Price Transmission in Afghanistan's Wheat Markets

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ABSTRACT. Variability in wheat prices in recent years in Afghanistan has highlighted the need for the country to consider policies to stabilize its wheat markets. Reliance on international markets did not stabilize domestic wheat prices during the 2007-08 food crisis. Policy responses to stabilize the domestic wheat market are conditioned on the degree of market integration with world and regional markets. We use a VECM (Vector Error Correction Model) to assess price transmission signals from regional to domestic markets, and between rural and urban areas in Afghanistan. Our analysis shows that in the long-run domestic prices follow wheat prices in the Central Asian region and Pakistan for the whole period, Jan 2004-Apr 2015. However, price adjustment occurs very slowly, particularly with respect to prices in Kazakhstan. Moreover, the regression analysis reveals that the Pakistan's export ban in 2008 has had a major impact on price shocks in Afghanistan. After the export restriction policy there is not a statistically significant price linkage between Afghanistan and Pakistan. Our analysis also show that markets are not well integrated between rural and urban areas in Afghanistan. Given the export restriction polices from Pakistan and weak market integration with Kazakhstan, in addition to reliance on international trade, Afghanistan may need to consider stocks polices to manage seasonality and delays in imports, and improve infrastructure in order to prevent price shocks in its domestic wheat market. Also, pursuing a self-sufficiency policy requires attention to market integration between rural and urban areas, in addition to the mechanism to increase wheat production.

Keywords: Afghanistan; Wheat; Price stabilization; Food security; Trade policy

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1. Introduction

The price shocks in international grain market during the 2007-2008 food crisis had a profound impact on food security in Afghanistan (D'Souza and Jolliffe, 2012). The increase in wheat prices in Afghanistan was much greater than the price increases experienced in the world wheat market, and even greater than those experienced in the regional wheat markets (Figure 1). The greater increase in wheat prices in Afghanistan in 2008 implies that local and regional issues dominated. The increase in wheat prices in Afghanistan was mainly due to low production in the country combined with export restrictions by Pakistan.

Wheat production is very volatile in Afghanistan, ranging from a high of over 5 million metric tons (MMT) in 2012 to a low of 2.1 MMT in 2008 (U.S. Department of Agriculture, 2015). While Afghanistan produces more than half of its wheat requirement, the country now imports a large amount of wheat and wheat flour, primarily from Pakistan and the Central Asian region to meet its domestic needs. Over the period 2000-2012 Afghanistan, on average produced 65% of its wheat requirements and imported the remainder (U.S. Department of Agriculture, 2015).

Afghanistan neighboring country, Pakistan, has a relatively stable supply of wheat. The Pakistani government intervenes heavily in its domestic wheat market to ensure stability. Provincial governments in major wheat producing provinces, and PASSCO (Pakistan Agriculture Storage and Supplies Corporation) procure annually about 20% of total Pakistani wheat production to support farmer incomes. The government also subsidizes wheat sales to flour mills or directly to consumers to stabilize prices at affordable levels to consumers (Dorosh, 2009).

Pakistan’s stabilization policy played a key role in price stability in Afghanistan before 2008. Afghanistan could free ride on Pakistan’s subsidy policy to make up its wheat deficit by importing subsidized wheat and flour from Pakistan. However, Pakistan’s policy changed during the 2007/08 food crisis. The country banned exports of wheat, including to Afghanistan, in January, 2008. This broke the linkage between Pakistan and Afghanistan wheat markets (Persaud, 2010). Pakistan’s ban on wheat exports to Afghanistan allowed Kazakhstan to increase its exports to Afghanistan. Since then Afghan wheat prices have had a higher correlation with prices of Central Asian countries (Kazakhstan, Tajikistan, Kyrgyzstan) than with Pakistani prices. Variability in wheat prices has increased in Afghanistan since 2008 as a result of

Pakistani policy reform. This is mainly because wheat markets in the Central Asian region are not as stable as in Pakistan. Thus, some of the variability in the Afghan domestic market is imported from the central Asian markets. Figure 1 and Figure 2 show monthly average flour and wheat prices of Afghanistan, Pakistan, and the Central Asian region.

Recent price shocks in Afghanistan suggest that reliance on international markets does not always guarantee price stability. The government of Afghanistan needs to examine policy options to combine with a trade policy in order to manage price instability in its wheat and flour markets. Policy responses to stabilize the wheat market are conditioned on whether Afghanistan is well integrated into the world market, as well as the integration level across rural and urban markets within the country. Trade policy without complementary stockholding policy is not as effective in the case of imperfect integration into world markets. Stocks policy is also needed to complement trade policy in order to manage seasonal price shocks along with delays in import delivery (Abbott, 2010). But, policy regimes that subsidize and boost domestic production may lower prices in wheat producing areas if markets are poorly integrated across rural and urban areas.

The Afghan Ministry of Agriculture, Irrigation and Livestock (MAIL) has considered in its recent national wheat policy document increasing wheat production to turn the country self-sufficient in wheat (MAIL, 2013). However, the national wheat policy document is focused on increasing wheat production, and pays little attention to trade policies and market integration between rural and urban areas. The bumper wheat harvest in 2009 showed that an increase in domestic production does not fully replace imports if rural marks are not well connected to urban markets (Halimi, 2011).

The price spikes in wheat and flour markets during 2007-08 in Afghanistan has made the Afghan government consider holding public stocks. MAIL, with the help of the Food and Agriculture Organization (FAO) developed a framework for a strategic grain reserves in 2013. The Strategic Grain Reserve plan, however, does not make a clear distinction between emergency reserves and buffer stocks. Although the strategic grain reserve program was proposed to stabilize prices, it is mainly used as an emergency reserve now. The rules for procuring and releasing wheat are not well defined, and there is no research on the optimal size nor mechanisms for holding public stocks in Afghanistan.

There has not been much research on domestic market integration in Afghanistan, nor integration of wheat markets with the Central Asian region and Pakistan. Chabot and Dorosh (2007) used monthly wheat price data over the 2002-2005 period for major markets in Afghanistan and Pakistan to assess market integration. They conducted formal econometric tests to explore issues of market integration between major cities within Afghanistan, and integration between markets in Afghanistan and Pakistan. Their findings suggested that wheat prices in major markets in Afghanistan and in Lahore, Pakistan, tended to move together in the long run (Chabot and Dorosh, 2007). However, this does not appear to be true after 2008, mainly due to the export restriction policies from the government of Pakistan.

In this study we examine the degree to which Pakistani wheat and flour price signals have been transmitted to Afghanistan domestic markets during the last 15 years. We also examine the transmission of wheat and flour price shocks from Central Asian countries to Afghanistan's domestic markets. We assess whether Pakistan is more or less integrated into the world market than the countries in the Central Asian region. We look into price transmission of wheat and flour between rural and urban areas in Afghanistan, as well. Market integration across commercial centers in Afghanistan is also assessed both in the long-run and short-run. Finally, we assess the effects of export restriction policy by the government of Pakistan on price transmission between Afghanistan-Pakistan versus Afghanistan-Kazakhstan.

2. Food Price Stabilization

The stability of staple food supply and prices has been a concern of many governments. Although there is debate both in favor of and against price stabilization in the literature, many successful developing countries have tried to stabilize food grains prices through different forms of policy intervention (Timmer, 1989). In his recent book, while Timmer expresses a firm belief in the market as the core for solving problems of food insecurity, he puts considerable emphasis on food price stabilization (Timmer, 2015).

Recent spikes in food prices made many developing countries rethink their policies regarding public stockholding, and their reliance on the international markets (Dorosh, 2009). The traditional view was that domestic price variability is largely due to domestic factors

(Byerlee et al., 2006). Thus, the recommendation has been to use trade liberalization to manage domestic price instability. However the 2007-2008 food crisis proved that the presumption of a relatively stable world market is not always right, and that reliance on international trade does not always guarantee domestic price stabilization (Baltzer, 2014; Dorosh, 2009).

The effectiveness of the trade liberalization on price stability depends on the degree of integration of domestic markets with world markets (Abbott, 2010). Trade liberalization is likely to be less effective if the domestic market is not well integrated with world markets. In the case of imperfect integration into world markets, stocks policy may be required as a complement to trade policy to deal with seasonal price dynamics, along with delays in import delivery (Abbott, 2010). Most developing countries use a combination of stocks and trade policy to adjust to both production shortfalls and world price spikes. Price shocks during pre-harvest periods can also be better managed by stockholding policy.

Grain markets in many developing countries do not appear to be well integrated into the world market, and the price signals from the world market are not transferred to their domestic markets quickly. Baffes and Gardner (2003) used an error correction model to estimate dynamic price linkages for eight countries and ten commodities. They found that agricultural markets in developing countries are often not integrated even after substantial policy reform following IMF conditionality. However, the extent of the domestic price adjustments to shocks in the world prices over a three-year period increases in most cases, when a significant policy shift is observed (Baffes and Gardner, 2003).

Minot (2011) used a VECM model with 62 domestic price series data for maize, rice, and wheat in nine Sub-Saharan African countries to assess their price relationships with the world market. His findings show that only 13 of the 62 price series data are cointegrated with the world price in the long-run. Moreover, only 6 of the 13 had a long-term elasticity of price transmission that was statistically significant. More recently, Abbott et al., (2014) uses a similar methodology to examine the transmission of world price shocks to Vietnam's domestic market. Their results show low speed of adjustment to the Law of One Price, and imperfect price transmission (Abbott et al., 2014). The long-run elasticity of price transmission from the world to domestic markets are not only low, but also incomplete (Baquedano and Liefert, 2014).

The price transmission pattern from international grain markets to domestic markets in developing countries during the 2007-08 food crisis varies across countries (Baltzer, 2014).

Using the prices for maize, rice and wheat in 14 developing countries, Baltzer (2014) finds that China and India kept their markets segmented from world market to ensure stability in their domestic prices. Brazil and South Africa stayed well connected to international grain market and let the price shocks pass-through in their domestic markets. The price shocks were much greater in some isolated grain importing countries such as Ethiopia and Nigeria than those in the world grain market.

