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SPATIAL PRICE TRANSMISSION: EVIDENCES FROM TAJIKISTAN AND UZBEKISTAN

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Spatial price transmission: evidences from Tajikistan and Uzbekistan

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ABSTRACT

This paper examines the extent and speed of price transmission from international to local markets in two transition economies, Tajikistan and Uzbekistan. The two countries have similar economic backgrounds, but a notable difference is that Tajikistan has adopted a more liberal agricultural trade regime than Uzbekistan. We use a vector error correction model to analyse how global agricultural prices are transmitted to domestic food prices in the two countries. The results of our estimation proved the line of expectation on strong evidence of integrated domestic prices of Tajikistan and world prices, while the cointegration of domestic and world prices was only partially proved in case of Uzbekistan. Partial integration of domestic prices and global prices may result to consumer welfare loss and should be the main concern for policy makers.

Keywords: Price transmission; market integration; agricultural trade
JEL classification: E39, F15, P22

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INTRODUCTION

The recent volatility in global food prices has attracted much attention of economists, as well as policy makers who deal with potential welfare effects of food prices on producers, consumers and in particular on the poor and vulnerable households. High food prices raise the cost of food for consumers but increase the income of farmers (Swinnen and Squicciarini, 2012), which belong among relatively poor segments of the society in many countries. Net effects of rising food prices depend on whether households or nations are net sellers or buyers of food items.

Highly integrated markets allow for efficient transmission of price signals across markets and assure efficient allocation of resources. Not integrated markets can convey inaccurate price information, leading to misguided policy decisions and a misallocation of scarce resources (Sexton et al. 1991). Domestic food prices depend on price transmission from world to domestic markets. However, global food prices need not be fully and rapidly transmitted to domestic markets either due to the existence of market imperfections or because of the government policies that attempt to separate world from domestic markets (Rapsomanikis et.al, 2003; Abbott and Battisti, 2011). There are three reasons for a lack of market integration such as imperfect competition, different trade barriers and prohibitive transactions costs (Sexton et al. 1991). Governments in net exporting countries, for example, often use export bans or export taxes to prevent rises of domestic prices when global food prices soar, while similarly net food importing countries might reduce tariffs or subsidize imports in such situations. However, concern arises whether trade liberalization alone is sufficient for markets to be integrated. For example, markets may not be well integrated because of high transaction costs due to poor transportation and communications infrastructure, non-tariff barriers etc. (Alam, Begum, 2012). The pass-through of the price shocks from world to domestic markets can have significant income distributional and welfare implications for farmers and consumers; this makes the issue of price transmission very relevant from the policy-making perspective.

In this paper we study how global agricultural prices are transmitted to domestic prices in two countries of Central Asia, namely Uzbekistan and Tajikistan. Agriculture belongs among the most important sectors in those countries as measured by its share in GDP, employment or trade. On the other hand, households spend significant share of their income on food. For these reasons price transmission significantly affects both consumers and producers in Uzbekistan and Tajikistan. In particular, we study the size, speed, and nature (symmetric and asymmetric) of pass-through of

world agricultural commodity prices to domestic agricultural prices. It is interesting and relevant from policy-making perspective to compare price transmission between Uzbekistan and Tajikistan as these neighboring countries are on a similar level of development but they differ significantly with respect to trade policies. While Uzbekistan relies on strong government involvement in managing international agricultural trade, Tajikistan has adopted more liberal trade policies towards agricultural commodities with limited interventions. Apart from trade policies, the two countries are at similar level with respect to the implementation of other economic reforms. Policy-makers can use our results in order to evaluate the effects of trade policies on domestic agricultural commodity prices and their developments.

In the next chapters, we briefly describe reform process in Uzbekistan and Tajikistan with emphasis on agricultural sector, provide literature review on horizontal price transmission, describe methodology, and state our results. The last chapter summarizes and draws conclusions.

Transition process in Uzbekistan and Tajikistan

Transition process in Uzbekistan and Tajikistan as well as in other Central Asian countries started after the break-up of the Soviet Union when these countries became independent. However, the real transition towards market economy began in Tajikistan only after the end of the civil war in 1998. During the civil war most of the fixed capital and infrastructure, that survived the collapse of Soviet Union, was devastated and the poverty rate reached 86 percent of the population in 1999, which was an increase from 51.2 percent in 1989. After the war, the country liberalized international trade, including agricultural trade, and started to reform other institutions and policies. Uzbekistan did not suffer from the civil wars to such an extent as its Tajik neighbor but the economic situation in the country at the beginning of the transition process was not very bright either. Historically both countries belonged among the least developed republics of the Soviet Union. The poverty headcount ratio in Uzbekistan reached 69 percent in 1998, which was also an increase from 43.6 percent in 1989. Since independence, economic policy of Uzbekistan stressed self-sufficiency, economic independence, and import substitution (Nurmetov et. al., 2015). In agriculture, emphasis was placed on increasing domestic production of grains at the expense of heavy reliance on cotton production.

The key components of agricultural reform in a transition country include privatization and establishment of property rights to land, land market regulations including liberalization of

international trade, and input and output liberalization (Spoor 2004; Rozelle and Swinnen 2004). Table 1 provides the data on the progress of reforms in both countries.

Table 1: The EBRD transition and reforms indicators of Tajikistan and Uzbekistan, 1999 - 2012

	TAJIKISTAN			UZBEKISTAN		
	1999	*2008*	*2012*	*1999*	*2008*	*2012*
Agricultural business	-	-	2	-	-	2
Large-scale privatization	2.33	2.33	2.33	2.67	2.67	2.67
Small-scale privatization	3	4	4	3	3.33	3.33
Enterprise restructuring	1.67	1.67	2	2	1.67	1.67
Price liberalization	3.67	3.67	4	2.67	2.67	2.67
Trade & forex system	2.67	3.33	3	1	2	1.67
Competitive policy	2	1.67	1.67	2	1.67	1.67
Banking reform & interest rate liberalization	1	2.33	-	1.67	1.67	-
Securities markets & non-bank financial institution	1	1	-	2	2	-
Overall infrastructure reform	1	1.33	-	1.33	1.67	-

Source: EBRD – World Bank, 2014 and Pomfret, (2010) *Note:* Indicators are measured on a scale from 1 (no reform) to 4, with pluses and minuses, e.g., 3+ and 3- are represented by 3.33 and 2.67

The table 1 shows that both Uzbekistan and Tajikistan made relatively small progress in economic reforms. Notable difference between the countries is in price and trade and for exchange market liberalization where Tajikistan is significantly more reformed and opened to world markets than Uzbekistan.

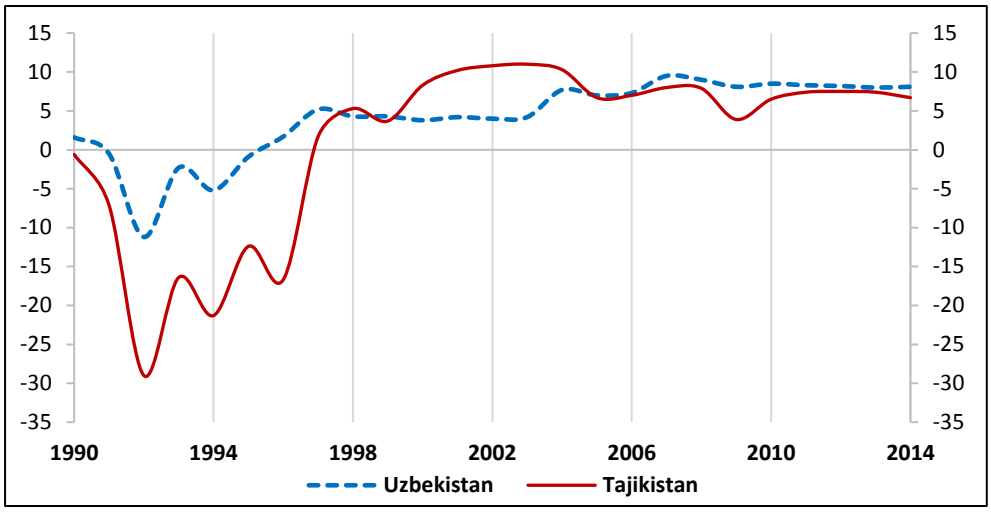
Macroeconomic performances of Tajikistan and Uzbekistan

After the collapse of the Soviet Union both Tajikistan (1991-1998) and Uzbekistan (1991-1995) experienced declines in total aggregate output, reduction in living standards, increased economic uncertainty, and growing income inequality and poverty. The change from decline to growth occurred in 1995 in Uzbekistan and in 1998 for Tajikistan. Since then, we observe improvements in economic indicators in both countries. In the period between 2000 and 2013, Uzbekistan reported 7 percent average annual growth of GDP while Tajik average growth of GDP for that period reached even higher 8 percent per year (see Figure 1).

High economic growth rates in that period are closely related to positive development of global commodity prices, in particular to prices of oil, natural gas, cotton, gold, and aluminum of which these countries are exporters. Moreover, economies of Uzbekistan and Tajikistan benefited from

increased inflow of remittances as well. In both countries, there are critical demographic pressures stemming from population growth. Significant population growth combined with inefficient labor markets consequently led to mass out-migration of labor especially to Russia or Kazakhstan. Actually, Tajikistan has become the most dependent nation in the world on remittance inflows. Money transferred by out-migrants back to Tajikistan make up 49.6 percent of GDP in 2013 (World Bank, 2014). Uzbekistan is only slightly less dependent on remittances than Tajikistan.

