A PARTIAL EQUILIBRIUM MODEL

OF AFGHANISTAN WHEAT MARKET

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by

FAZAL RAHMAN MALAKHAIL

Dr. Patrick Westhoff, Thesis Supervisor

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The undersigned, appointed by the dean of the Graduate School, have examined the thesis entitled

A PARTIAL EQUILIBRIUM MODEL OF
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presented by Fazal Rahman Malakhail,

a candidate for the degree of Master of Science and hereby certify that, in their options, it is worthy acceptance.

Dr. Patrick Westhoff

Dr. Wyatt Thompson

Dr. Jere L. Gilles

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LIST OF ABBREVIATIONS

ACD	Afghan Customs Department
ALCS	Afghanistan Living Conditions Survey
CSO	Central Statistics Organization
EFSA	Emergency Food Security Assessment
FAO	Food and Agriculture Organization of the United Nations
FAPRI	Food and Agricultural Policy Research Institute
FAS	Foreign Agricultural Service
FEWS NET	Famine Early Warning Systems Network
FSC	Food Security Cluster
GDP	Gross Domestic Product
GoIRA	Government of Islamic Republic of Afghanistan
GOP	Government of Pakistan
IMF	International Monetary Fund
MAIL	Ministry of Agriculture, Irrigation and Livestock
NRVA	National Risk and Vulnerability Assessment
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
PS&D	Production, Supply and Distribution
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WB	World Bank
WTO	World Trade Organization

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ABSTRACT

This study focuses on the construction of a structural economic model for the wheat market in Afghanistan. We create two models with alternative approaches to model closure, one based on a price linkage approach and the other using a trade linkage approach. The study addresses two overarching questions. First, what will the wheat market in Afghanistan look like in the coming ten years? Second, how will the market respond to some internal and external shocks? Some of the assumed shocks (also referred here as alternative scenarios) are similar to past occurrences in the wheat market in Afghanistan.

The alternative scenarios discussed are drought conditions, a wheat export ban from Pakistan, eliminating Pakistan's wheat export subsidy, increased wheat price in Kazakhstan, increased tariffs on wheat flour in Afghanistan, reduced transportation and transaction costs while importing wheat to Afghanistan and increased domestic production.

The first scenario (drought) was examined using both the price linkage and trade linkage approaches. Drought decreases wheat yields and production, but using the price linkage model, it does not change domestic wheat price, as imports increase to fill the gap

between reduced supply and consumption. In the trade linkage approach, the same scenario reduces yield and production but also increases domestic prices, while imports increase but not as much as in the first approach. A higher domestic price lowers domestic consumption.

The increased Kazakh wheat flour price, higher tariffs on wheat products and eliminating export subsidies by Pakistan scenarios all reduce imports and increase domestic prices. Higher wheat prices might also reduce the food security of low-income households that do not producer their own food.

On the other hand, increasing production through investing in irrigation rehabilitation, improving yield, and increasing efficiency in importing wheat will reduce the domestic wheat price in Afghanistan and can impact household food security. The impact of increase production on wheat producers depends on the effects it has on costs of production and how the required rehabilitation and expansion projects will be financed.

Areas of future research can focus on exploring how these scenarios affect urban and rural households separately and estimating the impact of wheat price changes on the prevalence and severity of food insecurity.

1. INTRODUCTION

1.1 Background

Afghanistan, geographically located between Central Asia and South Asia, is a landlocked country. To the north it is surrounded by Turkmenistan, Uzbekistan and Tajikistan, to the west by Iran, and to the south and east by Pakistan. Afghanistan also shares a short, inaccessible border with China (Figure 1.1). It is the least developed country in the region[1] with income per capita of about 550 United States Dollars (USD) and a population of approximately 35 million (World Bank, 2018).

Figure 1.1: Map of Afghanistan and wheat trade flows
Source: FEWS NET (2016)

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[1] For purpose of this study *the region* is defined as five Central Asian countries (Kazakhstan, Kirghizstan, Turkmenistan, Uzbekistan and Tajikistan) plus Afghanistan and Pakistan.

1.2 Rationale and significance of study

Wheat is the staple crop and food in the region, with average per capita consumption of 142 kilograms (kg) (FAO, 2019a). However, Afghanistan's consumption is even greater, averaging 160 kg per capita (FEWS NET, 2007). According to the National Risk and Vulnerability Assessment (NRVA[2]), Afghan households on average spent 60 percent of their budget on food in 2007/08, of which, 35 percent was spent on wheat. Moreover, wheat consumption comprised 54 percent of total caloric intake of Afghan households in that year (D'Souza & Jolliffe, 2013). From 2002/03 to 2016/17, cereals contributed from 9 to 18 percent to the national Gross Domestic Product (GDP), and wheat is the dominant crop among cereals by area and production (CSO, 2019c).

A review of existing literature suggests that Afghan households are vulnerable to higher food prices, and wheat is of special importance. Several authors in the past found links between high food prices and household food insecurity in Afghanistan. D'Souza and Jolliffe (2010) estimated the impact of higher wheat price on household food security using NRVA 2007/08 data in Afghanistan.

In the 2007/08 food crisis, Afghanistan had a poor harvest, world prices rose, and Pakistan banned exports, leading to a more than 100 percent increase in the wheat price compared to pre-crisis levels (FAO, 2019b ; MAIL, 2019; Meyers & Meyer, 2008; Persaud, 2010). According to D'Souza and Jolliffe (2010) the 2007/08 food crisis led to a substantial increase in the price of food in Afghanistan and as a result, food consumption at the household level decreased. The proportion of people not able to sustain minimum

[2] The National Risk and vulnerability Assessment (NRVA) is a national level survey conducted by the Central Statistics Organization (CSO) in Afghanistan. To date six rounds of NRVA were carried out; 2003, 2005, 2007/08, 2011/12, 2013/14, and 2016/17. Later it was renamed to Afghanistan Living Conditions Survey (ALCS).

caloric intake increased between the third quarter of 2007 and the second quarter of 2008. Their findings suggest that higher wheat flour prices affected both the quantity and quality of food at the household level. For example, a one-percent increase in the price of wheat flour reduced caloric intake by 0.07 percent and protein intake by 0.25 percent (D'Souza & Jolliffe, 2010). Since the wheat flour price more than doubled during the 2007/08 food crisis in Afghanistan, the food security situation seriously deteriorated.

Afghanistan is one of the most highly food insecure countries in the region (Grebmer, et all, 2018). The Afghanistan Living Conditions Survey (ALCS) conducted in 2016/17 reported that nearly 45 percent of households were food insecure. Of the total food insecure households, 27 percent were severely food insecure (CSO, 2018).

The Afghanistan Emergency Food Security Assessment (EFSA) that was conducted by the United Nations Food Security Cluster in the post-harvest season in 2018 found that 59 percent of rural households were trapped in food insecurity. Out of the total food insecure households, 13 percent had severe food insecurity. It is worth mentioning that 2018 was not a normal year, as 20 out of 34 provinces were affected by drought conditions. High food prices were also reported as one of the shocks households experienced in the last six months of the survey. In addition, the survey also reveals that expenditure on food comprised from 27 to 57 percent of total household expenditures across the provinces. The ratio was significantly higher for the urban population, which relies on purchases to meet consumption needs. It is clear from the literature that higher food prices will increase the food insecurity of households that rely on purchased food. For example, a modest increase in food prices will push households that spend a high proportion of their income on food into food insecurity and they will have limited disposable income for non-food expenses as well (EFSA, 2018).

1.3 Research purpose

In this thesis I will try to understand how the wheat market behaves in Afghanistan. Past authors already identified that high wheat prices can push more Afghan households into food insecurity, particularly those live on the verge of food insecurity. It is important to know how wheat price may evolve in the coming ten years given the domestic and regional wheat market dynamics. We will construct a structural economic model to understand expected price developments in the wheat market in Afghanistan, and how it relates to household food security.

Understanding current Afghanistan wheat market behavior will help us to estimate the future market outcomes under different scenarios. These scenarios will then improve our understanding about expected food security outcomes in Afghanistan.

1.4 Research questions

We divided our research question into two parts: estimating market outcomes for the outlook period (2019/20 – 2028/29) and simulating the model under several scenarios. The scenarios examine how the domestic wheat market could react to supply-side shocks (either production or imports) in Afghanistan, keeping demand behavior constant. Specific questions to answer are as follow:

1. *Base Scenario*: how will the wheat market evolve in the outlook period in Afghanistan?

2. *First Scenario*: how will the wheat market respond in Afghanistan if there is a domestic shock to wheat production?
3. *Second Scenario*: how will the wheat market respond in Afghanistan if Pakistan imposes an export ban?
4. *Third Scenario*: how will the wheat market respond in Afghanistan if Pakistan eliminates its export subsidy to Afghanistan in the outlook period?
5. *Fourth Scenario*: how will the wheat market respond if the price of wheat in Kazakhstan, the dominant exporting country to Afghanistan, increases due to internal or external shocks?
6. *Fifth Scenario:* how will the wheat market respond in the outlook period if Afghanistan imposes higher tariffs on wheat?
7. *Sixth Scenario*: how will the wheat market respond in the outlook period if Afghanistan increases production through expanding area and improving yield?
8. *Seventh Scenario*: how will the wheat market respond in the outlook period if transporting imported wheat become more cost efficient?

2. LITERATURE REVIEW

2.1 Importance of wheat

Wheat production in Afghanistan experienced many ups and down in the past couple of decades. Human interference (e.g. wars) and natural disasters (e.g. droughts), have often interrupted the growth and production of this important crop (Maletta, 2007; Persaud, 2010), while the country still remains a wheat deficit country (Chabot & Tondel, 2011).

Wheat production in Afghanistan fluctuated more than production in other exporting countries in the region, such as Kazakhstan and Pakistan (Persaud, 2010; USDA, 2019a). However, production variation decreased in recent years (author review of USDA PS&D data). The reason for this high production variation could be that nearly half of the wheat produced in Afghanistan is cultivated on rainfed area, which is solely dependent on timely precipitation (MAIL, 2019). The same applies for other Central Asian countries (Chabot & Tondel, 2011; FEWS NET, 2016).

Historically, Pakistan was the prominent wheat exporting country to Afghanistan. Afghan wheat markets were dominated by Pakistani imports, with ups and down in their trading relationships (Chabot & Tondel, 2011; Persaud, 2013; Schulte, 2007). Due to Pakistan's importance in the local market, Afghan policy makers were advised to monitor wheat production and prices in Pakistan as early warning indicators (Khan, 2007).

Price transmission studies confirmed the relationship between wheat markets in Afghanistan and Pakistan. Previous studies found that wheat prices were correlated between Afghanistan and Pakistan main markets between January 2000 and April 2009 and were found to be co-integrated in the long-run (Chabot & Dorosh, 2007; Persaud, 2010).

This association did not last forever. Pakistan used to impose export bans on its wheat to Afghanistan from time to time to maintain its own wheat price. However, due to poor border monitoring between the two, informal/illegal trade was always happening. Nevertheless, the May 2007 – December 2010 ban had severe impacts on the trade and wheat prices in Afghanistan, for it was then that the gap between wheat prices in the two countries widened (USDA, 2019b; CSO, 2019b; Persaud, 2013).

In the 2007/08 – 2009/10 export ban, Afghanistan had to resort to other countries, mainly in Central Asia, to import wheat. Kazakhstan replaced Pakistan in the export ban years and its share of wheat trade escalated in the following years (Figure 2.1) (CSO, 2019b). Halimi, Abbott, and McNamara, (2015) corroborated this point. They argued wheat prices were strongly integrated between Afghanistan and Pakistan before the ban. However, that link was not as strong afterwards, as Afghanistan wheat prices became more integrated with its northern trading partners (Halimi et al., 2015).

Hassanzoy, Ito, Isoda, and Amekawa (2017) advanced the idea that Afghan wheat market is integrated with the countries that supply its imports. They noted that price transmission is faster between Afghanistan and Pakistan for wheat grain, while for the wheat flour market, price transmission is faster between Afghanistan and Kazakhstan.

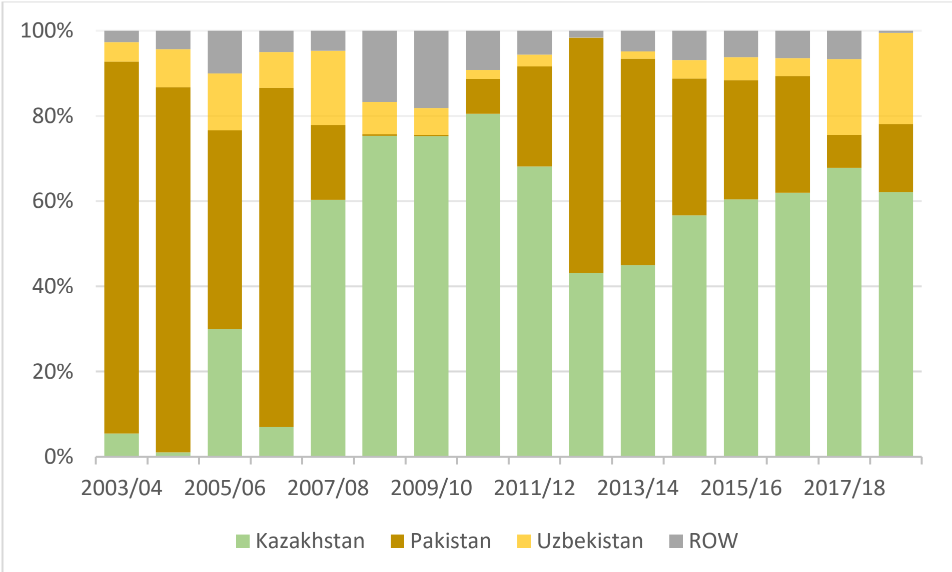


Figure 2.1: Afghanistan wheat import by exporting source
Source: Compiled from CSO trade statistics

Wheat prices are well correlated among urban markets in Afghanistan (Chabot, 2013) but rural markets are not well integrated with urban markets. This might help explain why Afghanistan still imported intensively even in good production years (Halimi et al., 2015).

Given the importance of wheat in Afghanistan, several authors advocated the ambitious goal of the Government of Islamic Republic of Afghanistan (GoIRA) achieving self-sufficiency (MAIL, 2016). Production could be increased either through area increment or yield improvement. Area can be extended through expanding irrigation infrastructure. However, Persaud (2013) suggested considering transboundary issues of water flowing between Afghanistan and its downstream neighbors, which might make it difficult to sharply expand irrigated area. Thus, improvement in yields on existing wheat area could be the best possible option. He concluded that for Afghanistan to achieve the self-sufficiency target it has to sustain an annual growth rate in yield of 5.5 percent compared to the then 0.9 percent growth rate.

Trade policy could be used to give producers greater incentive to grow more wheat. Persaud (2013) unveiled trade options and analyzed their possible impact on wheat market outcomes in Afghanistan. He found that increasing tariffs on wheat grain might encourage Afghan farmers to grow more wheat, but given limited irrigation infrastructure, the production growth might not be substantial. On other hand, under increased tariffs on wheat flour, local consumers have to bear the extra cost of bread. Free trade would result in less production than options that result in higher market prices, but it might result in better outcomes for consumers (Persaud, 2013).

Halimi (2016a) demonstrated that with a 20 percent increase in production relative to the above-average levels of 2009, Afghanistan could achieve self-sufficiency, but only if rural and urban markets are strongly integrated. Afghanistan achieved the 2009 level of production in subsequent years, but it never reached the increase required for self-sufficiency.

Afghanistan has been predominately importing wheat flour instead of wheat grain (ACD, 2019). As Figure 2.2 shows, the proportion of wheat flour in total wheat imports ranged from 63 percent to 97 percent between 2006/07 and 2018/19, with an average of 82 percent. Estimates of imports by source show that Pakistan tends to export mainly wheat flour to Afghanistan (Khan, 2007) while other Central Asian countries export both wheat grain and flour (CSO, 2019b).

The literature cites three prominent reasons for more Afghan imports of wheat flour than grain. First is the lack of milling capacity in Afghanistan. The government of Pakistan provides procured wheat grain to its mills at subsidized prices through its government support program (Dorosh & Salam, 2008; Faruqee, Coleman, & Scott, 1997; Khan, 2007). This leads to an excess number of mills[3] in Pakistan. In contrast, Afghanistan only has a few public and commercial mills with limited capacity (Khan, 2007; Persaud, 2013). Afghan mills have to rely on mixing cheap local grain with high quality Kazakh and Uzbek wheat to compete with subsidized Pakistani flour in the market (Halimi, 2016b).

Second, local wheat supplies are erratic, and hence Afghan millers and bakers need to rely on imported wheat grain and flour. A small portion of local wheat enters into markets and the rest is consumed or bartered to cover production expenses (Chabot, 2013; Khan, 2007; Schulte, 2007).

Third, imported flour is also preferred because of its good quality. The proportion of gluten found in imported wheat flour is higher, which makes it more elastic and more demanded among Afghan bakeries (Halimi, 2016b; Schulte, 2007). This quality trait is also reflected in the prices of wheat flour in Afghanistan (Chabot & Dorosh, 2007).

[3] Khan (2007) reports 1265 registered mills in Pakistan in 2007.

