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Trade and agriculture policy options to improve the wheat subsector in Afghanistan

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TRADE AND AGRICULTURE POLICY OPTIONS TO IMPROVE THE WHEAT SUBSECTOR IN AFGHANISTAN

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TABLE OF CONTENTS

Page

Page

Page

LIST OF TABLES

Table Page

Table Page

LIST OF FIGURES

LIST OF ABBREVIATIONS

ADF	Augmented Dicky-Fuller Test
AFN	Afghani is the currency of Afghanistan
CSO	Central Statistics Organization of Afghanistan
FAO	Food and Agriculture Organization of the United Nation
GDP	Gross Domestic Production
HER	Herat
ITC	International Trade Center (Geneva, Switzerland)
JAL	Jalalabad
KAB	Kabul
KAN	Kandahar
KDZ	Kunduz
KST	Khost
MAIL	Ministry of Agriculture, Irrigation and Livestock (Afghanistan)
MAZ	Mazar
MMT	Million Metric Tons
MSP	Minimum Support Price
NRVA	National Risk and Vulnerability Assessment
OECD	Organization for Economic Co-operation and Development
PASSCO	Pakistan Agricultural Storage and Services Corporation
PP	Phillips-Perron Test
UN	United Nations
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
VECM	Vector Error Correction Model
WB	World Bank
WFP	World Food Program

ABSTRACT

Halimi, Ghulam Hazrat. Ph.D., Purdue University, May 2016. Trade and Agriculture Policy Options to Improve the Wheat Subsector in Afghanistan: Major Professor: Dr. Philip C. Abbott.

In Afghanistan wheat availability is important for national food security as it is the key staple food, accounting for over half of calorie intake. The country has imported on average 32% of its wheat consumption over the period 2000-2015, primarily from Pakistan and Kazakhstan. Since domestic production is volatile, consumer well-being depends on access to international markets.

Pakistan, a key supplier of wheat and flour to Afghanistan, has not been a reliable source for Afghanistan to meet its wheat deficit. Pakistan subsidizes and stabilizes its wheat production, and this benefited Afghan consumers before 2008. Pakistan restricted wheat and flour exports to Afghanistan during the 2007-08 food crisis. Pakistani export restrictions combined with a severe shortfall in domestic production placed substantial pressure on the Afghan grain market. This forced Afghanistan to find alternative suppliers, so it started wheat imports from Kazakhstan. Kazakh prices are more variable than Pakistani prices, and the Afghan wheat market was not as well integrated with Kazakhstan as with Pakistan. The increase in the wheat prices in Afghanistan in 2008 was much greater than the increase experienced in international and regional grain markets. Afghan policy responses have focused on self-sufficiency (which could bring greater instability) and stockpiling in commercial centers.

In this research we assess the impacts of trade and stockholding policies on market outcomes in Afghanistan. Prior to assessing these stabilization policies, we use a VECM model to assess price transmission signals from regional to domestic markets, and between rural and urban areas in Afghanistan. Our analysis suggests domestic price adjustment occurs very slowly, particularly with respect to prices in Kazakhstan.

Moreover, Pakistan's export restrictions in 2008 had a major impact on transmission of price signals from Pakistan to Afghanistan. After the export restrictions policy there is no longer a statistically significant price linkage between Afghanistan and Pakistan. Our analysis also suggests that markets are not well integrated between rural and urban areas, but that commercial centers along the ring road are tightly integrated.

We also conducted a trader and miller survey in Afghanistan. Our survey findings suggest commercial centers are supplied by imported flour from both Pakistan and Kazakhstan. This implies rural zones are segmented from the urban centers and often surplus wheat is retained as private stocks in rural areas. The survey findings also suggest that domestic wheat is not a perfect substitute for imported wheat. Imported wheat, especially Kazakh wheat, is higher quality than domestic wheat and is preferred by bakeries in commercial centers.

Using the results and findings from the price transmission analysis and the trader survey, we develop a simulation model using Armington specifications that captures both weak market integration and imperfect price transmission to assess the impacts of trade and stockholding policies on prices and welfare of producers and consumers. Modeling results suggest that trade policy is effective mainly in trimming the upper tail of price distributions and thus mostly improving consumer welfare. Also, a trade policy is not as effective in stabilizing prices in rural areas as in commercial centers.

A stockholding policy with a primary objective to support producer prices is mainly effective in eliminating the lower tail of price distributions and this mostly improves producer welfare. A stockholding policy may also be used to stabilize prices for consumers and prevent extreme price shocks. Such a policy has to maintain large quantities of stocks (up to 2MMT) in commercial centers likely for several years, with an estimated annual holding costs of about $120 million.

Considering the welfare of both producers and consumers, and the costs of these stabilization policies, a combination of public stockholding and trade policy is recommended. Trade policy is more cost effective than a public stockholding policy in stabilizing prices for consumers. Public stockholding/procurement policy in rural areas of surplus regions is required to support producer prices.

CHAPTER 1. INTRODUCTION

1.1 Overview

The Afghan economy revolves primarily around its agriculture sector. Wheat is the most produced commodity and the major crop in the country, accounting for about 70% of cultivated land area (Persaud, 2010). Wheat is also the key staple food, providing about 60% of the calorie intake for the Afghan population. Average wheat consumption is about 162 Kilograms (Kg) per capita per year (Chabot and Dorosh, 2007; Persaud, 2010).