Figure 1: Tajikistan and Uzbekistan's annual percentage growth rate of GDP, 1990-2013



Source: National Statistic Agency of Tajikistan and Uzbekistan

After the civil war, macroeconomic stabilization, economic liberalization, restructuring and privatization of state-owned industrial enterprises, as well as land reforms and restructuring of large collective farms in agriculture also contributed to high growth in Tajikistan (Kimhi and Lerman, 2015; Pomfret, 2010). Gradual implementation of step-by-step economic reforms combined with achievement of economic stability made a significant contribution to economic growth in Uzbekistan despite huge economic distortions in the economy.

Agricultural production and trade

In Soviet times, Tajikistan and Uzbekistan were mainly specialized in production of agricultural commodities and in extraction of natural resources. Particularly, both countries had comparative advantage in cotton cultivation and fruits and vegetables production. Despite of the later adopted

diversification, the share of cotton in total agricultural output is still high. Agricultural sector remains one of the largest sectors of the economy in both countries. The agricultural employment is sizable in relative terms and there exist a strong linkage between agriculture and other sectors of the economy.

After gaining independence, Uzbekistan's government - economic policy started to focus on industrialization of the country and consequently the share of the agricultural sector in the whole economy has been declining steadily. Agricultural contribution to GDP decreased from 37.3 percent in 1991 to 17.5 percent in 2012. Overall, the agricultural employment decreased from 42 in 1991 to about 27.4 percent over the period 2005-2012. In contrast, the share of agricultural production in GDP remained stable at the average level of 24.6 percent in Tajikistan during the last decade. In the period of 2000 – 2013, the annual growth rate of agricultural sectors in Tajikistan and Uzbekistan reached 8.7 and 5.4 percent respectively (see Appendix 2). Table 2 provides the basic data about development of agricultural production and inputs in both countries.

Table 2: Agricultural cultivation potential and data of Tajikistan and Uzbekistan, 1992-2013

	TAJIKISTAN			**UZBEKISTAN**		
	1992	*2005*	*2013*	*1992*	*2005*	*2013*
Total Land Area (1000 ha)	*14310*	*14310*	*14255*	*42540*	*42540*	*42540*
Agricultural land *(% of land area)*	32.1	33.4	34.8	65.2	62.9	62.9
Arable Land *(1000 ha)*	873	773	869	4467	4382	4382
Land under cereal production *('00 hectare)*	273.5	417.2	418.2	1225.3	1615.9	1615.6
Permanent crop land *(% of land area)*	0.9	0.8	1.0	0.9	0.8	0.9
Cereal yield *(kg per hectare)*	994	2164	2798	1777	4042	4766
Fertilizer consumption *(kg.per hec. arable land)*	-	37.8	58.7	-	-	203.9
Crop production index *(2004-2006=100)*	76.1	97.9	151.1	83.3	100.2	144.4
Livestock production index *(2004 2006=100)*	113.8	102.3	163.9	77.5	99.5	165.8
Cereal production index *(2004 2006=100)*	30.6	102.4	134.0	38.4	102.6	122.3
Food production index *(2004-2006=100)*	90.8	98.2	155.7	73.6	98.0	163.3

Source : World Bank, 2014 and FAOSTAT, 2015

Moreover, the agricultural sector of Tajikistan and Uzbekistan suffers from weather variability and extreme weather events related to climate change, e.g. flooding, mudslides, landslides, and so on. Droughts in the region are associated with conflicts over water and energy resources between these two countries and involving other countries in Central Asia as well (Makhmedov et al., 2012; Awudu and Hendrik, 2006). According to the World Bank Uzbekistan and Tajikistan became the

most vulnerable countries to the climate change due to their poor infrastructure and institutional constraints leading to governments' low capacity to adapt to climate changes (World Bank, 2014). Uzbekistan after refocusing its agricultural production from cotton monoculture towards grains, livestock, and fruits and vegetables reached significant levels of self-sufficiency. However, self-sufficiency policy of the Uzbek government separated largely its agricultural sector from the world markets. Tajikistan has liberalized trade regime in agricultural products and removed majority of government interventions. As in Uzbekistan, Tajikistan government has also used policies (subsidies and taxes) to diversify agricultural crop production and to increase self-sufficiency for selected crops. Diversification of agricultural production led in Tajikistan to growth of grain, fruits, and vegetables, and partly livestock sector as well. In particular, wheat production increased from 166.4 thousand tons in 1992 to 812.6 thousand tons in 2012, which is 52 percent of self-sufficiency ratio. The self-sufficiency ratio in wheat in Uzbekistan is 91.5 percent (see Table 3).

Cotton and wheat are major crops in Uzbekistan and their production and trade is strongly regulated by the state. Cotton is exclusively sold through the state procurement system. Wheat is marketed both through the state procurement system (50 percent) and through open market (50 percent). Other commodities are sold through non-regulated local markets or traditional bazaars. Despite liberalization of output markets for all commodities except for cotton and wheat, which were only partially liberalized, there are substantial ad hoc state regulations affecting trade in Uzbekistan. Fresh fruits and vegetables can be exported to foreign market directly by agricultural producers but government restricts export if it has adverse implications for domestic markets (e.g. price increase). To a lesser extent these policy interventions are applied in Tajikistan too. In Uzbekistan, state often regulates domestic prices for selected agricultural products. For example, meat prices are often regulated in the case when there is meat shortage on domestic market. These state market interventions create uncertainty to agricultural producers in planning production (Nurmetov et al., 2015; Lerman, 2008; Djanibekov et al, 2012).

Table 3: Self-sufficiency ratio by food commodities in Tajikistan and Uzbekistan, 1992-2012

		Tajikistan			Uzbekistan		
		1992	*2002*	*2012*	*1992*	*2002*	*2012*
Wheat	Domestic production (‘000 ton)	166.4	544.6	812.6	964.0	4967.4	6612.2
	Export (‘000 ton)	-	-	-	-	-	-
	Import (‘000 ton)	900.0	291.6	751.5	4435.0	161.1	614.9
	Self-sufficiency (%)	***15.6***	***65.1***	***51.9***	***17.8***	***96.8***	***91.5***
Rice	Domestic production (‘000 ton)	20.2	50.2	82.4	538.9	175.1	325.7
	Export (‘000 ton)	-	-	3.7	-	-	-
	Import (‘000 ton)	14.1	1.33	36.7	51.3	185.2	23.8
	Self-sufficiency (%)	***58.9***	***97.5***	***71.4***	***91.3***	***48.6***	***93.2***
Chicken meat	Domestic production (‘000 ton)	5.2	0.1	7.5	38.8	10.1	30.0
	Export (‘000 ton)	-	-	-	-	-	-
	Import (‘000 ton)	-	0.85	19.3	29.0	6.5	15.1
	Self-sufficiency (%)	***-***	***10.5***	***28.0***	***57.2***	***60.8***	***66.5***
Fruits*	Domestic production (‘000 ton)	93.4	53.0	76.5	325.4	394.9	1086.0
	Export (‘000 ton)	21.6	26.0	18.4	58.5	73.3	254.4
	Import (‘000 ton)	-	0.6	0.2	1.1	0.2	0.2
	Self-sufficiency (%)	***161.6***	***192.0***	***131.2***	***121.4***	***122.7***	***130.6***
Vegetables*	Domestic production (‘000 ton)	327.1	289.6	1017.5	2522.1	1855.2	4729.1
	Export (‘000 ton)	-	8.4	2.6	123.8	63.9	201.2
	Import (‘000 ton)	-	5.2	2.2	1.3	0.7	5.4
	Self-sufficiency (%)	***144.0***	***101.1***	***100.1***	***105.1***	***103.5***	***104.3***

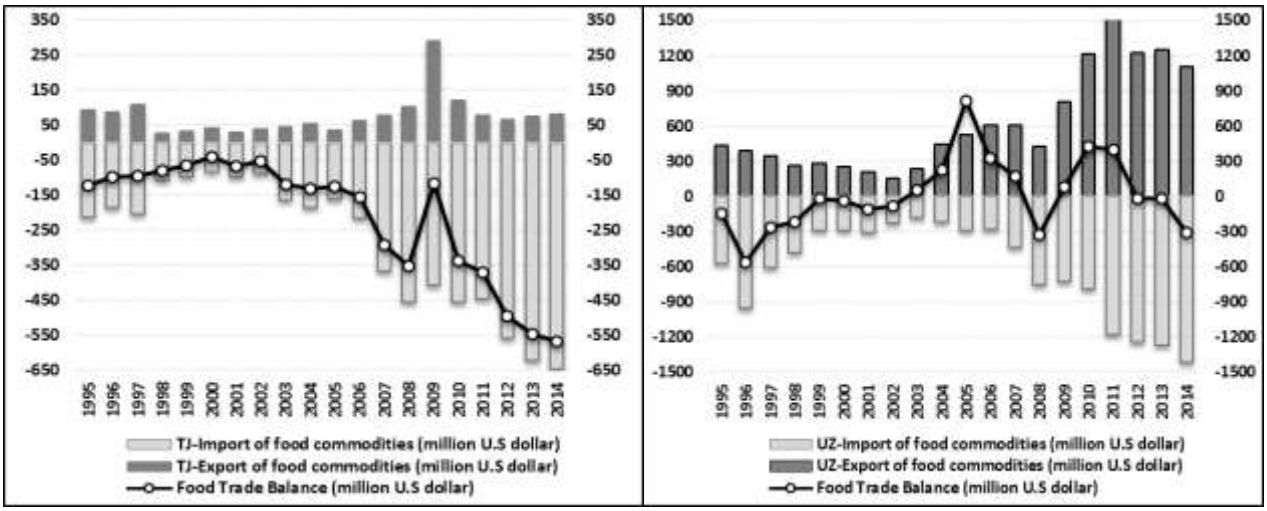
Source: own calculation based on FAOSTAT data, 2015 *data for 2011

At input markets, cotton and wheat farms receive credits under favorable conditions. The credit can be used only for input purchases (fuel, fertilizer, water, electricity, agricultural machinery services) at subsidies prices and only from authorized companies. The credits can be also used for labor and insurance. The maximum amount of favorable credit is up to 60 percent of the production contracted by the state. *Small peasant farms (dekhans)* do not have access to favorable credits so they have to buy inputs on free markets at higher prices. Dekhans, however, are not subject to any output regulations like bigger commercial private farms. Water supply is administered by Water Consumers Associations, which are under government control. Cotton and wheat farms are main consumers of water. Water supply is free; there is only symbolic payment for water supply, which farms usually do not pay anyway. However, in all input markets there is strong state involvement,

which is used by policy-makers to exert influence on production and trade decisions of farmers. Moreover, in Tajikistan and Uzbekistan the volume of cash subsidies are still very low in agricultural sector and food imports.

