EGYPT'S WHEAT TENDERS – A PUBLIC NOTICE BOARD FOR BLACK SEA GRAIN NOTATIONS?

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Abstract

Egypt, the world's biggest wheat importer, is the largest market for Black Sea wheat exports. Half of Egypt's wheat imports are purchased by its government's General Authority for Supply of Commodities (GASC), employing a tender system. Based on a unique data base of GASC tender prices, the price relationships between the GASC tender and Black Sea wheat exporters (Russia, Ukraine, Romania and Kazakhstan) and also France and the USA are investigated. Results of linear and threshold vector error correction models suggest that export prices in the Black Sea region continuously and rapidly adjust to GASC tender prices, while the GASC tender price only adjusts to the French export price. Obviously, the GASC tender price has the function of a wheat world market price in the Black Sea region. Also, the GASC tender system creates strong price competition between the Black Sea exporters and France. We trace this back to the fact that the GASC tender system enhances transparency about competitive prices of the Black Sea wheat market, where an effective price discovery mechanism is still missing.

Keywords: Black Sea region, wheat markets, spatial market integration, Egypt, tender system, TVECM

1. INTRODUCTION

In season 2017/18, the Black Sea wheat exporters Romania, Russia and Ukraine (RRU) contributed 36 percent to the world's total wheat exports (IGC, 2018). Russia's wheat exports alone accounted for around 23 percent of world wheat exports, once more making Russia the world's largest wheat exporter. Between 20 and 30 percent of the RRU's yearly wheat exports are delivered to their primary export market Egypt, which is the world's major wheat import country alongside Indonesia. Both countries jointly account for 14 percent world wheat imports. Close to half of Egypt's wheat imports are carried out by the state procurement organization for food commodities, the General Authority for Supply of Commodities (GASC). To purchase wheat on international markets, the GASC repeatedly holds large wheat tenders that are "closely watched by the global grain industry" (Bloomberg, 2016). Business news agencies like Bloomberg or Reuters regularly provide detailed reports worldwide on the outcomes of GASC tenders in which numerous trading companies compete to deliver wheat cargos from various origins to Egypt.

Against this background, we aim to shed light on the GASC's wheat tender market, focusing on its influence on price formation on Black Sea wheat markets. Therefore, this study addresses the research question on the characteristics of the GASC wheat tender market. How many and which countries and trading companies have successfully engaged in the tenders? How has this pattern developed over time?

In addition, we investigate the integration of the GASC tender price in world wheat markets. To what degree and at which speed are price changes transmitted between GASC tender prices and Black Sea export prices? Are GASC tender prices driving or following wheat prices from the Black Sea region or further major international exporters?

To answer these research questions, we make use of a unique data base containing transaction-specific information on prices, quantities, countries of origin and sellers of each wheat cargo purchased by the GASC in 365 tenders between July 2005 and June 2018. This data on GASC tenders has not been used in the literature before.

We characterize the GASC wheat tender market based on descriptive statistics. Previously, Ghoneim (2012) has described the functioning of Egypt's state import sector as a whole, focusing on its role in ensuring food security within the country. Young and Abbott (1998) as well as McCorriston and MacLaren (2005) have more generally analyzed how state trading enterprises (STEs) that manage wheat imports affect trade patterns on the world wheat market. However, to date no scientific study has investigated how prices negotiated within a state wheat tender system affect export prices of major trading partners.

To investigate price relationships between the GASC tender price and Black Sea wheat export prices we follow a price transmission approach, employing linear as well as threshold vector error correction models (TVECM). The TVECM is estimated utilizing a novel Bayesian estimator which outperforms the conventional maximum likelihood approach especially in small samples (Greb et al. 2013). However, this model framework with its bivariate setup is only allowing pairwise price analysis.

This paper adds to the strand of literature investigating price formation in the Black Sea grain markets. Götz et al. (2013, 2016) and Djuric et al. (2015) analyze the integration of regional wheat markets in Russia, Ukraine and Serbia in world wheat markets, assessing the effects of wheat export controls imposed by governments as crisis measures.

Goychuk and Meyers (2014) examine wheat price relationships in the world wheat market. They find French and US export prices to adjust to Russian export prices within the time period of 2004 through 2010. Furthermore, Svanidze et al. (2016) show that wheat import prices of countries in the South-Caucassian and Central Asian regions adjust to prices of the Black Sea wheat exporters. These findings are in line with further studies analyzing wheat and maize markets that identify the adjustment of import prices towards export prices (see Rosa et al., 2014, Hassanzoy et al., 2016 and Acosta, 2012). However regarding rice markets, export prices are also found to adjust to import prices which is attributed to global rice markets being relatively fragmented (see Jamora and von Cramon-Taubadel, 2015, Greb et al., 2012) while the world wheat market is characterized by numerous smaller importers and relatively few large exporters like France, Russia and the USA.

As our data base contains detailed information on origin-specific purchases by the GASC, we contribute to the scarce literature linking price transmission analysis with trade data that is not accessible reagarding most markets (see Myers and Jayne, 2011, Stephens et al., 2012 and Barrett and Li, 2002).

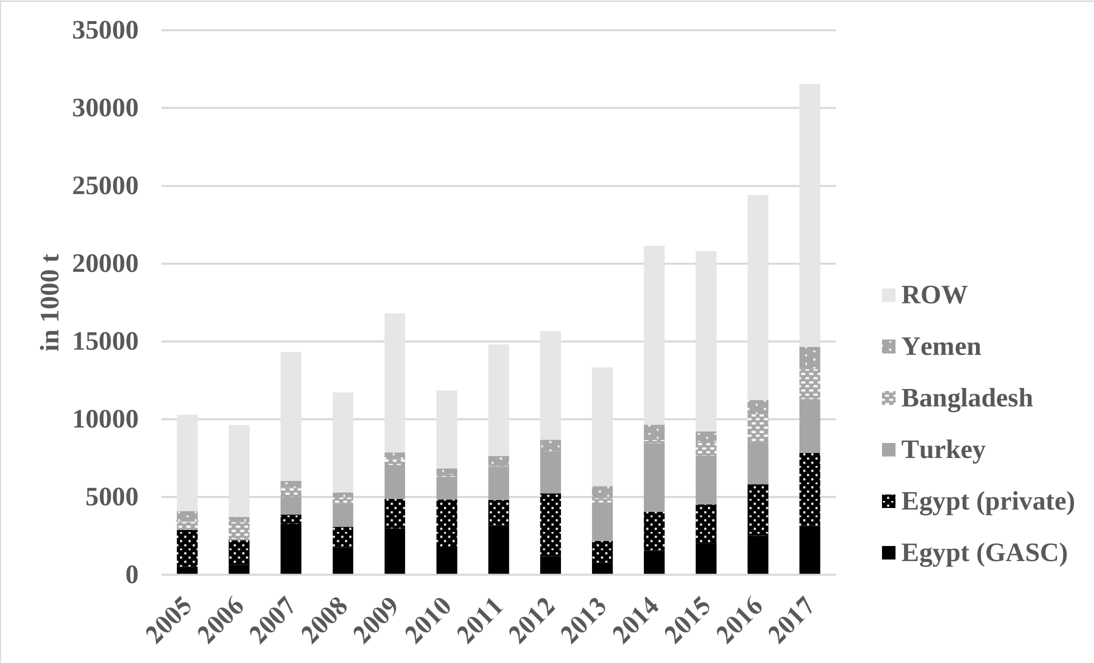
This paper is organized as follows: section 2 gives background information about Black Sea wheat markets and GASC's tender system. The methodology and estimation strategy are layed out in section 3. In section 4, the data base used in the econometric analysis is described. Section 5 discusses the estimation results and conclusions are presented in section 6.

