Food price fluctuations in Uzbekistan: Evidences from local markets in 2002-2010

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Abstract

This study identifies the main determinants of fluctuations of wheat, rice and beef prices in Uzbekistan. Our investigation is based on 2002-2010 weekly data from local markets in the Khorezm province. We applied autoregressive integrated moving average (ARIMA) models with exogenous variables such as water inflow, oil prices, market exchange rate and international prices of imported commodities. The results show that the price fluctuations are more sensitive to respective international prices, market exchange rate and oil prices. For reducing the price fluctuations, the creation and development of storage capacities and processing facilities require more emphasis in national policies.

Keywords

Price analysis, ARIMA models with exogenous variables, Price volatility, World-price transmission.

1 Introduction

Uzbekistan is among the most rapidly expanding economies among the countries of the Commonwealth of Independent States, and is expected to grow by more than 8% in 2012 (World Bank, 2011). However, one of the major economic challenges facing the country is the mitigation of the effects of rising food prices. Rural households, which are predominantly poor with limited access to natural resources and assets (Robinson, 2008), are particularly vulnerable to the common seasonal and inter-annual price fluctuations. A similar situation applies for Uzbekistan (Musaev et al., 2010). The rural households in Uzbekistan are net buyers of food products, particularly of wheat, which has the largest contribution to their energy intake. After 1991, wheat, formerly imported from other regions of the Soviet Union, gained increasing importance for the state and producers, and has become a strategic crop to satisfy domestic food needs (Kienzler et al., 2011). However, the annual wheat production of an average household in Khorezm can cover only around 30% of its annual consumption requirements (Djanibekov, 2008). As household income depends to a large extent on agricultural production and also as the largest share of the budget is spent on food consumption (WFP, 2008; Musaev et al., 2010), price fluctuations will have a strong effect on the level of both production and consumption, and thus on the households' overall welfare. The rise and volatility in food prices may result in a negative net-income effect for these households, particularly for those without access to land and those who depend on off-farm activities and employment (von Braun and Tadesse, 2012).

The general underlying causes of food price fluctuations are structural, environmental and global in nature (von Braun and Tadesse, 2012). The transmission of the effects of world commodity prices to the country level depends on several policy-related factors such as taxes, price controls and subsidies, and on the openness of the economy of the country. In transition countries practicing food self-sufficiency policies, which are indicated by the proportion of food imports to total consumption such as in Uzbekistan, the effects of local factors on price formation are high. Up to now, there have been only few studies in Uzbekistan on food price variability and its determinants at the local level. Such information is, however, required for understanding the household welfare impacts. A few studies are worth mentioning in this

context. Bobojonov and Lamers (2008), for instance, present a statistical analysis of commodity prices in the Khorezm province using market survey data of 23 months. A World Food Programme (WFP) study presents a comparative analysis of poverty rates and factors determining food insecurity in different provinces of Uzbekistan (Robinson, 2008). The UNDP analysis of food security in Uzbekistan (Musaev et al., 2010) presents an assessment of the food supply and demand. This study draws on official statistics and comprehensive household survey data from the World Bank's Uzbekistan Regional Panel Survey (URPS) of 2006 for three provinces in Uzbekistan. Although quite informative with respect to food security concerns, these studies do not address price movements of food commodities, which is a major issue for livelihoods of rural people that accounts for the largest share of the poor. This study attempts to fill this gap by looking into nine years of price movements of agricultural goods at the local market level of Uzbekistan using the example of the Khorezm province. Khorezm is home to about 1.7 million people, of whom 78% are rural (OblStat, 2007). The province has around 270,000 ha of land suitable for irrigated agricultural production using the water inflow from the Amudarya River (Conrad et al., 2012). This river is the most important water source for agriculture in Khorezm, and usually supplies a sufficient amount of water to satisfy the provincial demand. Yet during the last thirty years, Khorezm has experienced frequent water shortages during the vegetation period (March-October), which have affected agricultural production and rural livelihoods.