Although most of the cultivated land resources are devoted to wheat production in Afghanistan, the supply chain for wheat is volatile. Domestic wheat production is variable in Afghanistan, ranging between 2.1 million metric tons (MMT) in 2008, to over 5 MMT in 2014. Volatility in domestic production makes the imports of wheat and flour variable across time. Afghanistan is landlocked and does not share a border with any major wheat exporting countries in the world. This made Afghanistan primarily dependent on Pakistan for wheat and flour imports and vulnerable to Pakistani policy changes.

With a shared border of 1,600 kilometers and a long history of trade, Pakistan has been a key supplier of wheat and flour to Afghanistan. Pakistan heavily subsidizes and stabilizes its wheat and flour industry, which greatly benefits consumers in Afghanistan most of the time. However, the export restrictions on wheat and flour exports to Afghanistan in 2008 showed that Pakistan is not always a reliable source and it does not always stabilize prices in Afghanistan. Prior to the 2007-08 food crisis imports from Pakistan made wheat and flour readily available for Afghan consumers at low and stable prices. However, Pakistan banned wheat and flour exports to Afghanistan in 2008 to ensure food availability for its own population. Very low domestic production in Afghanistan combined with export restrictions from Pakistan led to approximately a 175% increase in wheat prices in Afghanistan. Although the increase in domestic prices forced Afghanistan to start wheat and flour imports from Kazakhstan, it could not stabilize prices as much as when using imports from Pakistan.

Kazakhstan is the largest exporter of wheat and flour in the region and a reliable supplier of wheat and flour to Afghanistan. However, the transportation costs of importing wheat and flour are very high from Kazakhstan, as Afghanistan does not share a border with Kazakhstan. Figure 1-1shows the map for Afghanistan, Pakistan and the Central Asian region. Wheat and flour imports from Kazakhstan have to go through Uzbekistan and Turkmenistan to reach the Afghan border at northern Mazar or western Herat. Moreover, Kazakh prices are more variable than wheat and flour prices in Pakistan.

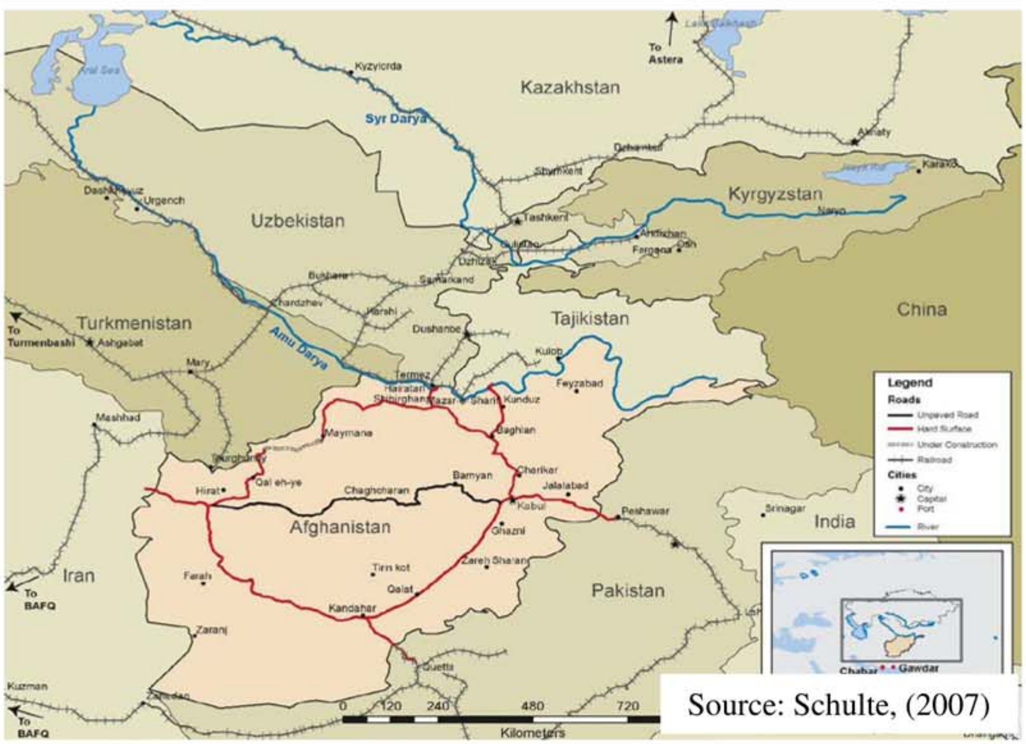

Figure 1-1: Afghanistan, Pakistan and the Central Asian Region

Given the high transportation costs for wheat and flour imports from Kazakhstan, Pakistan became a major supplier of wheat and flour to Afghanistan once again when the export restrictions were lifted. However, Pakistan is now viewed as a low cost but unreliable supplier of wheat and flour to Afghanistan.

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

The price spikes in wheat and flour markets during 2007-08 in Afghanistan have also made the Afghan government consider holding public stocks. MAIL, with the help of the Food and Agriculture Organization (FAO) developed a framework for a strategic grain reserves in 2013. The Strategic Grain Reserve plan, however, does not make a clear distinction between emergency reserves and buffer stocks[1]. Although the strategic grain reserve program was proposed to stabilize prices, it is mainly used as an emergency reserve now. The rules for procuring and releasing wheat are not well defined, and there is no research on the optimal size nor mechanisms for holding public stocks in Afghanistan.