Tajikistan does not have good conditions for agricultural production, as only 6.1 percent of its land is suitable for production of arable crops. Growing domestic population cannot be supplied from domestic agricultural production. Therefore, Tajikistan has to rely on world markets to obtain enough food. Tajikistan imports grain and flour, dairy and meat products, vegetable oil, sugar and confectionery preparations, coffee, tea and so on. Figures 2-3 provide the total food trade turnover of Tajikistan and Uzbekistan with net -trade food balance.

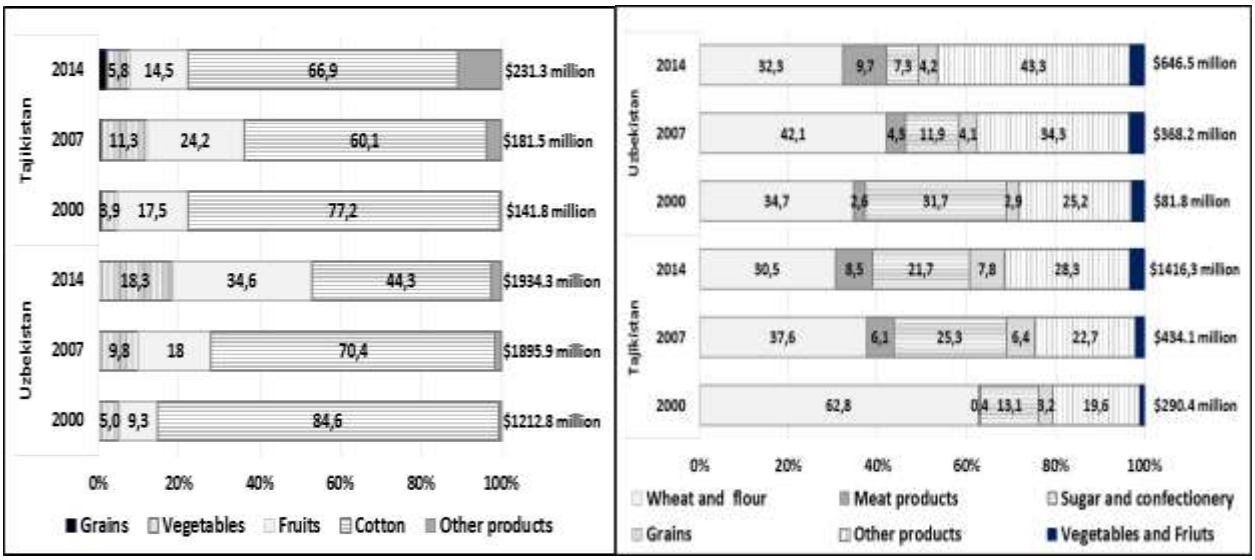
Figures 2-3: The volume of food trade turnover of Tajikistan and Uzbekistan, 1995-2013



Source: UNCTAD, 2015

Tajikistan is a significant net importer of food. Net food trade position of Uzbekistan is more balanced. Both countries reduced the volume of cotton export and Uzbekistan increased export of fruits and vegetables. Tajikistan has started gradually to export small volume of grains. Figures 4-5 show the volume of food export and import by specific food commodities in Tajikistan and Uzbekistan.

Figures 4-5: The volume of export and import by group of food products, 1995-2013



Source: UNCTAD, 2015

Table 4 shows the applied *Most Favored Nations* tariffs for four countries in Central Asia. Uzbekistan has significantly higher import tariffs on agricultural and food products than Tajikistan.

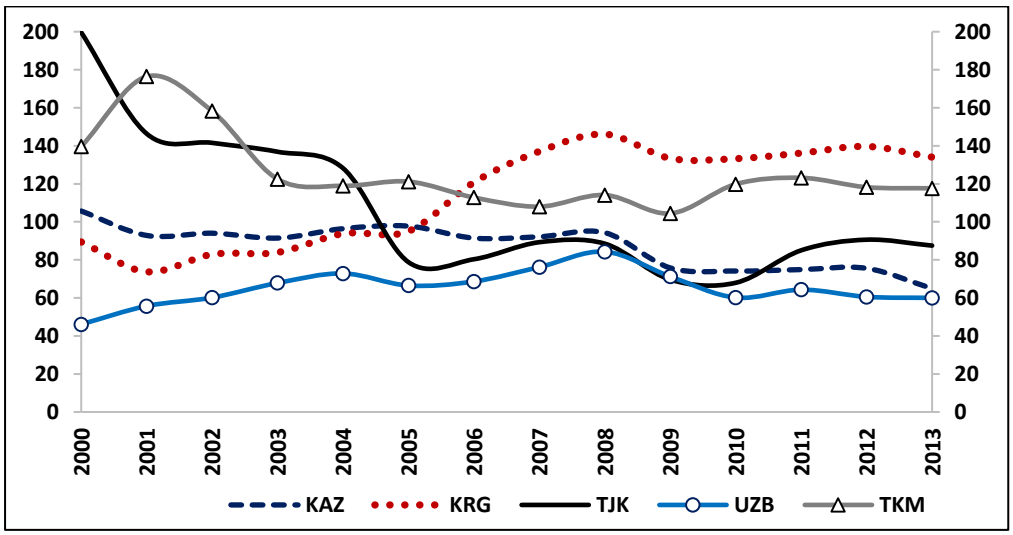
Table 4: Import tariffs for agricultural products in Central Asia countries, 2012-2014

	Kazakhstan		**Kyrgyzstan**		**Tajikistan**		**Uzbekistan**	
	2012	*2014*	*2012*	*2014*	*2012*	*2014*	*2012*	*2014*
Simple average MFN applied:								
Total	9.5	8.6	4.6	4.6	7.8	7.7	15.4	14.8
Non-Agricultural products	8.8	8.1	4.2	4.1	7.3	7.2	14.9	14.2
Agricultural products	13.4	11.6	7.4	7.6	**10.8**	**10.7**	**19.2**	**18.8**
MFN applied duties by group of agricultural products								
Animal products	23.8	19.7	7.6	7.6	9.6	9.6	13.8	15.3
Fruit, vegetables, plants	19.2	16.7	10.8	10.8	12.5	12.5	17.3	15.8
Coffee, tea	11.0	9.7	9.7	9.7	12.0	11.9	29.0	29.0
Cereals & preparation	9.5	7.5	6.8	6.8	6.7	6.7	15.8	15.3
Dairy products	13.2	11.2	7.8	8.3	9.9	9.9	20.3	18.7
Oilseeds, fats & oils	8.5	7.5	5.7	5.9	6.7	6.7	7.2	7.9
Sugars and confectionery	14.9	13.0	4.4	6.0	6.3	6.3	26.3	24.5
Beverages & tobacco	30.9	27.6	15.1	14.7	31.2	31.1	31.6	27.3
Other agricultural product	5.6	5.3	2.2	2.5	6.5	6.1	10.7	10.5
Source: WTO, World Tariff Profiles 2013-2015								

Uzbekistan and Tajikistan have signed *Free Trade Agreement*[3] within the framework of *Commonwealth of Independent States* (CIS) that applies zero import tariffs in mutual trade with few exemptions (Akramov and Mogilevskii, 2014). However, there are still important impediments and technical barriers to trade in both countries including high corruption at regulatory and administrative level.

Figure 6 describes the level of trade openness (measured as a ratio of trade to GDP) for all four Central Asian countries during the period between 2000 and 2013. Tajikistan has a higher degree of trade openness than Uzbekistan.