The effects of food price variability on food security and poverty are different across countries. Price shocks have more severe impacts on poverty and food insecurity in countries where food consumption is dominated by one major staple (Byerlee et al., 2006). Landlocked countries which are segmented from the world market are vulnerable to domestic production shocks, especially drought. Low income countries which are net importers of grain products are most exposed to world price variability (Byerlee et al., 2006). In most African countries, the increase in food prices and input costs have hurt consumers, governments, and possibly some farmers, while the impacts varied across countries depending on import dependency, availability of domestic substitutes, and the efficiency of policy response (Abbott and de Battisti, 2011).

Policy responses to keep food price stable are country specific and require different interventions in the short, medium and long-term (Byerlee et al., 2006). Governments should focus on long term investments in market development, and productivity growth, while at the same time use short-term programs to manage price instability. Policy must first address the domestic sources of instability, because domestic factors dominate in most years (Abbott, 2010).

Although reliance in international markets does not always guarantee price stability, it is a low cost price stabilization option as long as the import parity price is not higher than government policy targets for domestic prices. Given the 2007-08 grain price shocks, Dorosh (2009) argues that governments should not over-react and implement policies that result in large welfare losses. Instead, governments should consider a combination of policies, including national stocks, reliance on world markets, promotion of domestic production, and safety net programs, to deal with price instability (Dorosh, 2009).

It is important that policies at borders are coordinated with domestic production and storage polices in order to stabilize domestic prices. An optimal storage policy, without a trade policy, does not improve consumers' welfare, as its stabilizing benefits may leak to the world market (Gouel and Jean, 2015). Storage may increase domestic prices through additional demand for stockpiling, but it is not effective at preventing price shocks. Gouel and Jean (2015) find that an optimal combination of public stock policies and trade policies are effective in stabilizing domestic food prices. Their results show that an optimal combination of trade and storage policy eliminates both upper and lower parts of the domestic price distribution, and this can lead to welfare gains.

3. Characteristics of the Afghan Wheat Market

Wheat is an important staple food in Afghanistan, accounting for over half of the calorie intake of the population (Chabot and Dorosh, 2007; Persaud, 2010). This places individual Afghans among the world's top wheat consumers, with a national annual consumption of over six million metric tons (U.S. Department of Agriculture, 2015). Wheat is also a major crop in Afghanistan, accounting for about 70 percent of cultivated land area and one quarter of agricultural GDP (Persaud, 2010; World Bank, 2014). However, domestic production does not meet the national demand. Afghanistan imports a large quantity of wheat and flour, primarily from Pakistan and Kazakhstan.

Afghanistan is a landlocked country bordered on the south and the east by Pakistan, on the west by Iran, and on the north by Tajikistan, Uzbekistan, and Turkmenistan. With the exception of Kazakhstan none of the major wheat exporting countries is a significant supplier of wheat to Afghanistan. Kazakhstan, as an alternative to Pakistan, had been seen as a costly option to import wheat from, since Kazakhstan does not share a border with Afghanistan. The transportation costs of importing wheat from Kazakhstan to the northern province of Herat were estimated to be $60 per metric ton in 2007 (Schulte, 2007). However, the findings from our trader survey show much higher transaction and transportation costs for importing wheat and flour from Northern Kazakhstan, where wheat is produced, to Mazar, Afghanistan. Estimated transportation and transaction costs, including taxes and tariffs, for importing wheat from northern Kazakhstan to Mazar is nearly $150 per metric tons based on our trader survey. These findings are consistent with Chabot and Tondel (2011) estimates of transportation and transaction costs of nearly $150 per metric tons between northern Kazakhstan and Dushanbe, Tajikistan. Moreover, most of the wheat deficit provinces are located to the south and east in

Afghanistan, close to the Pakistani border, which further increases the costs of importing wheat from Kazakhstan.

With a shared border of 1,600 kilometers and a long history of trade, Pakistan has been relatively a low cost source for Afghanistan to import its excess demand for wheat and flour. Pakistan heavily subsidizes its wheat and flour industry, which greatly benefits consumers in Afghanistan. The Pakistan government procured about 9.2 MMT of wheat in 2009/10, and released this quantity with a subsidy of 4.28 Rs/Kg. The total subsidy costs were 39.5 billion Rupees in that year; that is about 463 million dollars (Dorosh, 2012). There are 700 operational mills in Pakistan and many of them are strategically located near the Afghan border (Schulte, 2007). Moreover, most of wheat deficit provinces are located in the southern and eastern regions of Afghanistan, near the Pakistani border (Halimi, 2011).

Afghanistan's wheat markets appear to be well integrated across major cities. Afghanistan's Ring Road plays a critical role in connecting major commercial centers and removing physical constraints to trade between them. Chabot & Dorosh (2008) used cointegration analysis with monthly price data for the period 2002-2005 to examine market integration with Pakistan. Their results suggest that wheat and flour markets between major cities in Afghanistan are reasonably well connected.

Market integration across rural and urban areas in Afghanistan is an important issue that policy makers should consider while thinking about policies to stabilize wheat and flour markets in Afghanistan. Wheat markets across rural and urban areas do not appear to be as well integrated (Halimi, 2011). Figure 3 shows the price series data across Daykundi and commercial centers. Daykundi is a wheat deficit rural market where we observe wheat prices are much higher than the prices in commercial centers. The big difference in price series data of Daykundi versus commercial centers suggests there are high transportation and transaction costs associated with moving wheat and flour between rural and urban areas in Afghanistan.

In this study we assess the relationship between price series data in each of the five commercial centers in Afghanistan along with price sets for Pakistan and Kazakhstan. The five commercial centers are Herat, Jalalabad, Kabul, Kandahar and Mazar. Figure 4 shows the location of these commercial centers and the selected rural markets used in our study.

To examine the price transmission of wheat between rural and urban areas, we assess the relationship between price series data of rural areas with their closest commercial centers. The selected five rural markets which are partially segmented from the commercial centers and the world market are: Bamyan, Badakhshan, Faryab, Ghor, and Daykundi. The rural areas are selected based on the proximity to commercial centers and the availability of monthly price data for the given rural markets from WFP (2015). Some of these markets might be more integrated with their closest commercial centers than others. Moreover, Daykundi and Bamyan are in wheat deficit areas, while the others are wheat surplus markets in a normal production year. Bamyan is close to the central Kabul, Badakhshan is at the north-east close to Mazar, Faryab is at the north-west close to Herat and Mazar, Ghor is close to Herat at the west central, and Daykundi is close to Kandahar in the south. The local markets may not be equally segmented from commercial centers, given different distance and road conditions between these local markets and their closest commercial centers. Considering the distance to the closest commercial center, Badakhshan appears to be less integrated with its commercial center than other rural markets.

4. The Price Transmission Model

There are several methods used to measure spatial price transmission. The traditional methodology used to assess the degree of market integration relied on correlations between pairs of market prices in different regions. Recent studies on the integration of agricultural markets in developing countries have typically relied on co-integration analysis to test whether price series data move together (Fafchamps and Gavian, 1996). More recently Baffes and Gardner (2003) used an error correction model to estimate dynamic price linkages for eight countries and ten commodities. Minot (2011) and Abbott (2014) have used similar methodology for price transmission analysis.

In this study we use a vector error correction model (VECM) to assess the transmission of wheat price signals in Pakistan and the Central Asian region to domestic markets (commercial centers) in Afghanistan, as in Minot (2011).

The VECM model can be used if each variable is nonstationary and integrated to degree 1, written as I (1). This implies that variable is nonstationary in levels, but its first difference is stationary. Also, VECM requires that variables are cointegrated. This means that a linear combination of the variables is stationary. The residual from regressing one nonstationary variable on another needs to be stationary (Minot, 2011). We will use the Augmented Dickey-Fuller and the Phillips-Perron tests to examine the stationarity of price series data and their corresponding linear combination.

Following Minot (2011), the analysis for each pair of prices under consideration consists of three steps:

1. We test each price series data individually for nonstationarity using the Augmented Dicky-Fuller (Dickey and Fuller, 1979), and Phillips-Perron (Phillips and Perron, 1988) tests.
2. We determine whether the two price series data are cointegrated, using the ADF and PP tests on the residuals of each corresponding level regression.
3. If there is a long-run relationship between the two price series data based on the cointegration tests, then we estimate the VECM.

The long-run relationship between the world price and domestic price can be captured by the following level regression.

$$p_t^d = \mu + \beta p_t^w + \varepsilon_t \tag{1}$$

Where p_t^d and p_t^w are the domestic and the world price of a given commodity in time t, often expressed in logarithms. μ and β are parameters to be estimated, and ε_t denotes the error term. The coefficient β is the long-run elasticity of price transmission. From the above regression the law of one price holds if β equals unity and the intercept term equals zero, assuming small transportation and transaction costs.

Once the long-run elasticity of price transmission (β) is estimated from equation (1), we use the residual from the level model to estimate the VECM. The simplified form of VECM is presented in equation (2), following Minot (2011);

$$\Delta p_t^d = \alpha + \theta(p_{t-1}^d - \hat{\beta} p_{t-1}^w) + \delta \Delta p_t^w + \rho \Delta p_{t-1}^d + u_t \tag{2}$$

Where p_t^d and p_t^w are the domestic and the world price of a given commodity in time t expressed in logarithms. Δ is the difference operator which indicates the first-difference of a variable. The estimated parameters are α, θ, β, δ, and ρ, and u_t is the error term.

The economic interpretation of the coefficients in equation (2) are as follows: The coefficient (β) is estimated in the level model in logarithmic form as in equation (1), and is the long-run elasticity of price transmission. The expected value of (β) is between zero and one. If equal to unity, (β) implies that prices are cointegrated, and all proportional changes in the international price will be transmitted to the domestic price in the long-run. The coefficient on the error correction term (θ) is called the speed of adjustment. The expected value is between zero and negative one. The larger (θ) is in absolute value, the more quickly the domestic price adjusts to changes in the world price. The coefficient on the first-difference of the world price (δ) is the short-run elasticity of price transmission. It is interpreted as the percentage adjustment of domestic price to change in the world price in the current period. Its expected value is less than the long-run elasticity of price transmission (β), and greater than zero. The last coefficient in equation (2) is (ρ). This is the autoregressive term, interpreted as the changes in the domestic price due to changes in the domestic price in the previous period.

