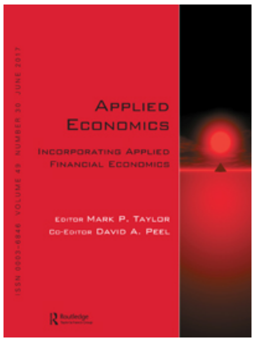

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Cointegration and spatial price transmission among wheat and wheat-flour markets in Afghanistan

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ABSTRACT

This article examines cointegration and spatial price transmission among Afghan wheat and flour markets as well as their linkages with those of supplier countries and global markets. Unit root tests, consistent momentum threshold autoregressive (M-TAR) models and vector error correction models (asymmetric and symmetric) are employed to achieve research objectives. The results suggest that provincial wheat and flour markets may have a long-run relationship with principal market of Kabul. Afghan wheat and flour markets may also be cointegrated with their respective global, Kazakh and Pakistani markets. While provincial wheat markets might adjust to divergence from their long-run equilibrium with Kabul wheat market, some of the provincial flour markets may not respond to deviation from their long-run equilibrium with Kabul flour market. The speed of adjustment towards the long-run Afghan–Pakistani and Afghan–Kazakh equilibrium may be faster for Afghan flour than wheat markets. The equilibrium adjustment coefficients are generally small and market imperfections may exist, however. A shock in Kabul wheat and flour markets may have long-lasting effect on the respective provincial markets whereas a shock in global wheat and Pakistani, and Kazakh wheat and flour markets might have transitory effect on the corresponding Afghan markets.

KEYWORDS
Threshold cointegration; asymmetric and symmetric price transmission; wheat and flour markets; Afghanistan

JEL CLASSIFICATION
Q02; Q13; Q18

I. Introduction

The efficient functioning of food and agricultural markets is essential for promoting agricultural growth, reducing poverty and enhancing food security in developing countries. Agricultural and food market reforms such as improving value chains and marketing linkages, enhancing marketing infrastructure (physical and institutional), promoting exports and investment, supporting farmers, traders and processors, and developing quality control and food safety measures are, therefore, essential components of the National Agriculture Development Framework (NADF) of Afghanistan (MAIL 2009). In addition, reconstruction of the 'national ring road' and other secondary roads, improvements in telecommunication and liberalization of trade may have, *inter alia*, influenced the integration of domestic wheat and wheat-flour (hereinafter 'flour') markets in the country. Market integration and price transmission have been used to measure the degree to which markets function efficiently. The tradeability of products between spatially separated markets refers to market integration, regardless of the existence or absence of spatial market equilibrium, implying the transfer of excess demand from one market to another reflected in the physical flow of goods, transmission of price shocks or both (Barrett and Li 2002).[1] Market integration may be consistent with market efficiency if spatial equilibrium exists along with trade flows among markets (Sanogo and Amadou 2010). In spatial price transmission, market integration may be considered as the transmission of price signals and information between distinct markets so that the prices of a commodity in spatially separated markets move together in the long run (Ghoshray and Ghosh 2011). The real world situation mostly contradicts the assumptions of a perfectly competitive market. This may reduce the

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[1]Spatial market equilibrium exists when the potential arbitrage profits are exhausted and arbitrageurs face zero marginal returns, regardless of whether this results in physical trade flows between markets or not (Barrett and Li 2002).

magnitude of price transmission, speed of adjustment and market integration (Minot 2011).

The methods of measuring market integration and price transmission have evolved from the simple bivariate correlation to advance regime-dependent non-linear methods (Abdulai 2000; Frey and Manera 2007). Enders and Siklos (2001) argue that the standard cointegration tests and their extensions are misspecified if adjustment towards long-run equilibrium is asymmetric, that is, the adjustment is different to an increase/decrease in prices. Factors such as market power, transaction costs, differentiated nature of agricultural products such as wheat and flour, government interventions, asymmetric information, menu costs and stock-holding behaviour may result in asymmetric adjustment towards long-run equilibrium (Abdulai 2000; Meyer and von Cramon-Taubadel 2004; Ghoshray 2008; Ankamah-Yeboah 2012). Although some of these factors such as higher transaction costs, market power of the major suppliers, quality differences of wheat and flour and asymmetric information may result in asymmetric equilibrium adjustment in the context of Afghanistan, no empirical studies have been carried out to examine asymmetric price transmission (APT) and threshold cointegration among wheat and flour markets in the country. However, Chabot and Dorosh (2007) studied cointegration among major wheat markets in the country as well as their relationship with Lahore wheat market of Pakistan using a traditional test of cointegration. Other studies (e.g. Schulte 2007; Persaud 2010; Chabot and Tondel 2011) used pairwise correlation to examine integration amongst domestic wheat and flour markets as well as their integration with those of regional markets.

Self-sufficiency in wheat production has been a prominent agricultural policy objective of the successive governments of Afghanistan, which may be difficult to achieve without improving the efficiency of wheat markets in the country. Moreover, developing the wheat value chain, improving the functioning of wheat and flour markets, facilitating integration of domestic wheat markets with global and regional wheat markets and stabilizing domestic wheat prices are at the heart of the national wheat policy (MAIL 2013). Although realization of these objectives critically requires an understanding of how domestic wheat and flour markets function in relation to each other and with reference to those of supplier countries and global markets, there are no sufficient empirical evidences in this regards. With this background, this study aims at examining the long-run relationship and dynamics of price transmission among Afghan wheat and flour markets as well as their linkage with those of supplier countries and global markets.

An overview of wheat production, consumption and trade in Afghanistan

Wheat is a major staple crop in Afghanistan that is crucial for ensuring national food and nutritional security. It is grown under irrigated and rainfed conditions. On average, about 80% of the total area under cereals is devoted to wheat (irrigated: 48%; rainfed: 52%) with almost an equal share in total cereals production, that is, around 79% (irrigated: 72%; rainfed: 28%) during 2005/2006–2014/2015. The average yield of wheat is 1.75 t/ha (irrigated: 2.63 t/ha; rainfed: 0.92 t/ha), which is lower than the potential yield averaged over the same period. Due to periodic droughts and variable climatic conditions, domestic wheat production is highly variable with the coefficient of variation of 23% (irrigated: 18%; rainfed: 44%) during the past decade or so. Moreover, the post-harvest losses account for about 15% of the total wheat production (on average 647,800 tonnes), which approximate the domestic wheat deficit. This implies that reduction of the losses should be given due attention (Khan 2007).

Most of the surplus wheat originates from the northern and north-eastern zones of the country, that is, 286,956 and 235,949 tonnes averaged over 2005/2006–2014/2015, respectively, which are known as the country's 'breadbasket'. Except for the western zone, which has a small surplus of 8,532 tonnes, all the remaining provincial zones have a deficit with shortfalls ranging from 59,846 tonnes in the west-central zone to 611,687 tonnes in the central zone averaged over the same period (Figure 1). It should be noted that not all the provinces in a deficit zone might have a deficit. For instance, the surplus province of Helmand is located in the south-west deficit zone. However, only about 11% of the total wheat production is supplied to local markets (Schulte 2007). The critical issue here is whether the marketable surplus is truly low or the market participation of farmers is limited due to

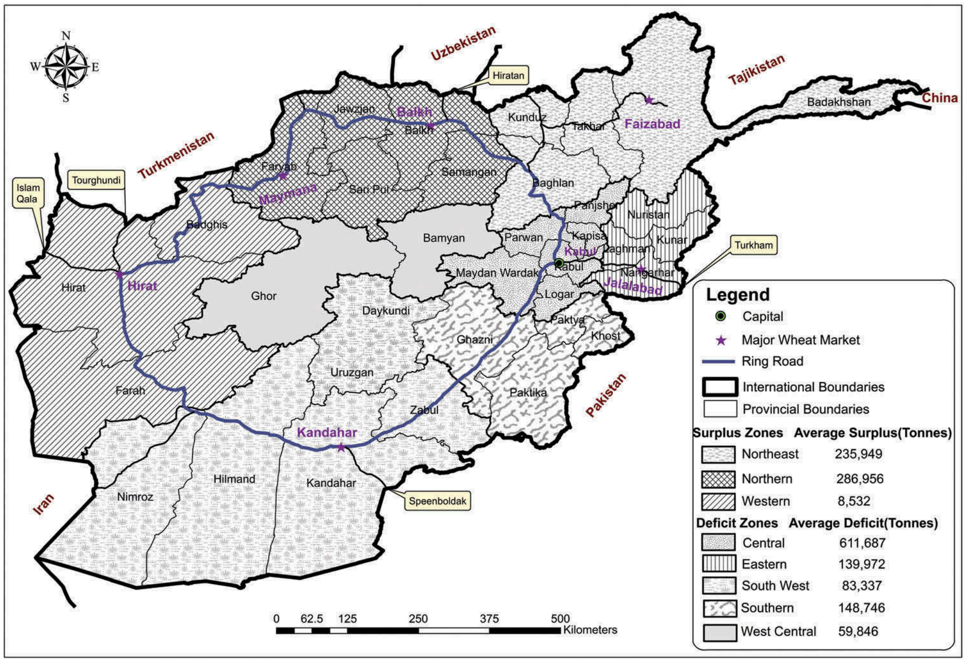

Figure 1. Surplus and deficit wheat production zones and markets studied. Source: Author's work.

lack of incentives for commercial wheat production and/or weak market integration.