Figure 6: Trade openness ratio of Tajikistan and Uzbekistan with compared to others CAC



Source: own calculation based on World Bank data, 2014

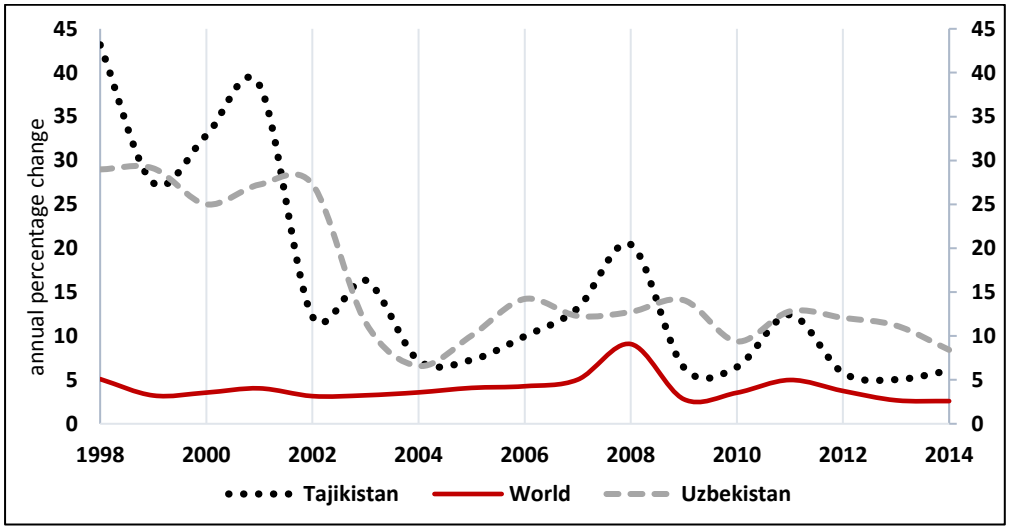
The recent instability in international geo-political situation and plunge in oil prices did not leave both countries without substantial negative effect. One of the main reason of recent CPI growth is the significantly high devaluation of national currency. Since December 2014 until December 2015, Tajik -TJS somoni lost value against US dollar over 50 percent and Uzbek - UZB suoms about 66 percent[4], which caused the rise in demand for foreign currency to finance imports.

[3] The government of Tajikistan had not yet ratified this agreement by the end of 2013, while Uzbekistan authorities acceded to the FTA on special conditions. The main reason behind of these special conditions allow the authorities of Uzbekistan to refrain from offering national regime to other parties and from unchangeable by WTO rules and norms, to which this FTA repeatedly refers, till Uzbekistan's WTO accession or 2020 (Akramov and Mogilevskii, 2014).

[4] Own calculation based on data of National Bank of Tajikistan, Uzbekistan and IMF, 2015.

Figure 7 shows the development of consumer prices in Tajikistan, Uzbekistan and the world. Tajik CPI follows more closely the development of the world CPI than the Uzbek CPI does. Furthermore, Tajik CPI fluctuates more than Uzbek CPI.

Figure 7: Inflation, average consumer price index in Tajikistan and Uzbekistan, 1998-2014



Source: UNCTAD, 2015 and National Statistic Agency of Tajikistan and Uzbekistan

Declining of financial resources from the exported goods and remittances inflow, especially from Russia and other CIS countries by devaluation of Russian rubles (RUB) is another part of history. Consequently, food imports, commonly denoted in US dollars, have become more expensive due to rubles crisis.

Price transmission mechanism

The price transmission was typically analyzed through the horizontally related markets as links between prices at different locations or through the various stages of the supply chain (Vavra and Goodwin, 2005).

Overall, the issues of horizontal price transmission has been widely investigated within the framework of "***law of one price***". In the context of perfect trade linkage between several or two markets, the movement of commodities prices will be equalized in both markets in the long -run, while allowing for deviations in the short run (Margarido et al., 2007).

From the studies on price transmission, most of the attention was paid to developed countries in Western Europe or USA. Only few studies can be found focusing on markets in developing and transition countries. Peter (2008) found that the cointegration relationship exists between world and domestic Indonesian rice market and found the elasticity of 0.369, meaning that markets are partially cointegrated. Yavapolkul et al. (2006) observed that the developed and developing countries' rice and wheat markets during the post-Uruguay trade negotiations were only partially cointegrated which means that Uruguay round of the trade negotiation did not improve the world markets to be fully integrated. Baffes and Bruce (2003) presented that only few of the Latin American countries are integrated after the agricultural trade liberalization. Although, the studies of Ravallion (1986), Dawson and Dey (2002) have examined the domestic spatial rice markets integration but to date no studies conducted on the domestic Bangladesh and international rice market except Alam at el. (2012). They used linear cointegration to investigate the market integration between domestic and international rice markets without considering the effects of transaction costs in the market integration study.

In previous literature such as Enders and Siklos (2001), Meyer (2004), Sarno et al., (2004), the standard cointegration has been highly criticized. Goodwin and Piggott (2001) have used threshold cointegration in US corn and soybean markets and found the presence of threshold effects in price transmission process. Sanogo and Maliki (2010) have analyzed the market integration between Nepal and India using threshold model and confirmed the presence of threshold effects. However, the evidence from literature is diverse and varies irrespective of methodology used and importing or exporting country, small or large country case. Apart from the trade liberalization, there are many factors that could influence the market integration outcome (as for example non-trade barriers, the policies of domestic and world markets, poor communication and infrastructure that leads to higher transaction costs, competition and so on).

Econometric methodology

We apply time-series modeling techniques to evaluate horizontal price transmission from world market to Khorezm market and vice versa. In this study, an asymmetric error correction model is employed to quantify the extent, speed, and nature of price adjustment. As the first step, we test the stationarity of time series using two unit root tests: the augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test. The number of lags of a dependent variable is determined by the

Akaike Information Criterion (AIC). If both time series are not stationary, they are suitable to test for cointegration relationship between them. We employ the Johansen approach to test for cointegration. The Johansen approach starts with a vector autoregressive model and reformulates it into a vector error correction model:

$$Z_t = A_1 Z_{t-1} + ... + A_k Z_{t-k} + \varepsilon_t \quad (1)$$

$$\Delta Z_t = \sum_{i=1}^{k-1} \Gamma_i \Delta Z_{t-i} + \Pi Z_{t-k} + \varepsilon_t \quad (2)$$

where Z_t is a vector of non-stationary variables (producer and consumer prices), A are different matrices of parameters, t is time subscript, k is the number of lags and ε_t is the error term assumed to follow i.i.d. process with a zero mean and normally distributed N(0,σ2) error structure. The estimates of Γ_i measure the short-run adjustment to changes in the endogenous variables, while Π contains information on the long-run cointegrating relationships between variables in the model.

The above cointegration tests assume symmetric price transmission. In order to capture asymmetric movements in the residuals, Enders and Granger (1998) and Enders and Siklos (2001) propose to use threshold cointegration approach. Assuming the long run relationship between two nonstationary variables X and Y:

$$Y_t = \lambda_0 + \lambda_1 X_t + \mu_t \quad (3)$$

where, μ is the error term. Engle and Granger (1987) show, that cointegration exists if the null hypothesis ρ=0 is rejected in:

$$\Delta\mu_t = \rho\mu_{t-1} + \xi_t \quad (4)$$

where, ξ is the error term for the residuals. Adjustment of the series of residuals expressed in $\rho\mu_{t-1}$ would be symmetric. To capture the asymmetry in adjustment process, a two-regime threshold cointegration approach should be used:

$$\Delta\mu_t = I_t \rho_1 \mu_{t-1} + (1 - I_t)\rho_2 \mu_{t-1} + \xi_t \quad (5)$$

where I_t is the Heaviside indicator $I_{t=1}$ if $\mu_{t-1} \geq \tau$ or It=0 if $\mu_{t-1} < \tau$. If μ_{t-1} is bigger than the threshold τ, then adjustment is at the rate ρ_1. If μ_{t-1} is smaller than the threshold τ, adjustment is shown in ρ_2. When $\rho_1=\rho_2$, then the adjustment process is symmetric. If the null hypothesis $\rho_1=\rho_2=0$ is rejected, then X and Y are cointegrated and the following TAR model is estimated:

$$\Delta Y_t = \theta_Y + \delta_Y^+ E_{t-1}^+ + \delta_Y^- E_{t-1}^- + \sum_{j=1}^{J} \alpha_{Yj}^+ \Delta Y_{t-j}^+ + \sum_{j=1}^{J} \alpha_{Yj}^- \Delta Y_{t-j}^- + \sum_{j=1}^{J} \beta_{Yj}^+ \Delta X_{t-j}^+ + \sum_{j=1}^{J} \beta_{Yj}^- \Delta X_{t-j}^- + \upsilon_{Yt} \quad (6)$$

where ΔY_t and ΔX_t are dependent and independent variables in their first differences, E is the error correction term, δ represents the speed of adjustment coefficients of ΔY_t if Y_{t-1} is above and below its long-run equilibrium, θ, δ, α and β are coefficients and υ is the error term, t is time subscript and j is the number of lags. Two error correction terms are defined as:

$$E_{t-1}^+ = I_t \mu_{t-1} \quad (7)$$

$$E_{t-1}^- = (1 - I_t) \mu_{t-1} \quad (8)$$

Enders and Granger (1998) and Enders and Siklos (2001) proposed also a model for cointegration, known as momentum threshold autoregressive model. The term "momentum" describes the rate of acceleration of prices and takes into account steep variations in the residuals; it is especially valuable when the adjustment is believed to exhibit more momentum in one direction than the other. Heaviside Indicator in this case is $I_{t=1}$ if $\Delta\mu_{t-1} \geq \tau$ or $I_t=0$ if $\Delta\mu_{t-1} < \tau$. Threshold error correction models were used for example by Goodwin and Harper (2000); Goodwin and Piggott (2001); Abdulai (2002); Barret and Li (2002); Fackler and Goodwin (2001); Liao and Sun (2011); Sun (2011) or Ning and Sun (2012). Abdulai (2000, 2002) used both TAR and M-TAR models and found out, that the M-TAR models fit data better than the others.

To summarize, four asymmetric models are considered in our study. They are threshold autoregression model with threshold value equal to zero; threshold autoregression model with threshold value estimated (consistent threshold autoregression model); momentum threshold autoregression model with threshold value equal to zero; and consistent momentum threshold autoregression model with threshold value estimated. A model with the lowest AIC and BIC will be used.

