Ukraine during the food crisis. In: Food Policy 38: 214-226.

GÖTZ, L., I. DJURIC and O. NIVIEVSKYI (2016): Regional price effects of extreme weather events and wheat export controls in Russia and Ukraine. In: Journal of Agricultural Economics 67 (3): 741-763.

GREB, F., S. VON CRAMON-TAUBADEL, T. KRIVOBOKOVA and A. MUNK (2013): The estimation of threshold models in price transmission analysis. In: American Journal of Agricultural Economics 95 (4): 900-916.

HANSEN, B. and B. SEO (2002): Testing for two-regime threshold co-integration in vector error-correction models. In: Journal of Econometrics 110 (2): 293-318.

JOHANSEN, S. (1988): Statistical Analysis of Cointegration Vectors. In: Journal of Economic Dynamics and Control 12 (2-3): 231-254.

LARSEN, B. (2012): A Threshold Cointegration Analysis of Norwegian Interest Rates. Master Thesis. University of Tromsø.

LIOUBIMTSEVA, E. and G. HENEBRY (2012): Grain production trends in Russia, Ukraine and Kazakhstan: New opportunities in an increasingly unstable world? In: G.M. Front. Earth Sci. 6 (2): 157-166.

LO, M.C. and E. ZIVOT (2001): Threshold cointegration and nonlinear adjustment to the Law of One Price. In: Macroeconomic Dynamics 5 (4): 533-576.

OECD/FAO (2012): OECD-FAO Agricultural Outlook 2012-2021. OECD Publishing and FAO.

ROSSTAT (2014): Federal State Statistics Service. www.gks.ru.

SURFACE TRANSPORTATION BOARD (2016): Carload Waybill Samples. www.stb.gov.

UNITED STATES DEPARTMENT OF AGRICULTURE (2016): Agricultural Marketing Service. www.marketnews.usda.gov.