The average per capita consumption of wheat in Afghanistan is 162 kg/year, one of the highest in South Asia, and its share in the daily per capita calorie intake is 66% averaged over 2009/2010–2013/2014. Wheat is mainly consumed in the form of flat breads with every meal. Overall, 43% of the total household consumption expenditure is spent on bread and cereals whereas it amounts to 54% for the poorest 40% of the population (CSO 2007). The aggregate demand for wheat is 5.1 million tonnes averaged over 2005/2006–2014/2015 with about 15% of deficit (762,700 tonnes), which is met by commercial imports and food aid.[2] This suggests an average self-sufficiency rate of 85% for the country. Since a modern and efficient wheat milling industry is presently not available and domestic consumers prefer imported flour, the country imports large quantities of flour than wheat (Schulte 2007; Khan 2007; Persaud 2013).[3] Pakistan and Kazakhstan are the two major suppliers of wheat and flour to the country, which accounted for 40% (616,140 tonnes) and 51% (787,441 tonnes) of the total wheat and flour imports (1,542,111 tonnes) during 2013/2014 and 2014/2015, respectively. Given the significant share of these countries in domestic wheat and flour markets, their trade distorting policies affect wheat and flour prices in Afghanistan (Khan 2007; Dorosh 2008).

II. Data and methods

Description of data

The data collected and employed in this research constitute monthly wheat and flour prices, exchange rates and consumer price indices. Annual data on production, consumption and imports of wheat and flour in Afghanistan are also used. The period of analysis runs from March 2004 to June 2015. Table 1 provides additional details about the data used in this study. Moreover, the retail prices of wheat and flour in the individual provincial central markets represent 'provincial wheat and flour markets' while their average denotes 'Afghan (national) wheat and flour markets' in this study. The export prices of U.S. No. 2 hard red winter wheat at U.S.

[2]The aggregate demand for wheat in the country may be underestimated as no population census has been conducted since 1979 and the current estimates of the population are not very reliable.
[3]Unlike other countries that mainly import wheat, Afghanistan imports flour in large quantities as compared to wheat. For instance, the share of wheat and flour imports was, on average, 25% and 75% during 2011/2012, respectively.

Table 1. Description of the data collected and used in the analysis.

Data series	Description	Sources
Domestic wheat prices Domestic flour prices	Monthly retail prices of wheat and flour in seven central provincial markets (*Kabul, Jalalabad, Kandahar, Hirat, Maimana, Balkh and Faizabad*) (Period: March 2004 to June 2015)	*Market Price Bulletin*, Vulnerability Analysis and Mapping Project, World Food Program, Country Office in Afghanistan
Pakistani wheat prices Pakistani flour prices	National average of monthly retail prices of wheat and flour across major markets in Pakistan (Period: January 2006 to June 2015)	*Food Prices Monitoring and Analysis Tool/GIEWS*, Food and Agriculture Organization, Web: http://www.fao.org/giews/pricetool/
Kazakh wheat prices	Monthly export f.o.b. prices of Kazakh milling wheat at *Aktau* port (Period: October 2006 to June 2015)	*Accessed* Pakistani (Wheat and Flour) and Kazakh Wheat: 16 August 2015 US No.2 HRWW and Kyrgyz Flour:
Kyrgyz flour prices	National average of the first grade Kyrgyz flour monthly retail prices (Period: October 2006 to June 2015)	18 October 2015
U.S. No. 2 HRWW prices	Monthly export f.o.b. prices of U.S. No. 2 Hard Red Winter Wheat (HRWW) at U.S. Gulf	
Consumer price indices (CPIs)	CPIs (all items) of Afghanistan, Pakistan, Kazakhstan, Kyrgyzstan and U.S.A.	*International Financial Statistics*, International Monetary Fund Web: http://data.imf.org
Exchange rates (ERs)	Dollar value of Afghani and Pakistani Rupees	*Accessed*: 14 September 2015
Miscellaneous	Annual data on wheat production, consumption and imports	Central Statistics Organization; Agriculture Prospects Reports (2004/2005–2014/2015) by Ministry of Agriculture, Irrigation and Livestock of Afghanistan

Source: Authors' compilation.
Flour prices stands for wheat flour throughout the text. f.o.b. is short for free on board. Since Kazakh flour prices data are not available, national average of Kyrgyz first grade flour retail prices are used as the proxy for Kazakh flour prices.

Gulf are used as the global reference prices. Pakistani wheat and flour, Kazakh wheat and Kyrgyz flour prices represent 'the suppliers' wheat and flour markets'. Since flour prices are not available for Kazakhstan, Kyrgyz flour prices are used as the proxy for Kazakh flour prices.[4] Kabul, Jalalabad, Kandahar, Hirat, Maimana, Balkh and Faizabad represent the domestic wheat and flour markets. The first three are located in wheat-deficit zones while the remaining are situated in wheat-surplus zones. All the markets, excluding Faizabad, are located on the 'national ring road'. Faizabad is also connected to the road through a secondary road (Figure 1).

The Afghan wheat and flour prices are basically the prices of imported wheat and flour in local markets. A small amount of domestic wheat and flour enter local markets, which are perceived as low quality by consumers. Since wheat and flour are imported from different countries, they have different quality standards. Kazakh wheat and flour are of high quality followed by that of Pakistani and Uzbek. The quality differences may be a source of asymmetric equilibrium relationships among the wheat and flour markets (Ghoshray 2002).

Description of methods

A pre-requisite for cointegration tests is that the price series should be integrated of the same order, which can be determined by unit root tests. Thus, to fulfil this condition and examine the non-stationarity property of the price series, Phillips–Perron (1988) and Kwiatkowski et al. (1992) unit root tests (hereinafter PP and KPSS tests) are used in this study. These two tests complement each other and may provide a high consistency in testing for unit roots. This is mainly because the null hypothesis of PP test is non-stationarity or unit root whereas that of KPSS test is stationarity. Hence, the low power of PP test in rejecting a false null hypothesis may be corrected by KPSS test.[5]

Enders and Siklos (2001) argue that the standard cointegration tests and their extensions are misspecified if adjustment is asymmetric. To account for asymmetry in cointegrating relationship, they extended the Threshold Autoregressive (TAR) and Momentum Threshold Autoregressive (M-TAR) models of Enders and Granger (1998) to a multivariate context. TAR model can capture aspects of 'deep movements' whereas M-TAR captures aspects of 'steep movements' in a price series (Enders and

[4]Kyrgyz and Kazakh flour prices are cointegrated under asymmetric adjustment (Table 3), hence they may move together in the long run.
[5]The results of PP and KPSS tests indicated that all the wheat and flour prices have unit root in level but they are stationary in the first difference. To save some space, the results of unit root tests are omitted here.

Granger 1998). The power of M-TAR model is superior to that of TAR and Engle and Granger tests. It is particularly useful if the objective is to smooth out any large change in a series (Enders and Siklos 2001). Since global and domestic prices of wheat and flour experienced a dramatic spike in 2007–2008, we applied the consistent M-TAR model to account for this large change in the price series. Equations (1)–(3) below are jointly known as the consistent M-TAR model. In M-TAR model, the speed of adjustment towards equilibrium depends on the direction of previous period's change in $\hat{\varepsilon}_{t-1}$, that is, $\Delta\hat{\varepsilon}_{t-1}$. Accordingly, the speed of adjustment is $\rho_1\hat{\varepsilon}_{t-1}$, if deviations from the long-run equilibrium are positive, and $\rho_2\hat{\varepsilon}_{t-1}$ otherwise.

$$\Delta\hat{\varepsilon}_t = I_t\rho_1\hat{\varepsilon}_{t-1} + (1 - I_t)\rho_2\hat{\varepsilon}_{t-1} + \sum_{i=1}^{p-1}\delta_i\Delta\hat{\varepsilon}_{t-i} + \omega_t, \tag{1}$$

where I_t is the Heaviside indicator function such that:

$$I_t = \begin{cases} 1 \text{ } if \ \Delta\hat{\varepsilon}_{t-1} \geq \tau \\ 0 \text{ } if \ \Delta\hat{\varepsilon}_{t-1} < \tau \end{cases}, \tag{2}$$

where τ is a consistent threshold value; ρ_1 and ρ_2 denote adjustment coefficients; δ_i shows the coefficient(s) of lagged changes; and ω_t is i.i.d. disturbance term. The necessary and sufficient conditions for stationarity of $\hat{\varepsilon}_t$ are $\rho_1<0$, $\rho_2<0$ and $(1+\rho_1)(1+\rho_2)<1$ for any values of τ (Petruccelli and Woolford 1984). Tong (1983, 1990) showed that the least square estimates of ρ_1 and ρ_2 have an asymptotic multivariate normal distribution provided that $\hat{\varepsilon}_t$ series is stationary.