We calculate the time it takes for domestic prices to adjust to the changes in the international price using the short-run elasticity of price transmission (δ) and the speed of adjustment coefficient (θ). The short-run elasticity of price transmission shows the portion of price adjustment in the current period. Further adjustment in each period is accumulated using the speed of adjustment coefficient following Baffes and Gardner (2003). The estimated 4-month price adjustment is reported (in % of long-run adjustment) for all price series.

5. Data:

The data for this study are monthly price series data measured in US$ per metric tons for Afghanistan, Pakistan and the Central Asian region. The domestic monthly price data for four commercial centers (Kabul, Kandahar, Jalalabad and Herat) are available from FAO GIEWS for the period January 2000 to April 2015 (FAO, 2015). The monthly price series data for commercial center Mazar and the five rural markets are obtained from (WFP, 2015).

The price data for Pakistan are obtained from FAO (2015), but are available only for the January 2004 to April 2015 period. Price series data for Kazakh and US (Gulf) wheat, and for Kyrgyzstan's flour are also obtained from FAO GIEWS. We could not get access to the monthly price data for Kazakhstan's flour. Instead the monthly price data for Kyrgyzstan are used as a proxy. The results from both ADF and PP tests on the residuals of a regression of Kyrgyzstan wheat price with Kazakhstan price indicates that the two series are cointegrated, at a 95% confidence level. Descriptive statistics of the data are presented in table A1, and the Kazakh-Kyrgyzstan price relationship is presented in table A3, in the appendix.

6. Results

Results from our analysis are presented in several parts. First, we present the results from the diagnostic tests run on the price series data to determine the stationarity properties of each individual price series. Second, results examining market integration of Afghanistan, Pakistan and Kazakhstan with the world wheat market are presented. Third, we show the results of price transmission from Pakistan and the Central Asian region to Afghanistan's domestic markets. Fourth, the results assessing the effects of policy reform on price transmission are presented. Finally, price transmission across commercial centers and across rural and urban markets within Afghanistan are presented.

All price series data are nonstationary in levels, but their first differences are all stationary, based on the Augmented Dicky-Fuller and Phillips-Perron tests. Table A2 in the appendix shows the results of stationarity tests on the price series data and their first differences. The cointegration test results on the residuals of a regression of corresponding price series data are presented together with corresponding regression results using equations (1) and (2). The results from the ADF (Augmented Dicky-Fuller) and PP (Phillips-Perron) tests are mostly consistent. However, in some cases, especially with a small number of observation, the ADF test shows cointegration between price series, but PP does not. The PP test is based on asymptotic theory (Phillips and Perron, 1988), and thus it may not be as powerful with small datasets.

6.1 Afghanistan, Kazakhstan and Pakistan Wheat Prices Related to US Wheat Prices

As discussed earlier, we are interested in which of the major wheat supplier countries to Afghanistan, Pakistan or Kazakhstan, is better integrated with the world wheat market. We also examine the degree of price transmission from world market to commercial centers in Afghanistan. We start presenting our modeling results with the analysis on market integration of Pakistan, Kazakhstan and Afghanistan with the world wheat market. We use US prices as the world price in this analysis. The modeling results show that Kazakh and Afghanistan wheat prices have a stronger linkage than Pakistani prices with the US gulf prices. Modeling results assessing Pakistan, Afghanistan and Kazakhstan price linkages with the world market are presented in Table 1. The ADF and PP cointegration test results suggests that Pakistan wheat prices do not follow world wheat prices in the long run, but Afghan and Kazakh wheat prices are cointegrated with the US prices.

The R-squared value of Kazakh and Afghan prices is much higher than the R-squared value of Pakistani prices. This implies a larger portion of variability in Kazakh and Afghan prices, compared to Pakistani prices, are explained by the changes in the US prices. The long-run adjustment coefficient is statistically significant for all three countries. However, the coefficient is smaller on Pakistan price data than for Kazak and Afghanistan prices, suggesting a smaller portion of variability in the world price is transmitted to the Pakistan wheat market than to the Kazakh and Afghan wheat market in the long-run. The greater than unity coefficient on Kazakh price suggests variability in Kazakh prices is higher than variation in the US prices. This can be due to large transaction costs between two regions and/or market power.

We also use a VECM model to assess price transmission dynamics from the world to Afghanistan and Kazakhstan's domestic markets. VECM cannot be used with Pakistani price, since the linear combination of the Pakistani prices and the US price is nonstationary.

The short-run adjustment coefficient (δ) is statistically significant and large for Kazakhstan, but is not significant for Afghanistan. This suggests price movements in the international market are transmitted to Kazakhstan, but not to Afghanistan in the current period. The speed of adjustment coefficient (θ) is statistically significant and small for both countries, suggesting Kazakh and Afghan prices adjust to the world price in the long-run, but slowly. The 4-month price adjustment is about 80 percent for Kazakhstan and 40% for Afghanistan. The results are consistent with our expectation, as Kazakhstan is better integrated than Afghanistan with the world grain market. We will examine in the next section how commercial centers in Afghanistan are integrated with Kazakhstan and Pakistan.

6.2 Price Transmission of Wheat and Flour to Afghanistan Domestic Markets

We now want to assess price transmission of wheat and flour from Pakistan and the Central Asian region into the Afghan domestic markets (commercial centers). Since most of the wheat imports to Afghanistan are in the form of flour, we look into price relationships for both wheat and flour. Since the data for flour prices are not available for Kazakhstan, we use the price data from Kyrgyzstan as a proxy for Kazakh flour prices. The cointegration test results show Kazakh and Kyrgyzstan wheat price series data are cointegrated and move closely in the long run. See results for Kyrgyzstan and Kazakhstan prices linkage in appendix Table A3.

The results from the level and VECM models are combined and presented in one table. The coefficient (β) from the level model is presented in the first row of the table. The R-squared values from the level model is labeled as R-squared (Level), and the R-squared from the VECM is labeled, R-squared (VECM).

Based on the results from the levels model, the Afghan-Kazakh price linkage for wheat is not as strong as expected. Modeling results for the Kazakh and Afghan price relationship are presented in Table 2. The long-run elasticity of price transmission ranges between 0.35 and 0.55, implying less than 50% of variability in the Kazakh wheat prices are eventually transmitted to Afghanistan's domestic markets. The values for R-squared are also small, ranging between 0.24 and 0.47, suggesting less than 50% of variation in domestic prices are explained by changes in Kazakh prices. The ADF test results indicates domestic prices in all commercial centers follow Kazakh prices in the long run. However, the results from the PP test are less significant than those from the ADF, and do not show strong cointegration between the two countries.

VECM modeling results show there is no immediate price transmission from the Kazakh wheat market to commercial centers in Afghanistan. The short-run adjustment coefficient is not significant for any commercial center. The speed of adjustment coefficient is statistically significant at 1% level for all commercial centers. However, the speed of adjustment parameter suggests the domestic prices return slowly to the value consistent with its long-run relationship to the Kazakh prices. The 4-month price adjustment ranges between 36% in Kandahar and 51% in Mazar. Mazar is the closest commercial center to Kazakhstan, and southern Kandahar is the furthest province from Kazakhstan.

The level regression results show a stronger linkage between Afghanistan and Kyrgyzstan flour prices, compared to the Afghan-Kazakh wheat price linkage. The results examining the relationship between Kyrgyzstan's flour prices and domestic prices of flour in four commercial centers are presented in Table 3. All coefficients are statistically significant at a 1% level, and close to unity. Kabul has the closest coefficient to one (0.99), implying all of the variation in Kyrgyzstan flour prices is eventually transmitted to flour prices in Kabul. R-squared values are also fairly high, all greater than 0.72. Mazar was dropped from the table since its price data for flour are not available. The ADF t-statistics are significant at 1% level for all commercial centers, ranging between -3.8 and -4.2. The results from the PP test are consistent here with the ADF test.

The results from the VECM indicate the flour price linkage is slightly faster than the wheat price relationship between Afghanistan and the Central Asian region. The speed of adjustment coefficient (θ) is statistically significant for all prices. The 4-month price adjustment ranges between 51 percent and 62 percent, slightly faster than for Kazakh wheat prices. None of the short-run adjustment coefficients (δ) are statistically significant. The autoregressive term is also significant for commercial centers. This means variation in current period prices affect next period prices.

Using the level regression model and VECM, the relationship of the Afghan domestic wheat and flour prices with wheat and flour prices of Pakistan are also assessed. The modeling results for wheat and flour prices are presented in Table 4 and Table 5, respectively. With Pakistan, the long-run coefficient (β) for both wheat and flour prices are statistically significant at the 1% level. All the coefficients on flour prices are greater than one. This implies the variation in Afghan domestic prices is higher than the variation in Pakistani prices. Pakistan heavily intervenes in its grain market and has been successful in keeping wheat and flour prices stable over time. Thus, the price shocks in the wheat and flour markets in Pakistan are less severe than those in Afghanistan and Central Asian countries.

In terms of R-squared values, the price linkage for flour is stronger than for wheat between Afghanistan and Pakistan. Using flour prices, the R-squared values ranges between 0.67

and 0.73, implying about 70% of variability in domestic prices of flour are explained by changes in Pakistani prices. But for wheat price series data between Afghanistan and Pakistan the R-squared values are smaller, ranging between 0.33 and 0.76. Most of the imports from Pakistan are in terms of wheat flour, rather than wheat grain.