The multi-year data allowed examination of seasonal and inter-annual price movements and determination of the influencing factors based on data from an agricultural commodity market in Khorezm. The selection of the determinants of commodity price fluctuations is based on the classical supply-demand theory, results from empirical studies, and data availability. Essentially, price determination depends on the interaction between supply and demand functions on markets. The basic model typically explains market equilibrium as an adjustment process between demand, supply, inventory and price variables (Labys, 1973; 1999). The most comprehensive analytical methods for commodity markets stem from structural models, which trace the interaction between endogenous market variables and exogenous variables and explain market behavior and performance (Labys, 1973; 2006). One advantage of these models is that with the incorporation of more variables the market model can be extended, thus providing a consistent framework for forecasting price movements and studying the effects of policies.

Supply-demand shifters can include both market-specific and broader macroeconomic factors. Supply shifters can be categorized into two main groups (Tomek and Robinson, 2003): short-run and long-run shifters. Water constraints are treated as a short-run change in output. As water is one of the most critical inputs in farming in Uzbekistan, shortages may decrease crop yields and/or lead to a decrease in sown area. Medium-run supply shifters can be attributable to changes in input prices (crude oil, fertilizer, pesticides), which are directly connected to production costs and to changes in prices of commodities competing for the same resource. In addition, as identified by several empirical studies, macroeconomic factors might also play an important role in crop-price determination, such as exchange rate, inflation and interest rates (Roache, 2010) over different time horizons. Demand shifters can be grouped according to demographic factors such as population size, population distribution by age, ethnicity, etc., economic factors such as income and its distribution, prices and availability of substitutes, and consumer preferences. The latter can be influenced by educational level, life experiences, information and social context (Tomek and Robinson, 2003). In this study, the explanatory variables were divided in two main categories according to the type of shifter (market or macroeconomic factors) and spatial influence (regional or international level). We chose water inflow, oil prices and international prices of selected

commodities imported to Uzbekistan such as rice and wheat as market shifters, while the exchange rate was the only macroeconomic factor included as a regressor.

2 Materials and Methods

The main data used for the analysis originate from the 2002-2010 market survey conducted by the ZEF/UNESCO Khorezm project on a weekly basis for the key food products at Khorezm's most important agricultural markets in Urgench (Martius et al., 2012). The Urgench and Khiva universal/dekhqan markets are the central agricultural markets and among the biggest in Khorezm. The data included product prices, number of sellers, and amount of food products brought and sold at both markets. The market survey covered 12 products, i.e., grains (wheat, rice and maize), fruits (apples, melons), vegetables (potatoes, carrots, onions and tomatoes), and animal products (eggs, sour cream, and beef). A weekly quantitative survey was conducted from May 2002 to May 2010 and constituted in total 97 uninterrupted monthly time-series observations for each commodity. The survey data thus included a drought year that occurred in 2008, and also price movements after the 2000 and 2001 drought years. This allowed analysis of the relationship between variability of water supply in Khorezm and commodity prices. Prices were recorded in Uzbek soums (UZS) per kg. Complementary quantitative questionnaires were completed using face-to-face interviews with market sellers on the same day as that of the price survey (every Sunday).

As a special case, the domestic prices for rice and wheat were analyzed based on their world market counterparts (Figures 1 and 2). Estimated were also their annual volatility indicated by the coefficient of variation[1] as well as the monthly price increases[2] over time.

Irrigation water intake for Khorezm at the provincial level was used as a proxy for water availability. The data were obtained from the Portal of Knowledge for Water and Environmental Issues in Central Asia (CAWATERinfo) and Interstate Commission for Water Coordination (ICWC). The world oil prices were obtained from the International Monetary

Fund (IMF). The international oil price is a simple average of three international spot prices (Dated Brent, West Texas Intermediate, and the Dubai Fateh), and is expressed in US dollars (USD) per barrel of crude oil (petroleum). World prices of rice and wheat (both in USD) were obtained from the database of the Food and Agriculture Organization of the United Nations (FAO). The world price of rice represents the monthly average of weekly prices for White Broken Rice, Thai A1 Super, FOB Bangkok, as reported by Jackson Son & Co. (London) Ltd on Wednesday of each week, while the world price of wheat is that of wheat No.1 Hard Red Winter, ordinary protein, FOB Gulf of Mexico, reported by the International Grain Council on Thursday of each week. Since indexes on monthly food prices were not available for Uzbekistan, all nominal prices were deflated using annual price indexes from the Asian Development Bank (ADB) and the IMF.