1.2 Motivation for the Research

The price shocks in wheat and flour markets in Afghanistan had a profound impact on food security in Afghanistan (D'Souza and Jolliffe, 2012). The great increase in wheat prices in Afghanistan in 2008 implies that local and regional issues dominated. The price spikes in the Afghan wheat market were mainly due to low domestic

[1] Public stocks aiming to stabilize commodity prices are called buffer stocks. Emergency stocks are maintained to provide assistance during food shortages and crises caused by sudden supply changes, such as natural disasters.

production combined with the export restrictions by Pakistan. Given the volatility in domestic production and export restrictions from Pakistan, it is likely that the recent price shocks may re-occur in the Afghan grain market.

Following the 2007-2008 food crisis, the country experienced a bumper wheat harvest in 2009. This was mainly due to favorable weather conditions and presumably the incentive provided by high wheat prices in the previous year. As a result prices of local wheat were extremely low in the areas where wheat is produced in Afghanistan. These actions demonstrate how Afghanistan has experienced issues with both production shortfalls and surpluses over a very short time period. The wheat supply chain will remain vulnerable to drought and export restrictions from wheat exporters to Afghanistan until there are counteracting policies from the Afghan government to manage it.

The variability in wheat production and prices in the recent years highlights the need for the Afghanistan to develop agricultural and trade policy regimes to deal with both production shortfalls and surpluses. The broad objective of this dissertation is to investigate trade and agriculture policy regimes available to improve the wheat subsector in Afghanistan. This research is expected to provide policy guidelines to stabilize domestic wheat market, while avoiding strategies that may not be economically efficient.

1.3 Roadmap

Prior to developing a model to analyze the impacts of stabilization polices on market outcomes, we conducted a trader and miller survey and assess price transmission signals from regional to domestic markets, and between rural and urban areas in Afghanistan. These analyses help us to develop a model that better fits the observed market structure in the country. Since formal estimates of supply and demand elasticities for wheat in Afghanistan are not available in the literature, we use regression analysis to estimate these elasticities, as well. Using estimated supply and demand elasticities, we calculate parameters for the linear supply and demand functions used in simulation modeling.

Using the findings from the price transmission analysis and the trader survey, we develop a simulation model in a framework of imperfect market integration to assess the impacts of stabilization policies on market outcomes in Afghanistan. First, we will analyze the impacts of the stockholding policy as an instrument to stabilize the wheat market in Afghanistan. We assess whether government intervention through public stockholding can stabilize domestic prices and the welfare of producers and consumers in the county. Second, we examine the impacts of trade policy, such as a variable levy, on wheat market outcomes in rural versus urban areas in Afghanistan. We assess the effects of a variable levy on the distribution of prices and on the welfare of producers and consumers across rural and urban areas. Finally, we assess the combined effects of trade and stockholding policies, implemented simultaneously, on the distributions of prices and on producer and consumer welfare. Analyses are done with both static and stochastic models. Measurement of changes in the market outcomes will be examined through Monte Carlo simulation, given stochastic world price and production.

The findings will provide guidelines for policy makers on how to stabilize the wheat supply chain in Afghanistan, taking into account the needs of producers, consumers, traders, millers, and the government. This quantitative economic research will improve the current discussions on these policy options for stabilization of the wheat markets in Afghanistan.

This dissertation is organized into ten chapters. The early few chapters contain all the background information needed to model Afghanistan's wheat sector: estimating supply and demand elasticities, price transmission elasticities, and findings from the trader and miller survey. Following this introduction is an overview of regional wheat supply and estimation of supply elasticities. The estimation of per capita demand for wheat in Afghanistan is presented in Chapters 3. Price transmission analysis between regional and domestic markets and between rural and urban markets is discussed in Chapter 4. Chapter 5 presents findings from our trader and miller survey. The second part of this dissertation focuses on the main objective of our research, which is assessing stabilization policies and their impacts on the welfare of producers and consumers. We discuss literature on stabilization policies in Chapter 6. Model specifications, including spatial specifications, and model equations for supply and use balance and trade flows are presented in Chapter 7. The implementation of the simulation analysis and explanation of alternative scenarios are presented in Chapter 8. The effects of trade and stockholding policies on market and welfare outcomes using a stochastic model are presented in Chapter 9. Chapter 10 contains conclusions and policy implications.

CHAPTER 2. WHEAT PRODUCTION

2.1 Background

The wheat sector has played a key role in agricultural income, employment and food security in Afghanistan, and its important role is likely to continue for the foreseeable future. Wheat accounts for one quarter of agricultural GDP and 6.3 percent of national GDP (World Bank, 2014). Although wheat production has exhibited an increasing trend after 2000, the increase in consumption has been larger and the country has become more dependent on imports.

Afghanistan's wheat production is variable across time, mainly due to high variability in precipitation. The amount of precipitation not only affects rainfed areas, but also irrigated areas. In Afghanistan about 80% of annual precipitation falls as snow in the mountain ranges of central Afghanistan during winter. For most parts of the country winter snowfall is the primary source of irrigation water and strengthens and stabilizes grain production in the country (U.S. Department of Agriculture, 2008).

Figure 2-1shows wheat production on irrigated and rainfed areas over the 2002-2013 period from Ministry of Agriculture, Irrigation and Livestock (MAIL). Most of domestic wheat is produced on irrigated acreage, and this production domain is less volatile and less vulnerable to poor rainfall than rainfed wheat production. Rainfed wheat production is very volatile and fully dependent on annual precipitation. In order to increase domestic wheat production, it makes sense to focus more on irrigated wheat rather than rainfed wheat. In its recent agriculture sector review, the World Bank has highlighted irrigated wheat as having the best potential for raising wheat production in the country (World Bank, 2014). Irrigated wheat production can increase either by expanding the irrigated areas or raising the yield on irrigated acreage.