2. BACKGROUND INFORMATION

2.1 The importance of Egypt as export market for Black Sea wheat

Figure 1 shows that Russia's wheat exports more than tripled from around 10 mt in 2005 to 33 mt in 2017. Egypt is the most important wheat export market for Russia accounting for around 25 percent of Russia's total wheat exports. Wheat is exported to Egypt either through the GASC or via the private sector. Between 2007 and 2011, the GASC is handling 60 percent of wheat exports from Russia to Egypt. From 2012 on however, this share decreases to 38 percent as the private sector expands its activities importing wheat to Egypt.

Figure 1: The largest five wheat export markets for Russia, 2005-2017.



Note: Export volumes to Egypt (private) are obtained by subtracting exports to the GASC from total exports to Egypt. ROW denotes 'Rest of World'. The largest five export markets are selected based on their shares in 2017. Source: UN Comtrade Database 2018, USDA 2018. Author's illustration.

Egypt is also the largest export market for Romanian and Ukrainian wheat. The two countries export 7.5 and 14 mt of wheat to Egypt between 2011 and 2017, respectively, representing 25 and 18 percent of their total wheat exports (UN Comtrade Database 2018).[1] While the largest share (85 percent) of Romania's wheat exports to Egypt goes through the GASC, the procurement agency plays a relatively minor role regarding Ukrainian exports compared to the private sector. Concerning France and the USA, 5 and 4 percent of total wheat exports go to Egypt between 2011 and 2015, respectively (UN Comtrade Database 2018).

2.2 Egypt's GASC and its wheat tender system

The General Authority for Supply of Commodities (GASC) is Egypt's state procurement organization for food commodities. It is responsible for around half of Egypt's total wheat imports. The grain is processed domestically to provide the Egypt's low-income population with heavily subsidized *baladi* bread.

The GASC continuously purchases wheat on the international markets via a tender system. Tenders are held every ten to twelve days between July and February, while tendering is rare between March and June when the GASC is purchasing domestically produced wheat during Egypt's harvesting season (World Grain 2013).

Announcing a tender, the agency asks authorized trading companies to submit one or several sealed price offers for wheat cargos of 55,000 to 60,000 t. The offers must contain an FOB price and a separate freight offer, both denoted in US dollars. Delivery is scheduled four to six weeks from the tender date. The companies may source wheat from various origins that are approved by the GASC based on quality standards. On average, the agency purchases three to four cargos per tender.

[1] Before 2011, Romania and Ukraine were not approved as wheat origins in GASC tenders and trade managed by private companies was also relatively minor (see section 5.1 for details).

3. METHODOLOGICAL FRAMEWORK AND MODEL ESTIMATION

3.1 Methodological framework

Price relationships in spatially separated markets which are linked by a common price equilibrium can be represented by the cointegration equation

$$P_t^i = \alpha + \beta P_t^j + \varepsilon_t \quad (1)$$

where P_t^i and P_t^j denote prices of a homogenous good (in natural logarithm) in import market i and export market j at time period t, α is an intercept and β is the coefficient of the long-run price transmission elasticity measuring the magnitude of the transmission of price shocks between the two markets. ε_t represents a stationary error term, which indicates that prices are related by a common long-run price equilibrium (Engle and Granger, 1987).

The cointegration equation (1) characterizes equilibrium price relationships in the long-run. However in the short-run, prices usually deviate from this parity. Spatial arbitrage then ensures the convergence back to the common equilibrium. To characterize short-run dynamics of price adjustments, we use dynamic linear and threshold vector error correction models (VECM and TVECM)

If two prices in spatially separated markets are linearly cointegrated, the short-run adjustment of the prices is modelled within a VECM as

$$\Delta \boldsymbol{P}_t = \boldsymbol{\gamma}\varepsilon_{t-1} + \sum_{l=1}^{L} \boldsymbol{\delta}_l \, \Delta \boldsymbol{P}_{t-l} + \boldsymbol{\omega}_t \quad (2)$$

where $\Delta \boldsymbol{P}_t = (\Delta P_t^i, \Delta P_t^j)$ is a vector of price differences between periods t and $t-1$ for markets i and j. The error correction term ε_{t-1}, which corresponds to the lagged residuals retrieved from equation (1), represents price deviations from the long-run price equilibrium. $\boldsymbol{\gamma}$ is a vector of speed of adjustment parameters which measures the fraction of a price disequilibrium eliminated in every time period t to restore the spatial price equilibrium. $\boldsymbol{\delta}_l$ corresponds to the impact of past price changes $\Delta \boldsymbol{P}_{t-l}$ with lags l, with $l = 1, \ldots, L$ on current price changes also ensuring that the model residuals $\boldsymbol{\omega}_t$ are serially uncorrelated. $\boldsymbol{\omega}_t$ represents the white noise residuals with expected value $E(\boldsymbol{\omega}_t) = \boldsymbol{0}$ and covariance matrix $Cov(\boldsymbol{\omega}_t) = \boldsymbol{\Omega} \in (\mathbb{R}^+)^{2\times 2}$.

VECM estimates can be biased if non-linear cointegration is not considered (Ghoshray, 2010). If prices between spatially separated markets are non-linearly related, we use a TVECM, which allows the modelling of non-linear price dynamics by distinguishing between regimes (Goodwin and Piggott, 2001). The two-threshold, three-regime TVECM (which is a straightforward extension of the one threshold, two-regime TVECM) can be written as

$$\Delta \boldsymbol{P}_t = \begin{cases} \boldsymbol{\gamma}_1\varepsilon_{t-1} + \sum_{l=1}^{L} \boldsymbol{\delta}_{1l} \, \Delta \boldsymbol{P}_{t-l} + \sum_{l=1}^{K} \boldsymbol{\theta}_{1l} \, \Delta \boldsymbol{P}_{t-l} + \boldsymbol{\omega}_{1t}, & \varepsilon_{t-1} \leq \tau_1 \quad \text{"lower regime"} \\ \boldsymbol{\gamma}_2\varepsilon_{t-1} + \sum_{l=1}^{L} \boldsymbol{\delta}_{2l} \, \Delta \boldsymbol{P}_{t-l} + \sum_{l=1}^{K} \boldsymbol{\theta}_{2l} \, \Delta \boldsymbol{P}_{t-l} + \boldsymbol{\omega}_{2t}, & \tau_1 < \varepsilon_{t-1} \leq \tau_2 \quad \text{"middle regime"} \\ \boldsymbol{\gamma}_3\varepsilon_{t-1} + \sum_{l=1}^{L} \boldsymbol{\delta}_{3l} \, \Delta \boldsymbol{P}_{it-l} + \sum_{l=1}^{K} \boldsymbol{\theta}_{3l} \, \Delta \boldsymbol{P}_{t-l} + \boldsymbol{\omega}_{3t}, & \tau_2 < \varepsilon_{t-1} \quad \text{"upper regime"} \end{cases} \quad (3)$$

where ε_{t-1} retrieved from cointegration equation (1) additionally serves as a threshold variable τ, which determines the regime state k with $k = \{\text{lower, middle, upper}\}$ depending on the size of price deviations relative to the threshold parameter.