Data use

We use monthly price data for selected agricultural commodities traded in Tajikistan, Uzbekistan and in the world market. Agricultural commodities traded in Tajikistan represent wheat, rice, beef meat, sheep meat, chicken, sugar, and soy oil. The data period covers January 2004 to December 2014. Tajikistan prices were converted from TJS-somoni to USD using current exchange rates collected from IMF and National Bank of Tajikistan. The domestic Tajik prices come from Agency

of Statistics under President of the Republic of Tajikistan (Taj Stat), except for the price of wheat. The average price of wheat was obtained from Ilyasov et.al, (2014)[5] as WFP market prices database in period 2003-2013 and period of 2014 come from Taj Stat. The agricultural food commodities chose for our analysis have significant proportion in consumption patterns of households in Tajikistan. According to *Household Budget Survey of Tajikistan (2012)*[6], the share of wheat, flour and bread as the base of the nation's staple diet consisted over 24.0 percent, rice 5.8 percent, beef meat 10.9 percent, sheep meat 2.2 percent, chicken meat 1.5 percent and sugar 3.2 percent.

Table 5: Descriptive statistics of Tajikistan's prices

Variable	*Obs.*	*Mean*	*Std. Dev.*	*Min*	*Max*
World/kg					
Wheat	132	0.251	0.072	0.141	**0.440**
Sheep	132	5.103	0.965	3.746	**6.995**
Chicken	132	1.901	0.270	1.489	**2.512**
Rice	132	0.396	0.116	0.194	**0.659**
Beef	132	3.328	0.860	2.144	**5.999**
Sugar	132	0.354	0.131	0.128	**0.653**
Soy oil	132	0.862	0.260	0.460	**1.423**
Tajikistan/kg					
Wheat	132	0.378	0.119	0.171	**0.608**
Sheep	132	4.812	1.640	2.529	**7.557**
Chicken	132	2.687	0.530	1.867	**3.832**
Rice	132	1.436	0.564	0.437	**2.140**
Beef	132	4.303	1.615	2.142	**7.181**
Sugar	132	0.878	0.267	0.480	**1.542**
Soy oil	132	1.194	0.183	0.901	**1.604**
Source: Own calculation					

World prices are reported in US dollars and come from the World Bank database. The world prices of wheat and rice were converted from metric tons into kilograms price, while soybean oil was converted from metric tons into litters based on substance with density: 926 kg/m^3. The world price of wheat was taken as the HRW nominal price and the rice price represents an average of three auctions, such as Nominal Vietnamese Rice Price- 5%, Nominal Thailand Rice Price- 5%, and Nominal Thai, A1 Special Rice Price.

[5] Ilyasov et.al. (2014) have estimated wheat markets integration in Central Asia.
[6] Agency on Statistics under President of the Republic of Tajikistan (Taj Stat) has conducting the Household Budget Survey of Tajikistan (2012) quarterly, and each year with the coverage of 3,000 households across five regions of country (HBS, 2012).

The data for Uzbekistan represent domestic prices of wheat, maize, barley, rice, beef meat and butter traded in Khorezm region in Uzbekistan. The data period covers January 2001 to December 2009. The commodities and data periods are chosen because of data availability. Uzbek prices were converted from UZB suoms to US dollars using the current exchange rate. All Uzbek prices come from the State Committee of the Republic of Uzbekistan on statistics and its Khorezm regional authorities.

World prices for Uzbekistan estimation come from World Bank and FAO; Wheat *(No.1 Hard Red Winter, FOB Gulf of Mexico, US dollar per metric ton)* and Barley *(Canadian no.1 Western Barley, spot price, and US dollar per metric ton).* Maize *-(U.S. No.2 Yellow, FOB Gulf of Mexico, U.S. price, US dollar per metric ton)* and Rice *-(rice Thai 100% Broken A1 Super, f.o.b., Us dollar per metric ton).* Beef *-(world reference price - beef producer price, Fed Steer Price, dead weight, Nebraska, FAO international prices in US per metric ton)* and Butter- *(world reference price - Butter, Oceania, f.o.b., US$ per metric ton).*

Table 6: Descriptive statistics of Uzbekistan's prices

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
World/ kg					
Wheat	108	0.192	0.072	0.121	**0.439**
Maize	108	0.131	0.045	0.083	**0.287**
Barley	108	0.124	0.040	0.082	**0.248**
Rice	108	0.275	0.117	0.141	**0.659**
Butter	108	2.133	1.006	0.999	**4.609**
Uzbekistan- Khorezm/kg					
Wheat	108	0.247	0.140	0.098	**0.636**
Maize	108	0.240	0.122	0.102	**0.522**
Barley	108	0.237	0.103	0.100	**0.509**
Rice	108	0.739	0.359	0.301	**2.191**
Butter	108	3.394	0.972	1.891	**5.611**
Source: own calculation					

Empirical results and discussion

The Augmented Dickey-Fuller and Phillips-Perron tests confirm that all our time series are non-stationary; we stationarized them by taking first differences.

Table 7: The Augmented Dickey-Fuller and Phillips-Perron tests for Tajikistan's price series

	Augmented Dickey Fuller test results				*Phillips Perron test results*			
	Level		**1st Diff**		**Level**		**1st Diff**	
	ADF_c	ADF_t	ADF_c	ADF_t	PP_c	PP_t	PP_c	PP_t
World								
Wheat	-1.856	-2.254	-7.611***	-7.599***	-1.816	-2.157	-8.776***	-8.762
Sheep	-1.519	-2.573	-5.422***	-5.396***	-1.129	-1.900	-7.296***	-7.283***
Chicken	0.114	-2.542	-5.975***	-6.076***	-0.287	-2.074	-5.000***	-5.031***
Rice	-1.969	-1.011	-4.561***	-4.895***	-2.160	-1.833	-10.976***	-11.141***
Beef	-0.173	-2.523	-6.192***	-6.242***	-0.728	-2.816	-6.952***	-6.894***
Sugar	-2.250	-1.936	-5.797***	-5.960***	-2.414	-1.925	-7.574***	-7.710***
Soy oil	-1.723	-1.872	-5.700***	-5.711***	-1.451	-1.229	-7.341***	-7.343***
Tajikistan								
Wheat	-1.942	-2.196	-5.171***	-5.193***	-1.996	-1.874	-10.968***	-11.062***
Sheep	-0.752	-1.882	-6.030***	-6.008***	-0.757	-1.493	-8.432***	-8.400***
Chicken	-1.858	-2.009	-3.632***	-4.324***	-1.479	-1.291	-10.115***	-10.138***
Rice	-2.508	-1.663	-6.239***	-6.606***	-2.267	-1.158	-8.416***	-8.724***
Beef	-1.034	-2.183	-4.034***	-4.015***	-0.686	-1.749	-9.133***	-9.103***
Sugar	-1.789	-1.367	-6.762***	-6.896***	-1.642	-1.452	-9.196***	-9.244***
Soy oil	-2.267	-2.334	-3.632***	-3.112***	-1.586	-1.344	-9.930***	-9.961***
Note: ADF_c is the ADF with an intercept and ADF_t with an intercept and a deterministic trend. *** denote significance at the 1% significance level.					Note: PP_c is the PP with an intercept and PP_t with an intercept and a deterministic trend. *** denote significance at the 1% significance level.			

The tests indicated that all variables were stationary in first differences. The Akaike Information Criterion (AIC) determined the lags of the dependent variable in the tests.

Table 8: The Augmented Dickey-Fuller and Phillips-Perron tests for Uzbekistan's price series

	Augmented Dickey Fuller test results				*Phillips Perron test results*			
	Level		**1st Diff**		**Level**		**1st Diff**	
	ADF_c	ADF_t	ADF_c	ADF_t	PP_c	PP_t	PP_c	PP_t
World								
Wheat	-1.611	-2.230	-6.038***	-6.029***	-1.436	-1.899	-8.088***	-8.072***
Maize	-1.434	-2.357	-6.331***	-6.300***	-1.229	-2.202	-8.446***	-8.403***
Barley	-1.718	-1.938	-6.048***	-6.032***	-1.718	-2.105	-7.483***	-7.453***
Rice	-0.623	-2.744	-6.585***	-6.554***	-0.383	-3.385*	-10.405***	-10.369***
Butter	-1.281	-3.503**	-3.615***	-3.626**	-0.471	-2.035	-4.624***	-4.629***
Uzbekistan								
Wheat	-1.639	-2.525	-5.574***	-5.598***	-1.517	-1.996	-9.087***	-9.058***
Maize	-1.376	-2.312	-9.195***	-9.174***	-1.291	-2.213	-9.195***	-9.174***
Barley	-1.995	-2.545	-6.307***	-6.305***	-1.803	-2.263	-8.507***	-8.489***
Rice	-2.031	-2.176	-10.579***	-10.561***	-2.087	-2.221	-10.579***	-10.561***
Butter	-1.357	-1.684	-10.094***	-10.373***	-1.376	-1.672	-10.094***	-10.373***
Note: ADF_c is the ADF with an intercept and ADF_t with an intercept and a deterministic trend. **, *** denote significance at the 5% and 1%, significance levels.					Note: PP_c is the PP with an intercept and PP_t with an intercept and a deterministic trend. *, *** denote significance at the 10% and 1% significance levels.			