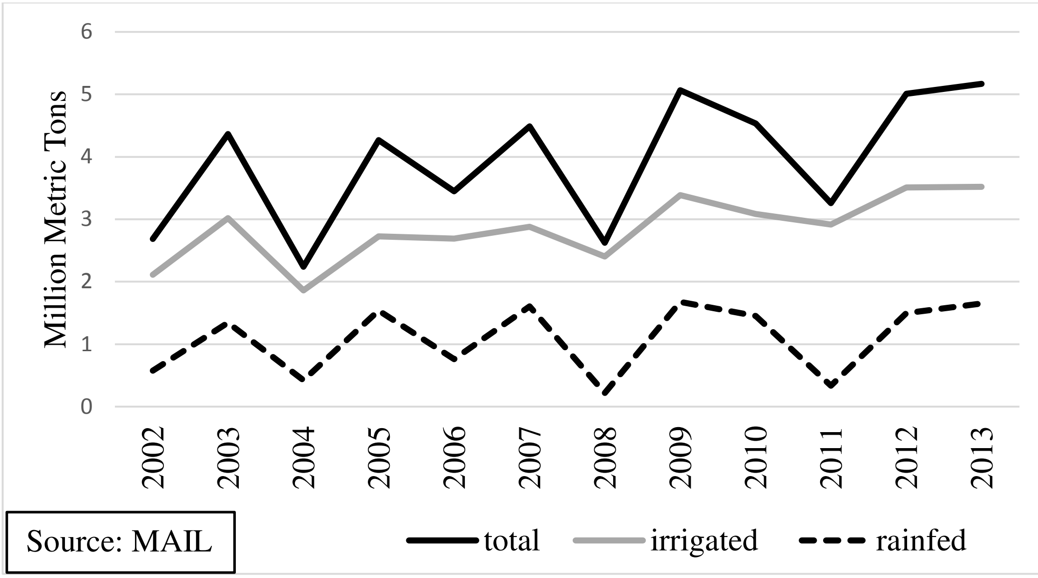

Figure 2-1: Irrigated, Rainfed and Total Wheat Production

Figure 2-2 shows domestic production, national imports and total supply of wheat and flour over the 1970-2015 period in Afghanistan from USDA (2015). Overall grain production exhibited a declining trend over the period 1987-1992 due to combined effects of droughts and war (Persaud, 2010). Imports of wheat and flour were low over this period, as well, because millions of people left the country and fled to Pakistan and Iran. Wheat production rebounded in 1997 and 1998 due to good growing conditions, but droughts led to a record decline in wheat output in 2000 and 2001. Wheat production was fairly good over the period 2002-2007, with a bumper harvest in 2003 (about 3.5 MMT). Very low rainfall and snowfall in late 2007 and early 2008 caused major declines in 2008 wheat production. Wheat production was down to 1.5MMT from 2.3MMT the previous year (Persaud, 2010; U.S. Department of Agriculture, 2008). In the 2009/2010 marketing year, wheat production recovered. Afghanistan produced its record level, at 4.3MMT, in that year[2]. According to Afghan authorities high domestic wheat prices encouraged

[2] Wheat production was 5 MMT in 2009 based on MAIL estimates. Wheat production data in Afghanistan are not consistent from various sources. National wheat production is higher based on the estimates from MAIL, compared to estimates from USDA. We use the production data from MAIL, as MAIL is the only source that has regional production data which we need for our model.

farmers to increase planted wheat acreage. This was combined with good growing conditions and above normal precipitation, and led to a bumper wheat harvest (U.S. Department of Agriculture, 2009). Domestic wheat production declined and fell below 3 MMT again in 2011, mainly due to insufficient rainfall. The annual wheat production has been fairly stable and high, at about 5 MMT, since 2012.