In the three-regime TVECM, the threshold parameters τ_1 and τ_2 are interpreted as estimates of transaction costs in both directions of trade, captured by the restriction $\tau_1 < 0 < \tau_2$. Likewise, in two-regime TVECM with one threshold, the parameter τ represents trade cost only in one direction of trade, i.e. from the export market j to the import market i. The model assumes that trade costs are a constant fraction of prices if they are denoted in natural logarithm.

In contrast to linear VECM, speed of adjustment parameters in TVECM may differ across regimes. In the three-regime TVECM, price deviations are expected to be eliminated more quickly in the "lower" and "upper" regimes, when price deviations exceed corresponding trade costs triggering spatial arbitrage until the price disequilibrium is eliminated. By contrast, price adjustment is slower or absent in the "middle" regime, since price deviations are smaller than trade costs. Similarly, in a TVECM with two regimes, the speed of adjustment parameter of the upper regime, which prevails when price deviations exceed the threshold parameter τ, is expected to be higher compared to the lower regime.

3.2 Model estimation

If a price pair is linearly cointegrated, we estimate a linear VECM (Johansen, 1988). Otherwise, if threshold cointegration with one threshold (Hansen and Seo, 2002) or two thresholds (Larsen, 2012) is identified between the price series in question, we estimate a two-regime and three-regime TVECM, respectively.

We apply a novel regularized Bayesian estimator (Greb et al., 2013) to estimate TVECM. A considerable advantage of this approach compared to the classic maximum likelihood (Hansen and Seo, 2002) and the least squares (Chan, 1993) estimator is its superior performance in small samples. The regularized Bayesian estimator relies on informative priors to obtain a well-defined space of threshold parameters, whereas the maximum likelihood estimator has to trim a number of values of the threshold variable τ to find the optimal thresholds.

The regularized Bayesian estimator for three-regime TVECM is calculated as a posterior median

$$\int_{\min(\varepsilon_{t-1})}^{\hat{\tau}_{irB}} P_{rB}(\tau_i|\Delta\boldsymbol{P},\boldsymbol{X})d\tau_i = 0.5\,, \qquad for\ i = 1,2 \qquad (4)$$

where matrix $\boldsymbol{X}$ contains error correction terms and lagged price differences. The posterior density $P_{rB}(\tau_i|\Delta\boldsymbol{P},\boldsymbol{X})$ for τ_i is well-defined on the entire space of the threshold parameters $\mathrm{T} = \{(\tau_i)|\min(\varepsilon_{t-1}) < \tau_i < \max(\varepsilon_{t-1})\}$. Threshold estimates are computed by using the restricted likelihood function of a generalized linear mixed effects model in R (Gałecki and Burzykowski, 2013). Following the identification of the optimal thresholds, we estimate the regime-specific speed of adjustment parameters of the TVECM.

4. DATA

We conduct the price transmission analysis for seven wheat price pairs. Each pair consists of the GASC tender price as an import price and the FOB export price of one of the Black Sea wheat exporting countries Kazakhstan, Romania, Russia and Ukraine or of France and the USA (Table 1 and Figure 2). The series of the GASC tender prices is constructed based on a comprehensive, transaction-specific data base on 166 wheat tenders issued between July 2011 and December

2017.[2] The data base comprises records on 553 individual cargoes and provides information about the quantity, price, seller and country of origin of wheat cargoes supplied to the GASC. To construct a regular monthly series of GASC tender prices, we select the highest CIF price paid by the GASC within one month as the GASC tender price for that month. We choose the highest CIF price since it is the price received by the marginal wheat supplier and therefore best represents the market equilibrium price.[3] It is the tender date and not the delivery date that determines which month a price is matched to. We linearly interpolate 14 missing values which mainly appear during Egypt's domestic wheat harvest and account for 18% of the total 78 observations.

Table 1: Data base of wheat prices underlying the price transmission analysis

Group	Country	Price type	Data Source
GASC	**Egypt**, tender prices	Highest CIF offer, monthly, USD/t	USDA (2018)
Black Sea exporters	**Kazakhstan**, milling, Aktau port	FOB, monthly, USD/t	APK-Inform (2018)
	Romania, Serbian Danube silos	FCA, monthly, RSD/t	Serbian Grains (2018)
	Russia, milling, deep-sea ports	FOB, monthly, USD/t	APK-Inform (2018)
	Ukraine, milling	FOB, monthly, USD/t	APK-Inform (2018)
Non-Black-Sea exporters	**France**, grade one, Rouen port	FOB, monthly, USD/t	IGC (2018)
	USA, no. 2 HRW, Gulf ports	FOB, monthly, USD/t	USDA (2018)
	USA, no. 2 SRW, Gulf ports	FOB, monthly, USD/t	USDA (2018)

Note: Sample period ranges from July 2011 to December 2017. FCA denotes 'free carrier'. In this case, FCA prices are comparable to FOB prices because the respective silos are close to the river Danube.
Source: author's illustration.

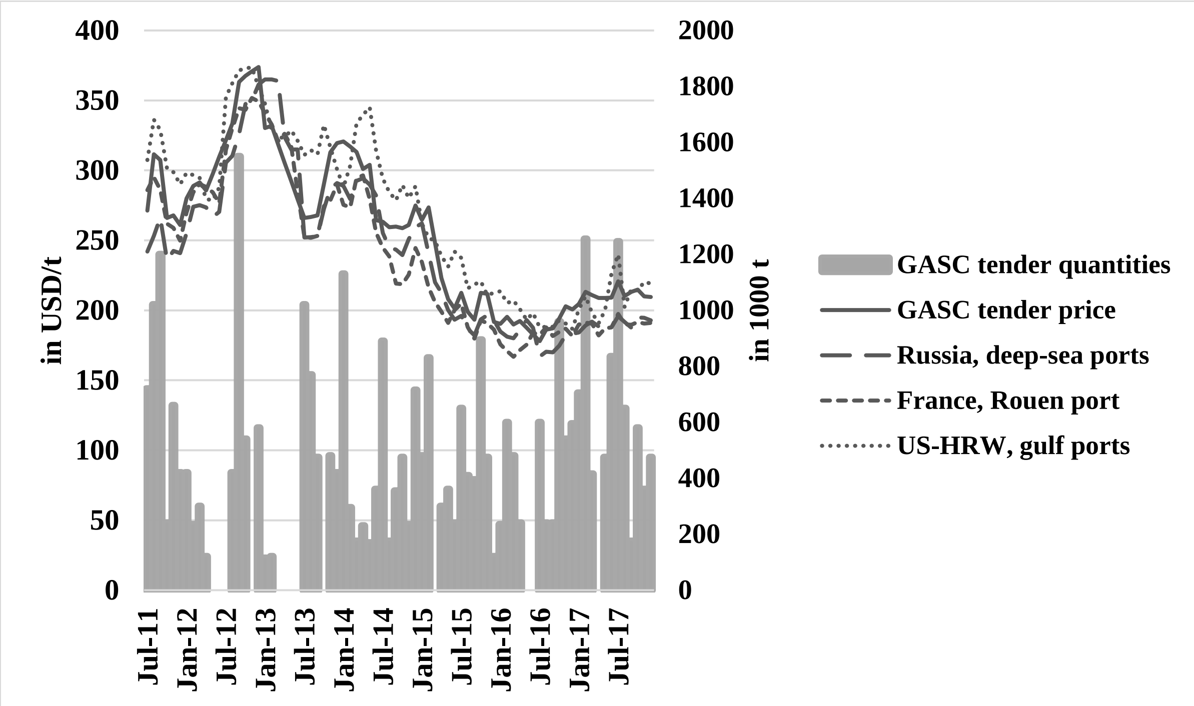
The data base for the Black Sea exporters contains FOB wheat export prices of Kazakhstan, Russia and Ukraine, as well as Serbian FCA wheat prices as a proxy for the Romanian export prices. We use Serbian prices since Serbian wheat is primarily exported via Romania's major Black Sea port Constanta. The Serbian prices are converted into US dollars based on the exchange rates provided by the Serbian central bank.