The M-TAR model is adopted in this study to examine the long-run relationship among the pairs of wheat and flour markets assuming asymmetric adjustment mechanism. To conduct threshold cointegration test with M-TAR adjustment, the following five-step procedure is adopted. First, a long-run relationship between the pairs of wheat and wheat-flour markets is estimated as follows:

$$P_{1,t} = \alpha_0 + \beta P_{2,t} + \varepsilon_t, \tag{3}$$

where $P_{1,t}$ and $P_{2,t}$ are logarithm of real wheat or flour prices in two spatially separated markets at time t; α_0 is constant term accounting for transaction costs and quality differences; β is elasticity of price transmission; and ε_t is disturbance term which may be serially correlated. Second, consistent estimates of threshold values for M-TAR models were obtained using Chan (1993) approach. It involves arranging the estimated residuals series, $\hat{\varepsilon}_t$, in ascending order and trimming 15% of both the smallest and the largest observations. The remaining 70% of values are considered as potential threshold. Equations (1) and (2) are estimated for each of the possible threshold. A superconsistent estimate of threshold,τ, is obtained by minimizing the sum of squared residuals from the fitted model. Third, the long-run relationship among the pairs of wheat and flour markets is examined by testing the null hypothesis of no cointegration, that is, $\rho_1 = \rho_2 = 0$, for each of the M-TAR model using the Φ-*statistic* instead of the *F-statistic* which have a non-standard distribution. This is equivalent to testing the estimated residuals, $\hat{\varepsilon}_t$, from Equation (3) for non-stationarity. If the null hypothesis of no cointegration is rejected, $\hat{\varepsilon}_t$ is stationary and the pairs of wheat and flour markets are cointegrated with M-TAR adjustment. Fourth, given that the null hypothesis of no cointegration is rejected, the null hypothesis of no asymmetric adjustment, that is, $\rho_1 = \rho_2$, is tested for each of the M-TAR model using the standard *F-test*. Since adjustment is symmetric if $\rho_1 = \rho_2$, Engle–Granger (1987) cointegration test represent a special case of M-TAR model. Fifth, Ljung–Box *Q-statistic* is used to ensure that the estimated residuals from M-TAR models, $\hat{\omega}_t$, follow a white noise process (Enders and Siklos 2001).

The Granger representation theorem postulates that an error correction model can best represent cointegrated series (Engle and Granger 1987). Upon confirmation of cointegration among the pairs of wheat and flour markets, the dynamics of price transmission among them are analysed using Asymmetric Vector Error Correction Models (AVECMs) with threshold (M-TAR) adjustment using the Equation below:

$$\Delta P_{1,t} = \mu_0 + \alpha^+ e^+_{t-1} + \alpha^- e^-_{t-1} + \sum_{i=1}^{p-1}\gamma_i\Delta P_{1,t-i} + \sum_{i=1}^{p-1}\theta_i\Delta P_{2,t-i} + \upsilon_t, \tag{4}$$

where $\Delta P_{1,t}$ is the first difference of logarithm of real wheat or flour prices at time *t*; $P_{1,t}$ and $P_{2,t}$ are logarithm of real wheat or flour prices in two spatially separated markets at time t; α^+ and α^- denote the speed of adjustment to positive and negative divergence from long-run equilibrium; the positive and negative error correction terms are defined as $\alpha^+ e^+_{t-1} = I_t \rho_1 \hat{\varepsilon}_{t-1}$ and $\alpha^- e^-_{t-1} = (1 - I_t)\rho_2 \hat{\varepsilon}_{t-1}$, where, I_t has the same definition as in Equation (2); γ_i and θ_i are short-run adjustment coefficients; and υ_t is the i.i.d. disturbance term. The null hypothesis of no short-run asymmetric adjustment, that is, $\alpha^+ = \alpha^-$, and Granger causality are examined using the standard *F-test*.

Since the equilibrium adjustment is not asymmetric for all the pairs of wheat and flour markets (Tables 2–5), Symmetric Vector Error Correction Models (SVECMs) are also estimated as follows:

$$\Delta P_{1,t} = \mu_0 + \alpha e_{t-1} + \sum_{i=1}^{p-1} \gamma_i \Delta P_{1,t-i} + \sum_{i=1}^{p-1} \theta_i \Delta P_{2,t-i} + \upsilon_t, \quad (5)$$

where $\Delta P_{1,t}$, $P_{1,t}$, $P_{2,t}$, γ_i, θ_i and υ_t are the same as in Equation (4); and αe_{t-1} is the error correction term. The orthogonalized impulse response functions (IRFs) are estimated for each of the SVECM to trace the effects of a shock in the principal wheat and flour market on that of other markets. The appropriate lag order for unit root tests, M-TAR models, AVECMs and SVECMs is selected using Akaike and Bayesian information criteria (hereinafter AIC and BIC) and ensuring that the residuals are not serially correlated using Ljung–Box *Q-statistic* at 4, 8 and 12 lags. The data analysis is carried out in R using the relevant packages, for example, apt, tsDyn (R Core Team 2015). It should be noted that spatial market integration and price transmission between the surplus and deficit wheat production zones as well as between rural and urban markets, and vertical price transmission along the wheat and flour value chain are not in the scope of the present research. These issues may be the subject matter of future investigations.

III. Empirical results

Threshold cointegration among the pairs of wheat and flour markets

A pre-condition for conducting cointegration tests is that price series should be integrated of the same order. PP and KPSS tests showed that all the wheat and flour prices are integrated of the same order, that is, I(1). Hence, the long-run equilibrium relationships among the pairs of wheat and flour markets were examined using the consistent M-TAR models.

Threshold cointegration between the pairs of wheat markets

The results of threshold cointegration are summarized in Table 2. It is evident that the null hypothesis of no cointegration, that is, $\rho_1 = \rho_2 = 0$, is rejected at less than the 10% significance level for all the pairs

Table 2. Results of threshold cointegration between the pairs of wheat markets.

Market pairs	Lag	ρ_1	ρ_2	τ	Hypothesis test: Φ-*Statistic* ($\rho_1 = \rho_2 = 0$)	Hypothesis test: *F-Statistic* ($\rho_1 = \rho_2$)
Balkh–Kabul	0	0.078	−0.178***	0.070	7.513***	5.559**
		(0.426)	(0.000)	[0.675]	(0.001)	(0.020)
Faizabad–Kabul	3	−0.087	−0.186***	−0.018	4.635***	1.402
		(0.129)	(0.006)	[0.776]	(0.011)	(0.239)
Hirat–Kabul	0	−0.314***	−0.118**	0.065	8.063***	3.344*
		(0.001)	(0.034)	[0.843]	(0.000)	(0.070)
Jalalabad–Kabul	1	−0.297***	−0.155**	0.022	7.111***	1.572
		(0.002)	(0.021)	[0.533]	(0.001)	(0.212)
Kandahar–Kabul	1	−0.109**	−0.308**	−0.047	4.902***	2.151
		(0.037)	(0.018)	[0.498]	(0.009)	(0.145)
Maimana–Kabul	4	−0.306***	−0.206***	0.028	7.350***	0.723
		(0.007)	(0.002)	[0.755]	(0.001)	(0.397)
Afghan–Pakistani	4	−0.200***	−0.126***	0.015	7.492***	0.784
		(0.005)	(0.010)	[0.215]	(0.001)	(0.378)
Afghan–Kazakh	4	−0.156**	−0.073*	0.020	3.826**	0.928
		(0.047)	(0.061)	[0.258]	(0.025)	(0.338)
Afghan–Global	3	−0.155*	−0.054	0.033	2.778*	1.023
		(0.088)	(0.144)	[0.296]	(0.067)	(0.314)

Source: Authors' estimation results.
***, ** and * indicate 1%, 5% and 10% level of significance, respectively. The figures in brackets and parenthesis are the minimum residuals at which the threshold value (τ) is selected and *p*-values, respectively; and ρ_1 and ρ_2 denote positive and negative long-run adjustment coefficients, respectively. The lag order is selected based on AIC ensuring that there is no autocorrelation and specification is a best fit.

of wheat markets. This suggests that the provincial wheat markets have a long-run relationship with the principal wheat market of Kabul. Moreover, Afghan wheat markets are also cointegrated with global and suppliers', that is, Kazakhstan and Pakistan, wheat markets. The standard cointegration test of Engle and Granger reported similar results for most of the wheat market pairs except the ones for Balkh–Kabul, Faizabad–Kabul, Afghan–Kazakh and Afghan–Global (Appendix 1).