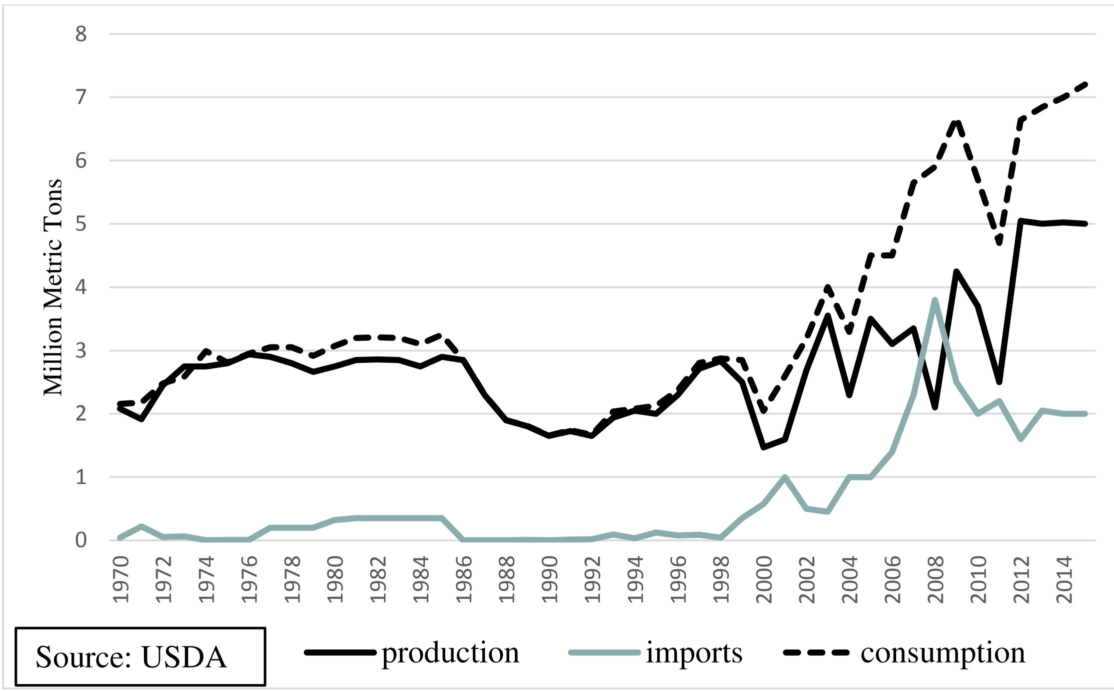

Figure 2-2: Production, Imports and Consumption of Wheat in Afghanistan-1970 to 2015

Figure 2-2 shows that Afghanistan was mostly self-sufficient in wheat until 1998. The difference between domestic production and consumption gets bigger starting in 1999 and reaches a peak in 2008. Imports have been stable since 2009, at about 2MMT each year. Wheat consumption has increased dramatically since 2000, mainly due to growing population. Total consumption was about 2MMT in 2000, and it increased to more than 6MMT in 2009. Domestic production could not catch up with total wheat requirements in the country and as a result imports have been increasing.

Figure 2-2 shows that apparent total consumption was much higher in 2009 than in 2010 and 2011. Total consumption data for Afghanistan estimated by FAS/USDA is reported as total domestic production plus total imports. Therefore, consumptions data implicitly includes stocks and seed used for the next planting season. Domestic production was high in 2009 and since the markets were not well integrated across the country, a large portion of domestic production was likely retained as stocks in wheat surplus areas[3]. The higher apparent consumption in 2009 can be partially explained by an increase in stocks, not consumption. Also, wheat prices were very low in 2009 compared to the previous and next years. The increase in consumption in 2009 was partially due to low wheat prices, as well.

The variability in production is higher in northern Kunduz and Mazar compared to other regions, mainly due to large rainfed wheat production in the northern regions. Irrigated wheat yields do not differs largely across regions. They range from 2.32 tons per hectares in Mazar to 2.85 tons per hectare in central Kabul. Irrigated yields are slightly lower in Mazar and Herat, because there are larger farm sizes in those regions and mostly extensive agricultural methods are used to increase production. Land is more scarce in the central Kabul and eastern Jalalabad, compared to the northern and western regions. Thus, it is more likely that farmers use fertilizer and other intensive methods to increase production. Summary statistics for our regional production data are presented in Table 2-1.

[3] This issue will be discussed later in the price transmission chapter.

Table 2-1: Summary Statistics on Regional Production, Area and Yield Data: 2002-2013

			(1)	(2)	(3)	(4)	(5)
	Abbr.	Region	N	mean	sd	min	max
	HER[4]	Herat	12	607.6	181.7	281	927
	JAL	Jalalabad	12	247	111.5	110	445
Production	KAB	Kabul	12	377	85.67	208	468
(1000 MT)	KAN	Kandahar	12	488.5	109.7	247	686
	KDZ	Kunduz	12	917.4	281.0	459	1,424
	KST	Khost	12	276.2	90.08	87	367
	MAZ	Mazar	12	1,015	371.4	472	1,378
	HER	Herat	12	398.6	52.47	313	461
	JAL	Jalalabad	12	91	24.53	57	121
Area	KAB	Kabul	12	148.8	22.87	102	180
(1000 ha)	KAN	Kandahar	12	196.4	21.69	167	231
	KDZ	Kunduz	12	543.3	69.78	384	633
	KST	Khost	12	104.8	24.38	44	140
	MAZ	Mazar	12	807.6	143.3	518	930
	HER	Herat	12	1.494	0.302	0.898	2.011
	JAL	Jalalabad	12	2.602	0.575	1.719	3.771
Yield	KAB	Kabul	12	2.518	0.376	1.893	3.211
(MT/ha)	KAN	Kandahar	12	2.476	0.431	1.479	2.985
	KDZ	Kunduz	12	1.675	0.395	0.832	2.252
	KST	Khost	12	2.581	0.460	1.511	3.096
	MAZ	Mazar	12	1.237	0.335	0.605	1.627

Data Source: Ministry of Agriculture, Irrigation and Livestock (MAIL)

[4] See Table 7-2 for more complete regional definitions.

The Northern region, with Balkh at its center, is the largest surplus zone in the country. Figure 2-3 represents wheat balance in 2010 for Afghanistan, showing deficit and surplus provinces. 2010 is considered a normal year for wheat harvest in Afghanistan. About half of wheat output is produced in the northern plains of Afghanistan (Chabot and Dorosh, 2007). Central and eastern Afghanistan are wheat deficit areas. The largest deficit areas are Kabul (the capital of Afghanistan), Nangarhar and Kandahar.