Additionally, we consider wheat export prices of the non-Black-Sea exporters France as well as the USA. France is the EU's primary wheat producer and a major global exporter largely supplying wheat to the Mediterranean countries. For the USA, we consider export prices for two types of wheat: Hard Red Winter (HRW) and Soft Red Winter (SRW). US-SRW is mainly bought by the GASC. US-HRW on the other hand, is the wheat type primarily produced exported by the USA. US-HRW is also frequently chosen to represent the world wheat market price (see Yavapolkul et al., 2006, Minot, 2011 and Zorya et al., 2015).

[2] In our data base, information on GASC purchases dates back to July 2005. However, CIF prices are systematically recorded only from 2011 on. Therefore, the sample for our price transmission analysis starts in July 2011.

[3] For comparison, we also have constructed a series of average monthly tender prices and a series containing the lowest monthly CIF price. Model results based on those data series do not change qualitatively but the size of the estimated price transmission elasticities and speed of adjustment parameters is smaller. We interpret this as evidence for the highest CIF prices containing the most relevant information on the export markets under consideration.

Figure 2. Selected export prices and GASC tender prices and purchased quantities



Source: USDA (2018), USDA (2018), APK-Inform (2018), IGC (2018)

5. EMPIRICAL RESULTS

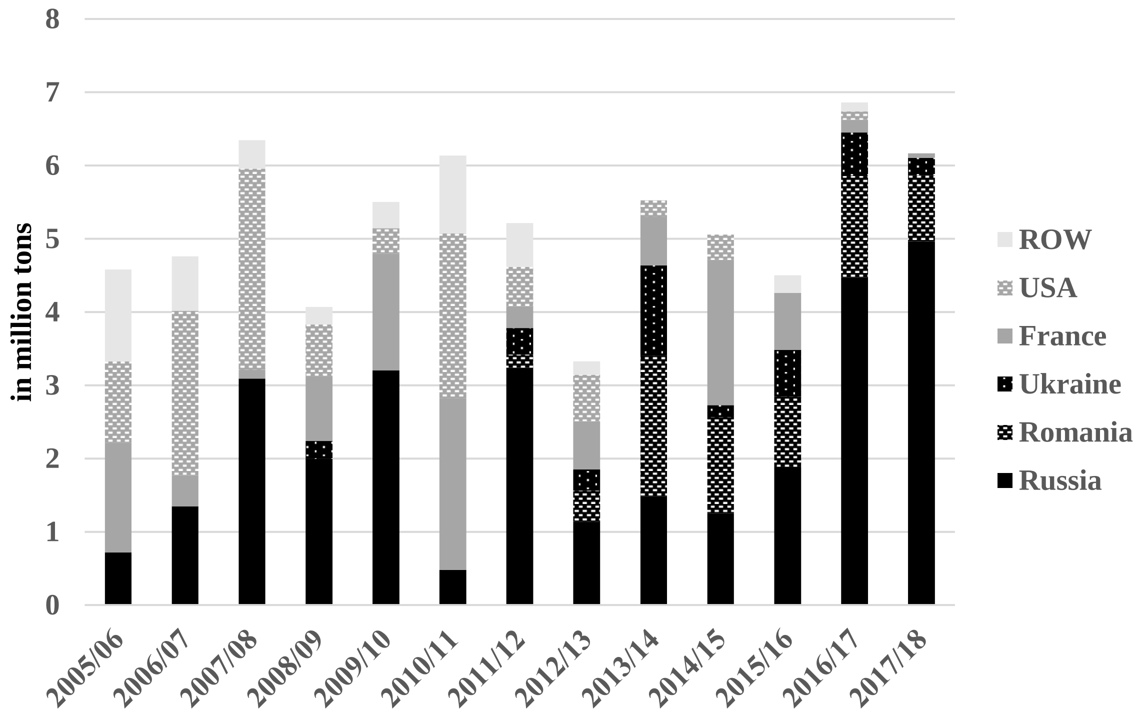
We begin with the descriptive statistics retrieved from the GASC tender data base to characterize the GASC tender market. This is followed by the empirical results of the price transmission analysis.

5.1 Characteristics of the GASC tender market

5.1.1 Countries of origins of the GASC's wheat imports

Figure 3 shows that the share of the RRU within GASC imports has increased constantly since the marketing year 2005/06 and reached 77, 94 and 99 percent in 2015/16 through 2017/18. In 2010/11, wheat exports from Russia were banned due to severe harvest shortfalls and thus the GASC's wheat imports from France and the USA increased. During 2005/06 through 2017/18 the majority of wheat purchased by the GASC originated from Russia (43%) followed by France and the USA (both 17%). Yet, since 2011/12 the GASC purchases only minor quantities of wheat from France. One exception is season 2014/15 when highly competitive French wheat accounted for 35 percent of the GASC seasonal wheat imports. The USA had been the largest supplier to the GASC until season 2006/07 but it only occasionally exports wheat to the GASC since 2010/11. Rather, the GASC approved Romania and Ukraine as additional Black Sea exporting countries in late 2011 within the agency's strategy to 'boost competition amongst Black Sea origin wheat' (Reuters, 2011). Wheat originating from Romania and Ukraine successfully competed with wheat from Russia in seasons 2012/13 through 2015/16. However, in 2016/17 and 2017/18, Russian wheat clearly dominated GASC imports, reaching shares of 65 and 81 percent, respectively.

Figure 3: Origin country shares in GASC wheat imports, 2005/06 to 2017/18



Note: Seasonal imports are aggregated based on the tender date, not the delivery date. ROW denotes 'Rest of World' and includes Argentina, Australia, Canada, Germany, Kazakhstan and Poland in this period.
Source: USDA 2018.

5.1.2 Seller-side concentration within GASC tenders

The GASC has closed transaction deals with between 16 and 22 trading companies per season between 2008/09 and 2017/18. Louis Dreyfus Company (10.3%), Glencore (8.9%), Venus International (8%), Cargill (7.5%) and Bunge (5.9%) are the five primary companies supplying wheat to the GASC in this time period, sourcing wheat from various countries. Further companies with large importance for GASC tenders are Ameropa (4.9%) and Aston (4.9%) selling wheat originating from Romania and Russia exclusively, respectively. To gain insights into the degree of competition among companies participating in GASC tenders, we calculate straightforward concentration ratios (CR) as well as the Herfindahl-Hirschman Index (HHI) separately for each season.[4] Overall, Table 2 shows that the statistics suggest low to moderate seller-side concentration. The HHI takes the highest values in seasons 2010/11 (0.111) and 2012/13 (0.108). In both seasons, droughts severely diminished wheat crops especially in the Black Sea region. Therefore, the constrained wheat supply resulted in fewer companies submitting offers and thus accounting for larger shares among the GASC's seasonal imports. By contrast, in periods of global excess supply and declining prices like in seasons 2013/14 through 2016/17, the HHI value is lower, ranging between 0.075 and 0.091. Overall, the results suggest rather strong competition among sellers participating in GASC tenders.