Using the VECM to examine Afghanistan-Pakistan's price relationships, we find a large portion of price variability in Pakistan is transmitted to the Afghanistan domestic market in the short-run. Using wheat prices the short-run adjustment coefficient (δ) is statistically significant for all commercial centers. The coefficient (δ) is fairly large in magnitude for all commercial centers, ranging between 0.4 and 0.7. This implies on average about 50% of price shocks from Pakistan are transmitted to Afghanistan markets in the current period. The speed of adjustment coefficient (θ) is significant for all commercial centers, except Mazar. This result is consistent with our expectation, as Pakistani wheat and flour does not flow to the northern province of Mazar. The 4-month price adjustment ranges between 61 and 79 percent. Surprisingly, wheat prices in Jalalabad adjust slowly to Pakistani price signals compared to other commercial centers. Jalalabad and Kandahar are the closest commercial centers to Pakistan, but wheat is rarely imported to Jalalabad from Pakistan. Most of the imports from Pakistan to Jalalabad are in flour.

Using flour prices, Kandahar and Jalalabad are more integrated than other commercial centers to Pakistan's flour market. The short-run adjustment coefficients are significant for all commercial centers, and large in magnitude. They range between 0.56 in Herat and 0.73 in Kandahar. The results are consistent with our expectations, as Kandahar is the closest province to Pakistan and Herat is furthest away. The speed of adjustment coefficient is also significant for all commercial centers. The 4-month adjustment ranges between 71 and 82 percent.

Based on the modeling results, variability in price both in Pakistan and the Central Asian region are eventually transmitted to Afghanistan domestic markets. The linkages of Afghan flour prices are stronger than wheat prices with both Pakistan and the Central Asian region. Results are consistent with our expectation, as most wheat imports to Afghanistan are conducted in the form of wheat flour rather than wheat grain (Persaud, 2013).

Using the overall data, the results suggest the level of integration between Afghanistan and Kazakhstan versus Afghanistan and US gulf to be quite similar. However, the results for the post-2008 data suggest that Afghanistan is considerably more integrated with the Central Asian region than with world market. This result is consistent with our expectations that Afghanistan has become more integrated with the Central Asian market after 2008. We discuss in detail Pakistani policy reform and post versus pre-reform periods in the next section.

6.3 Structural Changes and Pakistan Policy Reform

Wheat and flour prices in Afghanistan tended to follow wheat and flour prices in Pakistan until 2008. However, this does not appear to be as true after 2008. The linkage between Pakistan and Afghanistan wheat markets broke during the 2007/08 food crisis. Pakistan's ban on wheat and flour exports to Afghanistan allowed Kazakhstan to increase its exports to Afghanistan. Since then, Afghan wheat and flour prices appear to have a higher correlation with prices of Central Asian countries (Kazakhstan and Kyrgyzstan) than with Pakistani prices.

In this section we examine the price linkage between Afghanistan and Pakistan, as well as Afghanistan and the Central Asian region, taking into account these structural changes. The appropriate dating of policy reform by the government of Pakistan is not entirely clear. However, there was no such a policy before 2008, and it has been off and on since January 2008. To take this into account, we separate our price series data into two time periods: pre-reform and post-reform. The pre-reform period is from January 2004 to December 2007, and the post-reform period is January 2008 to April 2015.

We have to use the flour price data for Kyrgyzstan for this analysis since the price series data for Kazakhstan are available only from late 2006. Thus, we do not have enough observations to run a regression for the pre-reform period with Kazakh price data. Also, this analysis is carried out only with flour price data. The price data for wheat are available only after January 2006 for both Pakistan and Kyrgyzstan. That leaves us with few observation for the pre-reform period.

Our hypothesis is that the price linkage between Pakistan and Afghanistan is stronger in the pre-reform period than in the post-reform period. We expect that the Afghanistan wheat market has become more integrated with the Central Asian market after the 2007-08 food crisis. Table 6 presents the modeling results for pre-reform versus post-reform period flour price linkages between Afghanistan and Pakistan, and Table 7 for Afghanistan and the Central Asian region.

Modeling results show that the long-run elasticity of price transmission from Pakistan is close to unity for all commercial centers in the pre-reform period, and statistically significant at the 1% level. This implies the price linkage between Afghanistan and Pakistan was very strong before 2008. On the contrary, statistical results show no linkage between Afghanistan and Pakistani prices after 2008. The long-run elasticity of price transmission is not statistically significant for any of the commercial centers in the post-reform period, even though there are more observation in the post-reform period than in the pre-reform period. The R-squared values are very small for the post- 2008 data. This implies only a small portion of domestic price variability reflects Pakistani price movements after January 2008. The results from ADF test show strong cointegration between flour prices in Afghanistan and Pakistan in the pre-reform period, but there is not significant cointegration between them using the post-reform data. The results from the PP test is consistent with the ADF results using the post-reform data. However, for the pre-reform period PP tests results are not as significant as the results From the ADF, as PP test is not powerful with a small number of observations.

We want to analyze the impact of Pakistani policy reform on price transmission using the VECM model. The cointegration test results for sub-period data suggest that there is no long-run relationship between Afghanistan and Pakistan prices after 2008, while they are cointegrated before 2008. On the contrary, flour prices between Afghanistan and Kyrgyzstan are cointegrated for the post-reform period but they are not cointegrated before 2008. Thus, we cannot use VECM for both pre-reform and post-reform periods as the price series data are cointegrated only for one period. We use VECM model only for the sub-period that series are cointegrated. Results are compared with the overall period results. Thus, for Kyrgyzstan VECM is used with the post-reform period, and for Pakistan with the pre-reform period data.

We use VECM with the pre-reform period data of Pakistan and compare with the results from the overall data presented in Table 6. Although the number of observation are considerably smaller in the pre-reform period, compared to overall data, the results are informative to some extent. With the sub-period data, the speed of adjustment coefficient is larger compared to the results using overall data for all commercial centers. However the coefficient using Kabul and Jalalabad prices are less significant in the pre-reform period compared to the results with overall data. This can be due to the small number of observations in the pre-reform period. Also, the results in the pre-reform period show there is not instant price transmission from Pakistan to

Afghanistan domestic markets. However, the short-run adjustment coefficient is significant using overall data. The 4-month price adjustment is higher for the pre-reform period than for the overall period in all commercial centers except Kabul (table 7).

Regression analysis from the levels model reveals that the price linkage between Afghanistan and Kyrgyzstan is stronger in the post-reform period than in the pre-reform period, as expected. The modeling results for both periods are presented in Table 8. The long-run elasticity of price transmission coefficient is significantly larger for all commercial centers in the post-reform period compared to the period before 2008. The larger coefficient with the post-reform period data implies a larger portion of the variability in the Kyrgyzstan prices is transmitted to prices in Afghanistan compared to the pre-reform period. The ADF test results are consistent with our expectation that Afghanistan has become more integrated with the central Asian region after 2008. The t-statistics from the ADF test are highly significant for post-reform data, while none of them are significant with the pre-reform data. The results from the PP test is mostly consistent with the ADF test results, here.

The VECM results for Kyrgyzstan flour in the post-reform period are also presented in Table 8. The speed of adjustment coefficients for all commercial centers are larger in the post-reformed period compared to the overall period for Kyrgyzstan. The larger coefficient of (θ) in the post-reform period, compared to the overall period, suggests price signals in Central Asian region are transmitted to Afghan domestic markets faster after 2008 than in the pre-reform period. The 4-month price adjustment ranges between 75 in Kandahar and 96 percent, in Herat for the post-reform period. But the 4-month adjustment is less than 60 percent with the overall data. Although price series data are shorter here, R-squared values are larger with the post-reform period data, compared to the overall series. The short-run adjustment coefficient (δ) is statistically significant with Herat and Kabul prices, suggesting price variability in Central Asian region is immediately transmitted to Herat and Kabul. The short-run adjustment coefficient is not significant with any commercial centers with the overall data. Using the post-reform data the results show Herat, followed by Kabul, is more integrated with the Central Asian markets. This make sense as Herat and Kabul are closer than other commercial centers to the Central Asian region.

6.4 Wheat Price Relationships between Rural and Urban Markets

We use the levels model in logarithmic form and the VECM to examine price transmission across rural and urban centers, as well. Price data for rural markets are available only for wheat. The rural-urban price linkages examined are: Baymyan-Kabul, Badakhshan-Mazar, Ghor-Herat, Faryab-Mazar, and Daykundi-Kandahar. See figure 4 for a map of the rural markets and commercial centers used in our model. Table 8 presents the modeling results for rural-urban price linkages.

The results from the levels model show that there is a long-run linkage between rural and urban wheat prices. The long-run adjustment coefficient is statistically significant for all pairs of price series data. The long-run elasticity of price transmission between Kabul and Bamyan is 0.58, implying 58 percent of the variation in Kabul prices is eventually transmitted to the wheat prices in Bamyan. Although the price series data are very short for some rural markets (Bamyan and Ghor), the R-squared values are large, ranging between 0.55 and 0.83.

The cointegration test shows prices in rural markets are moving together in the long-run, with the prices in the closest commercial centers, except for Ghor. We use VECM to examine price relationship across rural and urban areas for the rural markets with statistically significant ADF t-statistics. The speed of adjustment coefficient (θ) is statistically significant at 1% for Badakhshan, Faryab and Daykundi, and it is significant at the 5% level with Bamyan. The price series data for Bamyan and Ghor are shorter than for the other three rural markets. The short-run adjustment coefficient is significant for Badakhshan, Faryab and Daykundi, at a 1% level implying a portion of the price shocks from commercial centers is transferred to these rural markets in the current period. The autoregressive term is significant only for Daykundi and Faryab price series. The 4-month price adjustment ranges between 72% in Badakhshan and 90% in Faryab. Although it is difficult to determine which rural market is more integrated to its closest commercial center as the number of observations are not the same for all rural markets, Faryab and Daykundi appear to be more integrated than other rural markets with their closest commercial centers. The results are consistent with our expectations when considering the geographical locations of the rural markets, poor transportation infrastructure and distance from the commercial centers, (Figure 4). Badakhshan has the longest distance to its commercial center, Mazar, and its price adjustment to changes in price in Mazar is the slowest. Ghor and

Bamyan appear to have the shortest routes to their commercial centers, but the number of observations for these markets are substantially less than for other rural markets.