Given the data restrictions on the exogenous variables used to run the regression, only four variables could be used. These variables mainly represent supply shifters. The mechanisms by which the selected exogenous variables might affect agricultural domestic prices on the Urgench market are summarized in Table 1.

In the framework of Autoregressive integrated moving average (ARIMA) with exogenous variables, the effects of selected determinants on commodity price behavior were analyzed The Box-Jenkins methodology refers to the set of procedures for identifying, fitting,

[1] The coefficient of variation (CV) is a measure of dispersion defined as the ratio of the standard deviation and the mean. We also estimated CVs for two periods: 2002-2006 and 2007-2009. The latter period might include effects of food crisis and water variability.

[2] The monthly price increase is defined as the monthly percentage change in prices.

and checking ARIMA models with time-series data. The models were run using STATA software.

Table 1. Explanatory variables included in regression models for market analysis.

Variable	Type	Mechanism
Water inflow	Supply factor	Proxy of water availability. In this context, this variable might affect prices via expectations and thus storage.
International real rice price	Supply factor	Transmission via imports
International real wheat price	Supply factor	Transmission via imports
International real crude oil price	Supply factor	Via production costs.
Exchange rate	Macroeconomic factor	Can affect prices through a number of channels, including purchasing power and the effect on margins of producers with non-USD costs

Before running the regression models, it is necessary to test the existence of stationarity. If the variables in the regression model are not stationary, the usual t-ratios will not follow a t-distribution, so it will not be possible to validly undertake hypothesis tests about the regression parameters. If a non-stationary process is detected, the variable must be transformed to stabilize the variance of the time series and thus to make it stationary. The augmented Dickey-Fuller test that tests the presence of non-stationarity in the time series was used. The basic objective of this test is to verify the null hypothesis that the series contains a unit root (or it is non-stationary) against the alternative hypothesis that the series is stationary. After testing various transformations, we found that the first difference is a stationary process for almost all of the selected time series.

3 Results and Discussion

The prices of rice, wheat and beef followed an upward trend, with a significant hike during 2007-2008 for rice and wheat (Figures 1 and 2), while the beef price shows gradual increase over the analyzed period. The 2008 hike in rice and wheat prices may be explained by the extreme drought conditions that affected Khorezm during that year and reduced regional production, as well as price transmission effects from international markets.

Rice prices (Figure 1) showed not only an upward trend, but also a distinct increase by a factor of more than 2 from the first quarter of 2006 to the second quarter of 2008. Before 2006, the average monthly price increase was 4.4%, while during 2006 this rate increased to 7.8% and in 2008 to 10.4%. During 2008, rice prices reached the highest peak during the observed period due to factors such as the 2008 drought, increased input prices, as well as price transmission from international rice markets. In fact, the imports of rice (milled) to Uzbekistan increased from 1,162 tons in 2007 to 8,249 tons in 2008 and further to 15,654 tons in 2009 (FAO, 2012). After 2009, prices continued to increase, but at a slower rate (monthly by 4.3%). The coefficient of variation decreased from 0.51 in 2002-2006 to 0.36 in 2007-2009 (Table 2).

Wheat prices (Figure 2) showed an upward trend during the entire period. The increase was quite large by a factor of more than 3 from the first quarter of 2006 to the second quarter

of 2008. Before 2006, the average monthly increase was 2.6%, while during 2006 prices increased monthly by 5% and in 2007 by 8.3%. During 2008, wheat prices were highest. This high price level could be associated with the transmission of the international wheat prices as well the drought in 2008 in Khorezm and in general in Central Asia. After 2009, the wheat prices decreased monthly by 5.1%. The coefficient of variation of wheat price increased from 0.34 in 2002-2006 to 0.38 in 2007-2009.