[4] The CR4 (CR8) refers to the combined market shares of the top 4 (8) suppliers. The HHI is calculated as the sum of the squared market shares of all companies winning at least one cargo in a GASC tender within the regarding season. An HHI value greater than 0.1 is usually interpreted as sign for low to moderately concentrated markets.

Table 2. Seller concentration within GASC tenders

Season	HHI	CR4	CR8	Total no. of sellers	No. of sellers of Russian wheat
2008/09	0.099	57%	74%	22	14
2009/10	0.088	48%	76%	17	10
2010/11	0.111	57%	87%	18	5
2011/12	0.107	53%	88%	16	12
2012/13	0.108	55%	80%	16	6
2013/14	0.087	46%	77%	17	9
2014/15	0.083	45%	73%	16	9
2015/16	0.091	48%	80%	18	12
2016/17	0.075	42%	65%	22	15

Note: CR4 (CR8) refers to the combined market shares of the top 4 (8) suppliers. Herfindahl-Hirschman Index (HHI) is calculated as the sum of the squared market shares of all companies delivering at least one cargo to the GASC within the regarding season.
Source: Author's calculations.

5.2 Measurement of market integration

5.2.1 Data properties

The Augmented Dickey-Fuller (Dickey and Fuller, 1979) unit root and the Kwiatkowski-Perron-Schmidt-Shin (Kwiatkowski et al., 1992) stationarity tests provide clear evidence on all analyzed price series to be integrated of order one (see Table A1 in the annex for details).
The trace as well as the maximum eigenvalue test statistic of the Johansen procedure confirm the existence of linear cointegration for all price pairs at the 5 percent level of significance (Table 3). Threshold cointegration is not confirmed for price pairs involving wheat prices of Kazakhstan, Russia, Ukraine and Romania by the Hansen and Seo (2002) and the Larsen (2012) test frameworks, respectively. We therefore assume that the four Black Sea export prices are linearly cointegrated with the GASC tender price. Threshold cointegration test results for price pairs involving US-HRW and French wheat prices provide unambiguous evidence for threshold cointegration with one and two thresholds, respectively. This motivates us to estimate TVECM with two and three regimes for the GASC-US-HRW and GASC-France price pairs, respectively. However, regarding the GASC-US-SRW wheat price pair, Hansen and Seo (2002) and Larsen (2012) tests both approve threshold cointegration, indicating that one and two thresholds are equally feasible. We therefore estimate a one threshold as well as a two threshold TVECM. Since the two threshold TVECM gives identical speed of adjustment parameters for the lower and middle regime, we choose the one threshold TVECM as optimal for this price pair (estimation results for the two threshold TVECM are available from the authors upon request).

Table 3. Results of linear and threshold cointegration tests

Price pairs. GASC and	Johansen (1988)			Hansen and Seo (2002)			Larsen (2012)
	Lags	Trace	Max eigenvalue	Specification	Sup-Wald statistic	P value	P value
Kazakhstan	2	**16.74****	13.69*	Intercept	10.30	0.754	0.622
Russia	1	**24.96*****	**22.23*****	No Intercept	8.87	0.585	0.490
Romania	2	**28.55*****	**26.43*****	Intercept	14.33	0.187	0.924
Ukraine	1	**32.56*****	**29.85*****	Intercept	14.80	0.166	0.222
France	1	**16.57****	**14.37****	Intercept	13.36	0.312	**0.017****
US-HRW	2	**25.36*****	**23.35*****	No intercept	**13.91***	**0.072**	0.553
US-SRW	1	**17.64****	**15.27****	Intercept	**17.80****	**0.033**	**0.049****

Note: Sample runs from July 2011 to December 2017 (78 obs). Johansen test statistics refer to no cointegration equation under the null against one cointegration relationship under the alternative. Johansen test is specified using an intercept in the cointegration equation as well as in the test VAR. P-values for Johansen test are from MacKinnon et al. (1999). Null hypothesis for Hansen and Seo (Larsen) test is linear cointegration against one (two) threshold cointegration under the alternative. For both tests, 5000 bootstraps are used. The lag length is set to one if not indicated otherwise. ***, **, * denotes rejection of the null hypothesis at 1, 5, 10 percent level of significance.
Source: Author's estimations.

5.2.2 Long-run price equilibrium

Results of the VECM and TVECM parameter estimates indicate that wheat prices in Ukraine and Russia are most strongly integrated with the GASC tender price with the long-run price transmission elasticity amounting to 0.98 and 0.94, respectively (Table 4). Thus, if the GASC tender price changes by 10 percent, wheat prices in Ukraine and Russia change by 9.8 and 9.4 percent, respectively. Price changes are thus transmitted in almost complete magnitude. Price pairs involving wheat prices from the USA, France and Romania show long-run price elasticities of 0.91, 0.89 and 0.88, respectively. Significantly lower integration is observed for wheat prices in Kazakhstan with the long-run price elasticity amounting to 0.82. The size of the intercept parameter, which we interpret as a proxy for trade costs, is highest for Kazakhstan and lowest for Ukraine and Russia, and thus corresponds to empirically observed transportation costs (see also Table A3 in the annex).

5.2.3 Speed of adjustment

The estimated speed of adjustment parameters retrieved from the linear VECM for the price pairs including wheat prices for Kazakhstan, Romania, Russia and Ukraine clearly show that the four Black Sea export prices adjust towards the GASC tender price to restore the long-run price equilibrium. Reversely, we find the estimated speed of adjustment parameter of the GASC tender price not statistically significant for these four price pairs, suggesting that the GASC tender price does not adjust to any of the four Black Sea wheat export prices. The speed of adjustment is highest for Romania, followed by Russia and Ukraine as 57, 51 and 52 percent of deviations from the GASC tender price are corrected within one period, respectively. As expected, this value is significantly lower for the Kazakhstan-GASC price pair, reflecting Kazakhstan's remote geographical position.