6.5 Wheat and Flour Price Linkages across Commercial Centers

Wheat and flour prices appear to move together across commercial centers and to adjust quickly. We examine Kabul wheat and flour prices versus other commercial centers using both levels models and VECM. The results of the VECM and the levels models for flour prices are presented in Table 9. Modeling results show that the long-run adjustment, short-run adjustment and the speed of adjustment coefficients are statistically significant at the 1% level for all commercial centers. The ADF and PP tests results also show strong cointegration between Kabul prices and price in all other commercial centers for both wheat and flour.

The results from the levels model suggest strong linkages across commercial centers. All the long-run adjustment coefficients are statistically significant at the 1% level and they are close to unity, implying nearly all price variability in other commercial centers are eventually transmitted to the Kabul flour market. The R-squared values are also fairly large, ranging between 0.88 and 0.92. This suggests about 90% of the variability in commercial centers prices are explained by changes in Kabul prices.

The short-run adjustment coefficient (δ) is large across all commercial centers, ranging between 0.45 and 0.65. This implies more than 50% of price shocks in other commercial centers are immediately transmitted to the Kabul flour market. The speed of adjustment coefficients are fairly large, ranging between 0.23 and 0.29. The 4-month price adjustment is about 90 percent. Results from both level regression and VECM models suggest Kabul is more integrated with Jalalabad and Kandahar compared to Herat. This intuitively makes sense since Jalalabad and Kandahar are closer to Kabul than to Herat.

Using wheat prices, the results are similar to the flour prices. The results show strong linkages between Kabul and all other commercial centers. With wheat prices, Mazar is added to our analysis, since its prices for wheat are available. It is interesting to notice that Kabul appears to be more integrated with the eastern and southern markets than with the northern market. The results of level regression and VECM for wheat prices are presented in Table 10.

7. Conclusion

Domestic wheat production is volatile in Afghanistan. Imports from Pakistan played an important role in stabilizing domestic wheat and flour markets in there until 2008. Pakistan's policy changed during the 2007/08 food crisis, banning exports of wheat and flour to Afghanistan in January, 2008. Pakistan's ban on wheat and flour exports to Afghanistan allowed Kazakhstan to increase its exports to Afghanistan. Although imports from Kazakhstan increased wheat availability in Afghanistan, it created variability in wheat and flour prices, because prices of wheat and flour in the Central Asian region are not as stable as prices in Pakistan.

The Pakistani export restriction policy appears to have had substantial effects on price transmission. The regression analysis suggests strong cointegration between Afghanistan and Pakistan price series data before January 2008, while there is no price linkage after January 2008 when the export restriction policy was in place. Modeling results also suggest that Afghanistan's domestic wheat and flour markets have become more integrated with the Central Asian market since January 2008.

Even though Kazakhstan has increased wheat and flour exports to Afghanistan since 2008, market integration with the Central Asian region is not strong enough to stabilize Afghan domestic wheat and flour markets in the short-run. Prices in Afghan domestic markets adjust to changes in Kazakh prices slowly. The 4-month price adjustment to changes in Kazakh prices is less than 50% for most cases. Moreover wheat and flour markets in the central Asian region are not as stable as those in Pakistan. They do not implement stabilization policies to the extent observed in Pakistan.

We also find a stronger relationships for Afghan flour prices than wheat prices with both Pakistan and the Central Asian region. Our analysis shows that spikes in flour prices in Pakistan and the Central Asian region are transmitted to Afghanistan's domestic markets faster than wheat prices. This result is consistent with our findings from the trader survey during summer 2014 in Afghanistan and from Persaud (2013), that most wheat is imported in the form of flour rather than grain to Afghanistan. Flour is imported to Afghanistan despite the fact that most commercial mills are operating at less than half capacity. This suggests the Afghan milling industry has problems competing with subsidized Pakistani flour and high quality Kazakh flour imports.

Our analysis shows that wheat and flour markets are well connected across commercial centers in Afghanistan. However rural markets do not appear to be well integrated with commercial centers. Thus, an increase in domestic wheat production is unlikely to fully replace imports. An increase in domestic wheat production may lower price in surplus areas, as in 2009. Moreover, it is less likely that imports from international markets could stabilize domestic markets in rural deficit areas in the short-run.

Several policy guidelines emerge from our analysis to improve the stability of wheat and flour markets in Afghanistan. Improving market integration with the Central Asian region could lessen the dependency on wheat and flour imports from Pakistan, and improve food security in Afghanistan. Importing wheat and flour from Kazakhstan is more challenging, requires more capital and the transportation costs are higher than importing from Pakistan. Afghan traders are required to make a fluctuating price contract with the government of Kazakhstan for large quantities of wheat and flour imports. Estimated transportation costs and related expenses for importing wheat from northern Kazakhstan to Mazar is nearly $150 per metric tons according to our trader survey in Afghanistan during summer 2014 and Chabot and Tondel (2011). Intervention from the Afghan government through negotiation and trade agreement with the Central Asian countries may help reduce some of these transactions costs.

The government of Afghanistan is considering increasing domestic wheat production to reduce domestic dependence on imports. Improving transportation infrastructure between rural and urban areas would be required for increased domestic production to replace imports. Focusing on mechanisms to increase domestic production are unlikely to make Afghanistan self-sufficient in wheat unless rural markets are better integrated with commercial centers. With the bumper wheat harvest in 2009 Afghanistan production was close to self-sufficiency, but large cities relied on imported wheat and flour. Domestic wheat was often retained as stocks in rural areas and wheat prices collapsed in wheat surplus provinces. This suggests promotion of both domestic and international market integration is important for long-run price stability.

However, better integration with international markets will not stabilize domestic markets at times of very high world prices, as in 2007-08 (Dorosh, 2009). Agricultural policies to promote domestic wheat production through investments in irrigation, research and extension can lessen dependency on imports and stabilize domestic production and prices. Also, public stocks could help to manage seasonal price shocks and delays in imports to stabilize wheat prices in Afghanistan. However, the government should be cautious with public stock polices, as large carry-over stocks each year resulting from inappropriate mechanisms would be costly.

Domestic agricultural policies in Afghanistan should consider the likelihood of recent price shocks to persist, given the volatility in domestic production and export restrictions from Pakistan. It is also important to avoid strategies that may not be economically efficient (Dorosh, 2009). When thinking about wheat price stabilization, policymakers should consider an analytical framework incorporating imperfect market integration in Afghanistan. Future research could build on the findings of this analysis by assessing stocks policy, and the optimal combination of trade and storage policies, to stabilize domestic wheat prices in Afghanistan.

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Table 1: Pakistan, Kazakhstan and Afghanistan Wheat Prices Related to US Gulf Prices

	PARAMETERS	(1) Pakistan	(2) Kazakhstan	(3) Afghanistan
Level Model (Equation 1)	Log (β)	0.427***	1.270***	0.955***
		(0.0660)	(0.0809)	(0.0463)
	Constant	3.291***	-1.682***	0.504**
		(0.368)	(0.454)	(0.247)
	ADF	-1.932	-3.124**	-3.275**
	PP	-1.718	-2.974**	-3.242**
	Observations	112	103	184
	R-squared (Level)	0.275	0.710	0.701
VECM Model (Equation 2)	Short-run Adjustment (δ)		0.530***	-0.0359
			(0.104)	(0.0688)
	Speed of Adjustment (θ)		-0.169***	-0.115***
			(0.0470)	(0.0206)
	4-month Adjustment (%)		78	39
	Autoregressive Term (ρ)		0.00132***	0.000363**
			(0.000344)	(0.000178)
	Observations		101	182
	R-squared (VECM)		0.388	0.175

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Dependent variables are domestic wheat prices in Pakistan, Kazakhstan and Afghanistan, and the independent variable is US gulf wheat prices. ADF is the Augmented-Dickey Fuller test and PP is the Phillips-Perron test.

Table 2: Domestic Prices of Wheat Related to Kazakhstan's Wheat Prices

PARAMETERS	(1) Kabul	(2) Kandahar	(3) Jalalabad	(4) Herat	(5) Mazar
Long-run Adjustment (β)	0.350*** (0.0615)	0.396*** (0.0697)	0.408*** (0.0622)	0.484*** (0.0698)	0.546*** (0.0584)
Short-run Adjustment (δ)	0.0568 (0.0912)	0.0615 (0.0720)	0.124 (0.0864)	0.0958 (0.0961)	0.114 (0.101)
Speed of Adjustment (θ)	-0.144*** (0.0457)	-0.107*** (0.0318)	-0.121*** (0.0414)	-0.133*** (0.0412)	-0.163*** (0.0496)
4-month Adjustment (%)	46	36	40	43	51
Autoregressive Term (ρ)	0.132 (0.0966)	0.113 (0.0937)	0.0885 (0.0960)	0.210** (0.0936)	0.0778 (0.101)
ADF	-2.916**	-3.439**	-3.09**	-3.179**	-3.263**
PP	-2.725*	-2.556	-2.593*	-2.650*	-2.903**
Observations	101	101	101	101	94
R-squared (Level)	0.242	0.242	0.299	0.322	0.471
R-squared (VECM)	0.123	0.161	0.153	0.186	0.172

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Dependent variable is the domestic wheat price in each commercial center, and the independent variable is the Kazakh wheat price.

The long-run adjustment coefficient (β) and R-squared (Level) are estimated using the level model, as in equation (1). The coefficients for short-run adjustment (δ), speed of adjustment (θ), autoregressive term (ρ), and R-squared (VECM) are estimated from the VECM model. ADF is the Augmented-Dickey Fuller test and PP is the Phillips-Perron test

Table 3: Domestic Prices of Flour Related to Kyrgyzstan's Flour Prices

PARAMETERS	(1) Kabul	(2) Kandahar	(3) Jalalabad	(4) Herat
Long-run Adjustment (β)	0.991*** (0.0493)	0.961*** (0.0540)	0.911*** (0.0507)	1.039*** (0.0507)
Short-run Adjustment (δ)	-0.0135 (0.117)	-0.0851 (0.107)	-0.0265 (0.122)	0.0372 (0.108)
Speed of Adjustment (θ)	-0.217*** (0.0487)	-0.173*** (0.0410)	-0.218*** (0.0503)	-0.164*** (0.0433)
4-month Adjustment (%)	62	53	62	51
Autoregressive Term (ρ)	0.246*** (0.0851)	0.176** (0.0857)	0.184** (0.0860)	0.300*** (0.0868)
ADF	-4.231***	-3.816***	-4.173***	-3.893***
PP	-3.892***	-3.445**	-3.976***	-3.552***
Observations	122	122	122	122
R-squared (Level)	0.768	0.721	0.725	0.775
R-squared (VECM)	0.193	0.150	0.159	0.191

Standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Note: Dependent variable is the domestic flour price in each commercial center, and the independent variable is the Kyrgyzstan flour price.