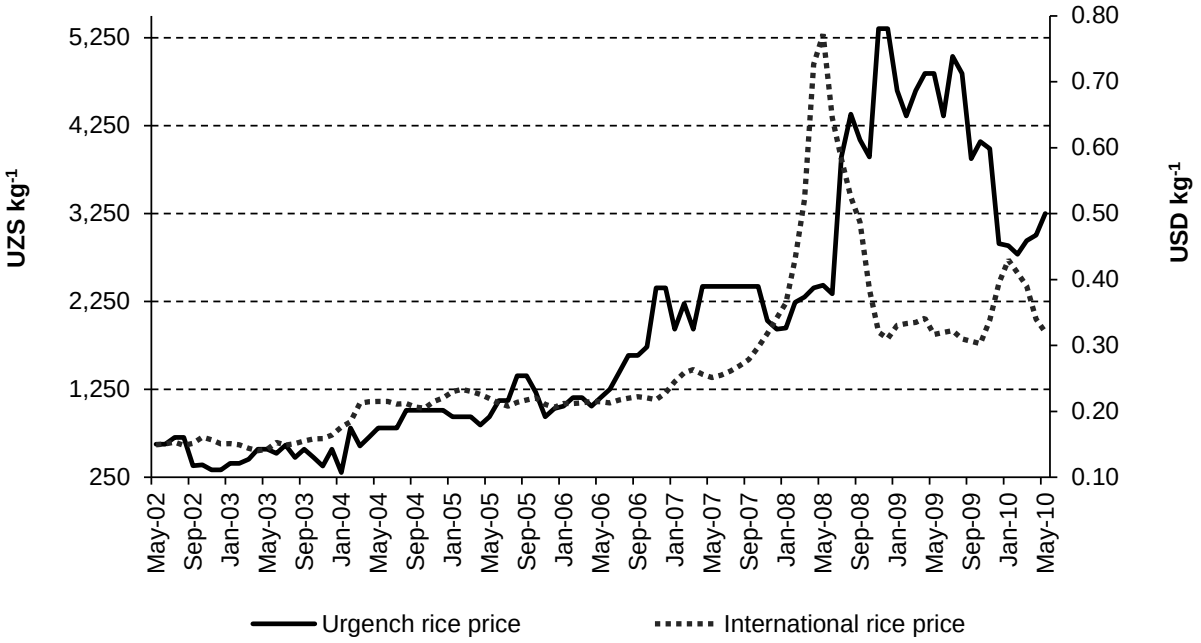

Figure 1. Urgench real rice price (UZS kg^{-1}) and international rice price (USD kg^{-1}) (May 2002 – May 2010).

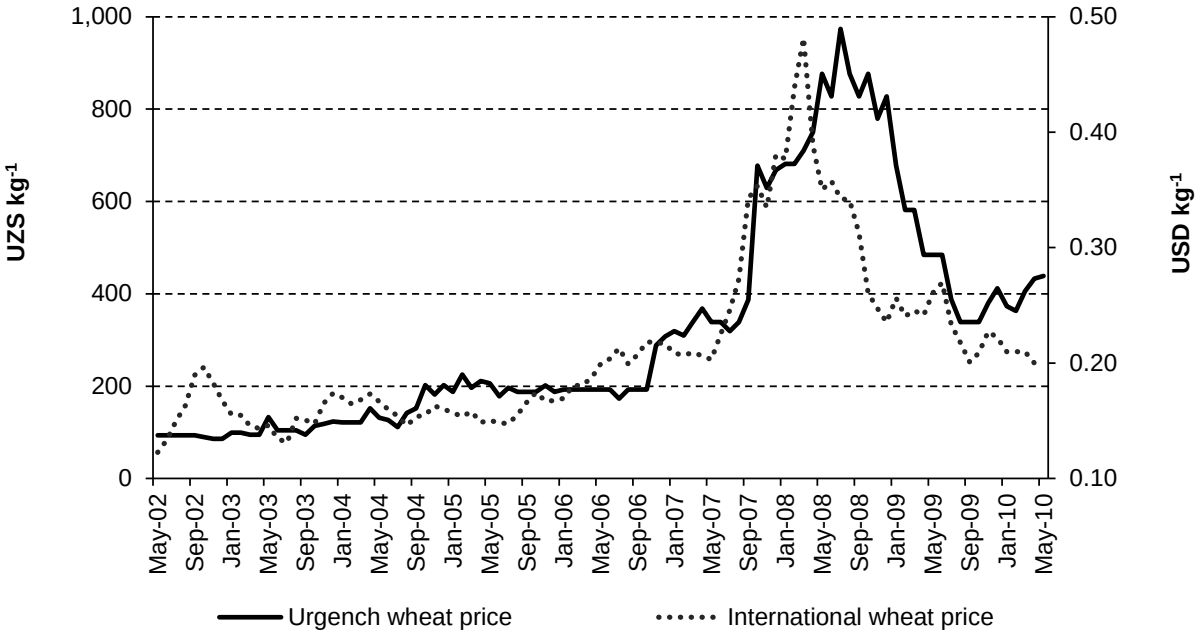

Figure 2. Urgench real wheat price (UZS kg^{-1}) and international wheat price (USD kg^{-1}) (May 2002 – May 2010).