Since the pairs of wheat markets are cointegrated, it is possible to test the null hypothesis of no asymmetric adjustment, that is, $\rho_1 = \rho_2$, using the standard *F-test* (Enders and Granger 1998). The null hypothesis of no asymmetric adjustment was not rejected at the conventional significance levels for all the pairs of provincial wheat markets except for the wheat market pairs of Balkh–Kabul and Hirat–Kabul. This indicates that the provincial wheat markets may adjust symmetrically to changes in Kabul wheat market, Balkh and Hirat wheat markets being exceptions. Likewise, Afghan wheat markets also adjust symmetrically to changes in global, Kazakh and Pakistani wheat markets in the long run (Table 2).

The coefficients of adjustment to positive (ρ_1) and negative (ρ_2) deviations from long-run equilibrium have the correct signs for convergence. They are statistically significant for all the pairs of the wheat markets, except for Balkh–Kabul and Faizabad–Kabul in case of ρ_1 and Afghan–Global in case of ρ_2. This suggests that most of the wheat market pairs respond to both positive and negative divergences from the long-run equilibrium. Hirat, Jalalabad and Maimana wheat markets adjust faster to positive divergence from their long-run equilibrium with Kabul wheat market such that about 30% of any positive deviation is corrected each month. Meanwhile, Balkh, Faizabad and Kandahar wheat markets adjust faster to negative deviation from the equilibrium such that nearly 18%, 19% and 31% of a unit negative deviation is removed each month, respectively. Afghan wheat markets adjust faster to positive than negative divergences from the long-run equilibrium with respect to global, Kazakh and Pakistani wheat markets such that as much as 16%, 16% and 20% of any positive deviation is eliminated each period, respectively (Table 2).

Threshold cointegration between the pairs of flour markets

Table 3 reports the results of threshold cointegration between the pairs of flour markets. The null hypothesis of no cointegration, that is, $\rho_1 = \rho_2 = 0$, is rejected for all the pairs of flour markets at less than the 5% significance level. This indicates that the provincial flour markets have a long-run relationship with the principal market of Kabul. Likewise, Afghan flour markets are cointegrated with Kyrgyz (Kazakh) and Pakistani flour markets. The standard cointegration test of Engle–Granger

Table 3. Results of threshold cointegration between the pairs of flour markets.

					Hypothesis test	
Market pairs	Lag	ρ_1	ρ_2	τ	Φ-*Statistic* $(\rho_1 = \rho_2 = 0)$	*F-Statistic* $(\rho_1 = \rho_2)$
Balkh–Kabul	0	0.037	−0.215***	0.041	9.328***	7.052***
		(0.648)	(0.000)	[0.415]	(0.000)	(0.009)
Faizabad–Kabul	0	−0.092	−0.377***	0.004	13.221***	6.979***
		(0.237)	(0.000)	[0.570]	(0.000)	(0.009)
Hirat–Kabul	2	−0.037	−0.316***	0.021	8.991***	5.883**
		(0.705)	(0.000)	[0.379]	(0.000)	(0.017)
Jalalabad–Kabul	2	−0.093	−0.274***	0.021	6.707***	2.292
		(0.357)	(0.000)	[0.346]	(0.002)	(0.132)
Kandahar–Kabul	0	−0.261***	−0.067	0.003	8.280***	4.623**
		(0.000)	(0.270)	[0.296]	(0.000)	(0.033)
Maimana–Kabul	3	−0.244***	−0.148**	0.016	5.995***	0.798
		(0.004)	(0.050)	[0.547]	(0.003)	(0.373)
Afghan–Pakistani	4	−0.255***	−0.114***	0.040	10.227***	3.126*
		(0.001)	(0.003)	[0.176]	(0.000)	(0.080)
Afghan–Kyrgyz	5	−0.437***	−0.053	0.007	13.704***	15.136***
		(0.000)	(0.396)	[0.225]	(0.000)	(0.000)
Kyrgyz–Kazakh	0	−0.022	−0.169**	−0.035	3.003**	3.299*
		(0.571)	(0.019)	[0.398]	(0.054)	(0.072)

Source: Authors' estimation results.

***, ** and * indicate 1%, 5% and 10% level of significance, respectively. The figures in brackets and parenthesis are the minimum residuals at which the threshold value (τ) is selected and *p*-values, respectively; and ρ_1 and ρ_2 denote positive and negative long-run adjustment coefficients, respectively. The lag order is selected based on AIC ensuring that there is no autocorrelation and specification is a best fit.

reported similar results (Appendix 1). Thus, domestic wheat and flour markets are integrated among themselves and with those of supplier countries and the world.

Given that the pairs of flour markets were found to be cointegrated, the null hypothesis of no asymmetric adjustment, that is, $\rho_1 = \rho_2$, is tested using the standard *F-test*. Unlike the provincial wheat markets, the evidence of long-run asymmetric adjustment is observable for the majority of the provincial flour markets. That is, all the provincial flour markets adjust asymmetrically to changes in Kabul flour market excluding Jalalabad and Maimana flour markets. Afghan flour markets also adjust asymmetrically to changes in the suppliers', that is, Pakistani and Kyrgyz (Kazakh), flour markets (Table 3).

The coefficients of adjustment to positive (ρ_1) and negative (ρ_2) deviations from long-run equilibrium have the correct signs for convergence. While ρ_2 is statistically significant for most of the flour market pairs, ρ_1 is significant only for a half of the flour market pairs. Balkh, Faizabad, Hirat and Jalalabad adjust faster to negative deviation such that about 21%, 38%, 32% and 27% of a unit negative divergence is corrected each month, respectively. But, Kandahar and Maimana adjust faster to positive deviations from their long-run equilibrium with Kabul flour market such that around 26% and 24% of any positive deviation is eliminated each month, respectively. Furthermore, Afghan flour markets also adjust faster to positive discrepancies from the long-run equilibrium with respect to Pakistani and Kyrgyz (Kazakh) flour markets such that about 26% and 44% of any positive deviation is removed each month, respectively (Table 3).

It is often assumed that the landlocked countries with poor infrastructure such as Afghanistan are much less likely to be following the movements in global and regional food prices (Zorya, Townsend, and Delgado 2012). Since Afghan wheat and flour markets showed a long-run relationship with their respective global, Kazakh and Pakistani markets, the assumption may be rejected for Afghanistan's wheat and flour markets. Hassanzoy et al. (2015) reported similar results for rice markets in the country. The adoption of the market economy system in 2004 with the new constitution, implementation of structural adjustments, reconstruction of the 'national ring road' and other secondary roads, improvements in telecommunication, lower tariff on imports with no quantitative trade restrictions and strong reliance on imports may be the possible factors that may have improved the integration of domestic wheat and flour markets with regional and global markets.

APT among the pairs of wheat and flour markets

APT between the pairs of wheat markets

The results of APT for the pairs of wheat markets are presented in Table 4. It is evident that the positive and negative error correction coefficients of all the pairs of wheat markets have the expected signs for convergence, except for the positive adjustment coefficient of Balkh–Kabul market pair. Among the provincial wheat markets, Hirat, Jalalabad and Kandahar wheat markets adjust to positive deviation from their long-run equilibrium with Kabul wheat market such that about 16%, 27% and 1% of a unit positive divergence is corrected each month, respectively. Moreover, Balkh, Faizabad, Hirat and Maimana wheat markets

Table 4. Results of asymmetric price transmission for the pairs of wheat markets.

					Hypothesis test	
Market pairs	α^+	n^+	α^-	n^-	AS-test ($\alpha^+ = \alpha^-$)	GC-test
Balkh–Kabul	0.216**	9	−0.212***	12	16.446***	1.581
	(0.033)		(0.000)		(0.000)	(0.184)
Faizabad–Kabul	−0.049	48	−0.118*	21	0.669	3.944***
	(0.393)		(0.085)		(0.415)	(0.005)
Hirat–Kabul	−0.163*	15	−0.182***	14	0.034	3.788***
	(0.093)		(0.002)		(0.854)	(0.006)
Jalalabad–Kabul	−0.267***	10	−0.113	22	1.305	3.049**
	(0.014)		(0.167)		(0.255)	(0.051)
Kandahar–Kabul	−0.084**	29	−0.170	15	0.609	8.530***
	(0.052)		(0.117)		(0.437)	(0.000)
Maimana–Kabul	−0.177	14	−0.196***	13	0.025	2.109*
	(0.107)		(0.002)		(0.875)	(0.084)
Afghan–Pakistani	−0.204***	12	−0.107**	23	1.606	2.821**
	(0.002)		(0.017)		(0.208)	(0.030)
Afghan–Kazakh	−0.198***	13	−0.038	62	4.448**	0.328
	(0.004)		(0.262)		(0.038)	(0.805)
Afghan–Global	−0.170**	15	−0.029	81	3.387*	2.430**
	(0.016)		(0.345)		(0.069)	(0.053)

Source: Authors' estimation results.
***, ** and * indicate 1%, 5% and 10% level of significance, respectively. α^+ and α^- are positive and negative error correction coefficients, respectively; n^+ and n^- indicate the time required to eliminate 90% of positive and negative deviations from the long-run equilibrium, respectively. Figures in brackets are *p*-values. The lag order is selected by AIC and BIC criteria ensuring that there is no autocorrelation and the model is best fit. GC: Granter Causality; AS-test: Asymmetry Test.

respond to negative deviations from their long-run equilibrium with Kabul wheat market such that as much as 21%, 12%, 18% and 20% of any negative deviation is corrected each month, respectively.[6] The time required to eliminate 90% of a unit positive and negative deviation from the long-run equilibrium is minimum for Jalalabad and Balkh wheat markets, that is, 10 and 12 months, respectively. This may be partly explained by the relative proximity of these two markets to the principal market of Kabul.