The long-run adjustment coefficient (β) and R-squared (Level) are estimated using the level model, as in equation (1). The coefficients for short-run adjustment (δ), speed of adjustment (θ), autoregressive term (ρ), and R-squared (VECM) are estimated from the VECM model. ADF is the Augmented-Dickey Fuller test and PP is the Phillips-Perron test

Table 4: Domestic Prices of Wheat Related to Pakistan's Wheat Prices

PARAMETERS	(1) Kabul	(2) Kandahar	(3) Jalalabad	(4) Herat	(5) Mazar
Long-run Adjustment (β)	0.981***	1.408***	1.009***	0.972***	0.797***
	(0.0863)	(0.0745)	(0.0949)	(0.116)	(0.110)
Short-run Adjustment (δ)	0.646***	0.594***	0.407**	0.713***	0.734***
	(0.215)	(0.159)	(0.199)	(0.216)	(0.217)
Speed of Adjustment (θ)	-0.121**	-0.122***	-0.103**	-0.0843**	-0.0124
	(0.0483)	(0.0411)	(0.0404)	(0.0357)	(0.0389)
4-month Adjustment (%)	79	75	61	79	74
Autoregressive Term (ρ)	0.0902	0.151*	0.145	0.201**	0.143
	(0.0966)	(0.0882)	(0.0946)	(0.0911)	(0.0932)
ADF	-2.979**	-3.645***	-2.910**	-3.264**	-3.317**
PP	-2.771*	-2.993**	-2.749*	-2.419	-2.492
Observations	111	111	111	111	108
R-squared (Level)	0.540	0.765	0.506	0.390	0.328
R-squared (VECM)	0.128	0.188	0.101	0.171	0.133

Standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Note: Dependent variable is the domestic wheat price in each commercial center, and the independent variable is the Pakistani wheat price.

The long-run adjustment coefficient (β) and R-squared (Level) are estimated using the level model, as in equation (1). The coefficients for short-run adjustment (δ), speed of adjustment (θ), autoregressive term (ρ), and R-squared (VECM) are estimated from the VECM model. ADF is the Augmented-Dickey Fuller test and PP is the Phillips-Perron test

Table 5: Domestic Prices of Flour Related to Pakistan's Flour Prices

PARAMETERS	(1) Kabul	(2) Kandahar	(3) Jalalabad	(4) Herat
Long-run	1.252***	1.236***	1.146***	1.313***
Adjustment (β)	(0.0748)	(0.0661)	(0.0710)	(0.0706)
Short-run	0.584***	0.733***	0.623***	0.567***
Adjustment (δ)	(0.137)	(0.119)	(0.139)	(0.124)
Speed of	-0.0887**	-0.0953***	-0.110***	-0.114***
Adjustment (θ)	(0.0361)	(0.0345)	(0.0384)	(0.0332)
4-month				
Adjustment (%)	71	82	76	73
Autoregressive	0.165**	0.234***	0.182**	0.373***
Term (ρ)	(0.0828)	(0.0790)	(0.0826)	(0.0818)
ADF	-3.314**	-3.645***	-3.284**	-3.485**
PP	-2.813*	-2.605*	-3.070**	-3.165*
Observations	129	129	129	129
R-squared (Level)	0.685	0.731	0.669	0.729
R-squared (VECM)	0.171	0.265	0.182	0.241

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Dependent variable is the domestic flour price in each commercial center, and the independent variable is Pakistani flour price.

The long-run adjustment coefficient (β) and R-squared (Level) are estimated using the level model, as in equation (1). The coefficients for short-run adjustment (δ), speed of adjustment (θ), autoregressive term (ρ), and R-squared (VECM) are estimated from the VECM model. ADF is the Augmented-Dickey Fuller test and PP is the Phillips-Perron test

Table 6: Pre-Reform versus Post-Reform Flour Price Linkage with Pakistan

	PARAMETERS	(1) Kabul	(2) Kandahar	(3) Jalalabad	(4) Herat
Pre-Reform	Log (β)	0.898***	0.882***	0.819***	0.707***
		(0.150)	(0.0819)	(0.0986)	(0.0965)
	Constant	0.716	0.745	1.123**	1.773***
		(0.820)	(0.448)	(0.539)	(0.528)
	ADF	3.612***	-2.957***	-3.349**	-3.375**
	PP	-2.747*	-2.417	-2.835*	-2.584*
	Observations	43	43	43	43
	R-squared	0.467	0.739	0.627	0.567
Post-Reform	Log (β)	0.152	0.131	0.0726	0.396*
		(0.225)	(0.197)	(0.219)	(0.221)
	Constant	5.325***	5.381***	5.723***	3.928***
		(1.323)	(1.160)	(1.291)	(1.301)
	ADF	-2.131	-2.781*	-2.681*	-2.335
	PP	-2.323	-1.863	-2.113	-2.283
	Observations	88	88	88	88
	R-squared	0.005	0.005	0.001	0.036
Pre-Reform (VECM)	Short-run Adjustment (δ)	-0.415	0.115	0.295	0.211
		(0.263)	(0.174)	(0.191)	(0.176)
	Speed of Adjustment (θ)	-0.171*	-0.618***	-0.308**	-0.381***
		(0.100)	(0.161)	(0.142)	(0.125)
	4-month Adjustment (%)	52	97	77	85
	Autoregressive Term (ρ)	0.117	0.0853	0.0550	0.217
		(0.223)	(0.190)	(0.192)	(0.168)
	Observations	41	41	41	41
	R-squared	0.166	0.286	0.144	0.249

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Note: We do not use VECM for Pakistan's post-reform data, as they are not cointegrated with Afghan prices in the post-reform period. See table 5 for comparison with overall data results and variable definition.

Table 7: Pre-Reform versus Post-Reform Flour Price Linkage with Kyrgyzstan

	VARIABLES	(1) Kabul	(2) Kandahar	(3) Jalalabad	(4) Herat
Pre-Reform	Log (β)	0.361***	0.387***	0.317***	0.289***
		(0.0441)	(0.0436)	(0.0436)	(0.0390)
	Constant	3.515***	3.267***	3.744***	3.940***
		(0.264)	(0.261)	(0.261)	(0.233)
	ADF	-2.398	-2.312	-2.468	-2.159
	PP	-2.291	-2.143	-2.562	-2.006
	Observations	36	36	36	36
	R-squared	0.663	0.699	0.608	0.618
Post-Reform	Log (β)	0.838***	0.653***	0.748***	0.897***
		(0.0605)	(0.0642)	(0.0686)	(0.0494)
	Constant	0.885**	1.995***	1.388***	0.543*
		(0.386)	(0.409)	(0.437)	(0.315)
	ADF	-3.785***	-2.946***	-3.722***	-3.533***
	PP	-3.545***	-2.725*	-3.658***	-3.266**
	Observations	88	88	88	88
	R-squared	0.690	0.546	0.580	0.793
Post-Reform (VECM)	Short-run Adjustment (δ)	0.380**	0.133	0.315*	0.467***
		(0.171)	(0.165)	(0.187)	(0.166)
	Speed of Adjustment (θ)	-0.380***	-0.295***	-0.333***	-0.480***
		(0.0812)	(0.0727)	(0.0788)	(0.0897)
	4-month Adjustment (%)	90	75	80	96
	Autoregressive Term (ρ)	0.303***	0.218**	0.235**	0.395***
		(0.0946)	(0.0977)	(0.0998)	(0.0967)
	Observations	88	88	88	88
	R-squared	0.269	0.185	0.205	0.318

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Note: We do not use VECM for Kyrgyzstan's pre-reform data, as they are not cointegrated with Afghan prices in the pre-reform period. See table 3 for comparison with overall data results, and variable definition.

Table 8: Rural Wheat Prices Related to Urban Wheat Prices

PARAMETERS	(1) Bamyan	(2) Badakhshan	(3) Ghor	(4) Faryab	(5) Daykundi
Long-run Adjustment (β)	0.584*** (0.0741)	1.152*** (0.0403)	0.628*** (0.0944)	1.018*** (0.0411)	0.811*** (0.0429)
Short-run Adjustment (δ)	0.261 (0.167)	0.469*** (0.0748)	NA	0.511*** (0.0987)	0.381*** (0.0771)
Speed of Adjustment (θ)	-0.428** (0.186)	-0.151*** (0.0394)	NA	-0.340*** (0.0594)	-0.212*** (0.0519)
4-month Adjustment (%)	89	72	NA	90	75
Autoregressive Term (ρ)	0.0909 (0.250)	0.0320 (0.0736)	NA	-0.158** (0.0771)	0.266*** (0.0847)
ADF	-3.241**	-3.807***	-2.543	-4.369***	-3.537***
PP	-2.370	-3.837***	-2.405	-5.043***	-3.418**
Observations	17	140	36	120	93
R-squared (Level)	0.766	0.851	0.552	0.829	0.786
R-squared (VECM)	0.336	0.265	0.239	0.351	0.387

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Dependent variable is the wheat price in rural markets, and the independent variable is the wheat prices in the closest commercial center to the rural market.