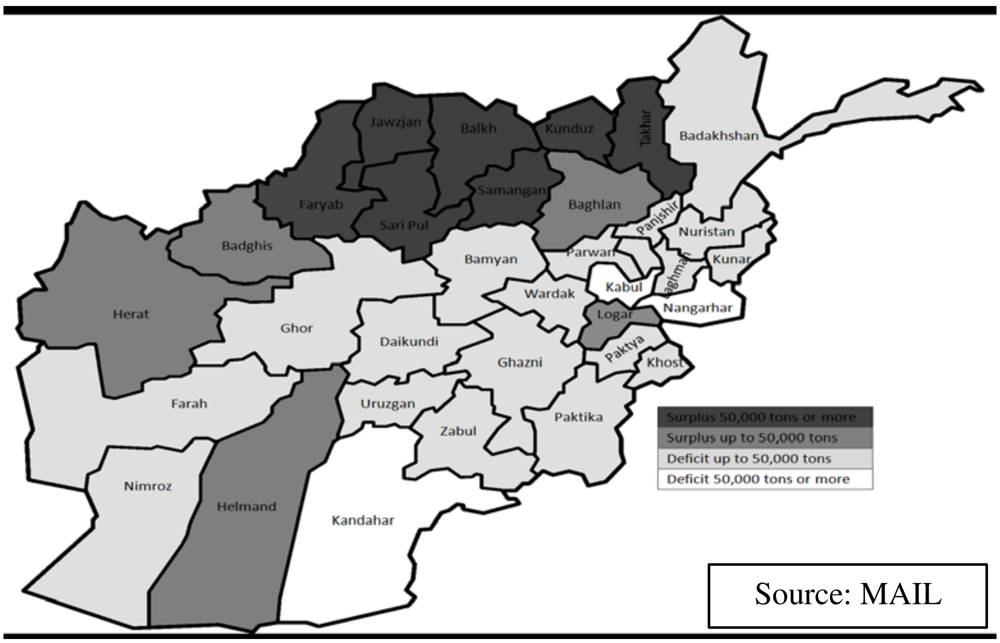

Figure 2-3: Surplus and Deficit Regions in 2010

Over the 2002 - 2013 period approximately 48% of wheat cultivated area was irrigated. Irrigated wheat acreage is the major source of wheat production in Afghanistan, accounting for about 72% of total wheat production. Over the 2002-2013 period the yields on irrigated wheat area were on average three times those on rainfed wheat land (2.6 tons/hectare versus 0.9 tons/hectare). Average wheat production, wheat cultivated area and yield across regions over the 2002-2013 period are presented in Table 2-2.

Table 2-2: Production, Area and Yield 2002-2013: Irrigated versus Rainfed Wheat

		HER[5]	JAL	KAB	KAN	KDZ	KST	MAZ
National	Production (1000 MT)	608	247	377	488	917	276	1015
	Area (1000 ha)	399	91	149	196	543	105	808
	Yield (MT/ha)	1.52	2.71	2.53	2.49	1.69	2.64	1.26
Irrigated	Production (1000 MT)	392	244	356	479	590	271	510
	Area (1000 hectares)	163	87	125	182	220	98	220
	Yield (MT/ha)	2.41	2.82	2.85	2.63	2.69	2.77	2.32
Rainfed	Production (1000 MT)	220	3	21	9	327	5	505
	Area (1000 hectares)	236	4	24	14	323	7	588
	Yield (MT/ha)	0.93	0.68	0.87	0.66	1.01	0.72	0.86

Data Source: Ministry of Agriculture, Irrigation and Livestock (MAIL)

About half of the wheat output is produced in the northern Kunduz and Mazar regions of Afghanistan. The remaining half is produced mostly in the southern and western regions of the country in Herat and Helmand. Helmand province is the main producer of wheat in the southern region, and most of the wheat in the western region is produced in Herat.

Given current production inefficiencies and moderate yields, there are real potentials to increase wheat production in Afghanistan. According to the World Bank (2014), even with current yields and production inefficiencies, domestic wheat production may compete with imports. Thus, Afghanistan appears to have comparative advantage to produce wheat, and it is not unrealistic to expect that Afghanistan could reach self-sufficiency in wheat within five to ten years, at least in non-drought years.

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[5] Regions are explained in detail in Table 7-2 in chapter 7.

There is potential for increasing yields of irrigated wheat in Afghanistan. Irrigated wheat yields in Afghanistan are lower compared to the regional standards, though they have been increasing at a 4.5 percent per year since 2002 (World Bank, 2014). Productivity of irrigated wheat can increase by providing adequate supplies of improved seed and fertilizer, and better on-farm water management and agronomic practices.

2.2 Price Elasticity of Supply

Assessment of wheat supply in 2008 and 2009 suggests that wheat production might respond to prices in Afghanistan. Therefore, we need the price elasticity of supply to generate parameters for the linear supply function that will be used in the simulation analysis later. We also need to capture the correlation of area harvested and yields between regions in Afghanistan for the simulation analysis. The variance-covariance matrix of the error terms from the area and yield functions will be used in the simulation analysis to capture the correlation of area harvested and yield of wheat across regions.

Formal estimates of supply elasticities and the trend for wheat production in Afghanistan are not available in the literature. Persaud (2012) uses an own-price elasticity of 0.20 for wheat cultivated area. He argues the assumed elasticity is plausible as his model predictions fit well with the actual data for wheat area over the 1997-2009 period. Using the production and yield data from MAIL, I estimate supply functions for wheat in each region in Afghanistan here.

Wheat production is computed as the product of area times yield. Producers are treated as rational economic agents. Wheat planted area is an increasing function of expected wheat price. A naive method of defining expected price is using the lagged price. Thus, we regress area planted for wheat on lagged wheat prices to measure the elasticity of area with respect to price.