Table 9: The Johansen co-integration test results for Tajikistan and Uzbekistan

	Rank	*Johansen trace statistics*		*Rank*	*Johansen trace statistics*
Tajikistan			***Uzbekistan***		
Wheat	0	33.890	Wheat	0	12.215
	1	4.488***		1	2.140
Sheep	0	11.640	Maize	0	11.344
	1	2.534		1	1.842
Chicken	0	5.862	Barley	0	11.567
	1	2.758		1	2.953
Rice	0	23.396	Rice	0	12.362
	1	8.021**		1	3.421***
Beef	0	13.325	Beef	0	9.305
	1	0.348		1	1.608
Sugar	0	24.863	Butter	0	9.247
	1	5.417***		1	1.113
Soyoil	0	16.965			
	1	2.066**			

Source: Own calculation. **, * denote significance at the 5% and 1%, significance levels.**

Johansen co-integration test[7] results indicate that most of the prices in Tajikistan are co-integrated with world prices. There is a cointegrating relationship between world and Tajik prices of wheat, rice, sugar and soy oil. On the other side, there is no cointegrating relationship between world prices and prices in Khorezm region in Uzbekistan.

One implicit assumption of the linear model like Johansen and Juselius (1992) and Engel and Granger (1987) is that adjustment of prices is a continuous and a linear function of the magnitude of deviations. This assumption might mislead the results because it ignores the effect of transaction costs in price adjustment (Alam, Begum, 2012). From this reason, in the next step we examine the presence of asymmetric adjustments in prices.

Threshold co-integration

Threshold co-integration models allow for non-linear relationship between world and local markets and vice versa. The theory does not guide us in the exact model specification and therefore in this paper we used four different threshold models: threshold autoregression model, consistent threshold autoregression model, momentum threshold autoregression model, and consistent

[7]Pantula principle was used to determine whether the time trend and the constant term should be included in the model.

momentum threshold autoregression model. We report the results for models with the lowest AIC and BIC. According to threshold cointegration tests, there is an evidence of cointegration between world and local prices of wheat, sheep, rice, beef, sugar and soy oil in Tajikistan. In case of Uzbekistan, there is an evidence of cointegration relationship between world and local prices of wheat, maize, beef, and butter. Weak evidence of cointegration can be observed in case of barley.

Table 10: The threshold co-integration test results for Tajikistan and Uzbekistan

	Model	*Threshold*	*Lags*	ρ_1	ρ_2	$\Phi(H_0:\rho_1=\rho_2=0)$	$F(H_0: \rho_1=\rho_2)$
Tajikistan							
Wheat	*cTAR*	-0.155	1	-0.189***	-0.309***	8.233***	**0.582**
						[0.000]	**[0.447]**
Sheep	*cMTAR*	0.038	1	0.028	-0.048***	4.044**	**4.404****
						[0.020]	**[0.038]**
Chicken	*cMTAR*	0.009	1	-0.050	-0.011	1.180	**0.908**
						[0.311]	**[0.343]**
Rice	*cTAR*	-0.134	2	-0.01	-0.196***	5.474***	**5.425****
						[0.129]	**[0.021]**
Beef	*cTAR*	-0.226	1	-0.098***	-0.040	5.145***	**1.289**
						[0.007]	**[0.158]**
Sugar	*cTAR*	0.117	1	-0.333***	-0.090**	8.632***	**6.003****
						[0.000]	**[0.016]**
Soy oil	*cTAR*	-0.049	2	-0.099**	-0.257***	6.605***	**2.746 ***
						[0.002]	**[0.100]**
Uzbekistan							
Wheat	*cTAR*	-0.437	3	-0.079*	-0.202***	4.976***	**2.111**
						[0.009]	**[0.149]**
Maize	*cTAR*	0.362	1	-0.212***	-0.064	5.655***	**2.916***
						[0.005]	**[0.091]**
Barley	*cMTAR*	-0.025	1	-0.015	-0.253***	8.519***	**10.376*****
						[0.000]	**[0. 002]**
Rice	*cTAR*	0.453	1	-0.188***	-0.033	4.666***	**3.277***
						[0.010]	**[0.073]**
Butter	*cTAR*	0.453	1	-0.172**	-0.023	3.537**	**4.041****
						[0.033]	**[0. 047]**

Source: calculated
Note: *, **, * denote significance at the 10%, 5%, and 1% significance levels, with P values in the brackets**

Even the pair of prices that have not proved to be cointegrated with the former test are cointegrated with threshold adjustment. This means that Enders and Granger model with threshold fits data better. Estimated models show, that the prices are cointegrated with threshold adjustment, which can be understood as a proxy for transaction costs. Rice prices in Uzbekistan are not cointegrated with threshold adjustment; however, they were proved to be cointegrated without threshold

adjustment based on the Johansen cointegration test. Chicken prices in Tajikistan are proved to be not cointegrated by any cointegration test.

From the tests, it also follows that there is an evidence of asymmetry for world and local prices of sheep, rice, sugar, and soy oil in Tajikistan and wheat in Uzbekistan. The null hypothesis $\rho_1=\rho_2$ is rejected at 5% significance level except for soy oil with only 10% significance level. In cases, where the absolute value of adjustment parameter ρ_1 is lower than the absolute value of adjustment parameter ρ_2, the positive deviation converges more slowly from the long term equilibrium than the negative deviations. Moreover, in appendix 3-4 and 5, we showed adjustment estimation results for global prices with Tajikistan and Uzbekistan's prices on selected food commodities. Deviations from long-term equilibrium resulting from price increases (above the threshold) in world wheat market would be more persistent compared to price deviations resulting from price decreases (below the threshold). In case of prices some food items, for instance, rice, sugar and chicken meat, there is huge gap between domestic and world price fluctuations, despite the analogous price movements (see Appendix 6). The main reason behind this might be connected with market factors, transport costs, monopoly trade environment and local price speculators, profit margin, taxes and trade barriers, which we were not able to estimate. On the other hand, limited access to world markets with a poor external-internal transport infrastructure, poor road network and railway system, resulted in an extremely inefficient and vertical costly transport supply for some importing food items to Tajikistan. As noted by Anderson and van Wincoop, (2004) in most of the developing countries trade costs from inadequate infrastructure and a cumbersome regulatory trade environment could be significantly higher rather than the costs from tariffs and nontariff barriers. These obstacles includes also poor transport conditions and lack of logistic services of refrigerated vans, as well as high transit tariffs and transport costs on high time-sensitive food products. In addition, undeveloped packaging services, have also negatively impacted trade of meat and meat products, and others food items.

Conclusions and policy recommendations

The results of our estimation proved the line of expectation on strong evidence of integrated domestic prices of Tajikistan and world prices, while the cointegration of domestic and world prices was only partially proved in case of Uzbekistan. Partial integration of domestic prices and

global prices may result to consumer welfare loss and should be the main concern for policy makers.

Empirical studies showed that agricultural trade liberalization makes a significant contribution to aggregate gains and contributes to higher rural household incomes and more rapidly economic growth (Anderson et al., 2006). Brooks and Matthews (2015) noted that most of the policymakers accept that there are benefits from trade openness in principle. They point out that reforms create winners and losers via terms of trade effects and are concerned that the losers could include the poor and food insecure. It is likely that open trade will become more important in terms of ensuring food security and price stability, which can be fairly noted in case of poor and developing countries in recent years. In this context, the level of food security in Tajikistan is highly sensitive from the price shocks and volatility, as the share of food expenditure in total household expenditure make up over 65 percent during the period 2005-2014 (Taj Stat, 2014). On the other hand, any further directive policies of food exporter countries during the food crisis i.e. shortage of food commodity maintained rapid instability of food supply in the domestic market of food importer countries. These factors raise legitimate concerns about the ability of the domestic market to cope with any unexpected interruptions in food supplies (Abassian, 2005).

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Appendix 1: Macroeconomic and demographic indicators of Tajikistan and Uzbekistan, 1991-2013

	TAJIKISTAN				UZBEKISTAN			
	1991	***1995***	***2005***	***2013***	***1991***	***1995***	***2005***	***2013***
Population *(million people)*	5.3	5.8	6.8	8.2	20.5	22.8	26.2	30.3
-Urban *(as % of population)*	31.7	28.9	26.5	26.6	40.2	38.5	36.7	36.3
-Rural *(as % of population)*	68.3	71.1	73.5	73.4	59.8	61.5	63.3	63.7
Life expectancy at birth[2]	63	62	66	67	67	66	67	68
Population growth *(as %)*	2.6	1.4	2.1	2.3	2.3	1.8	1.2	1.6
HDI**	0.61	-	0.57	0.61	-	-	0.63	0.66
EFI***	-	-	50.4	53.4	-	-	45.8	46
Agr. Share employment	44.7	59.0	67.5	48.9	41.9	41.0	29.1	26.6[3]
Corruption Index****	-	-	21.0	22.0	-	-	22.0	17.0
HC[1] *(as % of GDP)*	73.8	61.8	97.4	118.3	62.9	48.4	55.3	58.0
GDP per capita (*U.S dollar)*	496.0	212.9	339.8	1036.6	615.4	585.9	546.8	1878.1
Industry *(as % of GDP)*	38.6	39.4	31.2	21.8	33.0	27.8	23.2	26.3
Service *(as % of GDP)*	29.1	22.2	44.8	50.8	34.2	39.9	48.8	54.5
FDI *(as % of GDP)*	-	0.81	2.4	1.3	-	-0.2	1.35	1.9
Export* *(billion U.S dollar)*	-	748	908	1161	-	3431	4878	12401
Import* *(billion U.S dollar)*	-	837	1331	4151	-	2751	3667	12645
Remittance *(as % of GDP)*	-	-	20.1	49.6	-	-	-	12.0**