The long-run adjustment coefficient (β) and R-squared (Level) are estimated using the level model, as in equation (1). The coefficients for short-run adjustment (δ), speed of adjustment (θ), autoregressive term (ρ), and R-squared (VECM) are estimated from the VECM model. ADF is the Augmented-Dickey Fuller test and PP is the Phillips-Perron test

Table 9: Kabul Flour Prices Related to Other Commercial Centers

PARAMETERS	(1) Kandahar	(2) Jalalabad	(3) Herat
Long-run Adjustment (β)	0.939***	1.046***	0.959***
	(0.0263)	(0.0258)	(0.0297)
Short-run Adjustment (δ)	0.647***	0.627***	0.453***
	(0.0573)	(0.0526)	(0.0599)
Speed of Adjustment (θ)	-0.234***	-0.250***	-0.291***
	(0.0465)	(0.0475)	(0.0468)
Autoregressive Term (ρ)	6.66e-05	0.000105	7.43e-05
	(0.000120)	(0.000113)	(0.000132)
4-month Adjustment (%)	88	88	86
ADF	-3.763***	-4.867***	-6.008***
PP	-6.713***	-5.583***	-6.700***
Observations	178	182	182
R-squared (Level)	0.942	0.955	0.931
R-squared (VECM)	0.436	0.477	0.328

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Dependent variable is the domestic flour price in each commercial center, and the independent variable is the flour price in Kabul.

The long-run adjustment coefficient (β) and R-squared (Level) are estimated using the level model, as in equation (1). The coefficients for short-run adjustment (δ), speed of adjustment (θ), autoregressive term (ρ), and R-squared (VECM) are estimated from the VECM model. ADF is the Augmented-Dickey Fuller test and PP is the Phillips-Perron test

Table 10: Kabul Wheat Prices Related to Other Commercial Centers

PARAMETERS	(1) Kandahar	(2) Jalalabad	(3) Herat	(4) Mazar
Long-run Adjustment (β)	0.922*** (0.0208)	1.025*** (0.0212)	1.007*** (0.0269)	1.045*** (0.0401)
Short-run Adjustment (δ)	0.593*** (0.0754)	0.550*** (0.0646)	0.435*** (0.0606)	0.434*** (0.0751)
Speed of Adjustment (θ)	-0.140*** (0.0487)	-0.228*** (0.0460)	-0.141*** (0.0394)	-0.146*** (0.0398)
Autoregressive Term (ρ)	-0.000203 (0.000176)	0.000151 (0.000152)	6.07e-05 (0.000162)	4.57e-05 (0.000166)
4-month Adjustment (%)	77	84	69	70
ADF	-3.403**	-4.850***	-4.452***	-3.532***
PP	-4.479***	-5.248***	-4.877***	-3.654***
Observations	178	182	182	142
R-squared (Level)	0.916	0.928	0.885	0.826
R-squared (VECM)	0.270	0.330	0.243	0.242

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Dependent variable is wheat price in each commercial center, and the independent variable is the wheat price in Kabul.

The long-run adjustment coefficient (β) and R-squared (Level) are estimated using the level model, as in equation (1). The coefficients for short-run adjustment (δ), speed of adjustment (θ), autoregressive term (ρ), and R-squared (VECM) are estimated from the VECM model. ADF is the Augmented-Dickey Fuller test and PP is the Phillips-Perron test

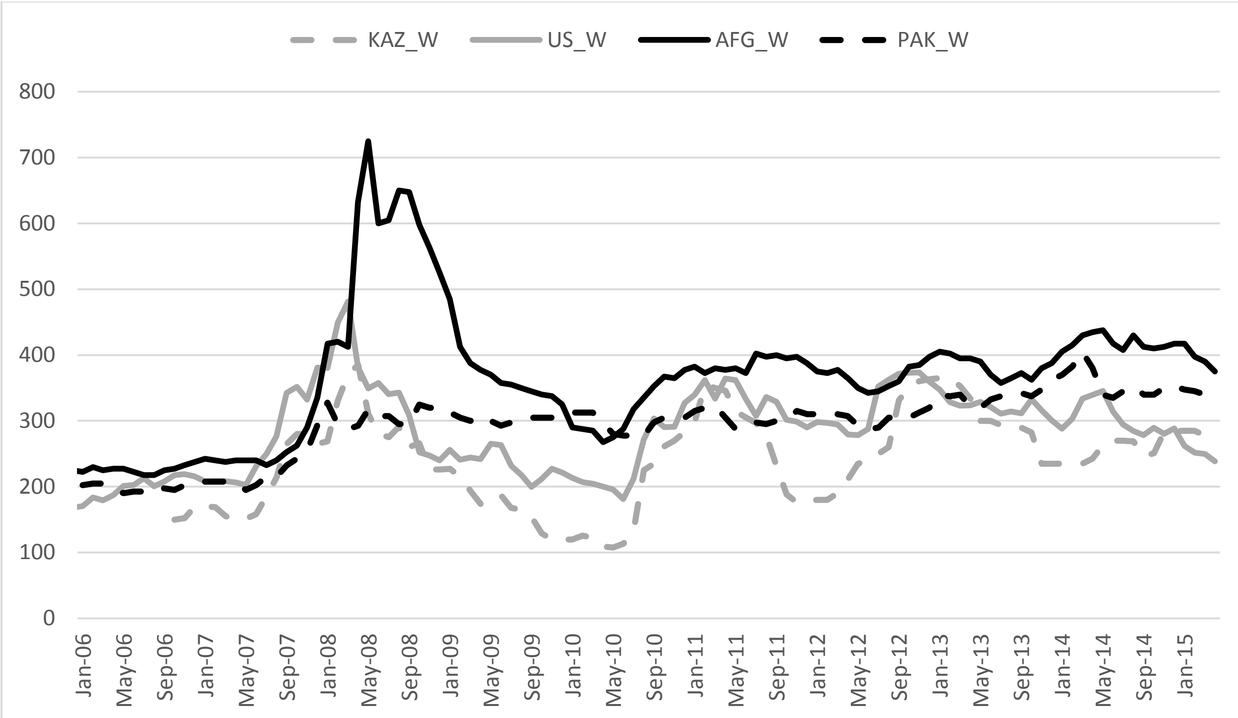

Figure 1: Wheat Prices in Afghanistan, Kazakhstan, Pakistan and the US for Jan 2006 – Apr 2015.

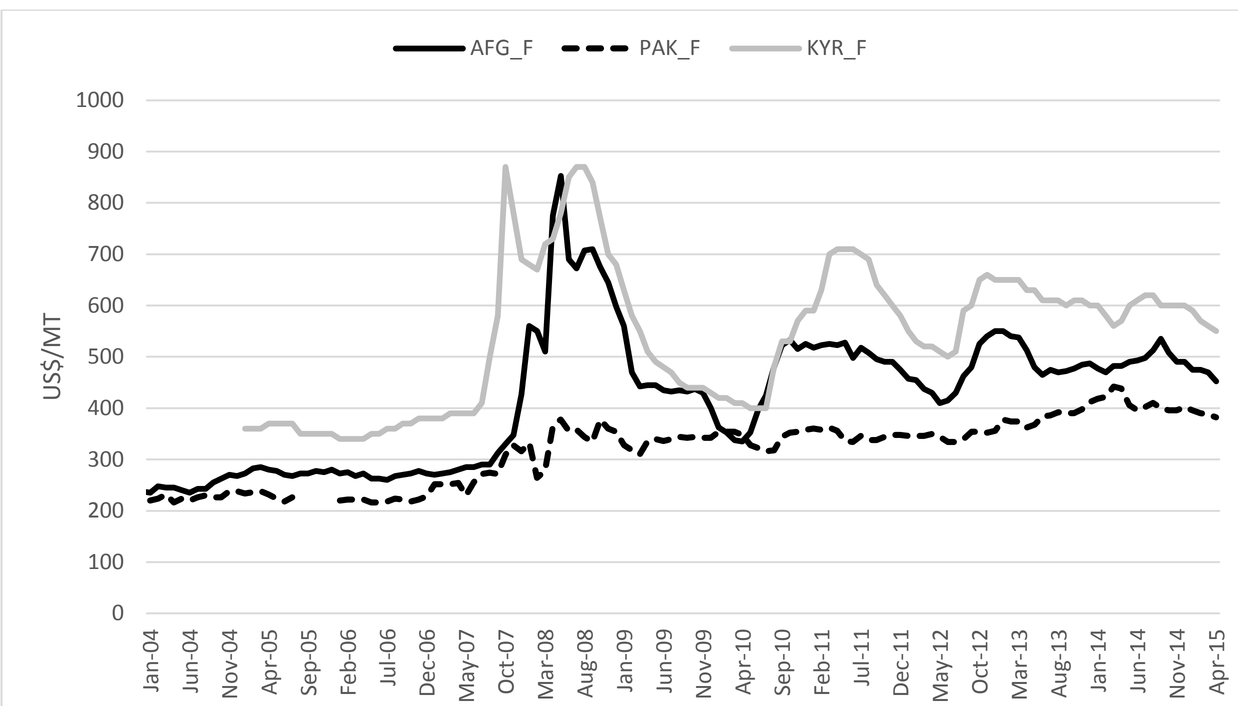

Figure 2: Flour Prices in Afghanistan, Pakistan, and Kyrgyzstan for the period Jan 2004 – Apr 2015.