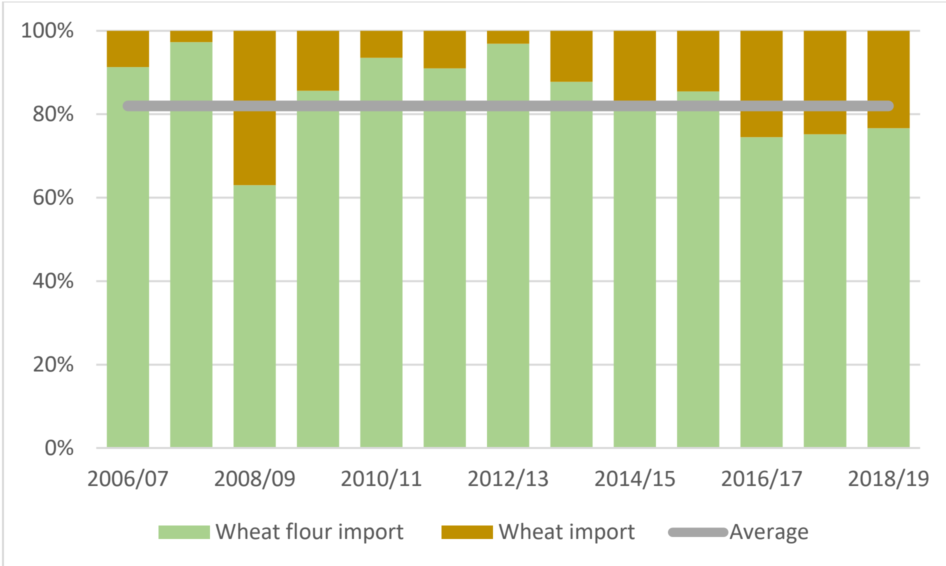


Figure 2.2: Proportion of wheat grain and flour imports by Afghanistan
Source: Compiled from the Afghan Customs Department data

2.2 Data sources

There are two data sources available that report wheat production in Afghanistan. Annual Agricultural Prospects Reports (APR), which are published by the Ministry of Agriculture, Irrigation and Livestock (MAIL) since 2005, and the United States Department of Agriculture's (USDA) Production, Supply and Distribution (PSD) database.

The MAIL staff collects preliminary data from the field through their extension agents using the Crop Cut survey for cereal crops (mainly wheat) to report the expected level of output for the coming harvest. The main information developed by MAIL consists of estimated balance sheets for cereal crops by province. On the other hand, USDA data also use MAIL data but sometimes they also consider other information and triangulate with other sources. Figure 2.3 shows a comparison of wheat production between the two data sources. The two follow the same trend most of the time, although there are important differences in particular years.

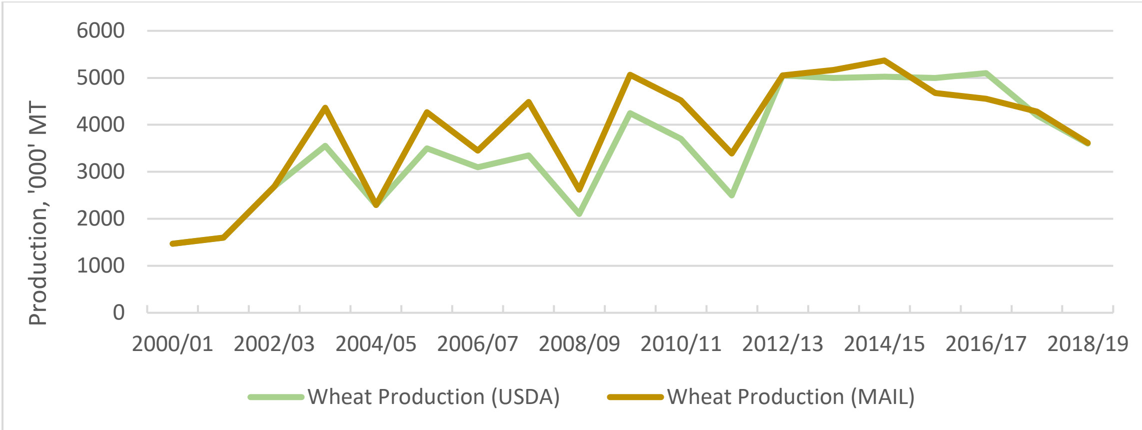


Figure 2.3: Wheat production according to MAIL and USDA data sources

2.2.1 A comparative view of the two data sources

Table 2.1 provides a comparison of the two data sources. In summary, MAIL data has the advantage that it provides information at the provincial level while USDA data only provides information at the national level. On the demand side, MAIL provides estimates of consumption[4] using CSO population data, while USDA estimates consumption using the World Bank (WB) figures. The difference between these two population datasets are enormous; for example, during 2017/18 the population difference was nearly six million.

[4] It is population times per capita consumption.

Table 2.1: Characteristics of MAIL and USDA production data

Type of information	MAIL database	USDA database
Area, yield and production estimates	- provincial level - separated by irrigated and rainfed area	- national level - aggregated at national level
Population number	- uses the CSO figures - estimated total population for 2017/18 was 29.7 million	- uses the WB figures - estimated total population for 2017/18 was 35.5 million
Domestic consumption	- estimated consumption requirement using the CSO population figures	- estimated consumption using the WB population figures
Type of domestic consumption	Separated by: - human consumption; - seed requirements; - post-harvest losses	Separated by: - feed consumption; - food, seed, and industrial (FSI) usage
Beginning stocks and ending stocks	N/A	estimated
Import/export	only estimates the amount of import required, that is total required consumption minus total production	provided and triangulated with other sources

The different population estimates constitute the big factor that explains the differences in consumption between the two data sources. Some contend that MAIL data, particularly production, yield and area, could be inflated because of political motives (Halimi, 2016b). For example, according to MAIL data, the self-sufficiency ratio for wheat in 2014/15 was 0.96 and only 242 thousand MT of wheat imports were required to meet total demand, but CSO (another official source) reported registered imports of 1,500 thousand metric of wheat in the same year.

2.2.2 Growth in wheat production, yield and imports

Most arable land is allotted to wheat cultivation. On average from 2008/09 to 2016/17, area under wheat cultivation was 2.3 million hectares (ha), which represented

76 percent of the total cultivated area (CSO, 2019c). The ratio of rainfed area in total wheat area varied by year depending on precipitation availability. In 2016/17 that ratio stands at 33 percent (MAIL, 2019)

According to USDA, in the last 10 years (2009/10 to 2018/19), Afghanistan on average produced 4.3 million metric tons (MT) of wheat and imported 2.5 million MT of wheat to meets its total domestic demand (USDA, 2019a). Based on this data the country stands at a 0.62 self-sufficiency ratio[5] (Table 2.2). In contrast, MAIL reports average production of around 4.6 million MT of wheat and import needs of around one million MT, suggesting a 0.83 self-sufficiency ratio (Table 2.3).

An attempt was made to use MAIL data as being the official data source, but given its discrepancies with other official sources as explained, USDA production, consumption and stock data will be used throughout this study.

After a drought-reduced harvest in 2008, wheat production in Afghanistan grew at an annual rate[6] of 4.5 percent between 2009/10 and 2018/19. Increases in yields accounted for most of this increase, while area receded by an average of 0.7 percent per year. Moreover, a retrospective view of the last 20 years tells a similar story – that yield increment was the major driver of production growth, while area exhibited sluggish growth.

Wheat imports accounted for 24 percent to 48 percent of total consumption during the 2009/10-2018/19 period. Wheat imports were highest during years with poor harvests

[5] Self-sufficiency ratio is defined as total production divided by total demand.
[6] Annual growth rate calculated using the log-linear model of regression.

such as 2011/12 and 2018/19, when almost half of domestic demand was met through imports.

Table 2.2: Supply and use balance sheet of wheat in Afghanistan based on USDA data

Marketing year	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	Average
Area harvested, thousands MT	2,575	2,300	2,100	2,512	2,550	2,560	2,550	2,300	2,100	2,000	2,355
Yield, MT/ha	1.65	1.61	1.19	2.01	1.96	1.96	1.96	2.22	2.00	1.80	1.84
Supply, thousands MT											
Production	4,250	3,700	2,500	5,050	5,000	5,025	5,000	5,100	4,200	3,600	4,343
Beginning stocks	0	70	70	70	80	285	310	410	460	410	217
Imports	2,500	2,000	2,200	1,600	2,050	2,000	2,700	2,700	3,300	3,700	2,475
Total supply	6,750	5,770	4,770	6,720	7,130	7,310	8,010	8,210	7,960	7,710	7,034
Demand, thousands MT											
Feed dom. Consumption	625	300	200	600	800	800	800	850	600	500	608
FSI consumption	6,055	5,400	4,500	6,040	6,045	6,200	6,800	6,900	6,950	7,000	6,189
Domestic consumption	6,680	5,700	4,700	6,640	6,845	7,000	7,600	7,750	7,550	7,500	6,797
Ending stocks	70	70	70	80	285	310	410	460	410	210	238
Exports	0	0	0	0	0	0	0	0	0	0	0
Total demand	6,750	5,770	4,770	6,720	7,130	7,310	8,010	8,210	7,960	7,710	7,034
self-sufficiency ratio	0.63	0.64	0.52	0.75	0.70	0.69	0.62	0.62	0.53	0.47	0.62

Table 2.3: Supply and use balance sheet of wheat in Afghanistan based on MAIL data

Marketing year	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	Average
Area harvested, thousands ha	2,575	2,354	2,232	2,512	2,553	2,654	2,128	2,300	2,104	1,635	2,305
Yield, MT/ha	1.97	1.92	1.52	2.01	2.02	2.02	2.20	1.98	2.03	2.21	1.99
Supply, thousands MT											
Production	5,064	4,521	3,388	5,050	5,169	5,369	4,673	4,554	4,281	3,613	4,568
Beginning stocks	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Import needs	191	711	1,795	386	329	242	896	1,222	1,517	2,307	960
Total supply	5,255	5,232	5,183	5,436	5,498	5,611	5,569	5,776	5,798	5,920	5,528
Demand, thousands MT											
Seed	319	313	328	316	322	349	298	371	344	266	323
Human consumption	4,175	4,240	4,346	4,362	4,401	4,461	4,570	4,721	4,812	5,112	4,520
Post harvest losses	760	679	509	758	775	803	701	683	642	542	685
Ending stocks	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Exports	0	0	0	0	0	0	0	0	0	0	0
Total demand	5,255	5,232	5,183	5,436	5,498	5,613	5,569	5,775	5,798	5,920	5,528
Self-sufficiency ratio	0.96	0.86	0.65	0.93	0.94	0.96	0.84	0.79	0.74	0.61	0.83

In addition to data from USDA, other data were pulled out from different sources and were used as a secondary source to our work. In general, data on wheat prices were available on a monthly basis, so they were averaged over the twelve months of the local wheat marketing year[7] (July-June) in Afghanistan. Macro level data were pulled from the

[7] Marketing year is a 12-month period for a crop that starts with its harvest and used in that period (USDA).

World Bank for the historical period, while for the outlook period estimates from IHS Markit were used. Currency exchange rates and customs data were extracted from respective central banks and statistics agencies of the countries. All statistics available on monthly and quarterly bases were converted to the marketing year. The precipitation data were available for each province in Afghanistan based on remote-sensed information using pentadal (5-days) estimation. We averaged cumulative precipitation across all provinces in Afghanistan to give us precipitation estimation for the country on a wet season (July-June) basis. Table 2.4 illustrates detailed description of the main data sources used in the study.

Table 2.4: Secondary data sources with their description used in this study

Data	Description	Source
Wheat grain and flour prices in Afghanistan	- Monthly retail prices of wheat and flour in Kabul, Afghanistan. January 2000 to May 2019.	Vulnerability Analysis and Mapping (VAM) of the World Food Program (WFP) in Afghanistan (WFP, 2018).
Wheat grain and flour prices in Kazakhstan, Pakistan and Uzbekistan	- Monthly retail prices of wheat (flour, first grade) in Kostanay, Kazakhstan. November 2005 to May 2019. - Monthly retail prices of wheat (flour) in Lahore, Pakistan. January 2006 to May 2019. - Monthly wholesale national average prices of wheat (flour, first grade) in Uzbekistan. September 2009 to May 2019.	Accessed from FAO GIEWS webpage: *http://www.fao.org/giews/food-prices/tool/public/#/home* (FAO, 2019b).
Wheat balance sheets for Afghanistan, Pakistan, and Kazakhstan	Statistics on wheat supply and demand in respective country. From 2000/01 to 2018/19.	USDA PSD database: *https://apps.fas.usda.gov/psdonline/app/index.html#/app/home* (USDA, 2019a).
Wheat grain and flour imports to Afghanistan	Quarterly trade statistics by country and commodity to Afghanistan. From 2008/09 to 2018/19	CSO Afghanistan: *http://cso.gov.af/en* (CSO, 2019b).

Macro level data	Population, GDP and GDP deflator for Afghanistan, Pakistan and Kazakhstan.	The World Bank database: *https://databank.worldbank.org/data/reports.aspx?source=world-development-indicators#* (WB, 2019). IHS Market: *https://ihsmarkit.com/index.html*
Currency exchange rates	Official exchange rates for Afghanistan, Pakistan and Kazakhstan from their respective central banks.	Da Afghanistan Bank: *http://dab.gov.af/en* Central Bank of Pakistan: *http://www.sbp.org.pk/* National Bank of Kazakhstan: *https://www.nationalbank.kz/?docid=3321&switch=english* IHS Markit: *https://ihsmarkit.com/index.html*
Customs data	- Yearly tariffs rates on wheat and flour. From 2006/07 to 2018/19. - Transportation and transaction costs for importing wheat and flour to Afghanistan. 2017/18 and 2018/19.	Accessed from the Afghanistan Customs Department (ACD, 2019). Personal communication with Balkh Customs Office and Commercial Attaché of Afghanistan in Islamabad, Pakistan.
Precipitation data	Remote-sensed estimation using Climate Hazards Group InfraRed Precipitation with Stations (CHIRPS) data on Afghanistan.	USGS webpage: *https://earlywarning.usgs.gov/fews/mapviewer/index.php?region=ag*
Fuel prices	Quarterly Europe Brent Spot Prices (FOB). From 2000 to 2028	IHS Markit: *https://ihsmarkit.com/index.html*

As mentioned earlier, all elements of the balance sheet were drawn from a USDA database except imports, which were taken from the CSO Afghanistan. The CSO source had imports by type and country of exports which helped us to enrich our model in coming scenarios. Because USDA and CSO report different estimates of total wheat imports by Afghanistan, we had to introduce a statistical discrepancy to balance the model for both the historical and the outlook periods.

2.3 Literature review about partial equilibrium modeling

Various economic models have been used to conduct economic analysis and predict the outcome of policy changes. Economic models can be divided into many categories, but models used to estimate equilibrium quantities and prices can be broadly grouped into two categories: the general equilibrium approach and the partial equilibrium approach. The general equilibrium approach first emerged with the work of French economist Léon Walras's (1834-1910) famous book, *Elements of Pure Economics* (1877). The partial equilibrium approach was introduced by the English economist Alfred Marshall (1842-1924) in his book, *Principles of Economics* (1890). Both ideas were further sharpened by Nobel laureate George Stigler (1911-1991) in his book, *The Theory of Price* (1952).

Both general and partial equilibrium analyses discuss how equilibrium is reached in an economic system. As Stigler describes, the former is a comprehensive approach that clears all interconnected markets in an economic system. The latter focuses on a single market or a subset of markets. Although the partial equilibrium approach is less comprehensive, it is more widely used for analysis where data and time are constraints (Francois & Reinert, 1997).

The two approaches have been extensively used in market and trade analysis to determine the impact of one or a few factors in an economic system. For example, the World Trade Organization (WTO) and the International Monetary Fund (IMF) used these approaches to measure the impact of policy change on agricultural markets (Tokarick, 2003; Bacchetta et al., 2008). Policy options can take any form of distortion, such as subsidies and tariffs, or can reflect the liberalization of trade.

In the case of wheat markets, the partial equilibrium approach is used for many purposes. For example, Fellmann, Hélaine, & Nekhay (2014) analyzed the impact of failed wheat harvest in Russia, Ukraine and Kazakhstan on world wheat markets and food security using a partial equilibrium approach. Similarly, Dorosh and Salam (2008) used the partial equilibrium approach to determine how government policies affect the wheat market in Pakistan.

Likewise, the partial equilibrium approach was used to assess several factors for wheat markets in Afghanistan. Chabot & Dorosh (2007) estimated import demand for wheat in Afghanistan for 2003/04 under several production and demand scenarios using a partial equilibrium model, with sensitivity analysis considering multiple income and own-price elasticities of demand. Persaud (2012; 2013) relied on a partial equilibrium approach to project outcomes from 2010 until 2020 under multiple yield increments and tariff scenarios for Afghanistan wheat market.

Many national and international agencies rely on a partial equilibrium approach as a tool to estimate the agricultural outlook for coming years. The OECD-FAO produces an annual agricultural outlook for the coming ten years for agricultural and fish markets at national, regional and global levels, using a partial equilibrium model called Aglink-Cosimo (Araujo Enciso, Pérez Dominguez, Santini, & Helaine, 2015). Similarly, FAPRI produces a ten-year outlook for agricultural markets using a partial equilibrium modeling approach (Meyers, Westhoff, Fabiosa, & Hayes, 2010). Both the OECD-FAO and FAPRI models have been used to examine the market consequences of alternative policies, such as changes in the U.S. farm bill, biofuel policies, and trade agreements.

3. BUILDING WHEAT MARKET MODEL FOR AFGHANISTAN

3.1 Introduction

As stated earlier, the main idea behind a partial equilibrium approach is to know how total supply and total demand attain equilibrium under certain conditions in a specific market(s). We developed a partial equilibrium model to test our hypotheses and to attain the objectives of this study. The model uses data on wheat supply and demand in Afghanistan and is constructed in an Excel Spreadsheet.