Appendix

Table 2a: Results of TVECM, 2009/10

	Price pair	**Lower regime**			**Middle regime**			**Upper regime**		**Total adjustment [Number of obs.]**			
	Dependent – indep. variable	ρ_1	**[Pvalue]**	**Lower Thresh.**	ρ_2	**[Pvalue]**	**Upper Thresh.**	ρ_3	**[Pvalue]**	**Lower**	**Middle**	**Upper**	**Band of inaction**
1	**Central - Black Earth**	-0.212	[0.360]	**-0.021**	-0.208	[0.336]	**0.018**	**-0.353**	[0.089]	**0.340**	**0.364**	**0.733**	**0.039**
	Black Earth - Central	**0.340**	[0.072]		**0.364**	[0.035]		**0.380**	[0.015]	[7]	[40]	[1]	
2	**Central - Volga**	-0.100	[0.291]	**-0.013**	-0.207	[0.337]	**0.003**	-0.147	[0.168]	**-**	**-**	**-**	**0.016**
	Volga - Central	0.121	[0.264]		-0.180	[0.408]		-0.081	[0.494]	[17]	[12]	[19]	
3	**Central -Urals**	-0.029	[0.757]	**-0.047**	-0.149	[0.259]	**0.029**	**-0.173**	[0.030]	**0.310**	**-**	**0.173**	**0.076**
	Urals - Central	**0.310**	[0.004]		0.179	[0.214]		0.100	[0.233]	[17]	[18]	[13]	
4	**Central - West Siberia**	-0.039	[0.646]	**-0.062**	-0.102	[0.311]	**0.021**	**-0.166**	[0.014]	**0.260**	**-**	**0.166**	**0.083**
	West Siberia - Central	**0.260**	[0.041]		0.082	[0.574]		-0.005	[0.955]	[12]	[17]	[19]	
5	**North Caucasus - Black Earth**	**-0.207**	[0.041]	**-0.021**	**-0.207**	[0.041]	**0.020**	**-0.207**	[0.041]	**0.207**	**0.207**	**0.207**	**0.041**
	Black Earth - North Caucasus	-0.018	[0.809]		-0.018	[0.809]		-0.018	[0.809]	[14]	[16]	[18]	
6	**North Caucasus - Central**	**-0.300**	[0.025]	**-0.030**	**-0.216**	[0.088]	**0.020**	-0.168	[0.136]	**0.300**	**0.216**	**-**	**0.050**
	Central - North Caucasus	**-0.152**	[0.187]		0.114	[0.299]		-0.031	[0.744]	[7]	[24]	[16]	
7	**North Caucasus - Volga**	**-0.167**	[0.078]	**-0.038**	-0.177	[0.136]	**0.012**	**-0.153**	[0.060]	**0.167**	**-**	**0.153**	**0.050**
	Volga - North Caucasus	-0.107	[0.276]		-0.074	[0.569]		-0.091	[0.328]	[4]	[26]	[18]	
8	**North Caucasus - Urals**	0.041	[0.684]	**-0.036**	-0.029	[0.820]	**0.024**	-0.064	[0.379]	**-**	**-**	**-**	**0.060**
	Urals - North Caucasus	0.176	[0.132]		0.154	[0.284]		0.081	[0.360]	[11]	[21]	[16]	
9	**North Caucasus - West Siberia**	-0.116	[0.146]	**-0.049**	**-0.125**	[0.036]	**0.029**	**-0.125**	[0.036]	**-**	**0.125**	**0.125**	**0.078**
	West Siberia - North Caucasus	-0.010	[0.926]		0.057	[0.573]		0.057	[0.573]	[6]	[29]	[13]	
10	**Black Earth - Volga**	**-0.094**	[0.086]	**-0.046**	**-0.146**	[0.052]	**0.011**	**-0.094**	[0.086]	**0.094**	**0.146**	**0.094**	**0.057**
	Volga - Black Earth	0.022	[0.781]		-0.003	[0.979]		0.022	[0.781]	[8]	[26]	[14]	
11	**Black Earth - Urals**	0.063	[0.318]	**-0.059**	0.063	[0.318]	**0.031**	0.005	[0.928]	**0.295**	**0.295**	**0.193**	**0.090**
	Urals - Black Earth	**0.295**	[0.000]		**0.295**	[0.000]		**0.193**	[0.016]	[10]	[28]	[10]	
12	**Black Earth - West Siberia**	-0.007	[0.898]	**-0.087**	-0.069	[0.208]	**0.025**	-0.049	[0.375]	**-**	**-**	**-**	**0.112**
	West Siberia - Black Earth	0.106	[0.229]		0.015	[0.859]		0.016	[0.849]	[6]	[26]	[16]	
13	**Volga - Urals**	-0.160	[0.203]	**-0.058**	-0.019	[0.858]	**0.038**	**-0.297**	[0.014]	**0.210**	**0.200**	**0.297**	**0.096**
	Urals - Volga	**0.210**	[0.067]		**0.200**	[0.043]		0.120	[0.245]	[8]	[33]	[7]	
14	**Volga - West Siberia**	-0.141	[0.274]	**-0.056**	**-0.201**	[0.035]	**0.035**	**-0.288**	[0.004]	**-**	**0.201**	**0.288**	**0.091**
	West Siberia - Volga	0.216	[0.125]		0.098	[0.228]		-0.026	[0.763]	[4]	[38]	[6]	
15	**Urals - West Siberia**	**-0.206**	[0.072]	**-0.027**	-0.186	[0.183]	**0.012**	-0.206	[0.141]	**0.206**	**-**	**-**	**0.039**
	West Siberia - Urals	0.213	[0.157]		0.167	[0.324]		0.011	[0.951]	[11]	[22]	[15]	