Source: **World bank, 2014**
Source: **UNCTAD, 2015**
** ***Source:*** **United Nations, HDI-Human Development Index (0-1)**
*** ***Source:*** **Heritage Foundation, EFI-Economic Freedom, overall index (100= high freedom)**
****Source:*** **Transparency International, Corruption Perceptions Index (100=no corruption),**
1)-HC-Household Consumption, 2)- Total years, 3)-data for 2012

Appendix 2: Main agricultural indicators of Tajikistan and Uzbekistan, 1991-2013

	TAJIKISTAN				UZBEKISTAN			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**
1991	927.8	548.7	36.6	-15.2	5106.4	-	37.0	-1.1
1993	383.5	538.6	23.3	-39.3	3982.1	912.9	30.4	1.3
1995	473.9	478.4	38.5	-25.1	4312.4	910.2	32.3	2.2
1997	326.1	438.2	35.4	-2.4	4747.6	893.2	32.2	5.8
1999	298.7	467.4	27.5	3.4	5721.1	964.8	33.5	10.0
2000	237.6	517.9	27.6	13.0	4714.9	989.3	34.4	1.7
2001	284.0	533.3	26.3	7.0	3876.3	1025.9	34.0	6.3
2002	301.6	590.5	24.7	17.3	3313.0	1086.2	34.2	3.7
2003	422.7	636.0	27.2	9.4	3362.5	1160.1	33.2	7.3
2004	450.5	722.3	21.7	11.0	3705.5	1272.4	30.8	8.9
2005	554.9	721.7	24.0	2.1	3977.3	1345.7	27.8	5.4
2006	685.8	749.6	24.2	6.0	4462.1	1422.7	26.2	6.7
2007	829.3	747.4	22.3	7.3	5354.6	1494.4	24.0	6.1
2008	1176.7	788.5	22.8	6.1	5977.9	1556.4	21.4	4.5
2009	1040.6	857.6	20.9	11.0	6399.1	1643.4	19.5	5.8
2010	1246.9	905.6	22.1	7.2	7512.4	1757.7	19.1	6.9
2011	1780.5	969.3	27.3	8.2	8656.9	1886.7	19.1	6.6
2012	2030.4	1064.6	26.6	10.0	9673.6	2024.3	18.9	7.2
2013	2339.7	1166.6	27.5	8.0	10279.9	2183.1	18.1	6.8

Source: World Bank, 2014 and GlobalEconomy.com ***www.theglobaleconomy.com***

1-Agricultural production, thous. U.S dollar;

2- Agriculture value added per worker, constant 2005 U.S. dollars

3- Share of Agricultural in GDP as percentage;

4-Agricultural Output Growth Index, as percent to previous year.

Appendix 3: Adjustment estimates for world and Tajikistan's prices

	Wheat		*Sheep*		*Chicken*		*Rice*	
	World	***Tajikistan***	***World***	***Tajikistan***	***World***	***Tajikistan***	***World***	***Tajikistan***
(Intercept)	0.003	0.000	0.001	0.012	0.001	0.004	-0.006	0.005
X.diff.world.t_1.pos	0.130	-0.004	0.389***	-0.123	0.705***	0.421	0.128	0.122
X.diff.world.t_2.pos	-	-	-	-	-	-	0.037	0.132
X.diff.world.t_1.neg	0.210	0.090	0.477***	0.317**	0.782***	-0.265	-0.137	0.689**
X.diff.world.t_2.neg	-	-	-	-	-	-	-0.012	-0.326
X.diff.domestic.t_1.pos	0.319**	0.116	0.140	0.162	0.011	-0.127	0.439***	0.078
X.diff.domestic.t_2.pos	-	-	-	-	-	-	-0.263**	0.036
X.diff.domestic.t_1.neg	0.319*	-0.128	0-131	0.577***	0.017	0.536***	-0.483**	-0.061
X.diff.domestic.t_2.neg	-	-	-	-	-	-	0.164	-0.030
X.ECT.t_1.pos	-0.132**	0.223***	-0.033*	-0.016	0.015	0.002	-0.148**	0.036
X.ECT.t_1.neg	-0.129	0.123	0.030***	-0.006	0.005	-0.001	-0.064	0.030
R-squared	0.134	0.142	0.277	0.153	0.582	0.082	0.166	0.157
Adj-R2	0.092	0.100	0.241	0.112	0.561	0.037	0.096	0.085
F-stat	3.176	3.381	7.835	3.714	28.523	1.823	2.352	2.194
Stat DW	1.978	1.922	1.931	2.011	1.427	1.962	1.933	1.986
p-value DW	0.722	0.540	0.528	0.894	0.002	0.602	0.518	0.728
AIC	-316.095	-339.000	582.856	-604.377	-854.214	-540.016	-315.970	-466.542
BIC	-293.155	-316.060	-559.916	-581.436	-831.274	-517.076	-281.652	-432.224
LB(4)	0.960	0.289	0.872	0.972	0.589	0.168	0.861	0.957
LB(8)	0.230	0.181	0.732	0.138	0.158	0.154	0.550	0.844
LB(12)	0.242	0.204	0.769	0.151	0.162	0.215	0.800	0.485

Source: calculated **Note: *, **, *** denote significance at the 10%, 5%, and 1% significance levels**

Appendix 4: Adjustment estimates for world and Tajikistan's prices

	Beef		*Sugar*		*Soy oil*	
	World	***Tajikistan***	***World***	***Tajikistan***	***World***	***Tajikistan***
(Intercept)	0.003	0.009**	-0.004	0.009	0.008	0.005
X.diff.world.t_1.pos	0.065	0.157	0.042	-0.0093	0.288	0.110
X.diff.world.t_2.pos	-	-	-	-	0.093	0.103
X.diff.world.t_1.neg	0.491***	-0.037	0.350**	0.095	0.247	0.155
X.diff.world.t_2.neg	-	-	-	-	-0.035	-0.266*
X.diff.domestic.t_1.pos	-0.104***	-0.025	0.017	0.120***	0.373**	0.109
X.diff.domestic.t_2.pos	-0.059	0.124***	-0.181**	0.086*	-0.124	-0.075
X.diff.domestic.t_1.neg	7.574	3.557	4.748	6.787	0.353**	-0.103
X.diff.domestic.t_2.neg	1.981	2.107	1.888	2.034	0.354*	0.266***
X.ECT.t_1.pos	-449.313	-569.077	-289.555	-404.410	-0.107	-0.006
X.ECT.t_1.neg	0.511	0.550	0.864	0.195	-0.108	0.059*
R-squared	0.270	0.148	0.188	0.249	0.242	0.186
Adj-R2	0.234	0.106	0.148	0.212	0.178	0.117
F-stat	7.574	3.557	4.748	6.787	3.770	2.689
Stat DW	1.981	2.107	1.888	2.034	1.964	1.956
p-value DW	0.766	0.786	0.390	0.958	0.708	0.712
AIC	-472.254	-592.018	-312.495	-427.350	-397.121	-580.053
BIC	-449.313	-569.077	-289.555	-404.410	-362.803	-545.735
LB(4)	0.511	0.550	0.864	0.195	0.384	0.779
LB(8)	0.367	0.646	0.932	0.584	0.325	0.858
LB(12)	0.318	0.420	0.514	0.474	0.384	0.769

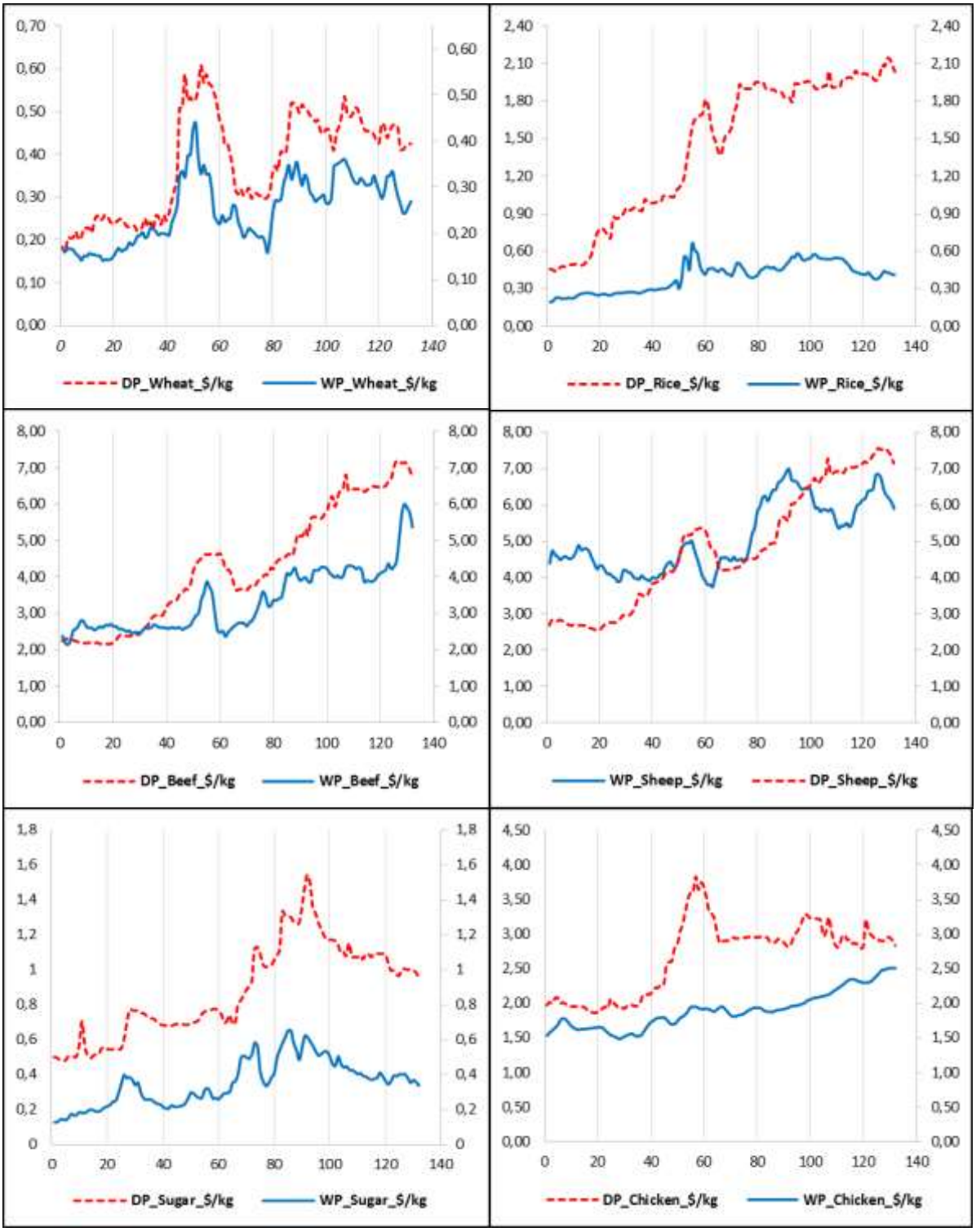
Source: calculated **Note: *, **, *** denote significance at the 10%, 5%, and 1% significance levels**