Elements of total wheat supply are production, beginning stocks and imports while elements of total wheat demand are domestic consumption, exports and ending stocks. Domestic consumption is further segregated into feed consumption and food, seed and industrial (FSI) use (Table 2.2). Because of inconsistency in MAIL data we pulled most of these elements from annual data maintained in USDA databases from 2000/01 to 2018/19. For trade figures, mostly imports, we referred to CSO quarterly trade statistics because it provides imports by type of commodity (wheat grain and wheat flour) and by exporting country, which is important for our trade linkage equations discussed later. All elements of supply and demand were aligned with the local wheat marketing year in Afghanistan, from July to June, including prices. Figure 3.1 provides an overview of why it was necessary to adjust all elements to wheat marketing year; USDA data was based on a marketing year (July to June) while all official statistics were based either on local year (21 March – 20 March) or fiscal year (21 December to 20 December).

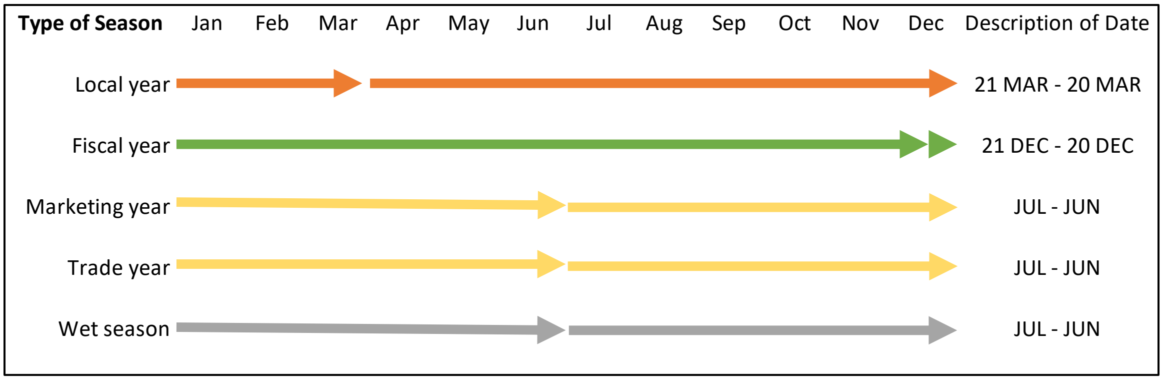


Figure 3.1: Description of different seasons for wheat crop in Afghanistan
Source: Compiled from USDA FAS, USGS and FEWS NET

3.2 Estimation of equations

To address our research questions, we utilized secondary data collected by other sources and developed a partial equilibrium model for the wheat market in Afghanistan. The model is used to project the wheat market outlook for Afghanistan for the coming ten years, from 2019/20 to 2028/29. Most international agencies examining agricultural markets, such as FAO, OECD and FAPRI, use a ten-year period timeframe for their outlook projections. To produce this outlook required estimates of the model parameters, some of which were obtained by econometric estimation. Figure 3.2 illustrates how supply and demand components interact to determine equilibrium through the partial equilibrium approach to modeling the wheat market in Afghanistan. Some of these equations were estimated using the ordinary least square (OLS) regression. The narrative below will explain how these behavioral equations were estimated, starting from the supply side and followed by the demand side equations. The specification of all these equations are given in Appendix 1, along with the estimated or assume model parameters.

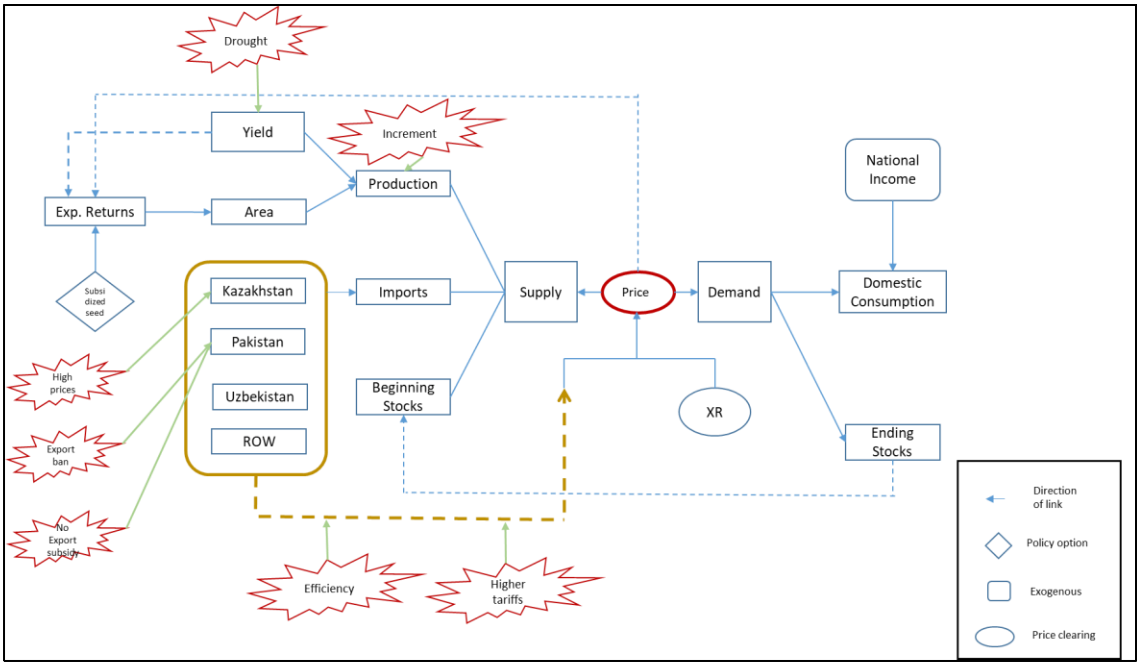


Figure 3.2: Framework for partial equilibrium model for wheat market in Afghanistan
Source: Baldos and Hertel (2013)

3.2.1 Supply-side equations

From the literature we know that the total supply, or availability of wheat, is equal to domestic production, plus beginning stocks, plus imports from other countries in a given year.

$$QS = QP + STB + IM \tag{1}$$

Where:

QS = quantity supplied

QP = quantity produced domestically

STB = stocks at beginning of a marketing year

IM = imports

Next, we explore each domestic supply component and its equation (imports will be discussed in a separate section on model closure). Domestic production is the product of area harvested and actual yield in a given year.

$$QP = AH * YLD \tag{2}$$

Where:

AH = area harvested

YLD = yield

We estimated area harvested and yield with two separate equations. To estimate a yield equation for wheat in Afghanistan, authors in the past tried lagged yield and wheat prices as explanatory variables using the OLS method (Persaud 2013; Halimi, 2016b). Kruse (1999) explains both traditional and alternative approaches that could be used to estimate yield for any crop. The former considers weather, technology and economic factors, while the latter could be captured using a trend yield. Given uncertainty both approaches may have their limitations (Kruse, 1999). Pre-testing found no significant relationship between expected prices and yields, and the final equation selected estimates yields as a function of precipitation levels and a trend to reflect technological change.

$$YLD = \beta 0 + \beta 1 \{\min \{0, \{PRCP_{t-1} - AVERAGE\ (PRCP_{LR})\}\} + \beta 2\ TRD + \varepsilon \tag{3}$$

Where:

YLD = yield

$PRCP_{t-1}$ = lagged precipitation

$PRCP_{LR}$ = long-term lagged precipitation

TRD = trend

ε = residuals

We regressed YLD on the right-hand-side variables to estimate the parameters (βi) in this equation using the OLS method. Wheat yield in Afghanistan is predominantly determined by previous year precipitation (the marketing year begins at harvest, so the precipitation that falls during the growing season occurs in the t-1 marketing year). We put additional restriction on the precipitation because yield response to precipitation is not linear and pretesting with a quadratic specification did not result in plausible parameters. In the utilized equation, $\beta 1>0$ indicates that precipitation only contributes to higher yields if it is less than the long-term average precipitation, once the precipitation level surpasses the average it is no longer has a marginal effect on yields. Trend can capture many factors including technology improvement, so $\beta 2>0$ implies that yield increases with time. We attempted to include wheat price in the equation, anticipating that yield may respond to prices in the long run, but we did not obtain significant results. Generally, yield response to price in wheat seems limited compared to other crops (Choi & Helmberger, 1993).

Previous econometric models used lagged price, lagged yield and trends to estimate wheat area in Afghanistan (Persaud 2013; Halimi, 2016b). Real expected returns in competing crops could be used to estimate area for a particular crop (Westhoff, Brown, & Hart, 2005). We estimated the wheat area equation for our model as a function of real expected returns of wheat. Rice could be considered competing crop for wheat in Afghanistan, but due to data limitations, it was not included in the estimated equation. We also tried to include lagged area to reflect partial adjustment concerns but did not get fruitful results.

The expected returns were computed as a product of the trend yield and the expected price of wheat in Afghanistan. The trend yield was computed regressing yield on a trend variable, while deflated lagged wheat prices were taken as a naïve expectation to reflect expected wheat prices in Afghanistan. Below is a stepwise depiction shows how the area equation was estimated:

a) $PRICE_{real} = PRICE / GDPD * 100$ (4)

b) $TRDYLD = \alpha 0 + \alpha 1 \ TRD + \mu$

c) $RH = PRICE_{real\ (t-1)} * TRDYLD$

d) $AH = \beta 0 + \beta 1 \ RH + \varepsilon$

Where:

AH = area harvested

RH = real marketing returns in local currency per ha planted to wheat

TRDYLD = trend yield

TRD = trend

$PRICE_{real}$ = real price of wheat

PRICE = nominal price of wheat

GDPD = GDP deflator

ε and μ = residuals

There are many ways to frame how producers develop their expectations of future prices and how these expectations affect production of crops, including adaptive expectations (Nerlove, 1979) and an approach that considers both lagged prices and deviations from expected yields (Westhoff et al., 2005). Here for simplicity we assume naïve expectations and consider last year's wheat price as the expected price for wheat in our model. The supply theory from economics expects a positive relationship between supply of a commodity and its expected price. We can expect a similar link for wheat production in Afghanistan. Hence, in the above area equation, $\beta 1>0$. It also supports our assumption that the higher the expected returns the more area will be planted to that crop.

It is worth mentioning that we did not have enough data points of farmgate or producer prices of wheat in Afghanistan, so instead retail prices of wheat were used as a proxy for expected producer prices to estimate the aforementioned equations. In addition, since retail wheat price in major markets are cointegrated with Kabul retail wheat price (Hassanzoy et al., 2017) we used Kabul retail wheat price as the indicator wheat price for all of Afghanistan throughout this study. All nominal prices were deflated by a consumer price index with base year 2002 equal to 1 to convert them to real prices. Beginning stocks are just lagged ending stocks.

Government sponsored programs, such as support prices and subsidies, can also influence farmers' decision to prefer one crop over another and hence affect planted area and production. The government of Afghanistan does not have a support price for wheat, but MAIL does provide subsidized improved wheat seed to farmers. However, due to data limitations, we did not consider this in our estimation.

3.2.2 Demand-side equations

Similar to supply, total demand is also an identity that sums up domestic wheat consumption, ending stocks and exports in a given marketing year on a balance sheet. Domestic consumption itself is the sum of feed consumption and FSI (food, seed and industrial) consumption. Since feed use is a small share of total domestic consumption in Afghanistan (on average less than 10 percent) we did not estimate two separate equations for domestic consumption. Rather it was covered in one equation reflecting overall domestic consumption, including both feed and FSI.

$$QD = QC + STE + EX \tag{5}$$

Where:

QD = quantity demanded

QC = quantity consumed domestically

STE = stocks at ending of a marketing year

EX = exports

We now turn to estimated equations for the demand component of this model. Afghanistan does not export wheat at all and the proportion of ending stocks is small. Because of this, most authors worked to estimate domestic consumption, and some referred to domestic consumption as total demand, particularly at the national level.

Chabot and Dorosh (2007) estimated the need for net imports of wheat in Afghanistan under three hypothetical demand scenarios with income and own-price elasticities of demand: low, high and completely inelastic. They used 0.2 and -0.2 under the low scenario, and 0.5 and -0.5 under high scenario for, respectively, income and own-price elasticities in their model.

Similarly, Persaud (2012) applied -0.2 for own-price elasticity and 0.32 for income elasticity in line with trends found in per capita wheat consumption, real wheat flour price and real GDP per capita. D'Souza and Jolliffe (2010) found no statistical significance of wheat flour price on wheat consumption at the national level using NRVA 2007/08 household level data. However they found a significant direct link between the two in urban areas, suggesting that wheat has the characteristics of an inferior and Giffen good. Halimi (2016b) used NRVA 2011/12 household level data and found that wheat has an upward-sloping demand curve in urban areas. However, at the national level its own-price elasticity was -0.202, very close to what other authors reported. He reported income elasticity at -0.04 and concluded that wheat is an inferior good in Afghanistan.

We borrowed some of these estimated parameters from others and used them for our analysis. It is obvious from our literature review that real income per capita and wheat flour prices are two major economic factors that explain domestic consumption in Afghanistan. Because of this we used these two variables to estimate domestic consumption.

$$\text{Log}(QC) = \beta 0 + \beta 1 \log(PFLOUR) + \beta 2 \log(GDPPC) + \mathcal{E} \tag{6}$$

Where:

QC = quantity consumed domestically (both feed and FSI)

GDPPC = real income per capita

PFLOUR = real wheat (flour) price in Afghanistan

Ɛ = residuals

Real GDP per capita was used as a proxy for real income per capita and real wheat flour price in Kabul used to represent real wheat flour prices in Afghanistan. As commented, authors in the past provided conflicting numbers for these parameters (β1 and β2), covering a broad range from negative to positive numbers. However, most of them agree that β1<0, representing a downward sloping demand. We assume β1 = -0.202, consistent with Halimi (2016). Given this assumed value for β1, we utilized a restricted regression to estimate the value of β2. Our estimated β2 is greater than zero and is close to Chabot & Dorosh's (2007) high elasticity scenario. We are confident in these coefficients because the rest of our equations come from the national level, and these coefficients are close to other authors' work, who also used national level data instead of household level data.

Given that Afghanistan is a wheat deficit country, some past researchers did not include a stock equation in their model, and assumed ending stocks are zero in all years (Persaud, 2012). Others did estimate the equation for both public and private stockholding using an inverse relationship between wheat prices and stockholding among other things (Halimi, 2016b).

The Afghanistan balance sheet for wheat crop now includes ending stocks since 2009/10, therefore, it is feasible to include an estimated stock equation into our model.

$$STE = \beta 0 + \beta 1\ (1/PFLOUR) + \beta 2\ (QP+STB) + \varepsilon \qquad (7)$$

Where:

STE = stocks at the end of a marketing year

PFLOUR = real wheat (flour) price in Afghanistan

QP = quantity produced domestically

STB = stocks at beginning of a marketing year

ε = residuals

In the above equation we expected an inverse relationship between real price of wheat flour and ending stocks. Because the model uses one over the real price as the price term in the equation, the expected value of $\beta 1$ is positive. In addition, both production and beginning stocks have a positive influence on ending stocks.

3.2.3 Linkage of domestic grain and flour prices

In above model, all supply-side equations represented wheat grain price while all demand-side equations represented wheat flour price. The reason was that wheat producers usually consider wheat grain prices in their decisions to cultivate, while wheat consumers consider wheat flour price when buying wheat products. In addition, more than 70 percent wheat imported to Afghanistan is in the form of wheat flour. We linked the two products (wheat grain and wheat flour) through an OLS regression (equation 8). So, in the model, the wheat flour price clears the market, and wheat flour prices are translated into wheat grain prices to producers using equation 8.

$$AFGWPL = \beta 0 + \beta 1 \ AFGFPL + \mathcal{E} \tag{8}$$

Where:

AFGWPL = Afghanistan wheat grain price in Afghani per kg

AFGFPL = Afghanistan wheat flour price in Afghani per kg

$\mathcal{E}$ = residuals

3.3 Closing the wheat market model

There could be many ways to close a market in a partial equilibrium model, but the main ones are either through a price linkage or quantity clearing. If a country exists in autarky (closed economy), then the equilibrium domestic price is the price that balances domestic supply and demand. On the other hand, if a country engages in trade with other countries (open economy) then the proper way to depict market closure depends on whether it is a small country or large country, whether the good is homogeneous or heterogeneous, and a number of other factors. A country is a small country if realistic changes in its volume of trade are small enough to have little or no impact on global market prices.

In the small country case for a homogenous good with fixed transaction costs per unit, a price linkage equation may be an appropriate method to clear a market. Domestic prices are connected to world prices through a price linkage equation considering other factors that affect trade, such as tariffs, subsidies and transportation cost. In this case, the quantity exported or imported depends on the difference between domestic supply and use at the price determined by the price linkage equation.

In the global wheat market, Afghanistan is considered a small country case, so a price linkage equation may seem a suitable option to close its wheat market. However, it is not clear that consumers consider domestic wheat products to be perfect substitutes for imports from other countries, and high transportation costs and other market imperfections may mean that local prices may not be perfectly correlated with prices in exporting countries. Kazakhstan, Pakistan and Uzbekistan are considered dominant exporters for the wheat market in Afghanistan. On average, these three countries provide more 90 percent of total wheat imports for Afghanistan. Imports from these countries were modeled as functions of prices in Afghanistan and in the exporting countries. Other imports were aggregated under a rest of the world (ROW) category. To demonstrate the consequences of alternative approaches to model closure, we examine two alternatives: the trade linkage and price linkage approaches.