Afghan wheat markets adjust to any positive deviation from the long-run Afghan–Pakistani, Afghan–Kazakh and Afghan–Global equilibrium such that about 20%, 20% and 17% of a unit positive deviation is eliminated each month, respectively. Meanwhile, Afghan wheat markets adjust to negative divergence merely from its long-run equilibrium with Pakistani wheat markets as almost 11% of any negative deviation is corrected each month. Being the closest major supplier of wheat to Afghanistan, the time required to eliminate 90% of a unit positive and negative deviation from the long-run equilibrium is minimum for Pakistani (12 and 23 months) wheat markets, followed by Kazakh (13 and 62 months) and global (15 and 91 months) wheat markets (Table 4).

The null hypothesis of no short-run asymmetric adjustment is rejected at the conventional levels of significance for Balkh–Kabul, Afghan–Kazakh, and Afghan–Global wheat market pairs. This indicates that the remaining wheat market pairs adjust symmetrically to divergences from the long-run equilibrium. Moreover, Kabul wheat market Granger causes majority of the provincial wheat markets with Balkh wheat market being the only exception. But, Balkh province alone may Granger cause Kabul wheat market. However, Pakistani and global wheat prices may Granger cause Afghan wheat prices but the same is not true for Kazakh wheat prices. It should be noted that if one or both of the speed of adjustment coefficients are significant, the causality might not be rejected (Table 4, Appendix 2). Accordingly, the results of Granger causality for Balkh and Kazakh wheat markets are not supported by the speed of adjustment coefficients.

Since Balkh is a surplus wheat market, the major destination for Kazakh wheat imports and relatively distant from Kabul wheat market, it adjusts asymmetrically to changes in Kabul wheat market. The ongoing market and trade reforms, the recent improvements in transportation infrastructure and the presumably lower probability of the existence of market power in domestic wheat markets may be the influential factors for the symmetric adjustment of the majority of provincial wheat markets (Schulte 2007). Moreover, the faster adjustment of Afghan wheat markets to positive deviations from the long-run equilibrium with Pakistani, Kazakh and global wheat markets indicates that imperfections such as concentration may exist in the wheat markets because traders may be willing to adjust faster to price changes that expand their margins than to those that squeeze their margins (Goletti and Babu 1994; Ghoshray 2002, 2011). While Afghan wheat markets adjust to only positive deviations from the long-run Afghan–Global and Afghan–Kazakh equilibrium, they adjust to both positive and negative divergence from the long-run Afghan–Pakistani equilibrium. The same is true for Afghan flour markets (Table 5). This may be due to the evidences that Afghan traders have built a very close partnership with their Pakistani counterparts and flourmills over the years, which ensures adequate supplies of wheat and flour to Afghanistan; provision of selling wheat and flour on credit by the suppliers; and existence of unofficial trade across the long border between the two countries (Khan 2007).

APT between the pairs of flour markets

Table 5 summarizes the results of APT between the pairs of flour markets. It is observed that the positive and negative adjustment coefficients imply convergence in the case of all the flour market pairs excluding the positive adjustment coefficient for Balkh–Kabul market pair. Among the provincial flour markets, Hirat and Maimana flour markets adjust to positive divergence from their long-run equilibrium with Kabul flour market such that as much as 25% and 23% of any positive deviation from the long-run equilibrium is removed each month, respectively. Balkh and Hirat flour markets respond to negative discrepancy from their long-run equilibrium with Kabul flour market in a way that 14% and 15% of a unit negative deviation from

[6]Kabul wheat market does not adjust to disequilibrium with respect to Faizabad, Jalalabad and Kandahar whereas it adjust asymmetrically to positive divergence from the long-run Kabul–Balkh, Kabul–Hirat and Kabul–Maimana equilibrium. This suggests that Kabul wheat market may be price leader, but it may not be true for all the provincial flour markets (see Appendix 2).

Table 5. Results of asymmetric price transmission for the pairs of flour markets.

Market pairs	α^{+}	n^{+}	α^{-}	n^{-}	Hypothesis test AS-test ($\alpha^{+}=\alpha^{-}$)	GC-test
Balkh–Kabul	0.182*	11	−0.140**	18	8.390***	2.304*
	(0.070)		(0.029)		(0.004)	(0.062)
Faizabad–Kabul	−0.041	57	−0.128	19	0.493	3.820***
	(0.670)		(0.150)		(0.484)	(0.006)
Hirat–Kabul	−0.253**	10	−0.147*	17	0.676	2.632**
	(0.020)		(0.101)		(0.413)	(0.038)
Jalalabad–Kabul	−0.190	13	−0.133	18	0.120	1.759
	(0.177)		(0.228)		(0.729)	(0.142)
Kandahar–Kabul	−0.117	21	−0.032	73	0.549	3.805***
	(0.166)		(0.666)		(0.460)	(0.012)
Maimana–Kabul	−0.225***	11	−0.107	23	1.050	1.813
	(0.011)		(0.174)		(0.308)	(0.167)
Afghan–Pakistani	−0.291***	9	−0.130***	19	3.850**	6.383***
	(0.000)		(0.001)		(0.053)	(0.000)
Afghan–Kyrgyz	−0.298***	9	−0.027	86	8.053***	2.010
	(0.000)		(0.660)		(0.006)	(0.140)

Source: Authors' estimation results.
***, ** and * indicate 1%, 5% and 10% level of significance, respectively. α^{+} and α^{-} are positive and negative error correction coefficients, respectively; $n^{+}$and n^{-} indicate the time required to eliminate 90% of positive and negative deviations from the long-run equilibrium, respectively. Figures in brackets are *p*-values. The lag order is selected by AIC and BIC criteria ensuring that there is no autocorrelation and the model is best fit. GC: Granter Causality; AS-test: Asymmetry Test.

the long-run equilibrium is corrected each period, respectively. The time required to correct 90% of any positive and negative deviation from the long-run equilibrium is 10 and 17 months for Hirat flour market, which is minimum among the provincial flour markets. However, Faizabad, Jalalabad and Kandahar flour markets may be weakly exogenous with respect to Kabul flour market because the respective adjustment coefficients are not statistically significant at the conventional levels of significance.[7] The null hypothesis that Kabul flour prices do not Granger cause the provincial flour prices is rejected for most of the provincial flour markets at the conventional levels of significance, except for Jalalabad and Maimana flour markets.[8] Since the positive adjustment coefficient is significant for Maimana–Kabul flour market pair, the causality cannot be rejected.

Afghan flour markets adjust to any positive and negative divergence from their long-run equilibrium with Pakistani flour markets such that about 29% of a unit positive and 13% of a unit negative deviation is eliminated each month. However, Afghan flour markets respond only to positive deviation from the long-run Afghan–Kyrgyz (Kazakh) equilibrium such that about 30% of any positive deviation from the equilibrium is removed each month. The time required for correcting 90% of a unit positive deviation from the long-run Afghan–Pakistani and Afghan–Kyrgyz (Kazakh) equilibrium is 9 months whereas 19 months may be required to remove a similar magnitude of any negative deviation from the long-run Afghan–Pakistani equilibrium (Table 5).

Among the provincial flour markets, the null hypothesis of no short-run asymmetric adjustment is rejected only for Balkh flour market. Likewise, Afghan flour markets adjust asymmetrically to changes in Pakistani and Kyrgyz (Kazakh) flour markets. Pakistani flour prices Granger cause Afghan flour prices and vice versa whereas the same is not true for Kazakh flour prices. However, the highly significant speed of adjustment coefficients implies that Kyrgyz (Kazakh) flour prices affect Afghan flour markets (Table 5).

Since the results of Balkh wheat and flour markets are similar, the same explanations provided for the wheat markets also holds with its flour market. Faizabad is located in a surplus zone and relies more on supplies from Balkh than Kabul flour market. Jalalabad and Kandahar markets have shared the border with Pakistan and are major routes of Pakistani flour imports. Thus, they may be less or not influenced by Kabul flour markets. The asymmetric adjustment of Afghan flour prices to changes in Pakistani and Kyrgyz (Kazakh) flour markets implies that inefficiencies may exist in the flour markets and trade.

Symmetric price transmission (SPT) among the pairs of wheat and flour markets

It was shown in the preceding sections that the adjustment mechanism is symmetric for most of the wheat and flour market pairs. Thus, SVECMs were also estimated for the wheat and flour market pairs.