Appendix 5: Adjustment estimates for world and Uzbekistan's prices

	Wheat		*Maize*		*Barley*		*Rice*		*Butter*	
	World	***Khorezm***	***World***	***Khorezm***	***World***	***Khorezm***	***World***	***Khorezm***	***World***	***Khorezm***
(Intercept)	-0.006	0.034	0.002	0.011	0.006	-0.024	0.005	-0.026	0.012*	-0.011
X.diff.world.t_1.pos	0.249	0.175	0.311	-0.129	0.230	0.430	0.467***	0.701**	0.610***	0.032
X.diff.world.t_2.pos	0.212	0.132	-	-	-	-	-	-	-	-
X.diff.world.t_3.pos	0.434	-0.178	-	-	-	-	-	-	-	-
X.diff.world.t_4.pos	-	-	-	-	-	-	-	-	-	-
X.diff.world.t_1.neg	0.309	-0.056	0.225	0.092	0.407**	-0.085	-0.788***	0.974**	0.852***	-0.255
X.diff.world.t_2.neg	0.008	0.558	-	-	-	-	-	-	-	-
X.diff.world.t_3.neg	-0.163**	0.215	-	-	-	-	-	-	-	-
X.diff.world.t_4.neg	-	-	-	-	-	-	-	-	-	-
X.diff.domestic.t_1.pos	-0.075	0.213	-0.039	0.126	0.037	0.317*	-0.104	0.095	0.294**	0.228
X.diff.domestic.t_2.pos	-0.015	-0.166	-	-	-	-	-	-	-	-
X.diff.domestic.t_3.pos	-0.018	-0.063	-	-	-	-	-	-	-	-
X.diff.domestic.t_4.pos	-	-	-	-	-	-	-	-	-	-
X.diff.domestic.t_1.neg	-0.046	0.087	-0.292	0.015	-0.023	0.106	0.036	0.108	0.100	-0.119
X.diff.domestic.t_2.neg	0.043	-0.161	-	-	-	-	-	-	-	-
X.diff.domestic.t_3.neg	0.027	0.348**	-	-	-	-	-	-	-	-
X.diff.domestic.t_4.neg	-	-	-	-	-	-	-	-	-	-
X.ECT.t_1.pos	-0.102**	0.074	-0.280***	-0.018	0.101	-0.018	-0.156***	0.356***	-0.051***	0.037
X.ECT.t_1.neg	-0.038	0.326***	-0.019	0.193***	-0.086	-0.271***	0.014	-0.041	0.012	0.027
R-squared	0.143	0.231	0.110	0.101	0.112	0.240	0.313	0.278	0.516	0.059
Adj-R2	0.008	0.110	0.056	0.046	0.058	0.194	0.271	0.234	0.486	0.002
F-stat	1.061	1.906	2.044	1.849	2.071	5.216	7.519	6.349	7.577	1.032
Stat DW	1.951	1.919	2.001	2.004	1.897	1.831	1.861	1.911	2.114	2.002
p-value DW	0.690	0.568	0.874	0.854	0.444	0.272	0.324	0.486	0.810	0.626
AIC	-250.328	-107.567	-277.525	-128.559	-245.888	-133.274	-86.867	-266.856	-350.642	-218.536
BIC	-208.018	-65.257	-256.217	-107.252	-224.580	-111.947	-65.559	-245.549	-329.335	-197.228
LB(4)	0.975	0.984	0.974	0.787	0.398	0.666	0.915	0.067	0.458	0.995
LB(8)	0.339	0.751	0.457	0.139	0.572	0.210	0.062	0.003	0.161	0.588
LB(12)	0.396	0.829	0.675	0.396	0.795	0.381	0.006	0.007	0.413	0.812

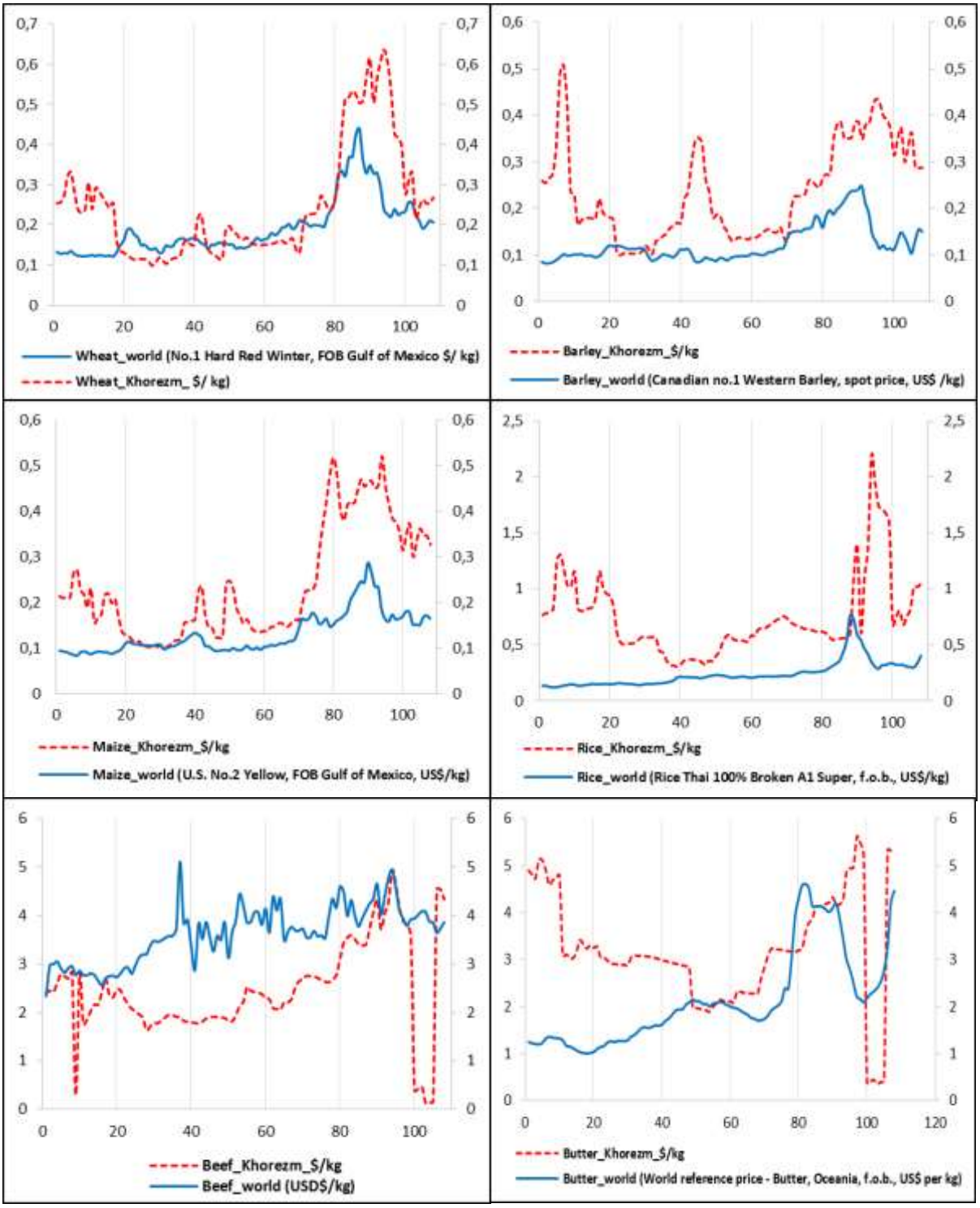
Source: calculated Note: *,,*** denote significance at the 10%, 5% and 1% significance levels**

Appendix 6: The global and domestic (Tajikistan) price trends for selected food commodities in the period of 2004-2014



Source: Own elaboration

Appendix 7: The global and domestic (Uzbekistan) price trends for selected food commodities, (monthly period from 2001 until 2009)



Source: Own elaboration