3.3.1 Closing wheat market model through the price linkage approach

Under this approach, it was assumed that the domestic wheat price in Afghanistan follows wheat prices in the exporting countries. A time series analysis revealed that the wheat price in Kazakhstan is more important and heavily influences the Afghan wheat price, with the Pakistani wheat price having a lesser effect, consistent with their shares of the Afghanistan market in recent years. Uzbekistan wheat (flour) prices did not have statistically significant effects on the Afghan wheat price.

$$AFGFP = \beta 0 + \beta 1\ (2/3 * KAZFPT + 1/3 * PAKFPT) + \varepsilon \qquad (9)$$

Where:

AFGFP = Afghanistan wheat (flour) price in USD per MT

KAZFPT = Kazakhstan wheat (flour) price plus transport costs and tariffs in USD per MT

PAKFPT = Pakistan wheat (flour) price plus transport costs and tariffs in USD per MT

Ɛ = residuals

In the above equation, β1 is expected to be positive, as increased wheat prices in the exporting countries are expected to increase the domestic price (AFGFP). Here we found β1 was 1.3 indicating that the wheat price in Afghanistan is strongly affected by prices in Kazakhstan and Pakistan.

In this model, imports clear the domestic wheat market in Afghanistan. Import supply is calculated as total wheat demand less domestic production less beginning stocks plus statistical discrepancy.

$$IM = QD - QP - STB + SD \qquad (10)$$

Where:

IM = import demand for wheat

QD = quantity demanded

QP = quantity produced domestically

STB = stocks at beginning of a marketing year

SD = statistical discrepancy

The advantage of this approach is that it assumes the domestic price is determined in international market, as trade theory suggests should be true for a small country like Afghanistan, under a conventional set of assumptions. The disadvantage is that some of these assumptions may not hold in practice, and as a result, the model may give qualitatively incorrect responses. For example, under the price linkage approach, domestic shocks, such as a harvest failure, will have no impact on domestic prices.

3.3.2 Closing wheat market model through the trade linkage approach

The alternative approach assumes that trade and prices are both sensitive to market conditions in the domestic market. Transportation costs and quality preferences mean that domestic prices may not always be perfectly correlated with prices in other countries. Here trade (imports) itself does not clear the market but is calculated as a function of domestic prices relative to export prices (while accounting for all transportation, transaction costs and tariffs).

The approach used here is based on a model of maize markets in southern Africa that has since been applied to other problems (Davids, 2017). We developed three distinct trade equations for each major country that exports wheat to Afghanistan (Kazakhstan, Pakistan and Uzbekistan). Authors in the past calculated transportation cost for importing wheat to Afghanistan. Some provided detailed descriptions of all costs while others provided a lump sum estimation of costs. Because the latest estimates we had were from 2014, we needed more recent estimates. We contacted Customs Office in Nangarhar Province (the entry point for Pakistani wheat) and Balkh Province (the entry point for Kazakh and Uzbek wheat) to provide us recent cost estimates for wheat imports to Afghanistan.

We linked the transportation costs with fuel prices to generate a trend from the past through the outlook period. It is assumed that half of any change in transportation costs reflects changes in fuel costs, as shipping between Afghanistan and the exporting countries occurs only through trains and trucks, where fuel is the main factor affecting costs. Although fuel prices that prevail inside Afghanistan would have been preferred, we did not have domestic fuel prices for the outlook period. Thus, we used Europe Brent spot prices FOB (free on board), using projections for the outlook period from IHS Markit. Additionally, the correlation coefficient between domestically used fuel prices and Europe Brent Sport prices was 0.92, indicating that both follow the same pattern most of the time.

Table 3.1 explains how customs and transportation costs contribute to the cost of importing wheat from Kazakhstan and Uzbekistan via Hairatan port (Balkh Province) to Afghanistan. It is estimated that it cost about $93 per ton in 2017/18 to import Kazakh wheat from Saryagash Station to Kabul via Hairatan port, while it would cost around $72 per ton to import Uzbek wheat from Tashkent to Kabul via the same port. Table 3.1 illustrates the breakdown of total customs and transportation cost for importing wheat from Kazakhstan and Uzbekistan to Afghanistan.

On the southern route, it would cost around $50 per ton to import Pakistani wheat from Lahore to Kabul. In contrast to the northern exporters, Pakistan provides an export subsidy on a certain amount of wheat exported to Afghanistan. For example, in 2017/18 the Government of Pakistan (GOP) provided a $159 export subsidy per ton, though the subsidy was limited to 200 thousand tons of exports to Afghanistan.

In total, 361 thousand tons of wheat were exported to Afghanistan from Pakistan in 2017/18. If 200 thousand were eligible for an export subsidy, the remaining 161 thousand tons had to pay the full cost of export. Consequently, two equations were created to capture this contrast in net costs of delivering wheat from Pakistan to Afghanistan. Table

3.2 provides a breakdown of total customs and transportation costs for both subsidized and unsubsidized wheat export to Afghanistan.

Table 3.1: Customs and transportation cost for importing wheat from Kazakhstan and Uzbekistan to Afghanistan in 2017/18

Description of Cost	USD/MT	Description of Cost	USD/MT
Cost of wheat (flour, high grade) in Saryagash, Kazakhstan	280.0	Cost of wheat in Uzbekistan	206.0
Total customs	37.78	Total customs	29.13
Ad Valorem (AV) tariff @ 5%	14.00	Ad Valorem (AV) tariff @ 5%	10.30
Business receipts tax @ 4% (levied on total value plus AV tariff)	11.76	Business receipts tax @ 4% (levied on total value plus AV tariff)	8.65
Fixed tax @ 2%	5.60	Fixed tax @ 2%	4.12
Red Crescent tax 2% (levied on AV tariffs)	0.28	Red Crescent tax 2% (levied on AV tariffs)	0.21
City tax 0.4%	1.12	City tax 0.4%	0.82
Miscellaneous	5.02	Miscellaneous	5.02
Total transportation cost	55.60	Total transportation cost	42.76
Wagon charges from Saryagash till Hairatan Port	48.50	Wagon charges from warehouse of supplier (Tashkent) till Termiz	25.00
		Wagon charges from Termiz till Hairatan Port	10.80
Transportation cost from Hairatan Port till Main Road (Dou Rahi) via trucks	5.29	Transportation cost from Hairatan Port till Main Road (Dou Rahi) via trucks	5.29
Transportation loss & Commission cost	0.37	Transportation loss & Commission cost	0.37
Bank transaction cost (0.2% of value)	0.56	Bank transaction cost (0.2% of value)	0.41
Mediator bank charges	0.88	Mediator bank charges	0.88
Total customs and transportation cost	93.39	Total customs and transportation cost	71.88

Source: Personal communication with the Balkh Customs Office in Afghanistan

Table 3.2: customs and transportation cost for importing wheat from Pakistan to Afghanistan in 2017/18

Description of Cost (with subsidy)	USD/MT	Description of Cost (without subsidy)	USD/MT
Wheat (flour) price in Pakistan	310.00	Wheat (flour) price in Pakistan	310.00
Transportation cost from Lahore to Peshawar	7.00	Transportation cost from Lahore to Peshawar	7.00
Afghanistan import duty	15.85	Afghanistan import duty	15.85
Transportation cost from Peshawar to Kabul	24.00	Transportation cost from Peshawar to Kabul	24.00
Export subsidty	159.00	No subsdity	0.00
Total cost to Kabul	197.85	Total cost to Kabul	356.85

Source: Personal communication with the Afghanistan Commercial Attaché in Islamabad, Pakistan

The above tables illustrate that trade through the northern route is more organized, hence figures are more reliable, compared to the southern route.

3.3.2.1 Trade equations

The trade equations used in this model utilize an approach developed by Davids (2017). They combine features of spatial equilibrium approaches that would seek to minimize the cost of supplying a homogeneous good and Armington approaches that would treat wheat from different exporters as differentiated products that are not perfectly substitutable for one another. The model equations for wheat exports by Kazakhstan, Uzbekistan and Pakistan all take the same form.

$$IMKAZF = max\left\{0, \left[\beta 0 + \beta 1 \frac{AFGFP}{KAZFPT} + \beta 2(max(0, AFGFP - KAZFPT))\right]\right\} \qquad (11)$$

Where:

IMKAZF = quantity of wheat (flour) imports from Kazakhstan

AFGFP = Afghanistan wheat (flour) price in USD

KAZFPT = Kazakhstan wheat (flour) price plus transport costs and tariffs in USD

This equation estimates the amount of wheat that would enter Afghanistan, given wheat prices in Afghanistan and Kazakhstan plus all transportation and transaction costs plus *ad valorem* tariff rates. The β1 can explain the substitutability between the exported good (Kazakh wheat) and the domestic good (local wheat). The greater the value of β1, the greater the degree of substitution between the two goods.

The β2 reflect how strong the arbitrage condition is. A higher value for β2 indicates that trade is very sensitive to any positive difference between the price of wheat in Afghanistan and the delivered price of imported grain. If β2 were infinitely large, trade would be infinitely elastic with respect to these relative prices, thus ensuring that domestic prices in Afghanistan would equal the cost of delivering imported grain. This special case is the same as would result from a conventional spatial equilibrium model that minimized the cost of supplying the domestic market. With limited reliable historical data, it was not practical to estimate the parameters of these equations econometrically.

Instead, they were determined using a calibration process that attempted to ensure plausible model behavior and trade estimates that reflected recent observations.

$$IMUZBF = max\left\{0, \left[\beta 0 + \beta 1 \frac{AFGFP}{UZBFPT} + \beta 2(max(0, AFGFP - UZBFPT))\right]\right\} \qquad (12)$$

Where:

IMUZBF = quantity of wheat (flour) imports from Uzbekistan

AFGFP = Afghanistan wheat (flour) price in USD

UZBFPT = Uzbekistan wheat (flour) price plus transport costs and tariffs in USD

Equation 12 uses the same approach to model wheat and wheat flour trade with Uzbekistan, comparing wheat flour prices in Uzbekistan and Afghanistan. As discussed earlier, for Pakistan we had to create two equations to distinguish between exports eligible for subsidy (equation 13) and exports without subsidy (equation 14). Both equations consider the delivered cost of Pakistani wheat, but they do not explicitly consider substitution between the two types of exports from Pakistan, a possible shortcoming of this specification. Equation 15 adds up total exports from Pakistan, which is just the sum of subsidized exports and unsubsidized exports.

$$\begin{aligned} IMPAKFs = min\Bigg\{EEX, \Bigg[max(0\,, \Bigg(\beta 0 + \beta 1 \frac{AFGFP}{PAKFPT} \\ + \beta 2(max(0, AFGFP - PAKFPT))\Bigg)\Bigg]\Bigg\} \end{aligned} \qquad (13)$$

Where:

IMPAKFs = quantity of wheat (flour) imports from Pakistan with export subsidy

AFGFP = Afghanistan wheat (flour) price in USD

PAKFPT = Pakistani wheat (flour) price plus transport costs and tariffs in USD

EEX = quantity eligible for export subsidy

$$IMPAKFw/s = max\left\{0, \left[\beta 0 + \beta 1 \frac{AFGFP}{PAKFPT} + \beta 2(max(0, AFGFP - PAKFPT))\right]\right\} \tag{14}$$

Where:

IMPAKFw/s = quantity of wheat (flour) imports from Pakistan without export subsidy

AFGFP = Afghanistan wheat (flour) price in USD

PAKFPT = Pakistani wheat (flour) price plus transport costs and tariffs in USD

IMPAKF = IMPAKFs + IMPAKFw/s (15)

Where:

IMPAKF = quantity of total wheat (flour) imports from Pakistan

IMPAKFs = quantity of wheat (flour) imports from Pakistan with export subsidy

IMPAKFw/s = quantity of wheat imports from Pakistan without export subsidy

Finally, the model was closed by requiring that total use of wheat (domestic consumption and ending stocks) is equal to the total supply of wheat (production, imports and beginning stocks). In the excel spreadsheet model, this is accomplished by calculating the difference between the quantity supplied and the quantity demanded at a given price and using this information to adjust the price (Figure 3.3). This process is repeated until the price is found that results in no difference between the quantities supplied and demanded.

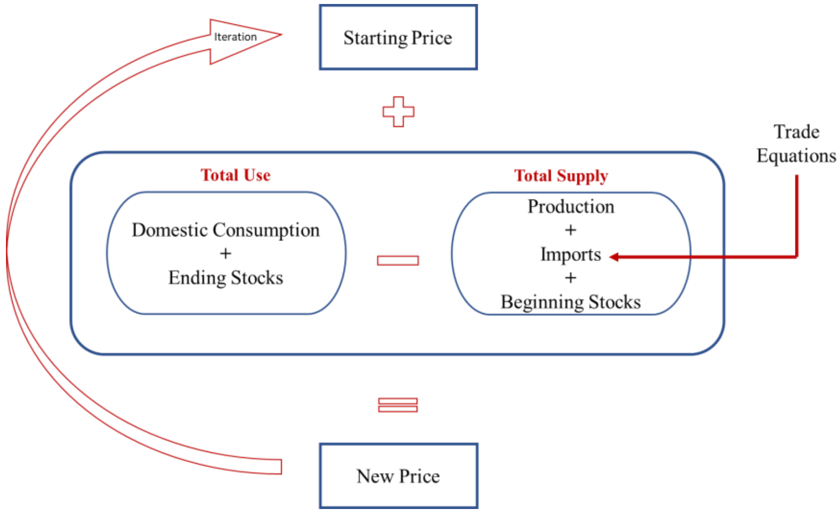


Figure 3.3: illustration of price iteration when the model is closed through the trade linkage approach

The trade linkage approach allows for more complex interactions between trade and prices than the simple price linkage approach. Based on this advantage we will close our model through the trade linkage approach and will use it to analyze all our scenarios after demonstrating the result of using the price linkage approach in the case of a domestic supply shortfall.

4. RESULTS AND DISCUSSION

We have closed the model through both price linkage and trade linkage equations and run simulations to see how the wheat market behaves in the outlook period (2019/20 – 2028/29). We will project market elements for the outlook and then will test the market under several scenarios to answer our research questions. Scenarios that we went through consist of: poor domestic production, an export ban from Pakistan, eliminating the export subsidy provided by Pakistan, a price spike of Kazakh wheat, imposing higher tariffs, higher production and improved efficiency in transportation and transaction costs of importing wheat to Afghanistan. The first scenario (domestic production shock) will be tested under both versions of the model to demonstrate the qualitative difference in model behavior. The remaining scenarios will be examined only under the trade linkage model. We will elaborate on each of these scenarios in the following sections.

4.1 Wheat outlook using the price linkage model

The baseline utilizes actual data or data estimated outside the model through the 2018/19 marketing year but uses model equations to generate projections for 2019/20 through 2028/29. Wheat area increases negligibly between 2019/20 and 2028/29, while yield increases gradually from 2.07 tons per ha to 2.37 tons per ha following the trend and assumed average precipitation throughout the outlook period. As a result, wheat production also progresses from a below-average production of 3600 thousand tons in 2018/19 to 4800 thousand tons in 2019/20 and 5800 thousand tons in 2028/29.

Demand, which is comprised of domestic consumption and ending stocks, also increases. Consumption increases from 8300 thousand tons in 2019/20 to 10,300 thousand tons in 2028/29. Population growth accounts for much of the projected increase;

Afghanistan's population is projected to increase by 2.1 percent per year between 2019 and 2028, while projected wheat consumption increases by 2.4 percent per year. After declining with reduced production in 2018/19, ending stocks average about 5 percent of annual use in subsequent years. The retail wheat flour price decreases in 2019/20 and then increases to 39 Afghani per kg at the end of outlook period (Table 4.1). However, this increase mostly reflects overall inflation in the Afghan economy; the real retail price almost remains constant throughout the outlook period.

Table 4.1: Baseline market outlook simulated with the price linkage approach

Marketing Year	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29
Area, thousands ha	2000	2342	2322	2339	2358	2371	2387	2404	2422	2440	2459
Yield, MT/ha	1.80	2.07	2.10	2.13	2.17	2.20	2.24	2.27	2.30	2.34	2.37
Total supply, thousands MT	6611	7630	7846	8035	8267	8484	8706	8930	9160	9393	9642
Production	3600	4840	4877	4993	5113	5221	5337	5457	5579	5704	5832
Imports	2601	2580	2550	2610	2725	2824	2926	3028	3133	3239	3356
Beginning stocks	410	210	419	432	429	439	442	445	448	451	454
Total use, thousands MT	7710	8729	8945	9134	9366	9583	9805	10029	10259	10492	10741
Domestic consumption	7500	8310	8513	8704	8927	9141	9360	9581	9808	10038	10281
Ending stocks	210	419	432	429	439	442	445	448	451	454	460
Statistical discrepancy	-1099	-1099	-1099	-1099	-1099	-1099	-1099	-1099	-1099	-1099	-1099
Wheat (flour) price, AFN per kg											
Retail, nominal	27.28	26.73	28.03	29.46	30.49	31.80	33.19	34.67	36.22	37.87	39.47

4.1.1 The drought scenario

In this scenario, we start from the baseline just described using the price linkage model and introduce a hypothetical shock in 2020/21, when precipitation is reduced 24 percent from the long-term average. Due to the lack of irrigation infrastructure in Afghanistan, wheat production is strongly correlated with timely precipitation during planting and growing season of the wheat crop. Poor precipitation in a given year will result in poor crop yield in the following marketing year (the marketing year begins when the crop is harvested, thus the precipitation that affects the growth of a particular crop occurs during the previous marketing year). This assumed scenario is similar to 2007/08, when only 254 mm precipitation was recorded, which was 23 percent less compared to average precipitation over the 2000/01 to 2006/07 period.