[7]Kabul flour market may be weakly exogenous with regard to Balkh, Kandahar and Maimana flour markets, but adjusts asymmetrically to deviations from its long-run equilibrium with Faizabad, Hirat and Jalalabad flour markets (Appendix 3).

[8]Conversely, the null hypothesis that the provincial flour prices do not Granger cause Kabul flour market is rejected for all the provincial flour markets except for Faizabad flour market. This may not hold for Balkh, Kandahar and Maimana flour markets, as the corresponding speed of adjustment coefficients are not significant (Appendix 3).

SPT between the pairs of wheat markets

The results of SVECMs for the pairs of wheat markets are presented in Panel A of Table 6. It is evident from the Table that the error correction coefficients imply convergence and are significant for all the provincial wheat market pairs at the conventional levels of significance. This indicates that the provincial wheat markets adjust to any divergence from their long-run equilibrium with Kabul wheat market. That is, as much as 15%, 8%, 18%, 17%, 9% and 19% of any deviation from the long-run Balkh–Kabul, Faizabad–Kabul, Hirat–Kabul, Jalalabad–Kabul, Kandahar–Kabul, and Maimana–Kabul equilibrium is removed each month, respectively.[9] The time required to eliminate 90% of discrepancies from the long-run equilibrium is minimum for Maimana wheat market (13 months) whereas it is maximum for Faizabad wheat market (31 months). While about 65% of a change in Kabul wheat market is transmitted to Kandahar wheat market, the magnitude of price transmission is 84% for Hirat wheat market.

Afghan wheat markets adjust to deviations from the long-run Afghan–Pakistani, Afghan–Kazakh and Afghan–Global equilibrium such that about 14%, 7% and 5% of any divergence from the long-run equilibrium is eliminated each period, respectively. Accordingly, it takes 18, 33 and 48 months to remove 90% of deviations from the long-run Afghan–Pakistani, Afghan–Kazakh and Afghan–Global equilibrium, respectively. The magnitude of price transmission is larger for Pakistani wheat market (71%), followed by global (37%) and Kazakh (31%) wheat markets. The above results suggest that the coefficients of speed of adjustment and magnitude of price transmission are larger with respect to Pakistani wheat markets. This may be due to the fact that Pakistan is the closest major supplier of wheat to Afghanistan (Panel A of Table 6).

SPT between the pairs of flour markets

The results of SVECMs for the pairs of flour markets are summarized in Panel B of Table 6. Unlike wheat markets, the error correction coefficient is statistically significant only for Hirat, Jalalabad and Maimana flour markets such that about 19%, 15% and 14% of any deviation from their long-run equilibrium with Kabul flour market is corrected each month, respectively.[10] This is consistent with the results of asymmetric price transmission albeit with some exceptions such as Jalalabad and Balkh flour markets. Thus, the same discussion also applies here. While 13 months are needed

Table 6. Results of symmetric PT for the pairs of wheat and flour markets.

	Panel A: Wheat markets			Panel B: Flour markets		
Market pairs	ECT	*n* (90%)	*β*	ECT	*n* (90%)	*β*
Balkh–Kabul	−0.146*** (0.003)	17	0.720*** (0.000)	−0.056 (0.336)	42	0.819*** (0.000)
Faizabad–Kabul	−0.077* (0.098)	31	0.825*** (0.000)	−0.089 (0.197)	27	0.893*** (0.000)
Hirat–Kabul	−0.178*** (0.001)	14	0.836*** (0.000)	−0.188*** (0.011)	13	0.811*** (0.000)
Jalalabad–Kabul	−0.170*** (0.010)	15	0.835*** (0.000)	−0.154* (0.097)	16	0.860*** (0.000)
Kandahar–Kabul	−0.092** (0.028)	26	0.650*** (0.000)	−0.070 (0.205)	34	0.857*** (0.000)
Maimana–Kabul	−0.192*** (0.001)	13	0.699*** (0.000)	−0.135** (0.035)	18	0.724*** (0.000)
Afghan–Pakistani	−0.139*** (0.000)	18	0.707*** (0.000)	−0.162*** (0.000)	15	0.525*** (0.000)
Afghan–Kazakh	−0.073** (0.019)	33	0.312*** (0.000)	−0.194*** (0.000)	13	0.510*** (0.000)
Afghan–Global	−0.049* (0.091)	48	0.386*** (0.000)	–	–	–

Source: Authors' estimation results.
***, ** and * indicate 1%, 5% and 10% level of significance, respectively. The lag order is selected by AIC and BIC criteria ensuring that there is no autocorrelation and the model is best fit. ECT is the error correction term or short-run speed of adjustment. *n* (90%) indicates the time required to eliminate 90% of any deviations from the long-run equilibrium. *β* is the elasticity of price transmission estimated from Equation (3).

[9] The results of SVECM for Kabul wheat market suggest that it may be weakly exogenous with respect to the provincial wheat markets as indicated by the non-significance of the corresponding error correction coefficients at the conventional levels of significance (Panel A of Appendix 4). Unlike AVECMs, this suggests that Kabul wheat market may be a price leader for the rest of provincial markets.

[10] The results of SVECM for Kabul flour market indicate that it adjusts to Balkh and Faizabad flour markets whereas it may be weakly exogenous to changes in the remaining provincial flour markets (Panel B of Appendix 4).

to eliminate 90% of any deviation from the long-run Hirat–Kabul equilibrium, it requires 18 months to remove a similar magnitude of any divergence from the long-run Maimana–Kabul equilibrium. Moreover, the maximum extent of price transmission is recorded for Faizabad flour market (89%) whereas the minimum is registered for Maimana flour market (72%).

Afghan flour markets respond to deviations from the long-run Afghan–Pakistani and Afghan–Kyrgyz (Kazakh) equilibrium in such a way that 16% and 19% of any divergence is corrected each month, respectively. Accordingly, it takes 15 and 13 months to remove 90% of a discrepancy from the long-run Afghan–Pakistani and Afghan–Kazakh equilibrium, respectively. The above results indicate that unlike Afghan wheat markets, Afghan flour markets adjust faster to Kyrgyz (Kazakh) than Pakistani flour markets. This is consistent with the recent increase in imports of flour from Kazakhstan than Pakistan. However, the magnitude of price transmission is slightly larger for Pakistani (53%) than Kyrgyz (Kazakh) (51%) flour prices (Panel B of Table 6).

IRFs of wheat and flour prices

Panels (a–f) of Figure 2 depict the IRFs of the provincial wheat markets with respect to a shock in Kabul wheat market. A common trend that can be observed from the IRFs is that a one standard deviation unit shock in Kabul wheat market has a rapid positive effect on all of the provincial wheat markets for the initial few months but the effect is stabilized at a higher level afterwards. This indicates that the shock has had long-lasting effect on the provincial wheat markets, although the magnitude of response appears low. Panels (a–f) of Figure 3 trace the IRFs of the provincial flour markets with respect to a shock in Kabul flour market. The IRFs depict common patterns similar to

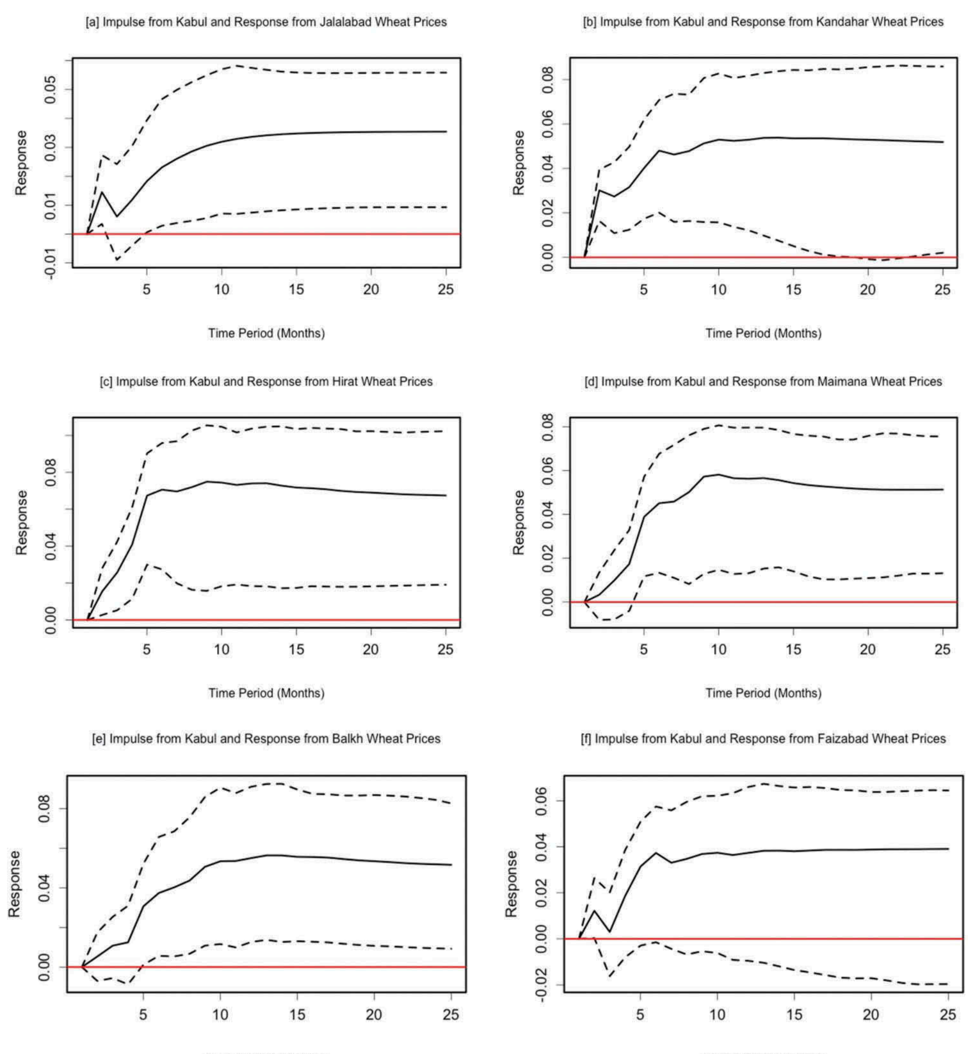

Figure 2. The effect of a shock in Kabul wheat market on provincial wheat markets. Source: Authors' estimation results.