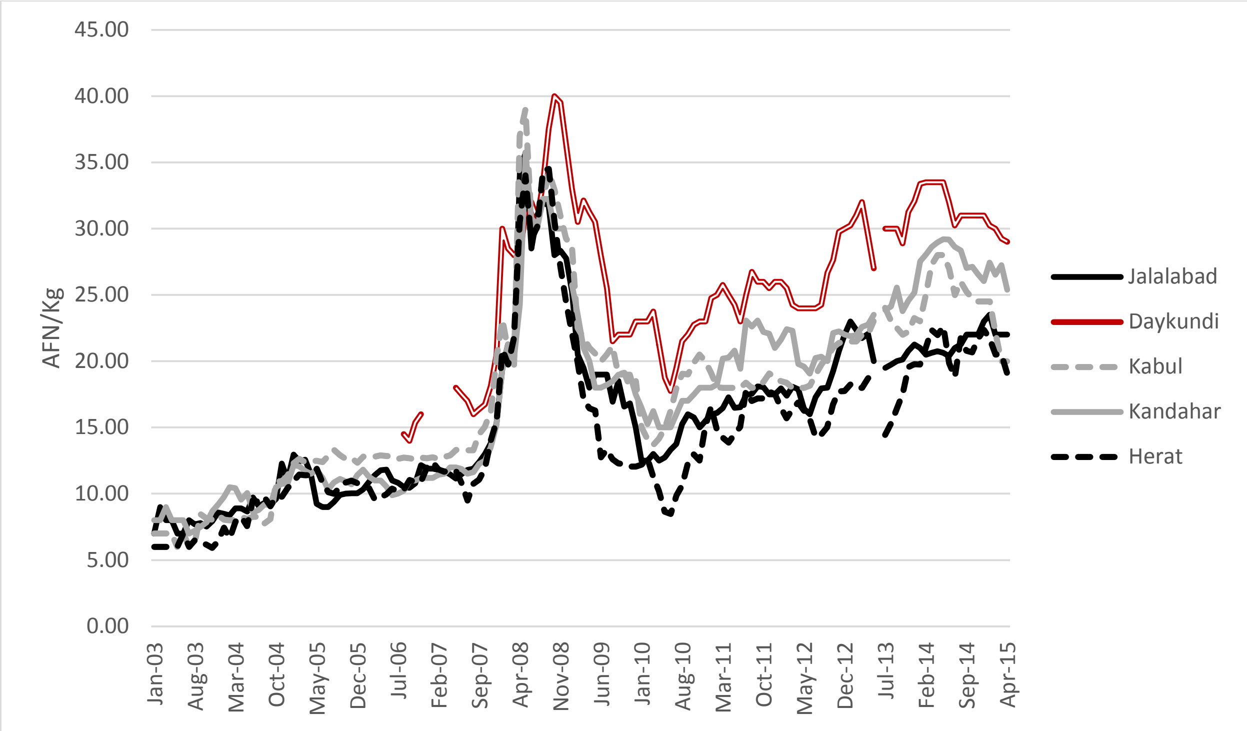

Figure 3: Price series data of Wheat across Commercial Centers and in Daykundi

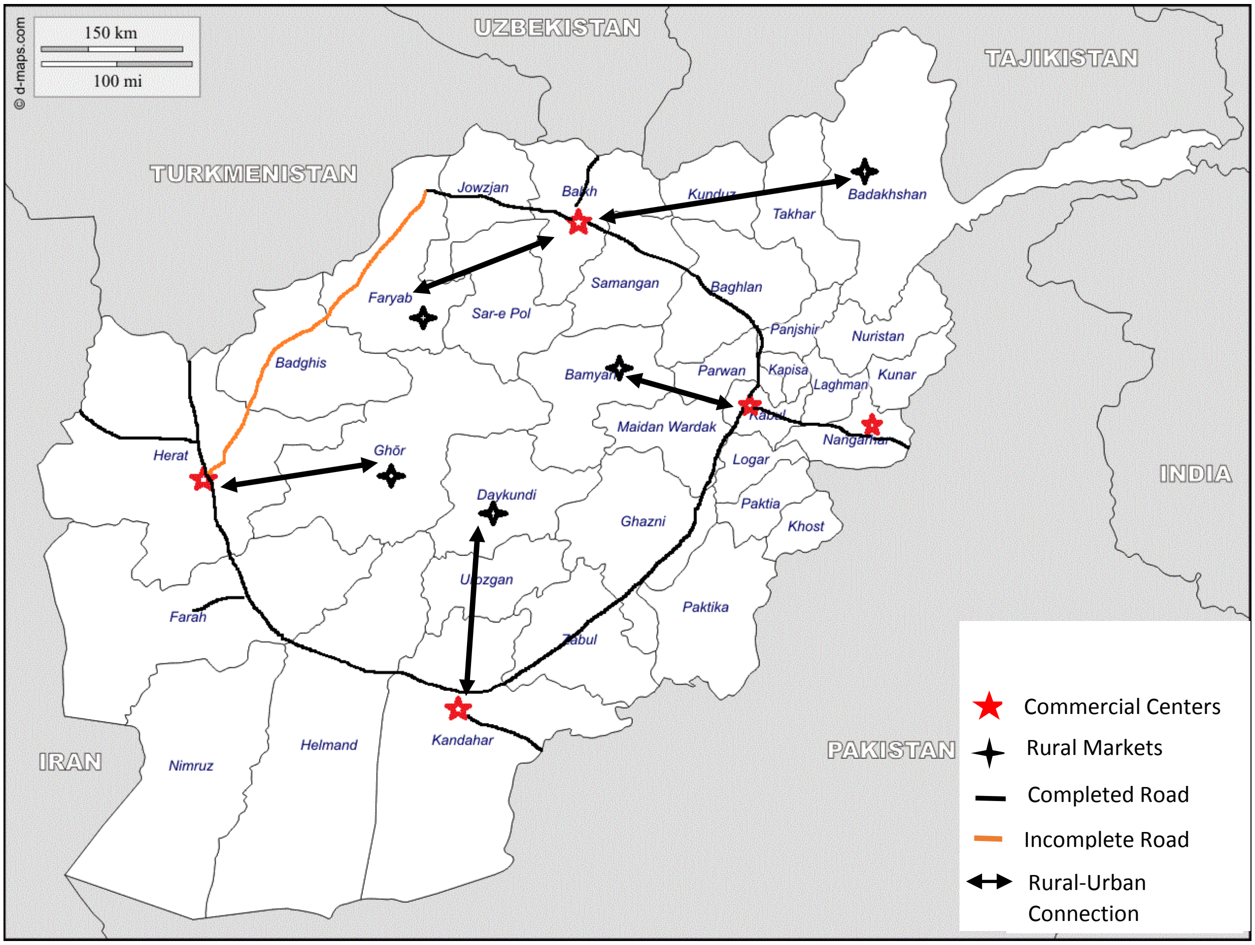

Figure 4: Rural Markets and Commercial Centers in Afghanistan

Appendix A: Summary Statistics and Diagnostic Tests Results

Table A1: Descriptive Statistics of the Price Series

Country	Market	Commodity	(1) N	(2) Mean	(3) Std. Dev	(4) Min	(5) Max
Afghanistan	Herat	Wheat	184	261.6	114.0	110	680
Afghanistan	Herat	Flour	184	375.5	166.0	140	840
Afghanistan	Jalalabad	Wheat	184	284.6	119.1	120	720
Afghanistan	Jalalabad	Flour	184	349.5	142.1	140	830
Afghanistan	Kabul	Wheat	184	312.2	132.8	120	780
Afghanistan	Kabul	Flour	184	371.8	155.7	150	880
Afghanistan	Kandahar	Wheat	181	314.3	136.2	100	720
Afghanistan	Kandahar	Flour	181	350.7	142.4	100	860
Afghanistan	Mazar	Wheat	145	296.8	107.0	117	711
Afghanistan	Bamyan	Wheat	21	246.3	29.60	191.4	287.5
Afghanistan	Badakhshan	Wheat	147	416.2	163.2	140.2	1,038
Afghanistan	Ghor	Wheat	38	384.7	128.6	210.4	747.9
Afghanistan	Faryab	Wheat	128	400.3	133.1	158.9	915.7
Afghanistan	Daykundi	Wheat	99	619.5	132.4	327.2	934.9
Kazakhstan	National Average	Wheat	103	241.3	71.09	107.5	385
Kyrgyzstan	National Average	Flour	124	539.8	139.3	340	870
Pakistan	National Average	Wheat	112	294.5	50.19	190	405
Pakistan	National Average	Flour	131	319.8	64.54	216	442
USA	Gulf	Wheat	184	219.7	80.37	105.1	439.7

Note: Units of measure are US$ per metric tons

Table A2: Stationarity Test on Price Series, and Price Differentials

Country	Market	Commodity	Price Series		Price Differentials	
			ADF	PP	ADF	PP
Afghanistan	Herat	Wheat	-2.083*	-1.882	-9.197***	-11.232***
Afghanistan	Herat	Flour	-1.810	-1.619	-9.786***	-11.224***
Afghanistan	Jalalabad	Wheat	-1.744	-1.730	-10.778***	-13.139***
Afghanistan	Jalalabad	Flour	-1.763	-1.716	-10.617***	-12.843***
Afghanistan	Kabul	Wheat	-2.000	-1.899	-13.043***	-12.498***
Afghanistan	Kabul	Flour	-1.904	-1.739	-12.085***	-11.730***
Afghanistan	Kandahar	Wheat	-1.272	-1.478	-9.572***	-13.081***
Afghanistan	Kandahar	Flour	-1.703	-1.899	-12.456***	-12.425***
Afghanistan	Mazar	Wheat	-2.061	-1.923	-7.902***	-10.118***
Afghanistan	Bamyan	Wheat	-1.012	-1.403	-2.941*	-4.076***
Afghanistan	Badakhsh	Wheat	-2.137	-1.942	-9.732***	-10.627***
Afghanistan	Ghor	Wheat	-0.958	-1.332	-5.004***	-8.114***
Afghanistan	Faryab	Wheat	-2.313	-2.510	-7.114***	-12.630***
Afghanistan	Daykundi	Wheat	-2.829*	-2.268	-5.710***	-6.873***
Kazakhstan	Average	Wheat	-2.730*	-2.145	-5.436***	-6.567***
Kyrgyzstan	Average	Flour	-2.314	-1.993	-6.215***	-8.143***
Pakistan	Average	Wheat	-1.991	-1.864	-8.435***	-8.390***
Pakistan	Average	Flour	-1.669	-1.678	-10.715***	-11.021***
US	Gulf	Wheat	-2.093	-1.922	-9.409***	-10.931***

Note: ADF is the Augmented-Dickey Fuller test and PP is the Phillips-Perron test.

Table A3: Kyrgyzstan Prices Related to Kazakhstan Prices

PARAMETERS	(1) Kazakhstan
Log (β)	0.613*** (0.0462)
Constant	2.968*** (0.251)
ADF	3.18**
PP	-3.104**
Observations	103
R-squared	0.636

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1