Table 4.2 shows that 24 percent lower precipitation reduced yield and production by 25 percent in the following year (2021/22). Lower production increases imports by 41 percent relative to the baseline, and lower production reduces ending stocks by 34 percent. Lower ending stocks results in lower beginning stocks in the following year (2022/23) which in turn affects total supply and subsequent ending stocks for that year. The effect of the shock completely dissipates by 2025/26.

Using a price linkage to exporter prices to determine domestic Afghan prices means the reduction in domestic production does not translate into higher prices. Instead, the expanded gap between domestic use and domestic supplies is filled by increased imports. In absolute terms, supply and use figures are internally consistent. For example, the change in production is exactly equal in absolute terms to the sum of the other changes in supply and use: the weather scenario reduces production in the first year by 1226 thousand tons, which is exactly equal to the sum of the reduction in ending stocks (144 thousand tons) plus the increase in imports (1082 thousand tons) (Table 4.2). Domestic use is unaffected in the scenario, given no change in domestic prices. Figure 4.1 depicts the effect of domestic shock on yield, production, domestic use, imports, and real wheat price.

Table 4.2: Impact of drought on Afghanistan wheat market outlook

Marketing Year	2020/21	2021/22	2022/23	2023/24	2024/25	2020/21	2021/22	2022/23	2023/24	2024/25
	ABSOLUTE CHANGE FROM THE BASELINE					PERCENT CHANGE FROM THE BASELINE				
Area, thousands ha	0	0	0	0	0	0.0%	0.0%	0.0%	0.0%	0.0%
Yield, MT/ha	0.00	-0.52	0.00	0.00	0.00	0.0%	-24.6%	0.0%	0.0%	0.0%
Total supply, thousands MT	0	-144	-17	-2	0	0.0%	-1.8%	-0.2%	0.0%	0.0%
Production	0	-1226	0	0	0	0.0%	-24.6%	0.0%	0.0%	0.0%
Imports	0	1082	127	15	2	0.0%	41.4%	4.7%	0.5%	0.1%
Beginning stocks	0	0	-144	-17	-2	0.0%	0.0%	-33.6%	-3.9%	-0.5%
Total use, thousands MT	0	-144	-17	-2	0	0.0%	-1.6%	-0.2%	0.0%	0.0%
Domestic consumption	0	0	0	0	0	0.0%	0.0%	0.0%	0.0%	0.0%
Ending stocks	0	-144	-17	-2	0	0.0%	-33.6%	-3.9%	-0.5%	-0.1%
Wheat (flour) price, AFN per kg										
Retail, nominal	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%	0.0%	0.0%

Figure 4.1: Afghanistan wheat market outlook – baseline vs. drought scenario

4.2 Wheat outlook using the trade linkage model

We also closed the model through the trade linkage equations and results are presented in the Table 4.3. Domestic supply and demand projection are similar to those obtained using the price linkage version of the model. Because the domestic supply and demand equations are identical in the two version of the model, differences can be ascribed to the differences in the model solution for Afghan wheat prices. An advantage of this model is that it gives us the proportion of imports from each exporting country to Afghanistan. The modeled exporters are Kazakhstan, Pakistan, Uzbekistan and the rest of the world (ROW). We assumed the ROW imports remain the same throughout the outlook period while the model equations result in increasing imports from the other three countries. Consumption increases from 8200 thousand tons in 2019/20 to nearly 10,000 tons in 2028/29 assuming an annual 2.1 percent increase in population and 3.2 percent increase in the national GDP. The nominal wheat flour prices also follow gradual increase from 29 Afghani per kg to 45 Afghani per kg at the end of the outlook period. While the baseline equilibrium prices using this approach are higher than they were using the price linkage approach, real flour prices only increase slightly over the projection period, and the real price in 2028/29 is still below the level of 2012/13.

Table 4.3: Baseline market outlook simulated with the trade linkage approach

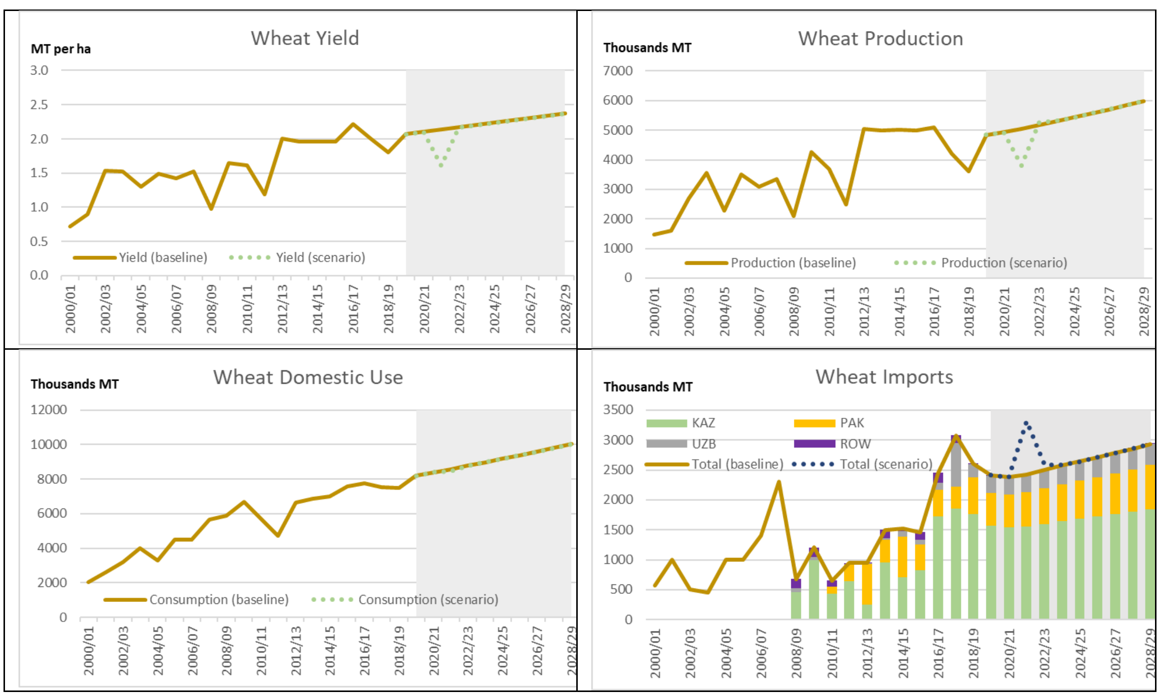
Marketing Year	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29
Area, thousands ha	2000	2342	2349	2367	2389	2408	2430	2453	2476	2501	2526
Yield, MT/ha	1.80	2.07	2.10	2.13	2.17	2.20	2.24	2.27	2.30	2.34	2.37
Total supply, thousands MT	6611	7460	7677	7854	8054	8248	8446	8649	8858	9072	9296
Production	3600	4840	4933	5052	5180	5303	5433	5567	5705	5845	5990
Imports	2601	2410	2383	2427	2503	2572	2642	2713	2784	2857	2936
Kazakhstan	1762	1574	1539	1559	1600	1640	1679	1720	1760	1801	1847
Pakistan	617	535	548	570	594	615	639	661	685	711	735
Uzbekistan	218	296	291	294	305	313	320	327	334	341	350
ROW	4	4	4	4	4	4	4	4	4	4	4
Beginning stocks	410	210	361	375	371	372	371	370	369	369	371
Total use, thousands MT	7710	8559	8776	8953	9153	9347	9545	9748	9957	10171	10395
Domestic consumption	7500	8198	8401	8582	8781	8976	9176	9379	9587	9800	10021
Ending stocks	210	361	375	371	372	371	370	369	369	371	374
Statistical discrepancy	-1099	-1099	-1099	-1099	-1099	-1099	-1099	-1099	-1099	-1099	-1099
Wheat (flour) price, AFN per kg											
Retail, nominal	27.28	28.58	29.94	31.59	33.08	34.80	36.61	38.52	40.54	42.65	44.80

4.2.1 The drought scenario

We will apply the same below average precipitation scenario to this trade linkage model and see how the model responds to it in comparison to the price linkage model. The lower precipitation triggers lower yield and hence lower production in the following year, as in the price linkage model. However, the main difference relative to the price linkage model results is that the trade linkage model solves for the internal price, given trade equations that depend on relative prices in Afghanistan and in exporting countries. Because of this consideration, domestic prices increase by 9 percent in response to lower production. The higher price pushes consumption down by 2 percent. Imports increase, but not as much as in the price linkage model, as part of the shock is absorbed in the domestic market. Lower supply and higher prices prompt lower ending stocks in 2021/22. The higher domestic price in 2021/22 encourages farmers to expand wheat area in the following year (2022/23) which leads to a slight increase in production. In 2022/23, the reduction in the beginning stocks outweighs the increase in production and imports, so domestic prices still exceed baseline levels by one percent. The effect of the shock largely disappears by 2024/25, and prices are essentially the same as in the baseline (Table 4.4). Figure 4.2 exhibits effects of this shock on the wheat market outlook.

Table 4.4: Impact of drought on Afghanistan wheat market outlook

Marketing Year	2020/21	2021/22	2022/23	2023/24	2024/25	2020/21	2021/22	2022/23	2023/24	2024/25
	ABSOLUTE CHANGE FROM THE BASELINE					PERCENT CHANGE FROM THE BASELINE				
Area, thousands ha	0	0	40	4	0	0.0%	0.0%	1.7%	0.2%	0.0%
Yield, MT/ha	0.00	-0.52	0.00	0.00	0.00	0.0%	-24.6%	0.0%	0.0%	0.0%
Total supply, thousands MT	0	-358	-37	-4	0	0.0%	-4.6%	-0.5%	0.0%	0.0%
Production	0	-1241	88	9	1	0.0%	-24.6%	1.7%	0.2%	0.0%
Imports	0	883	87	9	1	0.0%	36.4%	3.5%	0.3%	0.0%
Kazakhstan	0	598	59	6	1	0.0%	38.3%	3.7%	0.4%	0.0%
Pakistan	0	189	19	2	0	0.0%	33.1%	3.1%	0.3%	0.0%
Uzbekistan	0	96	10	1	0	0.0%	32.7%	3.1%	0.3%	0.0%
ROW						0.0%	0.0%	0.0%	0.0%	0.0%
Beginning stocks	0	0	-212	-21	-2	0.0%	0.0%	-57.1%	-5.8%	-0.6%
Total use, thousands MT	0	-358	-37	-4	0	0.0%	-4.0%	-0.4%	0.0%	0.0%
Domestic consumption	0	-146	-15	-2	0	0.0%	-1.7%	-0.2%	0.0%	0.0%
Ending stocks	0	-212	-21	-2	0	0.0%	-57.1%	-5.8%	-0.6%	-0.1%
Wheat (flour) price, AFN per kg										
Retail, nominal	0.00	2.80	0.29	0.03	0.00	0.0%	8.9%	0.9%	0.1%	0.0%



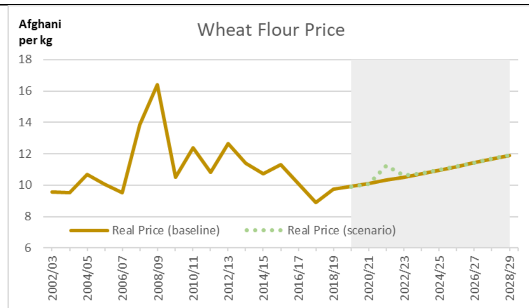


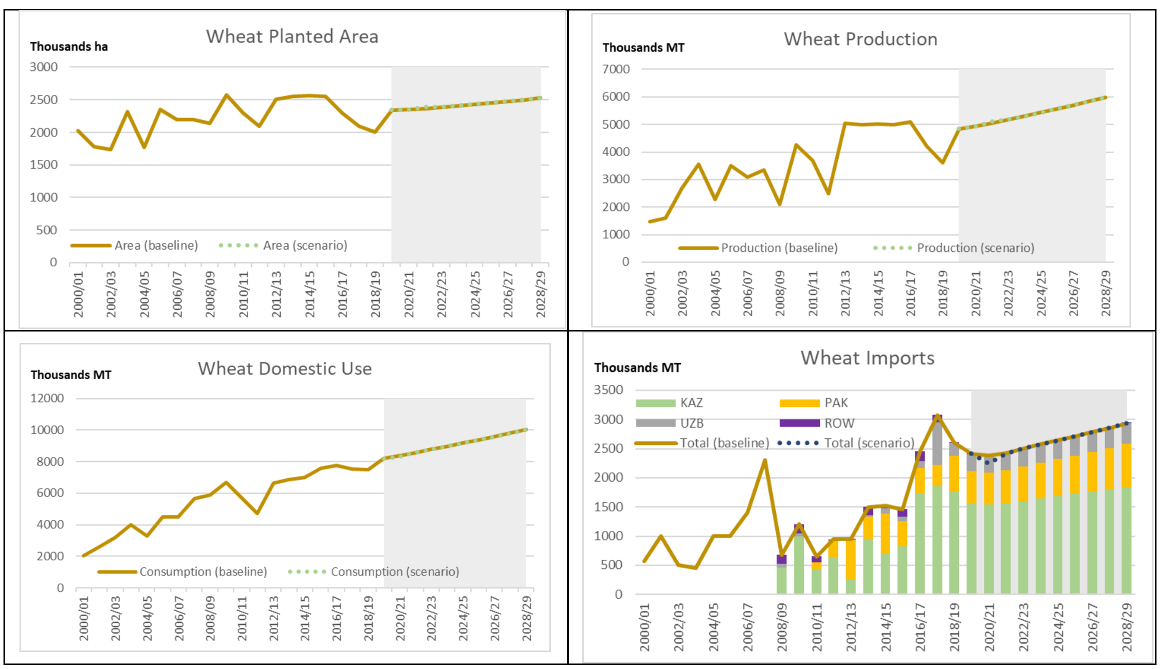
Figure 4.2: Afghanistan wheat market outlook – baseline vs. drought scenario

4.2.2 The export ban scenario

This scenario is similar to what Pakistan did during 2007-2010, when it banned the export of wheat to Afghanistan to maintain its own domestic prices. In the past, Pakistan occasionally has put a ban on exports of wheat to Afghanistan, even sometimes imposing a ban on interprovincial wheat movement so that every province should achieve its required procurement target (Khan & Burki, 2005). We introduce a one-time wheat export ban from Pakistan to Afghanistan in 2020/21 and simulated the model to see how it responds. As table 4.5 describes, this ban halts Pakistani exports completely. Kazakhstani and Uzbekistani wheat partially replace Pakistani wheat in the market. However, overall imports still decline by six percent. This reduced wheat supply increases domestic wheat price by five percent. The higher wheat price forces a reduction in domestic consumption. In the following year (2021/22) area planted under wheat increases by one percent due to the higher price in 2020/21, as the model implicitly assumes farmers expect the higher price to continue. This leads to increased production. The effect of the shock fades in the following year of 2022/23. Figure 4.3 shows how the shock affects wheat market elements in Afghanistan.