Beef prices also increased during the observed period: from the first quarter of 2006 to the first quarter of 2008, prices increased more than three-fold. After 2009, prices continued to increase, but at lower rates. The coefficient of variation decreased slightly from 0.26 in 2002-2006 to 0.24 in 2007-2009. Comparing the values of the two periods 2002-2006 and 2007-2010, the coefficient of variation of wheat and beef increased, indicating an increase in price volatility in Khorezm. The significant decrease in price variation over the two compared periods (2002-2006 and 2007-2009) is observed for rice (Table 2).

Table 2. Coefficient of price variation for the selected three commodities in the Urgench market during 2002-2009.

Commodity	Year								Period	
	2002	2003	2004	2005	2006	2007	2008	2009	2002-2006	2007-2009
Beef	0.05	0.05	0.10	0.14	0.14	0.16	0.16	0.15	0.26	0.24
Rice	0.32	0.16	0.26	0.18	0.32	0.10	0.36	0.14	0.51	0.36
Wheat	0.04	0.12	0.22	0.07	0.20	0.35	0.11	0.25	0.34	0.38

Increasing price volatility can be partly assigned to the price situation on the world market. This can be particularly true for wheat, which is still imported to Uzbekistan as wheat flour because the baking quality of Uzbek wheat is relatively low when compared to the quality of wheat on the world market. It should, however, be taken into account that, prior to baking, the locally produced (poor quality) wheat flour is mixed with imported flour (WFP, 2008). Hence, even if the quality differs between world market and local wheat, the substitution effect between them is strong. Consequently, the international wheat prices can be included in the analysis in this study. Another reason for the increase in price variability over time, particularly of rice, is the drought that Khorezm experienced in 2008, which reduced yields and the area under rice production, while the period 2002-2005 was more or less stable in terms of water supply. The increase in the inter-annual volatility of beef seems to be associated with the development of the processing sector in Uzbekistan, which increased the demand for this commodity. Another possible reason is that local production of these products remained below the demand. For instance, while a healthy diet as recommended in Uzbekistan requires an annual consumption of 46.1 kg of meat per capita (Musaev et al., 2010), in 2010 per capita food supply quantity of meat was only 29.7 kg (FAO, 2012). This indicates that it is necessary to develop local storage (Bobojonov and Lamers, 2008) and processing facilities, as well as to promote trade with other regions through relaxing trade barriers during the off-season and improving roads.

3.1 Interdependencies and relations

Results from the regression models for rice markets are displayed in Table 3. Four models with different explanatory variables[3] were run. In each model (from 1 to 4), an explanatory variable was added to observe how much it explained price fluctuations in the rice markets. In all four models, rice prices were influenced by an autoregressive process [AR(2)]. However, since rice imports and exports in Uzbekistan are almost negligible (FAO,

[3] Model 1 only estimates the effect of water inflow on rice prices; model 2 estimates the effect of this variable plus the effect of international rice prices, while model 3 includes the effect of the exchange rate. Finally, model 4 estimates the effects of all previous variables (water inflow, international rice prices and exchange rate) plus the impact of crude oil prices on rice prices.

2012), it is surprising that the model results indicate an impact of international market prices of rice on domestic markets at the first lag in all models where this variable was included. Yet Robinson (2008) postulated that up to 23% of the national rice requirements could have been imported to Uzbekistan during the drought year of 2008, partly through unofficial channels. These imports during the drought years could establish a positive transmission across rice prices.

Oil prices also showed a significantly positive effect on rice prices at the first lag (Model 4). There is a strong connection between input costs (such as fertilizers, machinery and freight costs) and output prices in agriculture. Through fertilizers and fuel, oil prices comprise a large percentage of agricultural production costs, particularly in rice production. Consequently, any change in oil prices will be channeled into the agricultural commodity prices through the respective changes in farmers' variable costs.