Table 4. Estimated Parameters of VECM and TVECM, GASC tender and major export prices

Specification		Long-run price equilibrium		VECM / TVECM			
Price pairs	Lag order Linear VECM	Price transmission elasticity (β)	Intercept (α)	Speed of adjustment (γ) GASC	 Exporter		
Kazakhstan - GASC[a]	1	**0.82**	0.98	-0.05	**-0.15*** **		
GASC - Romania	1	**0.88**	0.83	0.07	**0.57*** **		
GASC - Russia	0	**0.94**	0.33	0.12	**0.51*** **		
GASC - Ukraine	0	**0.98**	0.14	0.08	**0.52*** **		
	TVECM with 1 threshold			**Adjustment in lower / upper regime**		**Threshold**	**No. of obsv. in lower / upper regimes**
GASC - US-HRW	1	**0.91**	0.47	Lower: -0.10 Upper: 0.10	**Lower: 0.23**** **Upper: 0.51*** **	**0.081**	**67 / 9**
GASC - US-SRW	1	**0.91**	0.58	Lower: -0.07 Upper: -0.07	**Lower: 0.21*** **Upper: 0.39*** **	**0.081**	**69 / 7**
	TVECM with 2 thresholds			**Adjustment in lower / middle / upper regime**		**Thresholds**	**No. of obsv. in lower / middle / upper regimes**
GASC - France	1	**0.89**	0.67	Lower: -0.11 **Middle: -0.46**** Upper: -0.11	**Lower: 0.28*** ** Middle: -0.24 **Upper: 0.28*** **	**-0.036 / 0.054**	**17 / 50 / 9**

Note: All estimations based on sample period ranging from July 2011 to December 2017. Regarding the GASC-Romania price pair, sample only ranges up to June 2017. If denoted with [a], the dependent variable in the cointegration equation is P^{exp}. Otherwise, P^{gasc} is dependent variable. Lag order is chosen maximising the AIC. No autocorrelation in the model residuals up to 12th lag. ***, ** and * indicate rejection of null hypotheses at the 1, 5 and 10 percent significance level.
Source: Author's estimation.

Similarly, results of the TVECM with one threshold indicate that if prices are in a disequilibrium, the US-HRW and the US-SRW wheat prices adjust to the GASC tender price but not vice versa. For both wheat price series, the speed of adjustment parameter is relatively small in the lower regime. In particular, the HRW and SRW prices corrects 23 and 21 percent of the deviation from the GASC tender price within one period. In the upper regime, the speed of adjustment substantially increases to 51 and 39 percent, respectively. However, as the upper regimes contain only 9 and 7 observations, as compared to 67 and 69 observations in the lower regimes, respectively, we can state that the adjustment of US prices towards GASC tender is usually more than 50 percent lower compared to RRU export prices (23 and 21 percent versus 57, 51 and 52 percent).

By contrast, results of the two threshold TVECM for the GASC-France price pair indicate that the GASC tender price adjusts towards the French export price in the middle regime as 46 percent of a deviation from the price equilibrium are corrected within one period. However, the direction of adjustment reverses in the upper and lower regime, containing 17 and 9 observations, respectively. French prices correct 28 percent of a deviation once it exceeds the upper or lower threshold, respectively. Yet, since 50 out of 78 observations are attributed to the middle regime, we conclude that the GASC tender price in general adjusts to the French export price.

Relationships between GASC tender and export prices were also investigated using straightforward bivariate Granger causality (GC) tests (Granger, 1969). GC tests confirm the findings of the VECM if price relations are linear, like in case of the GASC-Black Sea price pairs. However, GC test results deviate from the finding of the VECM if more complex, non-linear price relationships are considered (Grosche, 2014). This is in particular the case for the GASC-France and GASC-US price pairs. GC test results are presented in table A2 in the annex.

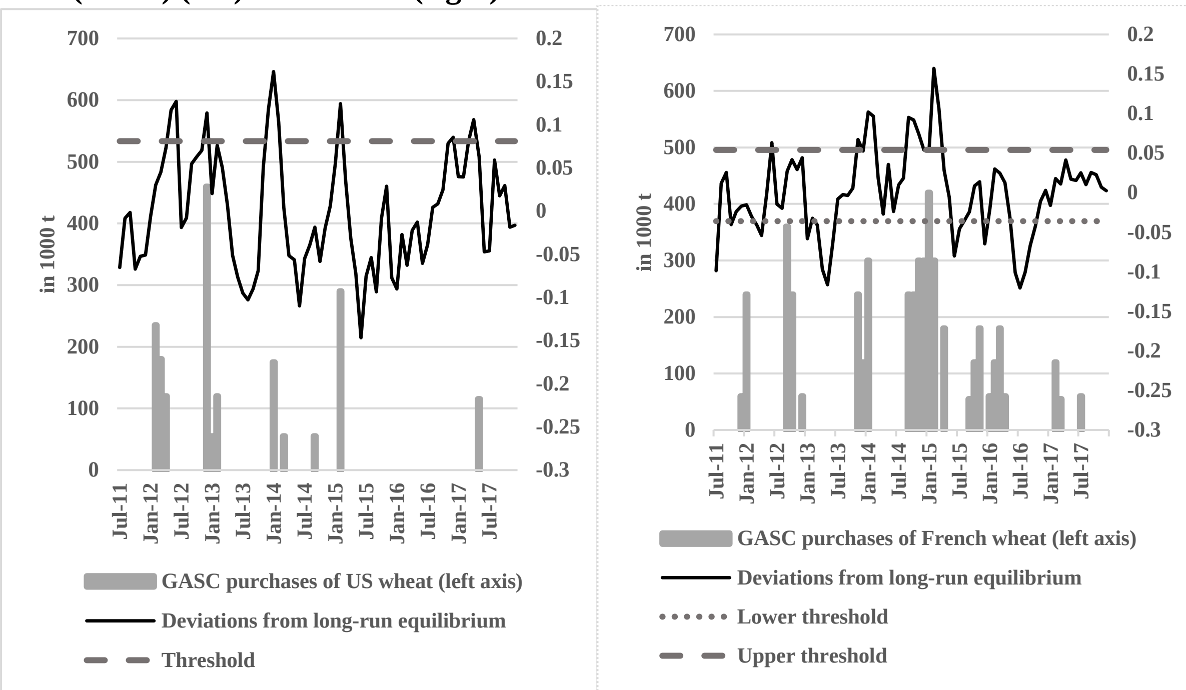
5.2.4 TVECM regime classification and trade flows

To further illustrate the model estimation results for the GASC-US-HRW and GASC-France price pairs, we link the identified model regimes with empirically observed trade flows. Figure 4 displays the residuals retrieved from the long-run price equilibrium equation, i.e. the error correction term, as well as the estimated thresholds and the quantities of wheat imported by the GASC per month from the USA (Figure 4 left) and France (Figure 4 right), respectively.

Figure 4 shows that the GASC imports of US wheat regularly coincide with deviations from the price equilibrium exceeding the threshold value (dashed line). This corresponds to a switch to the upper regime. The US-HRW price is then substantially lower than the GASC tender price which is particularly observable in December through February, when frosty temperatures restrain grain exports from the Black Sea region (see 2012 through 2015). Conversely, GASC purchases of US wheat are rare in the lower regime when price deviations do not exceed the threshold. This trade pattern also corresponds to the observed error correction behavior. The US-HRW price adjusts to the GASC price at a substantially higher speed in the upper regime when trading volumes are larger and higher demand from Egypt thus causes US-HRW prices to rise towards GASC tender prices. In the lower regime, when exports to Egypt are relatively rare, the speed of adjustment parameter takes a significantly smaller value.

Similarly, Figure 4 (right) shows that the GASC purchases large quantities of French wheat when deviations from the price equilibrium exceed the upper threshold and the upper regime prevails (as observed in seasons 2013/14 and 2014/15, see also Figure 5 below). This is also reflected in exporters' share in the GASC's wheat purchases in the different regimes of the GASC-France TVECM (Table 5).

Figure 4. TVECM regime classification and GASC purchases of wheat originating in the USA (HRW) (left) and France (right).