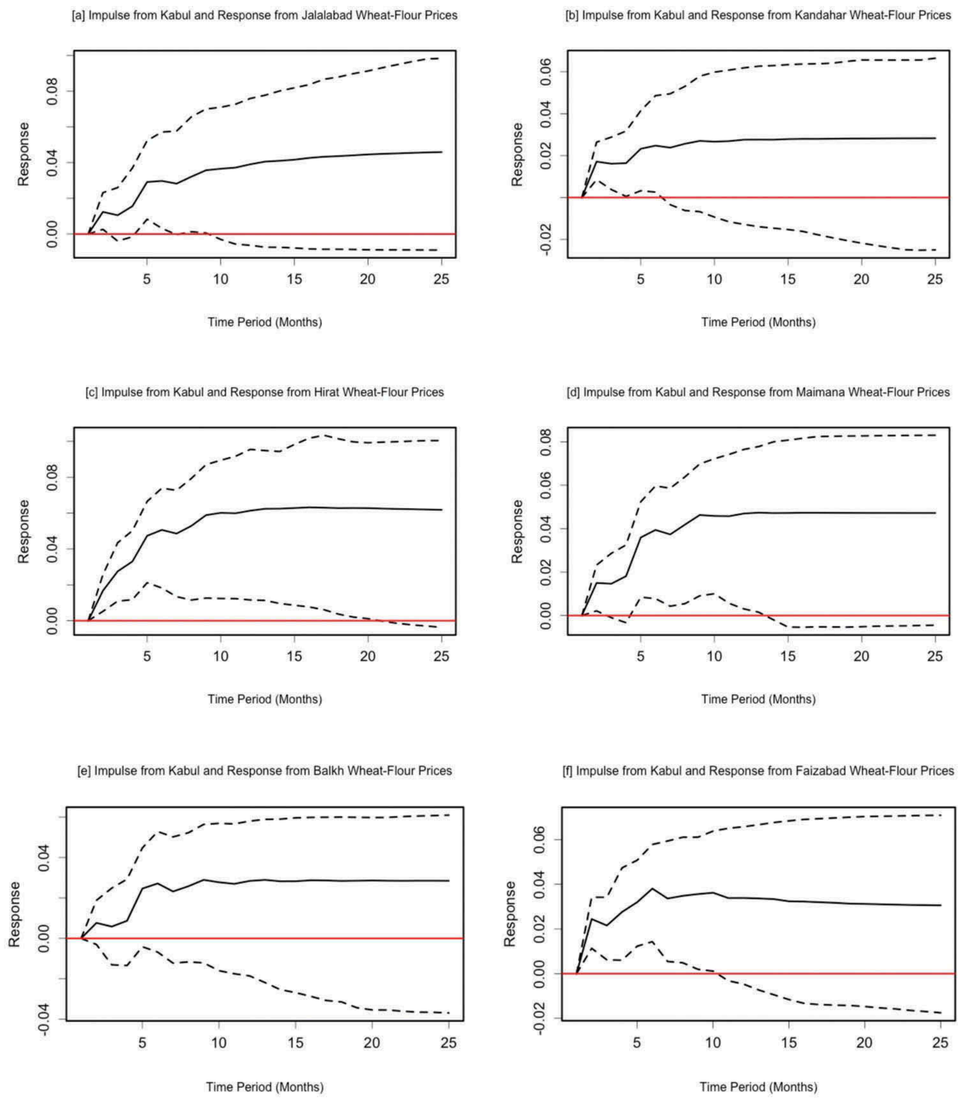

Figure 3. The effect of a shock in Kabul flour market on provincial flour markets. Source: Authors' estimation results.

those of wheat markets. Hence, the results of wheat IRFs also holds with the provincial flour markets.

The impulse response functions of Afghan wheat markets with respect to a shock in Pakistani wheat, Pakistani flour, Kazakh wheat, Kyrgyz (Kazakh) flour and global wheat prices are depicted on panels (a–e) of Figure 4, respectively. A shock in Pakistani, Kazakh and global wheat markets has a rapid increasing effect on Afghan wheat prices for the initial few months, but the effect is declined rapidly (except for Kazakh wheat) and eventually stabilized at a lower level afterwards. A similar pattern holds with Kyrgyz (Kazakh) and Pakistani flour markets albeit with the latter initially showing a negative effect. It may be said that these wheat and flour markets have had transitory effects on Afghan flour markets and the response level of Afghan markets appears relatively low.

IV. Conclusions and policy implications

Despite the landlocked situation, poor infrastructure, weak marketing and trade institutions, high transportation costs and political instability in the country, Afghan wheat and flour markets may be cointegrated with their corresponding global, Kazakh and Pakistani markets. The provincial wheat and flour markets may be also cointegrated with the principal market of Kabul. However, the relatively small values of the speed of adjustment coefficients imply that the respective wheat and flour markets may be weakly integrated. This is also consistent with the results of the impulse response analysis. Thus, appropriate measures should be taken to enhance integration among wheat and flour markets in the country.

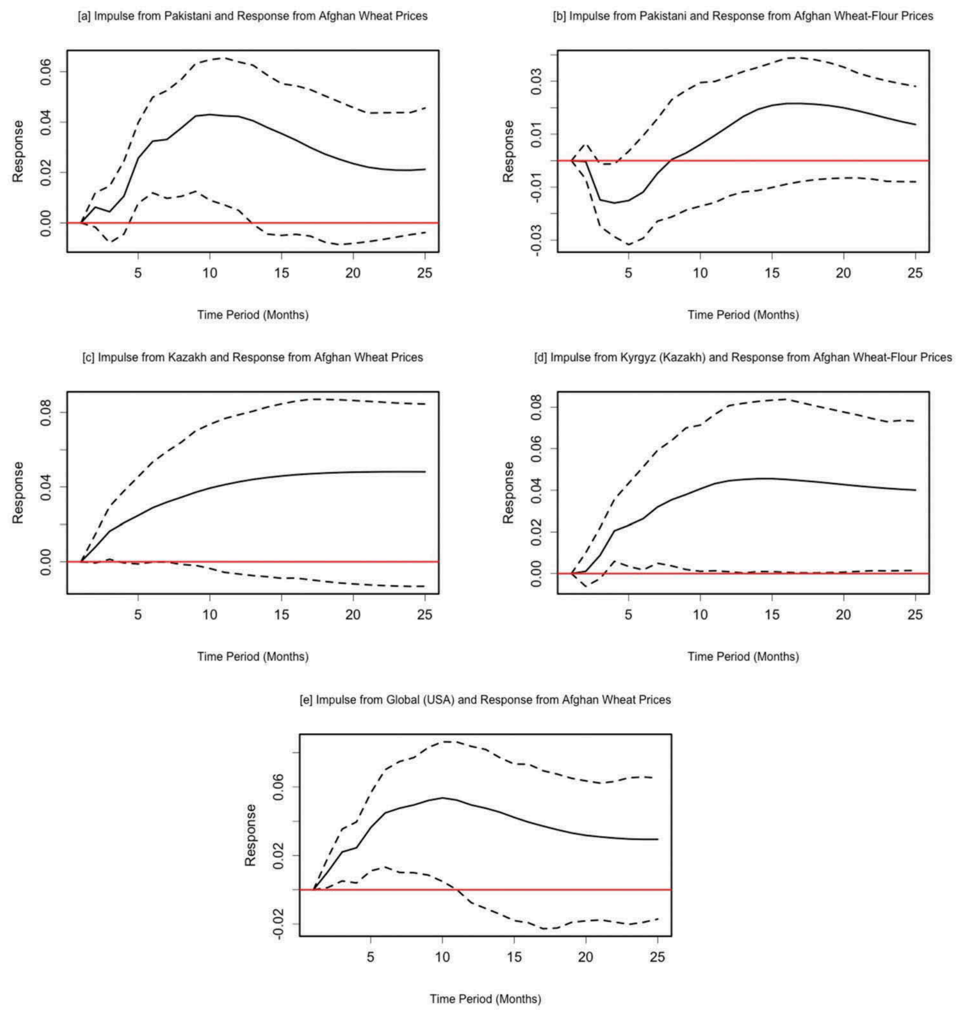

Figure 4. The effect of a shock in global and regional wheat and flour markets on Afghan wheat and flour markets. Source: Authors' estimation results.