Table 4.5: Impact of export ban from Pakistan on Afghanistan wheat market outlook

Marketing Year	2020/21	2021/22	2022/23	2023/24	2020/21	2021/22	2022/23	2023/24
	ABSOLUTE CHANGE FROM THE BASELINE				PERCENT CHANGE FROM THE BASELINE			
Area, thousands ha	0	23	0	0	0.0%	1.0%	0.0%	0.0%
Yield, MT/ha	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%	0.0%
Total supply, thousands MT	-130	2	0	0	-1.7%	0.0%	0.0%	0.0%
Production	0	50	-1	0	0.0%	1.0%	0.0%	0.0%
Imports	-130	-5	-1	0	-5.5%	-0.2%	0.0%	0.0%
Kazakhstan	360	-4	0	0	23.4%	-0.2%	0.0%	0.0%
Pakistan	-548	-1	0	0	-100.0%	-0.2%	0.0%	0.0%
Uzbekistan	58	-1	0	0	19.9%	-0.2%	0.0%	0.0%
ROW					0.0%	0.0%	0.0%	0.0%
Beginning stocks	0	-42	1	0	0.0%	-11.2%	0.4%	0.0%
Total use, thousands MT	-130	2	0	0	-1.5%	0.0%	0.0%	0.0%
Domestic consumption	-88	1	0	0	-1.1%	0.0%	0.0%	0.0%
Ending stocks	-42	1	0	0	-11.2%	0.4%	0.0%	0.0%
Wheat flour price, AFN per kg								
Retail, nominal	1.61	-0.02	0.00	0.00	5.4%	-0.1%	0.0%	0.0%



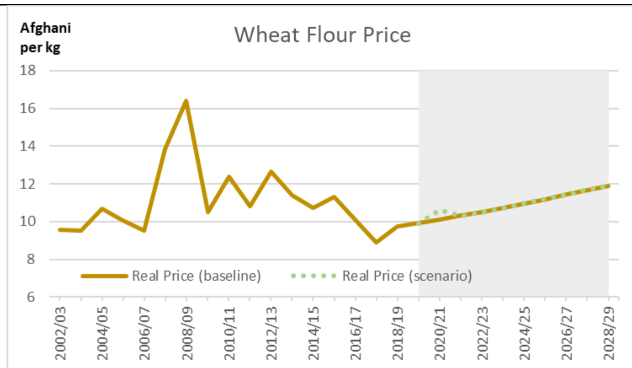


Figure 4.3: Afghanistan wheat market outlook – baseline vs. export ban scenario

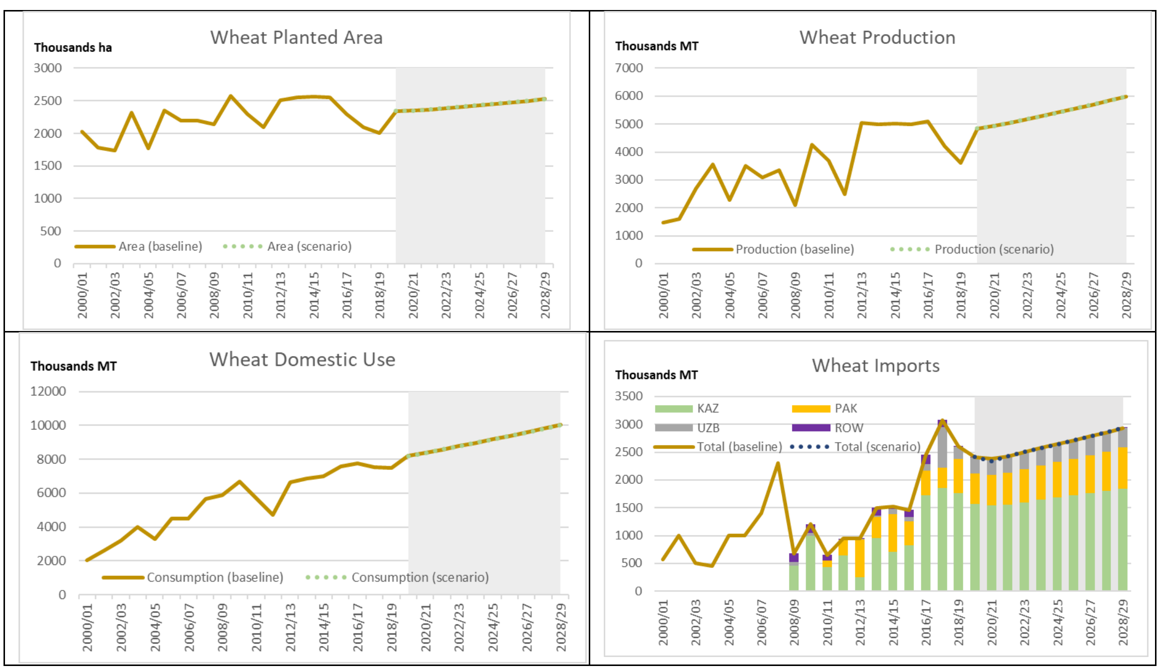
4.2.3 The no export subsidy scenario

This scenario also relates to Pakistani export policy. As mentioned earlier, Pakistan heavily intervenes in its wheat market to ensure that domestically produced wheat is available all the time to its growing population and to protect producer income. Due to this heavy government influence, the margin between the Pakistani wheat price and the global wheat price is increasing. The Pakistani government has started providing an export subsidy to remove excess wheat stocks at home, and this export subsidy has been provided on some exports to Afghanistan. In the last several years, the government of Pakistan has provided a subsidy on its wheat exports. It started at 50 USD per ton in 2014/15 and reached 159 USD per ton in 2017/18. We assumed in the baseline that the export subsidy will remain in place at 100 USD per ton for exports to Afghanistan. In addition, Pakistan also puts a limit on the quantity of exports eligible for subsidy, depending how many stocks they want to clear. In the past years, this limit has ranged from 200 thousand tons to 1200 thousand tons. Sometimes the limit was binding while in other years, subsidized exports did not reach the limit. For the projection period in the baseline, we put this limit at 200 thousand tons per year for Afghanistan.

In this scenario we removed this subsidy in 2020/21 and simulated the impact on the wheat market in Afghanistan. As Table 4.6 illustrates, the volume of exports from Pakistan is reduced by 166 thousand tons in 2020/21, with a larger drop in subsidized exports and a small increase in unsubsidized trade. This result is plausible only if subsidized and unsubsidized exports are poor substitutes for one another. If the subsidy is purely infra-marginal and the products are close substitutes, eliminating export subsidies would have no effect on total imports from Pakistan, as the reduction in subsidized sales would be fully offset by increased unsubsidized exports. Kazakhstani and Uzbekistani exports increase, but they do not fully offset the reduced Pakistani volume, as total imports are reduced by 40 thousand tons. Therefore, the Afghan domestic wheat price slightly increases in response to the reduction in total imports and supply. The impact does trigger small changes in the following year and those impacts largely disappear by 2022/23. Figure 4.4 shows the impact of this shock on Afghanistan wheat market outlook.

Table 4.6: Impact of no export subsidy from Pakistan on Afghanistan wheat market outlook

Marketing Year	2020/21	2021/22	2022/23	2020/21	2021/22	2022/23
	ABSOLUTE CHANGE FROM THE BASELINE			PERCENT CHANGE FROM THE BASELINE		
Area, thousands ha	0	7	0	0.0%	0.3%	0.0%
Yield, MT/ha	0.00	0.00	0.00	0.0%	0.0%	0.0%
Total supply, thousands MT	-40	1	0	-0.5%	0.0%	0.0%
Production	0	15	0	0.0%	0.3%	0.0%
Imports	-40	-1	0	-1.7%	-0.1%	0.0%
Kazakhstan	108	-1	0	7.0%	-0.1%	0.0%
Pakistan	-166	0	0	-30.3%	0.0%	0.0%
Uzbekistan	17	0	0	6.0%	0.0%	0.0%
ROW				0.0%	0.0%	0.0%
Beginning stocks	0	-13	0	0.0%	-3.5%	0.1%
Total use, thousands MT	-40	1	0	-0.5%	0.0%	0.0%
Domestic consumption	-27	0	0	-0.3%	0.0%	0.0%
Ending stocks	-13	0	0	-3.5%	0.1%	0.0%
Wheat flour price, AFN per kg						
Retail, nominal	0.48	0.00	0.00	1.6%	0.0%	0.0%



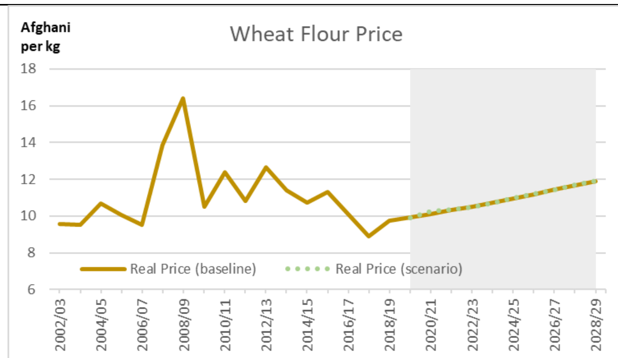


Figure 4.4: Afghanistan wheat market outlook – baseline vs. no export subsidy scenario

4.2.4 The increased Kazakh price scenario

This scenario is concerned with Kazakhstan, which has the highest share of Afghan wheat imports. The scenario assumes that the price of Kazakh wheat increases by 50 percent in 2020/21 in comparison to the preceding year. This might happen due to a poor harvest in the northern Kazakhstan region, where rainfed areas depend on timely precipitation. The 50 percent price spike resulted in a Kazakhstan price of 156 USD per ton, which is still in the range of previous Kazakh prices. It is much lower, for example, than the price when Kazakhstan had a wheat harvest failure in 2012/13.

Table 4.7 describes effects of this shock. The Kazakh wheat exports decrease by 333 thousand tons, while Uzbek wheat export also decreases by 203 thousand tons. In our model we did not have Uzbek wheat prices for the outlook period, and we assumed that Uzbek prices will tend to move with Kazakh prices, since the countries compete in regional markets. We regressed Uzbek wheat price on Kazakhstan wheat price and use this relationship to generate Uzbekistan prices in the outlook period (equation 16). Consequently, Uzbek prices also increase in the scenario, resulting in lower exports to Afghanistan. Pakistani wheat exports increase by 256 thousand tons but do not fully offset the combined reduction in Kazakhstan and Uzbekistan wheat exports. Domestic wheat price increases by 12 percent in 2020/21 relative to the baseline, which pushes domestic consumption down by 2 percent. In the following year, wheat area increases by 2 percent given the naïve expectation from the previous year of higher market prices. Higher area increases wheat production and reduces domestic prices in that year. The shock results in negligible effects in 2022/23 and the impacts vanish completely by 2023/24. Figure 4.5 summarize the effects of this shock on the Afghanistan wheat market.

$$UZBFP = \beta 0 + \beta 1\ KAZFP + \mathcal{E} \qquad (16)$$

Where:

UZBFP = Uzbekistan wheat (flour) price in USD per MT

KAZFP = Kazakhstan wheat (flour) price in USD per MT

Ɛ = residuals

Table 4.7: Impact of increased Kazakh wheat price on Afghanistan wheat market outlook

Marketing Year	2020/21	2021/22	2022/23	2023/24	2020/21	2021/22	2022/23	2023/24
	ABSOLUTE CHANGE FROM THE BASELINE				PERCENT CHANGE FROM THE BASELINE			
Area, thousands ha	0	53	-1	0	0.0%	2.2%	0.0%	0.0%
Yield, MT/ha	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%	0.0%
Total supply, thousands MT	-281	7	1	0	-3.7%	0.1%	0.0%	0.0%
Production	0	112	-2	0	0.0%	2.2%	0.0%	0.0%
Imports	-281	-16	-2	0	-11.8%	-0.7%	-0.1%	0.0%
Kazakhstan	-333	-11	-1	0	-21.7%	-0.7%	-0.1%	0.0%
Pakistan	256	-3	0	0	46.6%	-0.6%	-0.1%	0.0%
Uzbekistan	-203	-2	0	0	-69.6%	-0.6%	-0.1%	0.0%
ROW					0.0%	0.0%	0.0%	0.0%
Beginning stocks	0	-89	4	0	0.0%	-23.8%	1.1%	0.1%
Total use, thousands MT	-281	7	1	0	-3.2%	0.1%	0.0%	0.0%
Domestic consumption	-191	3	0	0	-2.3%	0.0%	0.0%	0.0%
Ending stocks	-89	4	0	0	-23.8%	1.1%	0.1%	0.0%
Wheat (flour) price, AFN per kg								
Retail, nominal	3.62	-0.05	-0.01	0.00	12.1%	-0.2%	0.0%	0.0%

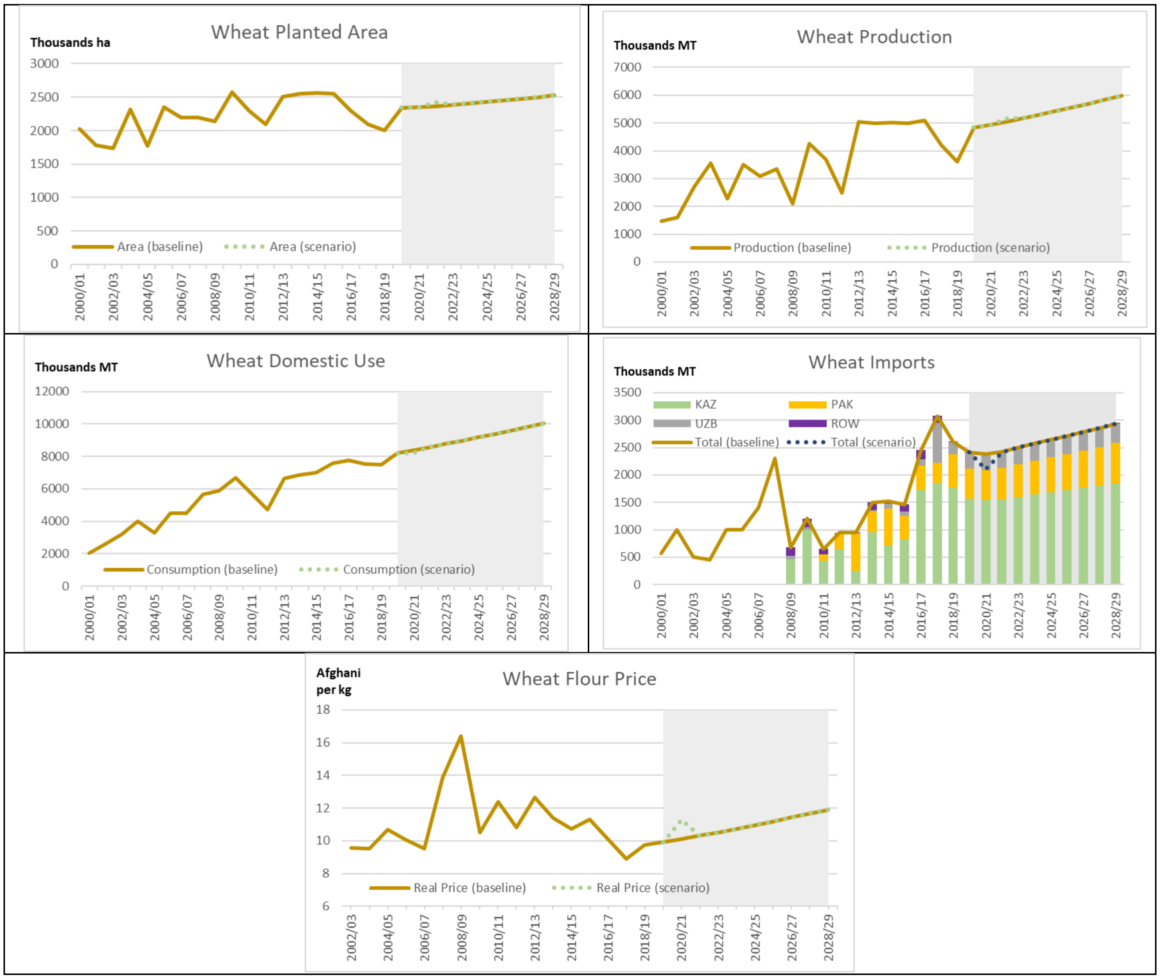


Figure 4.5: Afghanistan wheat market outlook – baseline vs. increased Kazakh wheat price scenario

4.2.5 The high tariffs scenario

Sometimes tariffs are used as an option to protect a specific industry at home and encourage domestic producers. Raising tariffs will increase the price of imported goods and make it costly to the consumers compared to local good which does not pay such duties. The result is a reduction in imports and higher market prices, which provide a benefit to producers but a cost to consumers that are net purchasers of the good. Afghanistan levies only negligible tariffs on wheat products to limit the food security impacts on low-income consumers. Currently, this tariff rate is 2.5 percent on wheat grain and 5 percent on wheat flour. We assumed these rates will remain the same throughout the baseline. The maximum tariffs rate imposed so far on wheat was 10 percent.

The scenario assumes that government of Afghanistan increases the *ad valorem* tariff rate on wheat flour from five percent to 20 percent in 2020/21. This is a temporary (one-year) increase to see how the wheat market will respond. Table 4.8 presents the summary of impact on our baseline. Higher tariffs discourage imports and total imports decrease by 211 thousand tons. Imports from all exporting countries to Afghanistan decrease. The reduced supply of wheat raises the wheat price in Afghanistan by 9 percent, and higher wheat prices lower domestic consumption by 2 percent. In the following year (2021/22), the area under wheat increases by 2 percent and hence production also increases by 2 percent. Higher wheat supply forces the price to fall back. The effect of this shock largely disappears in the following year (2022/23). Figure 4.6 shows impacts of higher tariffs on the wheat market outlook.