The mathematical form of the area, yield and supply functions are presented in equations 2.1:

$$A_r = \alpha_r + \beta_r P_{rt-1} + e_r \qquad 2.1$$

$$Y_r = \mu_r + \rho_r Y_{rt-1} + u_r$$

$$Q_r = A_r Yd_r$$

Where A is the area planted, P is wheat price, α is the constant, β is the coefficient measuring area response to price, Y is yield, e and u are the error terms, and the index r represents region. Wheat yield growth is driven by rates of improvement in technology and irrigation. However, yield data does not show improvement in yield over the period 2002-2013. Hence the yield data do not follow a regular time trend.

We use the Ordinary Least Square (OLS) method to estimate equation (1) using the data for each separate region in Afghanistan. Our annual time series data are too short to allow us to test for stationarity. The OLS estimates are presented in Table 2-3. The data used for this analysis are for the period 2002-2013.

Table 2-3: OLS Estimates of Price Elasticity for Wheat Area Planted.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	HER	JAL	KAB	KAN	KDZ	KST	MAZ
β (log lagged	0.157	0.602***	0.301***	0.147**	0.0961	0.303**	0.250
price)	(0.0910)	(0.0750)	(0.0584)	(0.0591)	(0.0698)	(0.0905)	(0.148)
Constant	5.123***	1.148**	3.307***	4.453***	5.769***	2.985***	5.308***
	(0.497)	(0.415)	(0.328)	(0.331)	(0.403)	(0.512)	(0.831)
Observations	12	12	12	12	10	10	10
R-squared	0.230	0.866	0.726	0.383	0.192	0.584	0.262

Standard errors in parentheses

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

The dependent variable is the area of wheat measured in hectares, in logarithmic form, regressed on the lagged wheat prices. The coefficient for lagged price is statistically significant for four of the seven regions. The price coefficient is significant for all of the deficit regions, but not significant for surplus regions. The coefficient is significant at the 1% level for Jalalabad and Kabul, and at the 5% level for Kandahar and Kunduz. The magnitude of the price coefficient is the highest in eastern Jalalabad and the lowest in northern Kunduz.

The price coefficient is less significant in explaining wheat area planted in the north and west because wheat production in these regions is mainly determined by the amount of snowfall and rainfall in the region. Precipitation has its effects on wheat production in all regions, but the effect is more pronounced in the north and west regions where spring wheat is planted. We could not get access to rainfall data for Afghanistan to include that variable in our model. We could find some limited data that show the number of snowing days in Afghanistan and we included that variable in the model, but it was not significant in explaining area planted to wheat. We also tried the model with a time trend as an explanatory variable in the model. Not only was the trend insignificant, but also it reduced the significance of the price coefficient.

2.3 Seemingly Unrelated Regression

We also use the Seemingly Unrelated Regression (SUR) model to estimate supply of wheat with respect to prices. The SUR model is used to estimate a system of linear equations with errors that are correlated across equations. We expect that area planted and yields are correlated across regions in Afghanistan, thus the errors of equations estimating those functions for each region should be correlated. If error terms are correlated, we can gain a more efficient estimator using the SUR model (Zellner, 1962).

The results from the SUR model are reported in Table 2-4. Using the SUR model, the coefficient of price for all regions are more significant than the results from the OLS Model. With the exception of northern Kunduz region, all coefficients for price are significant at the 1% level. The price coefficient for Kunduz region is significant at the 5% level.

Table 2-4: SUR Estimates of Price Elasticity for Wheat Area Planted

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	HER	JAL	KAB	KAN	KDZ	KST	MAZ
β (log lagged	0.185***	0.552***	0.337***	0.166***	0.0790**	0.261***	0.307***
price)	(0.0682)	(0.0548)	(0.0251)	(0.0277)	(0.0377)	(0.0569)	(0.0605)
α (Constant)	4.960***	1.441***	3.086***	4.330***	5.867***	3.221***	4.993***
	(0.380)	(0.311)	(0.146)	(0.159)	(0.219)	(0.323)	(0.341)
N	10	10	10	10	10	10	10
R-squared	0.283	0.797	0.750	0.598	0.186	0.573	0.249

Standard errors in parentheses

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

As the SUR model produces better results than the OLS model, we generate parameters for the supply functions from the SUR model estimates. The price coefficient is significant for all regions in the SUR model, but it is not always significant using the OLS model. Also, the variance-covariance matrix of error terms that will be used in the simulation analysis is from the SUR model. The variance-covariance matrix of errors from the SUR model are presented in Table 2-5. The variance-covariance matrix of error terms is from a function with logarithmic specification, where area planted is measured in thousand hectares[6]. In most cases the correlation is positive across regions, except for eastern Jalalabad and Southern Kandahar which demonstrate negative correlation with some regions. Area planted are highly correlated across surplus regions. The correlation

[6] In the simulation model, we take the exponential of the error realization and add to the expected area in order to obtain the realized area planted in each iteration.

coefficient between Herat and Mazar is around 0.7, and between Herat and Kunduz is around 0.47.