The presence of long-run asymmetry in some of the wheat and most of the flour markets implies that persistent imperfections may exist in the markets. Among the provincial markets, short-run asymmetric adjustment is observed in Balkh wheat and flour markets alone. Although Afghan wheat markets adjust symmetrically to Pakistani wheat markets, they adjust asymmetrically to Pakistani flour, Kyrgyz (Kazakh) flour, Kazakh wheat and global wheat markets. This also suggests the existence of imperfections such as market power in the wheat and flour markets, which may not only deteriorate the welfare of consumers and farmers but also prevent the effective implementation of agricultural policies. Hence, appropriate measures that reduce market imperfections and enhance the functioning of wheat and flour markets may be needed. The speed of adjustment towards the long-run Afghan–Pakistani and Afghan–Kazakh equilibrium may be faster for Afghan flour than wheat markets. This may be due to the fact that Afghanistan imports large volumes of flour as compared with wheat. While Afghan wheat prices adjust faster to Pakistani wheat prices, Afghan flour prices adjust faster to Kyrgyz (Kazakh) flour prices. Nevertheless, a shock in Kabul wheat and flour markets may have a long-lasting effect on the corresponding provincial markets whereas a shock in global wheat, Pakistani wheat and flour, Kazakh wheat and Kyrgyz (Kazakh) flour markets might have a transitory effect on the respective Afghan markets.

Since Afghan wheat and flour markets are cointegrated among themselves as well as with those of supplier countries and global markets, any shock (domestic, global or regional) can affect wheat and flour markets in the country. This may necessitate taking precautionary measures such as monitoring changes in wheat and flour prices and maintaining emergency grain reserves. Although the provincial markets of wheat and flour are cointegrated among themselves, the market participation of Afghan farmers and commercial flour mills is very limited and the markets are rather occupied by imported wheat and flour. Besides, to achieve the 'self-sufficiency' objective of the national wheat policy, measures such as increasing the marketable surplus of farmers, supporting the development of a modern wheat processing industry and improving the quality of domestic wheat and flour may be undertaken. Moreover, to enhance integration and reduce imperfections among wheat and flour markets in the country, the following measures may be adopted: (1) improving the rural and urban transportation infrastructure; (2) reducing the influence of big traders and the supplier countries on domestic wheat and flour markets; (3) enhancing marketing infrastructure (physical and institutional); (4) providing reliable market information to farmers, processors and traders through the establishment of a reliable marketing information system; (5) regulating the activities of private sector involved in wheat imports and transportation; (6) reducing production, processing and transfer costs; (7) enhancing market participation of the farmers and (8) ensuring political stability.

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Appendix 1. Results of Engle and Granger (EG) cointegration test.

Panel A: EG-test for wheat markets		Panel B: EG-test for flour markets	
Market pairs	Test statistic	Market pairs	Test statistic
Balkh–Kabul	−3.048	Balkh–Kabul	−3.218*
Faizabad–Kabul	−2.973	Faizabad–Kabul	−4.356***
Hirat–Kabul	−3.493**	Hirat–Kabul	−3.416**
Jalalabad–Kabul	−3.899**	Jalalabad–Kabul	−4.637***
Kandahar–Kabul	−3.543**	Kandahar–Kabul	−3.635**
Maimana–Kabul	−3.722**	Maimana–Kabul	−3.952**
Critical Value 1% (***): −3.979 5% (**): −3.382 10% (*): −3.076			
Afghan–Pakistani	−3.778**	Afghan–Pakistani	−4.498***
Afghan–Kazakh	−2.596	Afghan–Kyrgyz	−3.115*
Afghan–Global	−2.973	Kyrgyz–Kazakh	−1.827
Critical Value 1% (***): −4.006 5% (**):−3.397 10% (*):−3.087			

Source: Authors' estimation results.

Appendix 2. Results of asymmetric price transmission for Kabul wheat market.

					Hypothesis test	
Market pairs	α^+	n^+	α^-	n^-	AS-test ($\alpha^+ = \alpha^-$)	GC-test
Kabul–Balkh	0.294***	7	−0.005	462	7.693***	2.708**
	(0.005)		(0.922)		(0.006)	(0.033)
Kabul–Faizabad	0.063	35	0.082	27	0.054	0.636
	(0.263)		(0.216)		(0.816)	(0.637)
Kabul–Hirat	0.216***	9	−0.030	78	6.462***	1.305
	(0.018)		(0.575)		(0.012)	(0.272)
Kabul–Jalalabad	0.041	55	0.071	31	0.050	0.389
	(0.706)		(0.388)		(0.824)	(0.678)
Kabul–Kandahar	−0.064	37	−0.072	33	0.002	1.577
	(0.314)		(0.650)		(0.960)	(0.185)
Kabul–Maimana	0.213**	10	0.010	229	2.936*	0.615
	(0.051)		(0.876)		(0.089)	(0.653)

Source: Authors' estimation results.
***, ** and * indicate 1%, 5% and 10% level of significance, respectively; α^+ and α^- are positive and negative error correction coefficients, respectively; n^+ and n^- indicate the time required to eliminate 90% of positive and negative deviations from the long-run equilibrium, respectively. Figures in brackets are *p*-values. The lag order is selected by AIC and BIC criteria ensuring that there is no autocorrelation and the model is best fit. GC: Granter Causality; AS-test: Asymmetry Test.

Appendix 3. Results of asymmetric price transmission for Kabul flour market.

Market pairs	α^{+}	n^{+}	α^{-}	n^{-}	Hypothesis test: AS-test ($\alpha^{+}=\alpha^{-}$)	Hypothesis test: GC-test
Kabul–Balkh	0.126	17	0.079	28	0.199	4.308***
	(0.180)		(0.183)		(0.657)	(0.003)
Kabul–Faizabad	0.038	59	0.236***	9	3.260*	0.439
	(0.659)		(0.003)		(0.073)	(0.780)
Kabul–Hirat	−0.291***	9	0.154*	14	10.825***	3.278***
	(0.011)		(0.102)		(0.001)	(0.014)
Kabul–Jalalabad	−0.175	14	0.174*	12	5.566**	2.008*
	(0.166)		(0.079)		(0.020)	(0.098)
Kabul–Kandahar	.142	15	0.059	38	0.369	2.550*
	(0.159)		(0.508)		(0.545)	(0.059)
Kabul–Maimana	0.098	22	0.020	114	0.574	2.470*
	(0.212)		(0.779)		(0.450)	(0.089)

Source: Authors' estimation results.

***, ** and * indicate 1%, 5% and 10% level of significance, respectively; α^{+} and α^{-} are positive and negative error correction coefficients, respectively; $n^{+}$and n^{-} indicate the time required to eliminate 90% of positive and negative deviations from the long-run equilibrium, respectively. Figures in brackets are *p*-values. The lag order is selected by AIC and BIC criteria ensuring that there is no autocorrelation and the model is best fit. GC: Granter Causality; AS-test: Asymmetry Test.

Appendix 4. Results of SVECMs for Kabul and provincial wheat and flour markets

Market Pairs	Panel A: Wheat markets ECT	Panel A: n (90%)	Panel A: β	Panel B: Flour markets ECT	Panel B: n (90%)	Panel B: β
Kabul–Balkh	0.041	55	0.624***	0.091*	24	0.752***
	(0.391)		(0.000)	(0.085)		(0.000)
Kabul–Faizabad	0.071	31	0.577***	0.148*	14	0.763***
	(0.119)		(0.000)	(0.019)		(0.000)
Kabul–Heart	0.023	99	0.619***	−0.019	122	0.919***
	(0.642)		(0.000)	(0.809)		(0.000)
Kabul–Jalalabad	0.060	37	0.809***	0.048	47	0.917***
	(0.357)		(0.000)	(0.569)		(0.000)
Kabul–Kandahar	−0.065	37	0.792***	0.096	23	0.848***
	(0.292)		(0.000)	(0.145)		(0.000)
Kabul–Maimana	0.055	41	0.684***	0.081	27	0.775***
	(0.334)		(0.000)	(0.163)		(0.000)

Source: Authors' estimation results.

***, ** and * indicate 1%, 5% and 10% level of significance, respectively. The lag order is selected by AIC and BIC criteria ensuring that there is no autocorrelation and the model is best fit. β is the elasticity of price transmission estimated from Equation-(3). ECT is the error correction term or short-run speed of adjustment.