Exchange rate (USD to UZS) is another variable that shows an immediate, direct and significant impact on rice prices in Khorezm (Models 3 and 4). This variable may impact agricultural commodity prices through a number of channels, including international purchasing power and the effect on margins for producers with non-USD costs (IMF, 2008). Finally, our regression analysis reveals a negative and significant impact of water inflow on rice prices at its third lag in all models. This effect of water shortage might be transmitted to rice markets through farmer's expectations.

Table 3. Regression models for rice.

Variable	Model 1	Model 2	Model 3	Model 4
L1_crude oil				0.485 ***
L3_water inflow	-0.019 ***	-0.019 ***	-0.017 ***	-0.019 ***
L1_international rice price		0.203 ***	0.208 ***	0.214 **
Exchange rate			0.108 **	0.096 **
AR (2)	0.261 ***	0.310 ***	0.387 ***	0.324 ***
R^2	0.269	0.335	0.435	0.668

* 10% of significance

** 5% of significance

*** 1% of significance

Results from the regression models for wheat markets are influenced by an autoregressive process [AR(3)] as well as by exogenous variables (Table 4). In this case, three models were run, and in each model (from 1 to 3) an explanatory variable was added to observe how much

it can explain price fluctuations in wheat markets[4]. International wheat prices had a significantly positive effect on domestic market prices at its first lag (Model 3). As wheat is also imported from other countries as flour, a positive transmission across prices is expected. Similar to the case of rice, oil prices also show a significantly positive effect on wheat price at its first lag (Model 2 and 3). Finally, water inflow has a low but nevertheless significant negative impact on wheat prices at the third lag in all models. This indicates that wheat, which in Uzbekistan is mainly winter wheat, depends less on water variability that is the highest in summer season, but is rather influenced by its world price. Surprisingly, the exchange rate did not show any impact on the wheat prices. This can be explained by the fact that the governmental control over the prices of domestically produced wheat and flour as part of the national food security policy was successful in reducing the impact of exchange rates on wheat prices (Al-Eyd et al., 2012). For instance, in 2008, the grain distributed through the state organization at subsidized prices (USD 500 or less) made up 39% of the total flour sold in Uzbekistan, while imports accounted for 20% (Robinson, 2008).

Table 4. Regression models for wheat prices.

Variable	Model 1	Model 2	Model 3
L1_crude oil		1.537 **	1.523 **
L3_water inflow	-0.041 ***	-0.041 **	-0.033 **
L1_international wheat price			0.593 *
AR (3)	0.195 ***	0.207 **	0.195 **
R^2	0.110	0.379	0.443

* 10% of significance

** 5% of significance

*** 1% of significance

The results from the regression models for the beef markets reveal the influence by an autoregressive–moving-average process [ARMA (2,2)] (Table 5). In this case, two models were run. In each model, an explanatory variable was added to observe how much it can contribute to explain price fluctuations in beef markets[5]. Again, oil price showed a significantly positive effect on beef prices at its first lag, (Model 1 and 2). Rice price also had a positive effect on beef price at its first lag. This positive and significant impact might be explained by the complementary relationship between these two agricultural commodities. For instance, they are both an essential part of a national Uzbek dish (*plov*). Finally, in none of the models do water inflow or wheat prices show a significant impact on beef prices. As livestock is mainly fed on forage such as maize stem and crop by-products such as cotton-

[4] Model 1 only estimates the effect of water inflow on wheat prices; Model 2 estimates the effect of this last variable plus the effect of crude oil prices and Model 3 includes the effect of the international wheat prices on domestic wheat prices.

[5] Model 1 estimates the effect of crude oil prices and rice prices on beef prices, while Model 2 estimates the effect of all these variables plus the effect of water inflow and wheat prices on beef markets.

seed cake and husk (Djanibekov, 2008), it is expected that wheat prices do not play a significant role as a determinant of beef prices in Khorezm.

Table 5. Regression models for beef prices.