Note: Threshold for US-HRW (left figure) is 0.081. Thresholds for France (right figure) are 0.054 (upper) and -0.036 (lower). GASC purchases of French/US wheat refer to respective left y-axes.
Source: Author's illustrations.

Especially, the French export price is substantially lower than the GASC import price in the upper regime implying that with 41 percent an over proportionately large share of the GASC's wheat purchases originate from France in the upper regime, compared to 13 percent in the total period (Table 5).

Table 5. Export country shares in GASC tenders in the three regimes of the TVECM for the GASC-France price pair

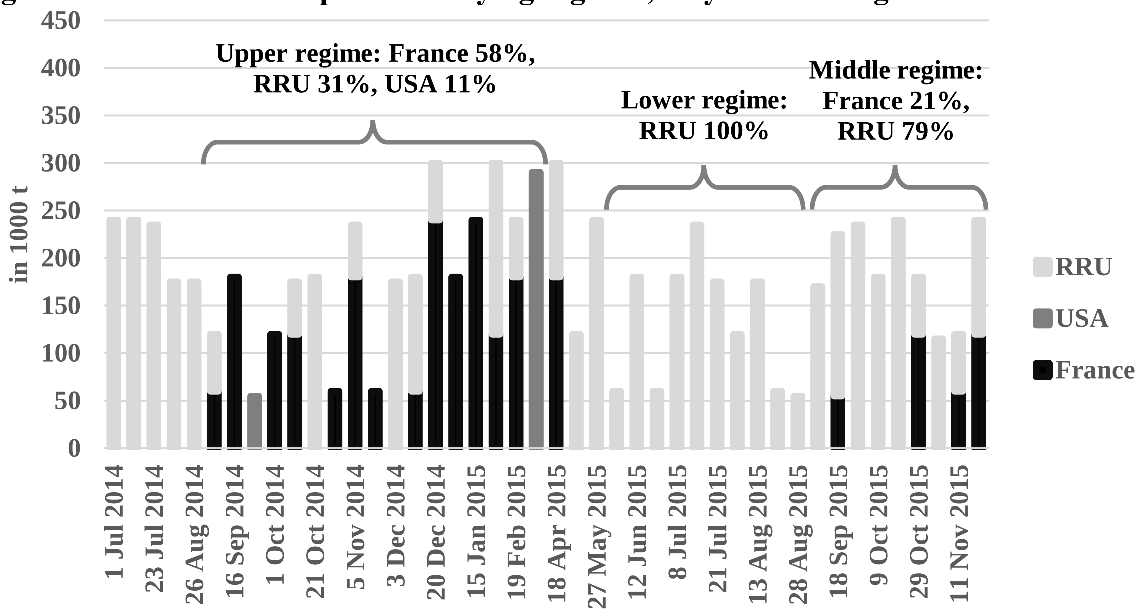
	France	Black Sea Exporters	USA	ROW	Total
Upper regime (9 obs.)	1.62 mt (41%)	1.78 mt (45%)	0.52 mt (13%)	0 mt (0%)	3.92 mt
Middle regime (50 obs.)	2.99 mt (12%)	20.93 mt (82%)	0.99 mt (4%)	0.60 mt (2%)	25.50 mt
Lower regime (17 obs.)	0 mt (0%)	3.89 mt (86%)	0.36 mt (8%)	0.30 mt (7%)	4.55 mt
Total period (78 obs.)	4.61 mt (13%)	26.60 mt (79%)	1.86 mt (5%)	0.90 mt (4%)	33.97 mt

Note: 'mt' denotes million tons. Numbers represent the sum of monthly GASC imports from the respective countries during the three regimes. Black Sea exporters include Romania, Russia and Ukraine. ROW denotes rest of world and includes Argentina, Canada, Kazakhstan and Poland.
Source: USDA 2018.

In the middle regime, 82 percent of GASC imports are sourced from Black Sea exporters while the GASC buys French wheat rather occasionally. Yet, the GASC tender price adjusts to the French export price in the middle regime. Obviously, successful tender offers submitted by exporters of Black Sea wheat are priced in reference to potentially competing French offers. This results in a strong error correcting behavior of the GASC tender price towards the French price in the middle regime.[5] We interpret these price relationships as evidence for price competition between the Black Sea exporters and France in the middle regime.

In the lower regime, 86 percent of GASC wheat purchases originate from the Black Sea region while imports from France are not recorded. Figure 4 (right) shows that this regime frequently prevails at the beginning of a harvesting season when newly harvested wheat is priced especially competitively by exporters from the Black Sea region due to insufficient storage facilities (see June through August 2011, 2013, 2015 and 2016). Due to quality and freight differences, French FOB export prices have to be quoted at least 4 USD/t below Black Sea FOB export prices to be competitive versus Black Sea FOB export prices in a GASC tender.[6] However, in the lower regime the level of French export prices is similar or above competing Black Sea prices (see also Figure 2), explaining why France is not among the successful tenderers in this regime, while the share of Black Sea exporters amounts to 86%. To regain competitiveness and to defend market shares versus Black Sea exporters French prices adjust to GASC tender prices in the lower regime periods. These findings are also reflected in Figure 5 which presents the regime classification and the countries of origin regarding each GASC tender between July 2014 and November 2015.

Figure 5. GASC wheat imports in varying regimes, July 2014 through November 2015.



Note: Each bar represents quantities purchased in one specific GASC tender. Regimes refer to thresholds obtained from the estimated two-threshold-VECM using GASC tender prices and French export prices. Source: Author's illustrations.

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[5] We estimated additional linear VECM to investigate direct price relations between Russian and French (US) FOB export prices. Results are presented in Table A4 in the annex. Russian export prices are found to adjust to French as well as US prices. 38 and 26 percent of deviations from long-run equilibria with French and US prices are corrected within one period. This additionally underlines the importance of French export prices for the formation of Russian wheat prices.

[6] Observed freight costs to transport a 60.000 mt wheat cargo from France, USA and Russia to Egypt amount to around 16, 28 and 11 USD/t in the chosen sample period on average (Table A3 in the annex presents average freight costs paid by the GASC for each season and origin). Thus, US FOB export prices have to be around 18 USD/t lower than Russian FOB prices to be competitive in a GASC tender.

6. CONCLUSIONS

This study has utilized a unique data set on the GASC wheat tender transactions. It identified characteristics of Egypt's wheat tender market and investigated the integration of the GASC tender price in world wheat markets in the Black Sea region (Russia, Ukraine, Romania and Kazakhstan) as well as France and the USA.

We find that wheat imports by the GASC are increasingly dominated by the Black Sea exporters RRU, which have replaced the USA since 2006/7. In the last years, Russia has advanced to the primary wheat supplier to the GASC. Although the number of countries engaged in the GASC tender market is rather limited, the number of trading companies is relatively high, varying between 16 and 22 per season. This is underlined by the HHI index, confirming rather strong competition among trading companies participating in GASC tenders.

We find the GASC tender price linearly cointegrated with the FOB prices of all Black Sea exporters and threshold cointegrated with FOB wheat prices of France and the USA. For all investigated price pairs the long-run price transmission elasticity is relatively high, but it is highest for the GASC-Russia and GASC-Ukraine price pairs indicating almost perfect price transmission in the long-run.