Table 4.8: Impact of high wheat tariffs on Afghanistan wheat market outlook

Marketing Year	2020/21	2021/22	2022/23	2023/24	2020/21	2021/22	2022/23	2023/24
	ABSOLUTE CHANGE FROM THE BASELINE				PERCENT CHANGE FROM THE BASELINE			
Area, thousands ha	0	39	0	0	0.0%	1.6%	0.0%	0.0%
Yield, MT/ha	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%	0.0%
Total supply, thousands MT	-211	4	0	0	-2.7%	0.1%	0.0%	0.0%
Production	0	83	-1	0	0.0%	1.6%	0.0%	0.0%
Imports	-211	-11	-1	0	-8.9%	-0.4%	0.0%	0.0%
Kazakhstan	-132	-7	-1	0	-8.6%	-0.5%	0.0%	0.0%
Pakistan	-73	-2	0	0	-13.3%	-0.4%	0.0%	0.0%
Uzbekistan	-6	-1	0	0	-2.2%	-0.4%	0.0%	0.0%
ROW					0.0%	0.0%	0.0%	0.0%
Beginning stocks	0	-68	3	0	0.0%	-18.0%	0.7%	0.1%
Total use, thousands MT	-211	4	0	0	-2.4%	0.0%	0.0%	0.0%
Domestic consumption	-143	2	0	0	-1.7%	0.0%	0.0%	0.0%
Ending stocks	-68	3	0	0	-18.0%	0.7%	0.1%	0.0%
Wheat (flour) price, AFN per kg								
Retail, nominal	2.66	-0.03	0.00	0.00	8.9%	-0.1%	0.0%	0.0%

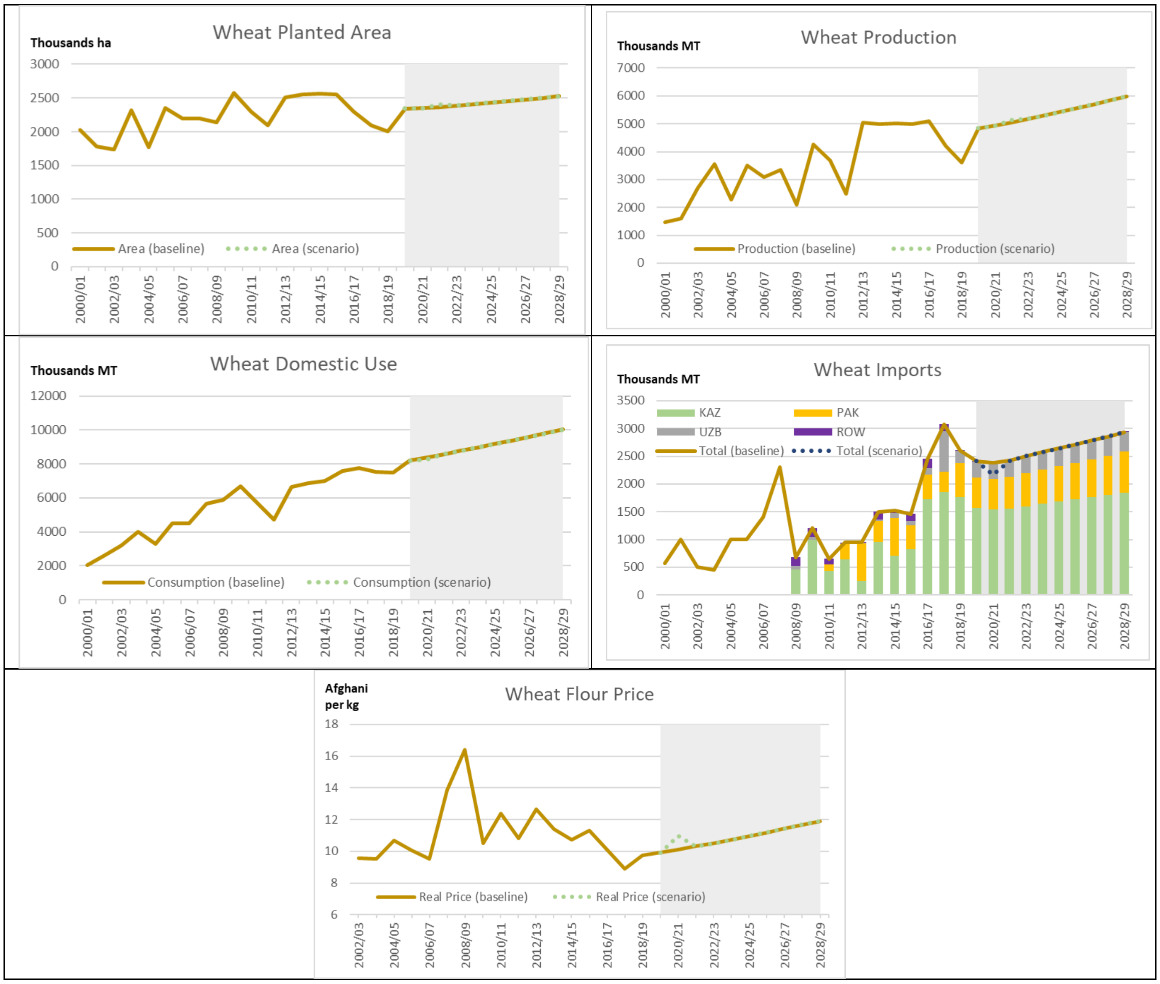


Figure 4.6: Afghanistan wheat market outlook – baseline vs. high wheat tariffs scenario

4.2.6 Towards self-sufficiency scenario:

The government of Afghanistan has targeted self-sufficiency in the wheat market, but it has not been achieved. We introduced a 20 percent improvement in yield compared to the 2020/21 baseline, phased in over 5 years. Currently Afghanistan stands at 2 tons per ha average wheat yield and compared to its neighbors it is only higher than Turkmenistan. After 20 percent improvement, the yield reaches 2.6 tons per ha in 2024/25. Such a level would surpass the average current yield in Iran, but it will still be lower than current average yields in Tajikistan, Uzbekistan and Pakistan.

As part of the same scenario, we also introduced a shift in the area equation equivalent to a 10 percent increase in area under wheat, also phased in over five years. We do not assume that this area will come from other crops, as wheat is not highly competitive with other cash crops. Several irrigation projects are underway (or are at least in the designing stage) and we suppose that upon completion of these projects, area available to cultivate wheat might increase. The reported increases in area and production are smaller than the shift in the supply curves, as lower prices reduce supply incentives.

As Table 4.9 shows this scenario leads to a production increase of 27 percent and a domestic price reduction of 18 percent. Consequently, total imports decrease 38 percent. Lower prices encourage consumption, and it is up 4 percent from the baseline. Even with this large increase in production, Afghanistan does not achieve self-sufficiency in the outlook period.

Table 4.9: Impact of increased production on Afghanistan wheat market outlook

Marketing Year	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29
	PERCENT CHANGE FROM THE BASELINE								
Area, thousands ha	2.0%	3.6%	5.0%	6.1%	7.0%	5.8%	5.7%	5.7%	5.7%
Yield, MT/ha	4.0%	7.9%	11.6%	15.3%	18.8%	18.5%	18.2%	18.0%	17.7%
Total supply, thousands MT	1.2%	2.6%	4.4%	6.5%	8.7%	8.4%	7.9%	7.4%	7.0%
Production	6.1%	11.7%	17.2%	22.3%	27.1%	25.4%	25.0%	24.7%	24.4%
Imports	-8.8%	-18.3%	-26.1%	-32.6%	-38.5%	-39.0%	-39.1%	-39.2%	-39.2%
Kazakhstan	-9.2%	-18.7%	-23.5%	-28.6%	-33.5%	-34.3%	-34.7%	-35.2%	-35.8%
Pakistan	-8.2%	-17.8%	-30.9%	-36.7%	-40.8%	-42.1%	-43.2%	-44.3%	-44.1%
Uzbekistan	-7.9%	-17.6%	-30.7%	-45.9%	-60.6%	-58.1%	-54.3%	-50.6%	-47.2%
ROW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Beginning stocks	0.0%	14.2%	31.4%	51.9%	75.3%	99.7%	98.6%	95.3%	91.8%
Total use, thousands MT	1.0%	2.3%	3.9%	5.7%	7.7%	7.4%	7.0%	6.6%	6.3%
Domestic consumption	0.4%	1.0%	1.8%	2.9%	4.0%	3.9%	3.6%	3.4%	3.2%
Ending stocks	14.2%	31.4%	51.9%	75.3%	99.7%	98.6%	95.3%	91.8%	88.5%
Wheat flour price, AFN per kg									
Retail, nominal	-2.1%	-4.8%	-8.6%	-13.1%	-17.6%	-17.1%	-16.2%	-15.3%	-14.5%

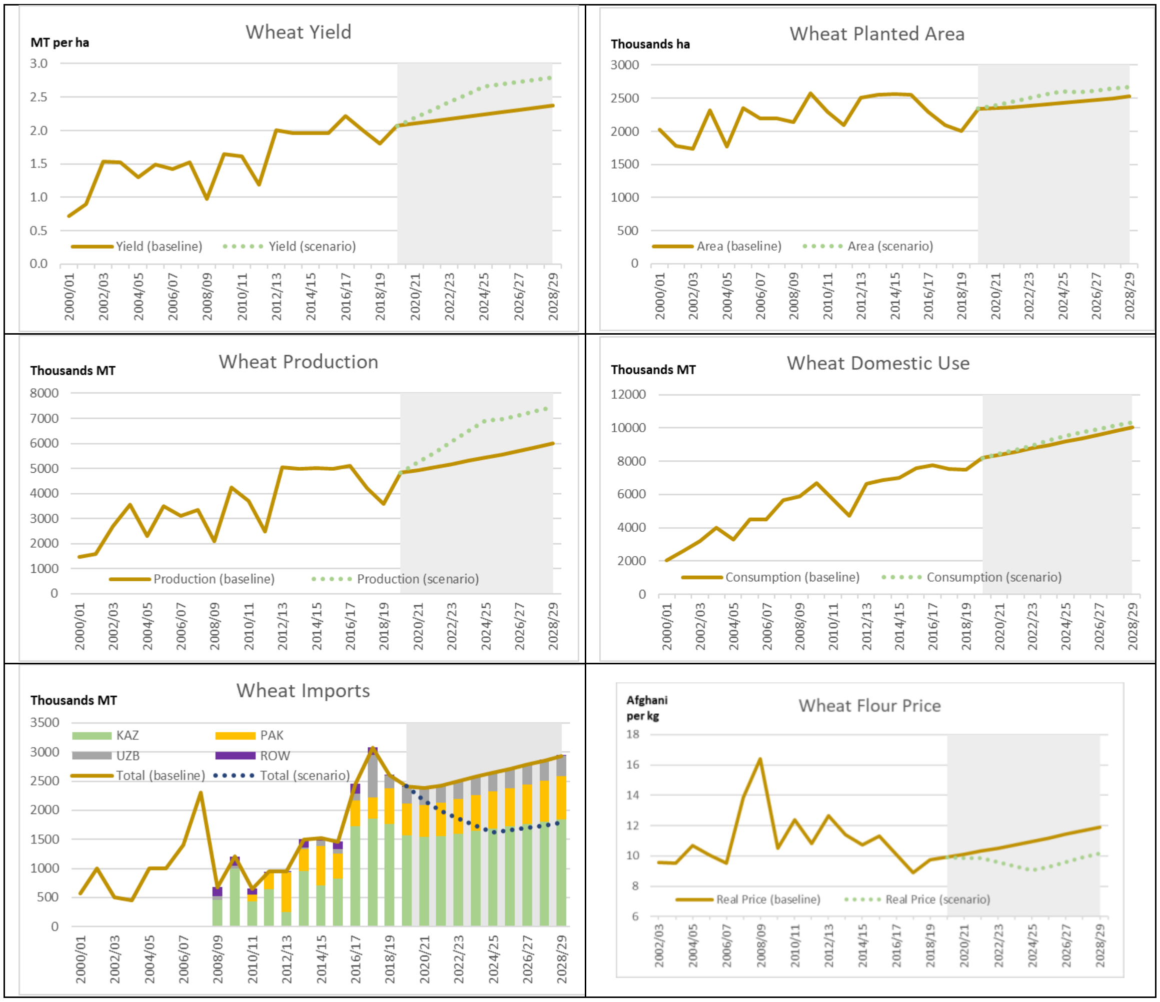


Figure 4.7: Afghanistan wheat market outlook – baseline vs. increased production scenario

4.2.7 The transaction cost efficiency scenario

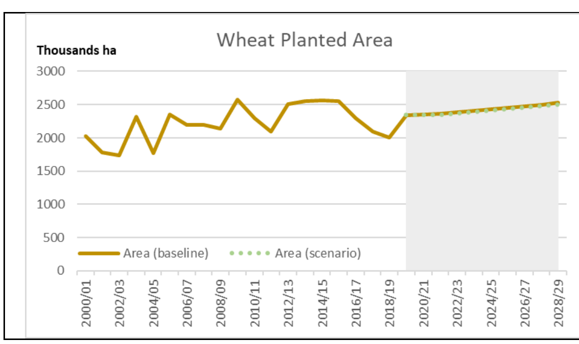
The final scenario assumes a reduction in overall transaction costs of importing wheat to Afghanistan, including transportation efficiency and improvement in customs clearance. Bringing efficiency in all these areas reduces the final price of imported wheat to Afghan households and will affect all wheat market elements in Afghanistan. Chabot and Tondel (2011) pointed out that completion of the Hairatan – Mazar railway project will reduce transportation and shipping cost for importing wheat from Central Asian countries to Afghanistan. The railway became operational at the end of 2011.

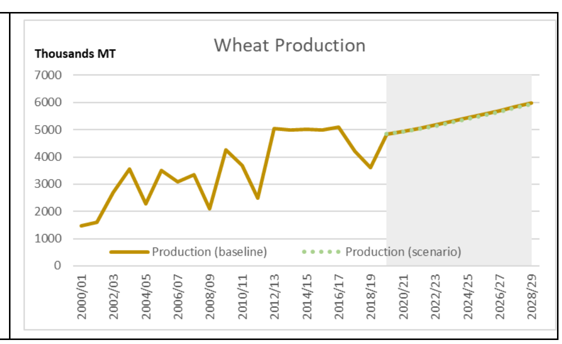
A number of railway projects are under construction connecting Afghanistan to Central Asia. It is assumed that once these projects are fully functional, the cost and time of transportation will be reduced. Similarly, there have been problems with collecting taxes in the border customs offices, and informal taxes are being collected. In this scenario we assumed that cost of all land transportation and informal tax collection will be reduced by 25 percent in 2020/21. Table 4.10 describes the impact of this assumption on Afghanistan wheat market through the outlook period. The improvement in infrastructure permanently reduces transaction costs, with market impacts throughout the outlook period. Note that this scenario only considers the impact of reducing the cost of importing wheat; it does not consider possible impacts of reducing the cost of transporting domestic wheat within Afghanistan.

Lowering transportation cost will reduce the final imported price in Kabul, hence imports will increase. The higher supply of wheat because of the increase in imports will reduce the domestic wheat price. Lower domestic prices will encourage consumption. We note that overall imports increase but imports from Pakistan decrease. The scenario imposes the same proportional reduction in costs for all exporters, but because total transaction costs are lower for Pakistan, the absolute decline in Pakistan import delivery costs is less than that for the other exporters. In the scenario, the increased imports from Kazakhstan and Uzbekistan result in a larger drop in Afghanistan wheat flour prices than the assumed reduction in Pakistan wheat flour prices. Thus, the relative price of Pakistani wheat increases relative to domestic Afghanistan prices, resulting in reduced imports from Pakistan. Figure 4.8 shows that these changes will last throughout the outlook period.

Table 4.10: Impact of increased efficiency in transaction cost on Afghanistan wheat market outlook

Marketing Year	2020/21	2021/22	2022/23	2023/24	2024/25	2020/21	2021/22	2022/23	2023/24	2024/25
	ABSOLUTE CHANGE FROM THE BASELINE					PERCENT CHANGE FROM THE BASELINE				
Area, thousands ha	0	-15	-15	-16	-17	0.0%	-0.6%	-0.6%	-0.7%	-0.7%
Yield, MT/ha	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%	0.0%	0.0%
Total supply, thousands MT	91	87	87	87	88	1.2%	1.1%	1.1%	1.1%	1.0%
Production	0	-33	-33	-35	-37	0.0%	-0.6%	-0.6%	-0.7%	-0.7%
Imports	91	90	93	96	99	3.8%	3.7%	3.7%	3.7%	3.7%
Kazakhstan	98	94	96	98	100	6.4%	6.0%	6.0%	6.0%	6.0%
Pakistan	-25	-21	-21	-20	-20	-4.6%	-3.7%	-3.5%	-3.3%	-3.2%
Uzbekistan	19	17	18	18	19	6.5%	5.9%	5.9%	5.9%	5.9%
ROW						0.0%	0.0%	0.0%	0.0%	0.0%
Beginning stocks	0	30	28	27	26	0.0%	8.0%	7.5%	7.2%	7.0%
Total use, thousands MT	91	87	87	87	88	1.0%	1.0%	1.0%	0.9%	0.9%
Domestic consumption	61	59	60	62	63	0.7%	0.7%	0.7%	0.7%	0.7%
Ending stocks	30	28	27	26	25	8.0%	7.5%	7.2%	7.0%	6.7%
Wheat flour price, AFN per kg										
Retail, nominal	-1.06	-1.06	-1.10	-1.16	-1.22	-3.5%	-3.4%	-3.3%	-3.3%	-3.3%





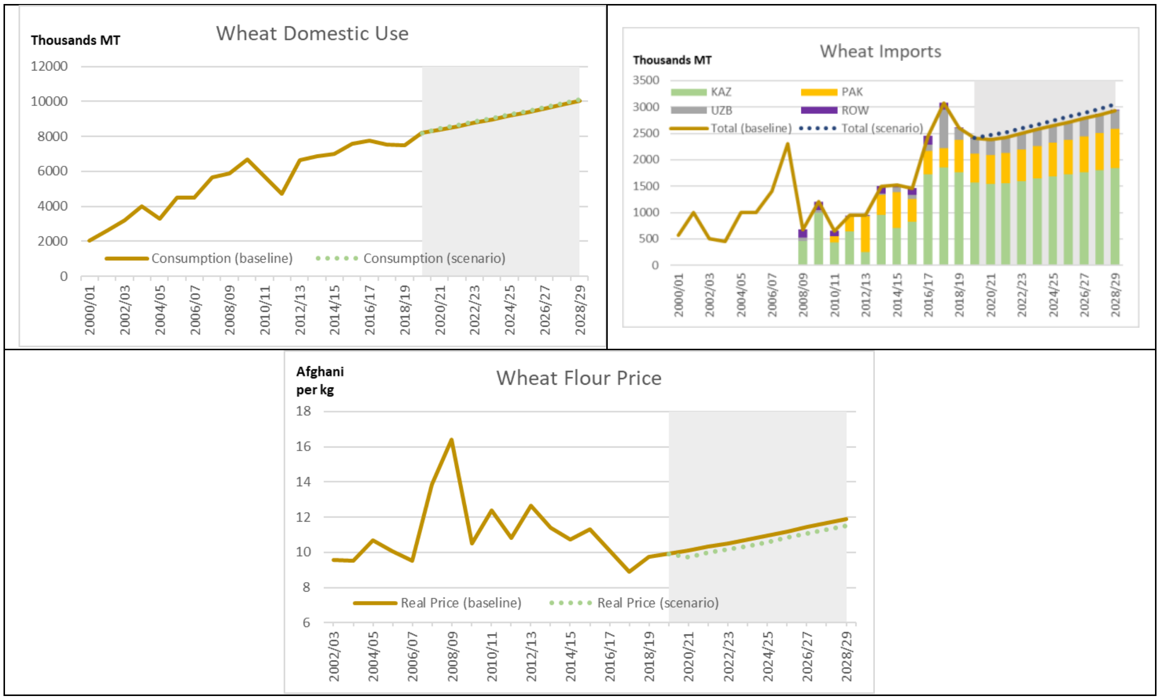


Figure 4.8: Afghanistan wheat market outlook – baseline vs. increased efficiency in transaction cost scenario

5. SUMMARY AND CONCLUSIONS

In this study we constructed a partial equilibrium model to test our hypotheses and find answers to our proposed research questions. We closed our model two ways. First, where the price of wheat imported from Kazakhstan and Pakistan determines the domestic wheat price in Afghanistan, referred to here as the price linkage model. Second, where domestic price clears the market while considering trade as a function of relative prices in Afghanistan and exporting countries, referred to as the trade linkage model. We learned that it is crucial how we close the model, as results under certain scenarios are qualitatively different depending on the approach used.