Variable	Model 1	Model 2
L1_crude oil	0.163 ***	0.163 ***
L3_water inflow		0.0007
Rice price	0.357 **	0.356 **
Wheat price		0.982
AR (2)	0.445 **	0.440 **
MA (2)	0.356 **	0.353 **
R2	0.345	0.450

* 10% of significance

** 5% of significance

*** 1% of significance

The food consumption will continue to increase due to urbanization, population and income growth thus putting more pressure on water resources and food security (Djanibekov et al., 2013a). The situation can be further exacerbated by the effect of climate change, e.g. increasing frequency of droughts, weather shocks and the shifts in river flow, on agricultural production (Bobojonov et al., 2014). The pressure of water flow on agricultural commodity prices can grow further due to industrialization and urbanization, as well as the growth of upstream hydropower sectors. The policies should thus take into account not only the increasing consumption volumes, but also diet composition, production technologies and practices, climate and water flow variability, as well as institutions that determine water use efficiency at micro- and meso-levels, and the regional policies of transboundary water allocation. The pressure of changes in climate and water supply can be reduced through better agronomic management strategies (Sommer et al. 2013), adjustments of the cotton production policies (Djanibekov et al. 2013b), and greater crop diversification (Bobojonov et al. 2013). The recent program of consolidation of cotton-wheat producing farms can provide a basis for further improved agricultural production as a first step and would require supplementary measures such as the development of storage capacities and processing facilities (Djanibekov et al. 2012).

4 Summary and conclusions

The results of the analysis of market prices can serve as critical information for policymakers. Due to data limitations, the analysis does not consider directly the effect of

grain storage on rice and wheat prices respectively. Moreover, the effects of other variables should be incorporated into the analysis such as relevant input prices as well as institutional factors that reflect the agricultural policies, e.g. the cotton procurement, that may have cross-effects in food commodity markets. In addition, the presented price analysis can be extended to other agricultural commodities for a more comprehensive view on food price's variability in the region.

The fluctuations of rice, beef and wheat prices are more sensitive to external factors such as their respective international prices, currency exchange rate and oil prices. A detailed analysis for these three commodities in Khorezm presents a case of the price transmission between international and local markets in Uzbekistan. The international price transmission of rice and wheat demonstrates that the markets of these products are integrated into world market, and the rising food prices on world markets will have a direct effect on the prices of these products. While rice and wheat prices were strongly connected to world prices, they also depended on the oil price and the currency exchange rate. In the case of wheat, the state program on food security could offset the direct link between exchange rate and wheat price. However, the observed trend of rice prices is also subject to the impact of water shortages as occurred in 2008. That climatic event could have added to the significance of the impact of the international price transmission in 2008 during which rice prices in Uzbekistan boomed. According to the model results, oil prices also had a significant impact on the beef price due to transportation costs. Surprisingly, the prices of rice and beef are positively correlated, which shows their complementarity in the food diets in Khorezm. The policy implication of this inter-commodity price transmittal is that the government of Uzbekistan could focus on, for instance, the price of rice to achieve its price objective also for the price of beef.

The model results show that, despite increasing regional and national production levels, an increasing price variability of wheat and rice is evident. The prices became more volatile, thus reflecting the unstable conditions in domestic supply and demand. These two commodities account for the largest share in the regional agricultural revenues and in the expenditure of consumers, and these price volatilities will thus directly affect both consumers and producers in Khorezm. In addition to international and cross-regional trade within Uzbekistan, regional production patterns certainly influenced the domestic prices during the observed period. From the demand side, the population growth and income-driven changes in consumption diets also contribute to price trends. Hence, future work should take into account effects of local food production and consumption on the domestic prices.

The results of this study are relevant for policy- and decision-making discussions about prices, infrastructure such as storage and roads, as well as about food and trade policies in Uzbekistan. The data analysis reveals that the price increases were transmitted across commodities, in our case rice and beef. This cross-commodity integration implies that development of either trade or storage facilities of one food commodity (e.g., rice) will be beneficial to stabilize the price of other key food commodities (e.g., beef).

There is strong statistical evidence that market prices of the selected commodities have increased since 2002, but also that they have experienced a larger variation within a particular year. This seasonal price movement reveals the necessity to develop storage and processing facilities as well as to develop outside trade through relaxing the trade barriers during the off-season and improving roads.

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