Regarding the direction of price adjustments, our results suggest that prices of all Black Sea exporters and also the USA adjust towards the GASC tender price to correct deviations from the price equilibrium. However, the GASC tender price does not exhibit statistically significant error-correction behavior to any of the four Black Sea export countries nor the USA. This result is surprising since it does not support the findings of Minot (2011) and Zorya et al. (2015) among others, that import prices adjust to export prices if wheat markets are considered. The results for the Black Sea exporters are confirmed by the Granger-causality tests.

The GASC tender price shows statistically significant error-correction behavior only towards French FOB prices. This adjustment behavior is observed in the situation when the GASC primarily (over 80 percent) sources its wheat from Black Sea exporters, yet also purchases smaller quantities from France, corresponding to the middle regime in the GASC-France TVECM, to which about 65% of observations are attributed.

Obviously, successful tender offers submitted by the Black Sea exporters are priced in reference to potentially competing French offers. This results in a strong error correcting behavior of the GASC tender price towards the French price in the middle regime. We interpret this as evidence for strong price competition between the Black Sea exporters and France which is induced by the GASC's tender system.

Results further suggest that the Black Sea exporters RRU adjust to the GASC tender price with the highest speed amounting to between 0.51 to 0.57, while the USA prices usually adjust at a speed which is by more than 50 percent lower, amounting to between 0.21 and 0.23. This is in line with the large trade flows observed between the RRU and the GASC, while trading companies are only rarely successful selling US wheat in GASC tenders in recent years. The GASC adjusts to the French price at a speed of 0.46 which is s almost as high as the speed observed for the RRU.

As a conclusion, this study has made evident that the GASC tender price has a strong influence on the price formation in the Black Sea wheat market. Given the observed price adjusting behavior, the GASC tender price, which corresponds to a CIF import price, can be interpreted to have the function of a world market price in the Black Sea region.

This may be traced back to the GASC wheat tender system, which –as was shown in this paper – successfully creates strong competition between Black Sea and French trading companies in GASC tenders. In addition, the GASC tender system enhances transparency about competitive prices from the rather opaque Black Sea wheat markets. While an effective price discovery mechanism based on well-functioning futures markets is still missing for the Black Sea region, the regularly issued GASC tenders resemble a public noticeboard providing reliable information about competitive price offers from traders selling wheat from the world's new top exporting region. Therefore, tender prices – for now – may serve as a benchmark against which other traders in the region and beyond can place their bids and offers. In future research the factors underlying the large importance of the GASC tender price should be explored, for example by comparison with Japan's wheat tender system.

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Annex

Table A1. Results of ADF unit root and KPSS stationarity tests

	ADF test				**KPSS test**			
	Intercept		Intercept and trend		Intercept		Intercept and trend	
	Lags	Test statistic	Lags	Test statistic	Lags	LM-statistic	Lags	LM-statistic
				Series in levels				
GASC	0	-1.546	0	-2.149	6	**0.944*** **	6	0.129*
Kazakhstan	1	-2.232	1	-2.646	6	**0.542** **	6	**0.149** **
Romania	1	-1.947	1	**-3.728** **	6	**0.960*** **	5	0.130*
Russia	0	-1.664	0	-2.062	6	**0.906*** **	6	**0.148** **
Ukraine	0	-1.585	1	-2.400	6	**0.928*** **	6	**0.152** **
France	0	-1.516	1	-2.381	6	**1.012*** **	6	0.132*
US-HRW	0	-1.191	0	-1.995	6	**1.006*** **	6	**0.153** **
US-SRW	0	-1.106	0	-2.663	6	**1.053*** **	6	0.132*
				Series in first differences				
GASC	0	**-9.307*** **	**0**	**-9.265*** **	4	0.064	4	0.058
Kazakhstan	0	**-5.228*** **	**0**	**-5.194*** **	4	0.055	4	0.057
Romania	0	**-6.395*** **	**0**	**-6.352*** **	5	0.063	5	0.053
Russia	0	**-7.985*** **	**0**	**-7.957*** **	3	0.073	3	0.065
Ukraine	0	**-7.241*** **	**0**	**-7.215*** **	3	0.075	3	0.067
France	0	**-7.088*** **	**0**	**-7-075*** **	2	0.088	2	0.064
US-HRW	0	**-8.287*** **	**0**	**-8.231*** **	8	0.103	9	0.106
US-SRW	0	**-8.245*** **	**0**	**-8.190*** **	7	0.073	7	0.063

Note: All time series in natural logarithm form. Sample period from July 11 to December 2017. H0 for ADF and PP tests is unit root. H0 for KPSS is stationarity. ***, ** and * denote rejection of the H0 at the 1, 5 and 10 percent level of significance, respectively. 5 percent critical values are -2.899 (with intercept) and -3468 (with intercept and trend) for ADF tests and 0.463 (intercept) and 0.146 (intercept and trend for KPSS tests. P-values for ADF tests are from MacKinnon (1996). P-values for KPSS test are from Kwiatkowski et al. (1992, table 1). Lag length determined using the Schwarz Information Criterion for ADF and the Newey-West bandwidth method for KPSS tests.
Source: author's calculations.

Table A2. Results of Granger causality/Wald tests (Toda-Yamamoto procedure)

Price pairs. GASC and	H0: GASC price does not Granger-cause export price		H0: Export price does not Granger-cause GASC price	
	χ2 statistic	Degrees of freedom	χ2 statistic	Degrees of freedom
Kazakhstan	0.86	2	0.94	2
Romania	**16.46*** **	2	0.01	2
Russia	**10.15*** **	1	1.63	1
Ukraine	**15.34*** **	1	1.01	1
France	0.03	1	2.37	1
US-HRW	**6.01** **	2	5.80*	2
US-SRW	0.01	1	**6.92*** **	1

Note: ***, ** and * denote one, five and ten percent significance levels. Sample length from July 2011 to December 2017 (78 obs.). χ2 Test statistics are calculated within a VAR framework following the procedure proposed by Toda and Yamamoto (1995).

Source: author's calculations.

Table A3. Seasonal average freight costs paid in GASC tenders in USD/t.

	Romania	Russia	Ukraine	France	USA
2011/12	16	16	16	18	27
2012/13	11	11	14	15	29
2013/14	13	13	15	22	36
2014/15	10	10	14	15	30
2015/16	7	9	12	11	
2016/17	10	11	13	14	22

Note: Freight prices refer to panamax vessels transporting cargos of 60.000 mt from respective ports to Egypt. Numbers reflect the average freight rates the GASC paid in the respective season.

Source: USDA (2018).

Table A4. Results of linear VECM estimations, Russia and major exporters

Specifications			Cointegration Equation		Error Correction Models
Price pairs Russia and	**VECM order**	**Sample**	**Price transmission elasticity (β)**	**Intercept (α)**	**Speeds of adjustment (γ)**
France	0	Jul-2011 – Dec-2018	**0.95** (0.07)	0.29	**γrus = -0.38***** γfra = -0.10
US-HRW	1	Jul-2011 – Dec-2018	**1.01** (0.08)	0.16	**γrus = -0.26***** γhrw = 0.14*
US-SRW	1	Jul-2011 – Dec-2018	**1.01** (0.09)	0.00	**γrus = -0.26***** γsrw = 0.07

Note: Standard errors in parentheses. ***, ** and * denote one, five and ten percent significance levels. Lag length is chosen maximizing the AIC.

Source: author's calculations.