To test this point, we run our first scenario (drought in Afghanistan) under both models and demonstrate that the price linkage model yields the seemingly unlikely result that domestic Afghan prices for wheat would be unaffected by a scenario that sharply reduces domestic production. The second model yields a more intuitive result, where the reduction in production results in higher prices in the domestic market and reduced consumption, as well as larger imports. This is very similar to what happened in 2008/09 when wheat price increased following a poor harvest. The same phenomenon was repeated in 2011/12. Judging it to be a more plausible representation of the Afghan wheat market, we used the trade linkage model and tested the remaining scenarios with it.

The scenarios examined are lowering domestic production, increasing domestic production, introducing an export ban by Pakistan, eliminating the export subsidy by Pakistan, increasing the Kazakh wheat price, imposing higher tariffs, and increasing efficiency in importing wheat to Afghanistan.

We tried to be reasonable while constructing our scenarios. All of these scenarios occurred in the past and are likely to appear in the future. It is likely that multiple scenarios may happen at a time, such as in 2008/09, when Pakistan had an export ban in place, the export price from Kazakhstan increased and Afghanistan had a harvest failure. But to evaluate the impact of each scenario on its own, we considered them separately.

The food security literature clearly suggests that high prices for wheat and other staple foods are associated with higher food insecurity, especially for non-farm households. We do not estimate how many households will be pushed into food insecurity by any given increase in wheat prices, as that was beyond the scope of this study. But we can be confident that changes in wheat prices will affect household consumption and thus food security. We find that lower domestic production, more trade restrictions such as export bans and higher tariffs, and higher prices in exporting countries will increase domestic wheat prices in Afghanistan, and we would expect those higher prices to translate into reduced food security for many households.

In contrast, increased production (due to increased area and yields) and increasing efficiency in importing wheat will reduce domestic prices and increase food security for households that are net purchasers of wheat. For farm households, the net impact may depend on changes in farm-level production and production costs, as well market prices.

At one point, Afghanistan was more dependent on Pakistan wheat production and Pakistan's export policy could affect Afghanistan wheat prices and food security directly. However, now as we showed in our scenarios, Afghanistan wheat market is no longer as vulnerable to Pakistan wheat policies. For example, a complete wheat ban from Pakistan will increase Afghan wheat prices by just 5 percent, while eliminating its export subsidy program will increase Afghan wheat prices by only 2 percent.

However, the Afghan market is now more dependent on the Kazakhstan market and thus with the world market (it is believed that Kazakhstan wheat prices are more integrated with the world price than are Pakistani wheat prices). A scenario assuming much higher Kazakh wheat prices increased Afghanistan wheat prices by 12 percent in the outlook period. A complete export ban would increase Afghanistan wheat prices greatly.

Among policy options, governments usually levy tariffs on imported goods, which discourage trade, encourage domestic production and may generate revenue. We run a scenario where the Afghan government increases tariffs from the current 5 percent to 20 percent on wheat flour, and wheat price is increased 9 percent. Increased tariffs might generate revenue and encourage domestic production, but ultimately consumers must pay the price. Given fragile food security situation in Afghanistan, it is a not considered a good option. There is ongoing debate among researchers regarding which commodity should be preferred between wheat grain and flour, considering the consumption requirements and observing capacity of millers inside Afghanistan. However, these questions were not addressed and could be interesting topics for future research.

Increasing efficiency to reduce transportation and transaction costs could reduce consumer food costs. Facilitating smooth imports in terms of cost and timing will reduce domestic wheat prices and dependence on certain exporting countries. Although beyond the scope of this study, reducing domestic transportation and transaction costs could reduce the gap between farm and retail prices. In this way, consumers and farmers could both be better off. Reducing the cost of delivering imported wheat to Afghanistan, such as improved transport, efficiency in clearing taxation, and preventing loss during transportation could reduce wheat domestic price by 4 percent.

Afghanistan has been through several droughts in the last two decades, reflecting its dependence on timely precipitation and vulnerability to climate change. It is important that Afghanistan should consider all policy options that are feasible and ensure that food is available to all people at all times, including wheat. Reaching self-sufficiency seems not a realistic near-term goal given current constraints. However, many options could be undertaken to ensure wheat prices do not temper food security in Afghanistan. Increasing wheat yield, expanding both irrigated and rainfed area, investment on transportation and customs clearance systems are among few feasible options that yield better lasting results, provided they can be achieved at an acceptable cost.

Due to data and time limitations we did not make the model disaggregated by regions in Afghanistan. If we had constructed the model in that way, we could determine how urban areas (and wheat deficit regions in general) and rural areas (wheat surplus regions) might respond differently to assumed shocks.

Given time and resource constraints, we did not examine newly available household data such as ALCS 2013/14 and ALCS 2016/17. Instead we borrowed demand price elasticities from others. It would be interesting to use the latest household data and re-estimate those parameters. Further research areas include disaggregating the model by multiple locations (maybe by rural and urban) to see how different regions are affected by the scenarios. Similarly including other wheat-competing crops in the model (e.g., rice) would better reflect supply and demand decisions, but would then require a broader model that can endogenize rice prices. Though we used prices from Kazakhstan, Pakistan and Uzbekistan, we did not model the way in which they are generated. Instead we borrowed the prices for outlook period from other sources. It would be interesting to model those markets as well and include them in a global wheat market, but that would greatly expand the scope of the modeling effort.

LIST OF REFERENCES

Afghanistan Customs Department. (2019). *Trade statistics*. *(Personal communication)*. Kabul, Afghanistan.

Afghanistan Food Security Cluster. *Afghanistan Emergency Food Security Assessment*. (2018). Kabul, Afghanistan.

Agukwe, F. C. (2014). Favorable and Unfavorable Balance of Equilibrium. *American Journal of Economics*, *4*(5), 195–199.

Araujo Enciso, S. R., Pérez Dominguez, I., Santini, F., & Helaine, S. (2015). *Documentation of the European Comission's EU module of the Aglink-Cosimo modelling system*. Joint Research Centre (Seville site).

Bacchetta, M., Beverelli, C., Cadot, O., Fugazza, M., Grether, J.-M., Helble, M., … Piermartini, R. (2008). *A practical guide to trade policy analysis*.

Baldos, U. L. C., & Hertel, T. W. (2013). Looking back to move forward on model validation: insights from a global model of agricultural land use. *Environmental Research Letters*, *8*(3), 034024.

Central Statistics Organization. (2018). *Afghanistan Living Conditions Survey 20161/17*. Kabul, Afghanistan.

Central Statistics Organization. (2019a). *Trade statistics data*. Kabul, Afghanistan. Retrieved from http://cso.gov.af/en.

Central Statistics Organization. (2019b). *Statistical yearbook (various issues)*. Kabul, Afghanistan. Retrieved from http://cso.gov.af/en

Chabot, P. (2013). *Wheat markets and food security in Afghansitan*. Retrieved from UNFAO website: https://www.humanitarianresponse.info

Chabot, P., & Dorosh, P. A. (2007). Wheat markets, food aid and food security in Afghanistan. *Food Policy, 32*(3), 334–353.

Chabot, P., & Tondel, F. (2011). A regional view of wheat markets and food security in Central Asia. *International Development Famine Early Warning Systems Network*.

Choi, J.-S., & Helmberger, P. G. (1993). How sensitive are crop yields to price changes and farm programs? *Journal of Agricultural and Applied Economics*, *25*(1), 237–244.

Davids, P. T. (2017). *Modelling regional market integration: Application to policy simulation in Eastern and Southern African maize markets*.

Dorosh, P., & Salam, A. (2008). Wheat markets and price stabilisation in Pakistan: An analysis of policy options. *The Pakistan Development Review*, 71–87.

D'Souza, A., & Jolliffe, D. (2010). *Rising food prices and coping strategies: Household-level evidence from Afghanistan*. The World Bank.

D'Souza, A., & Jolliffe, D. (2013). Conflict, food price shocks, and food insecurity: The experience of Afghan households. *Food Policy*, *42*, 32–47.

Food and Agriculture Organization of the United Nations. (2019a). *FAOSTAT database*. Rome. Retrieved from http://www.fao.org/faostat/en/

Food and Agriculture Organization of the United Nations. (2019b). *GIEWS FPMA Tool*. Room. Retrieved from http://www.fao.org/giews/food-prices/tool/public/#/home

Faruqee, R., Coleman, J. R., & Scott, T. (1997). Managing price risk in the Pakistan wheat market. *The World Bank Economic Review*, *11*(2), 263–292.

Fellmann, T., Hélaine, S., & Nekhay, O. (2014). Harvest failures, temporary export restrictions and global food security: the example of limited grain exports from Russia, Ukraine and Kazakhstan. *Food Security*, *6*(5), 727–742.

FEWS NET. (2007). *The contribution of regional markets to Afghan wheat supplies*.

FEWS NET. (2016). *Central Asia Regional Wheat Market Fundamentals*.

Francois, J. F., & Reinert, K. A. (1997). *Applied methods for trade policy analysis: a handbook*. Cambridge University Press.

Grebmer. (n.d.). *2018 Global Hunger Index: Foreced Migration and Hunger.*

Halimi, G. H. (2016a). *Can Afghanistan achieve self-sufficiency in wheat? Limitations due to market integration*. Purdue University.

Halimi, G. H. (2016b). *Trade and agriculture policy options to improve the wheat subsector in Afghanistan*. Purdue University.

Halimi, G. H., Abbott, P. C., & McNamara, K. T. (2015). Price Transmission in Afghanistan's Wheat Markets. *IPIA Report*, *1062015*.

Hassanzoy, N., Ito, S., Isoda, H., & Amekawa, Y. (2017). Cointegration and spatial price transmission among wheat and wheat-flour markets in Afghanistan. *Applied Economics*, *49*(30), 2939–2955.

Khan, S. (2007). Pakistan Wheat Subsector and Afghan Food Security: A special report by the Famine Early Warning Systems Network (FEWS NET). *US Agency for International Development*, *1300*, 52.

Kruse, J. R. (1999). *Trend Yield Analysis and Yield Growth Assumptions*. Food and Agricultural Policy Research Institute (FAPRI) at the University of ….

Maletta, H. E. (2007). *Food and agriculture in Afghanistan: a long term outlook*.

Ministry of Agriculture Irrigation and Livestock. (2019). *Agriculture Prospects Reports (various issues)*. Kabul, Afghanistan.

Ministry of Agriculture Irrigation and Livestock. (2016). *National Wheat Policy (draft)*. Kabul, Afghanistan

Meyers, W. H., & Meyer, S. D. (2008). *Causes and implications of the food price surge*.

Meyers, W. H., Westhoff, P., Fabiosa, J. F., & Hayes, D. J. (2010). The FAPRI global modelling system and outlook process. *Journal of International Agricultural Trade and Development*, *6*(1), 1–20.

Nerlove, M. (1979). The dynamics of supply: retrospect and prospect. *American Journal of Agricultural Economics*, *61*(5), 874–888.

Persaud, S. (2012). *Long-term growth prospects for wheat production in Afghanistan*.

Persaud, S. (2013). Afghanistan's Wheat Flour Market: Policies and Prospects. *Economic Research Service Report. USDA. Http://Www. Ers. Usda. Gov/ErsDownloadHandler. Ashx*.

Persaud, S. C. (2010). *Price Volatility in Afghanistan's Wheat Market*. US Department of Agriculture, Economic Research Service.

Schulte, R. B. (2007). *Northern Wheat Trader Survey and Afghan Food Security: A Special Report by the Famine Early Warning Systems Network (FEWS NET)*. United States Agency for International Development. August.

Tokarick, M. S. (2003). *Measuring the impact of distortions in agricultural trade in partial and general equilibrium*. International Monetary Fund.

U.S. Department of Agriculture, Foreign Agricultural Service. (2019a). *Production, Supply and Distribution (PSD) database*. Washington, D.C.

U.S. Department of Agriculture, Foreign Agricultural Service (2019b). *Pakistan Grain and Feed Annual Report, GAIN Report (various issues)*. Washington, D.C.

Westhoff, P., Brown, S., & Hart, C. (2005). When point estimates miss the point: Stochastic modeling of WTO restrictions. *Meeting of the International Agricultural Trade Research Consortium, San Diego, CA*.

World Bank. (2018). *Afghanistan Development Update, August 2018*. World Bank, Washington, DC. © World Bank.

World Bank. (2019). *World Development Indicators*. Washington, D.C. Retrieved from https://databank.worldbank.org/reports.aspx?source=world-development-indicators#

World Food Programme. (2018). *VAM market data from Afghanistan main cities (Kabul, Kandahar, Mazar, Jalalabad, Faizabad, Hirat, Maimana and Nili)*. Kabul, Afghanistan

APPENDIX 1: Equations specifications

Unless otherwise noted equations were estimated using the ordinary least square method of regression. The table presents p-values in parentheses.

$YLD = \beta 0 + \beta 1 \{\min \{0, \{PRCP_{t-1} - AVERAGE(PRCP_{LR})\}\} + \beta 2\ TRD + \varepsilon$		(3)
$\beta 0 = -1.387$		
$\beta 1 = 0.006$ *(0.0005)*	Elasticity = - 0.03	
$\beta 2 = 0.034$ *(0.0017)*		
N = 18		
Adj. $R^2 = 0.78$		

$AH = \beta 0 + \beta 1\ RH + \varepsilon$		(4)
$\beta 0 = 1934.41$		
$\beta 1 = 22.06$ *(0.1615)*	Elasticity = 0.17	
N = 16		
Adj. $R^2 = 0.07$		

$Log(QC) = \beta 0 - 0.202 \log(PFLOUR) + \beta 2 \log(GDPPC) + \varepsilon$		(6)
$\beta 0 = 0.97$		
$\beta 2 = 0.511$ *(0.0041)*	Elasticity = 0.5	
N = 17		
Adj. $R^2 = 0.39$		

$STE = \beta 0 + \beta 1 (1/PFLOUR) + \beta 2 (QP+STB) + \varepsilon$		(7)
$\beta 0 = -1074.98$		
$\beta 1 = 8335.42$ *(0.0322)*	Elasticity with respect to the flour price = -3.27	

β2 = 0.12 *(0.0105)*	Elasticity = 2.26	
N = 10		
Adj. R^2 = 0.65		

AFGWPL = β0 + β1 AFGFPL + Ɛ		(8)
β0 = -0.15		
β1 = 0.86 *(0.0000)*	Elasticity = 1.01	
N = 19		
Adj. R^2 = 0.94		

AFGFP = β0 + β1 (2/3 * KAZFPT + 1/3 * PAKFPT) + Ɛ		(9)
β0 = - 151.01		
β1 = 1.66 *(0.0000)*	Elasticity = 1.32	
N = 14		
Adj. R^2 = 0.77		

$* IMKAZF = max\left\{0, \left[\beta 0 + \beta 1 \frac{AFGFP}{KAZFPT} + \beta 2(max(0, AFGFP - KAZFPT))\right]\right\}$		(11)
β0 = 0		
β1 = 1500		
β2 = 15		

** all parameters are assumed, not estimated*

$* IMUZBF = max\left\{0, \left[\beta 0 + \beta 1 \frac{AFGFP}{UZBFPT} + \beta 2(max(0, AFGFP - UZBFPT))\right]\right\}$		(12)
β0 = - 200		

β1 = 300		
β2 = 2		

* *all parameters are assumed, not estimated*

$* \, IMPAKFs = min\left\{EEX, \left[max\left(0, \left(\beta 0 + \beta 1 \frac{AFGFP}{PAKFPT} + \beta 2(max(0, AFGFP - PAKFPT))\right)\right]\right\}$		(13)
β0 = - 100		
β1 = 300		
β2 = 5		

* *all parameters are assumed, not estimated*

$* \, IMPAKFw/s = max\left\{0, \left[\beta 0 + \beta 1 \frac{AFGFP}{PAKFPT} + \beta 2(max(0, AFGFP - PAKFPT))\right]\right\}$		(14)
β0 = - 100		
β1 = 300		
β2 = 5		

* *all parameters are assumed, not estimated*

UZBFP = β0 + β1 KAZFP + Ɛ		(16)
β0 = - 171		
β1 = 1.3 *(0.003)*		
N = 10		
Adj. R^2 = 0.65		