Table 2b: Results of TVECM, 2010/11

	Price pair	**Lower regime**			**Middle regime**			**Upper regime**		**Total adjustment [Number of obs.]**			
	Dependent – indep. variable	ρ_1	**[Pvalue]**	**Lower Thresh.**	ρ_2	**[Pvalue]**	**Upper Thresh.**	ρ_3	**[Pvalue]**	**Lower**	**Middle**	**Upper**	**Band of inaction**
1	**Central - Black Earth**	0.018	[0.964]	**-0.022**	**-0.437**	[0.096]	**0.014**	-0.272	[0.369]	**0.587**	**0.437**	**-**	**0.036**
	Black Earth - Central	**0.587**	[0.098]		0.022	[0.915]		0.301	[0.243]	[6]	[36]	[6]	
2	**Central - Volga**	**-0.690**	[0.005]	**-0.018**	-0.290	[0.161]	**0.008**	-0.168	[0.334]	**0.690**	**-**	**-**	**0.026**
	Volga - Central	-0.142	[0.568]		0.117	[0.566]		0.178	[0.292]	[8]	[27]	[13]	
3	**Central -Urals**	**-0.457**	[0.000]	**-0.095**	0.042	[0.524]	**0.058**	-0.039	[0.826]	**0.457**	**-**	**0.304**	**0.153**
	Urals - Central	-0.017	[0.873]		0.084	[0.171]		**0.304**	[0.078]	[3]	[41]	[4]	
4	**Central -West Siberia**	**-0.329**	[0.007]	**-0.105**	**0.118**	[0.061]	**0.054**	0.158	[0.131]	**0.329**	**-0.118**	**0.274**	**0.159**
	West Siberia - Central	0.040	[0.772]		0.028	[0.764]		**0.274**	[0.042]	[3]	[38]	[7]	
5	**North Caucasus - Black Earth**	**-0.244**	[0.054]	**-0.090**	**-0.264**	[0.035]	**0.038**	-0.217	[0.121]	**0.244**	**0.264**	**-**	**0.128**
	Black Earth - North Caucasus	-0.014	[0.846]		-0.075	[0.171]		0.008	[0.921]	[2]	[38]	[8]	
6	**North Caucasus - Central**	**-0.239**	[0.010]	**-0.032**	-0.385	[0.397]	**0.004**	**-0.242**	[0.009]	**0.129**	**-**	**0.129**	**0.036**
	Central - North Caucasus	**-0.110**	[0.094]		0.308	[0.154]		**-0.113**	[0.089]	[16]	[14]	[18]	
7	**North Caucasus - Volga**	**-0.308**	[0.049]	**-0.046**	**-0.315**	[0.075]	**0.007**	**-0.260**	[0.066]	**0.054**	**0.315**	**0.103**	**0.053**
	Volga - North Caucasus	**-0.254**	[0.009]		0.033	[0.748]		**-0.157**	[0.042]	[10]	[23]	[15]	
8	**North Caucasus - Urals**	**-0.323**	[0.002]	**-0.099**	**-0.323**	[0.002]	**0.085**	**-0.328**	[0.098]	**0.323**	**0.323**	**0.328**	**0.184**
	Urals - North Caucasus	-0.036	[0.365]		-0.036	[0.365]		-0.149	[0.210]	[4]	[40]	[4]	
9	**North Caucasus - West Siberia**	**-0.381**	[0.000]	**-0.053**	**-0.370**	[0.011]	**0.038**	**-0.453**	[0.003]	**0.381**	**0.370**	**0.453**	**0.091**
	West Siberia- North Caucasus	-0.048	[0.536]		0.013	[0.921]		-0.134	[0.335]	[10]	[29]	[9]	
10	**Black Earth - Volga**	-0.139	[0.371]	**-0.029**	-0.139	[0.404]	**0.008**	-0.126	[0.401]	**-**	**-**	**-**	**0.037**
	Volga - Black Earth	0.012	[0.948]		-0.056	[0.766]		-0.008	[0.963]	[6]	[22]	[20]	
11	**Black Earth - Urals**	**-0.271**	[0.011]	**-0.103**	0.020	[0.780]	**0.076**	**-0.322**	[0.003]	**0.271**	**-**	**0.322**	**0.179**
	Urals - Black Earth	-0.063	[0.500]		0.039	[0.518]		-0.123	[0.184]	[2]	[44]	[2]	
12	**Black Earth - West Siberia**	**-0.246**	[0.008]	**-0.107**	0.041	[0.430]	**0.071**	-0.063	[0.657]	**0.246**	**-**	**-**	**0.178**
	West Siberia - Black Earth	-0.150	[0.186]		0.104	[0.126]		0.003	[0.984]	[2]	[44]	[2]	
13	**Volga - Urals**	**-0.194**	[0.027]	**-0.107**	-0.092	[0.163]	**0.069**	**-0.225**	[0.027]	**0.194**	**-**	**0.225**	**0.176**
	Urals - Volga	-0.018	[0.812]		0.015	[0.791]		-0.043	[0.624]	[2]	[43]	[3]	
14	**Volga - West Siberia**	-0.104	[0.170]	**-0.105**	0.041	[0.529]	**0.046**	0.105	[0.439]	**-**	**-**	**0.418**	**0.151**
	West Siberia - Volga	0.032	[0.679]		0.061	[0.376]		**0.418**	[0.005]	[4]	[37]	[7]	
15	**Urals - West Siberia**	0.053	[0.513]	**-0.061**	0.039	[0.619]	**0.029**	0.039	[0.619]	**0.318**	**0.300**	**0.300**	**0.090**
	West Siberia - Urals	**0.318**	[0.012]		**0.300**	[0.020]		**0.300**	[0.020]	[3]	[36]	[9]	

Note: Total adjustment in one regime is calculated as the sum of the absolute value of the respective regime-specific speed of adjustment parameters of the TVECM. The band of inaction is given as the difference between the absolute value of the upper and lower threshold.

Source: Own estimations.