Table 2-5: Variance-Covariance Matrix of Errors from the SUR Model

Regions	HER	JAL	KAB	KAN	KDZ	KST	MAZ
HER	0.01503	-0.00388	0.00536	0.00126	0.00489	0.00334	0.01245
JAL	-0.00388	0.01049	0.00360	0.00336	-0.00373	0.00388	0.00070
KAB	0.00536	0.00360	0.00654	0.00445	0.00259	0.00471	0.00715
KAN	0.00126	0.00336	0.00445	0.00532	0.00197	0.00537	-0.00004
KDZ	0.00489	-0.00373	0.00259	0.00197	0.00709	0.00056	0.00114
KST	0.00334	0.00388	0.00471	0.00537	0.00056	0.00852	0.00087
MAZ	0.01245	0.00070	0.00715	-0.00004	0.00114	0.00087	0.02052

2.4 Yield

In most cases yield data do not follow a clear time trend over the period 2002-2013, as seen in Figure 2-4. Yield is lower in northern and western regions as more wheat is produced on rainfed land in those regions. We also used lagged price and lagged yield as explanatory variables to estimate yield, but these variable are not significant in the estimated results either. Thus, the stochastic yield which is required for the simulation analysis is generated using the variance-covariance matrix of the yield data for the period 2002-2013.

The variance covariance matrix of the yield data is presented in Table 2-6. Yield data are measured in MT/hectare. Yield is also highly correlated across regions. Highest correlation are observed across surplus regions, as surplus regions have similar agronomical characteristics. The correlation coefficient of yield between Herat and

Mazar is about 0.73, and it is 0.70 between Herat and Kunduz. The correlation between surplus and deficit regions are positive but smaller in magnitude. The correlation coefficient between Herat and Jalalabad is 0.29, and it is 0.32 between Herat and Kabul.

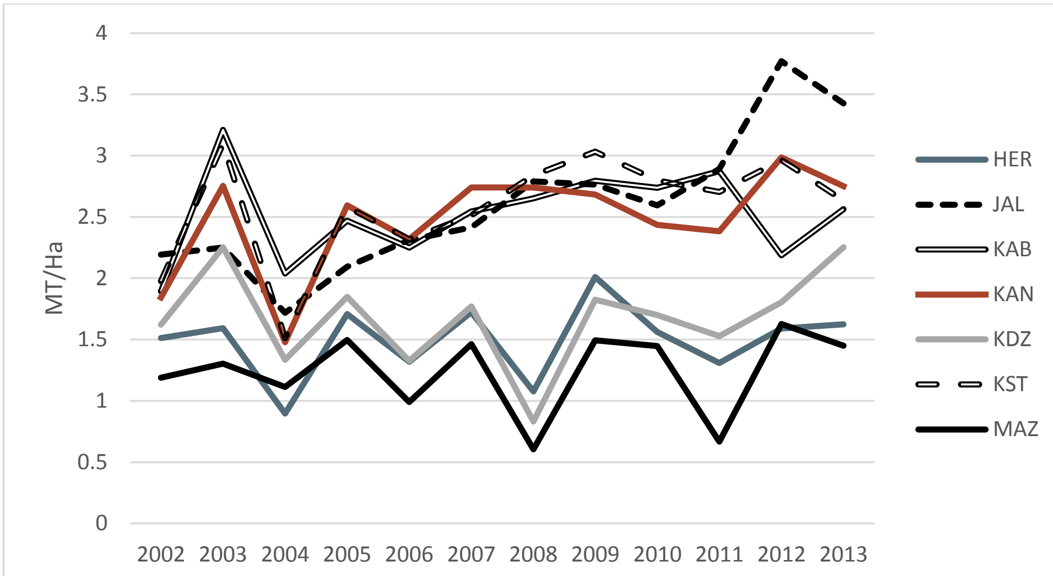

Figure 2-4: Wheat Yield across Regions in Afghanistan

Table 2-6: Variance-Covariance Matrix of Yield across Regions

Regions	HER	JAL	KAB	KAN	KDZ	KST	MAZ
HER	0.0835	0.0463	0.0330	0.0685	0.0772	0.0726	0.0676
JAL	0.0463	0.3034	0.0295	0.1548	0.0470	0.1455	0.0324
KAB	0.0330	0.0295	0.1296	0.0837	0.0457	0.1201	-0.0080
KAN	0.0685	0.1548	0.0837	0.1701	0.0567	0.1640	0.0408
KDZ	0.0772	0.0470	0.0457	0.0567	0.1433	0.0580	0.0891
KST	0.0726	0.1455	0.1201	0.1640	0.0580	0.1943	0.0278
MAZ	0.0676	0.0324	-0.0080	0.0408	0.0891	0.0278	0.1028

Units are in metric ton/hectare

2.5 Summary

In conclusion, wheat is an important crop for improving food security, agricultural income and employment in Afghanistan. Afghanistan appears to have comparative advantage in wheat production and this can be improved with increasing yield and more efficient production (World Bank, 2014). Although the time series data are short, our results show wheat planting areas are responsive to lagged wheat prices. The estimated price elasticity of supply indicates on average a one percent increase in wheat prices is associated with a 0.27 percent increase in the next year's wheat planting area. Price elasticities are larger in the eastern and central regions compared to others as irrigated land is limited in those regions. Thus, planting decisions are more responsive to prices. However, in the northern and western regions, where price elasticities are relatively lower, large rainfed areas for wheat production are available which are more responsive to precipitation than wheat prices.

Based on the current wheat policy the government is planning to reach self-sufficiency in wheat by 2020. Although domestic wheat production may increase by subsidizing inputs and managing post-harvest losses, imports are expected to persist in the foreseeable future. First, domestic wheat is not a perfect substitutes for imported wheat. Imported wheat, especially Kazakh wheat, has a higher quality than domestic wheat and it is preferred by most bakeries in commercial centers. Second, rural areas where domestic wheat is produced are not well integrated with commercial centers. An increase in domestic production may lead to low prices in rural surplus regions and an increase in on-farm wheat stocks.

An increase in domestic production may also lead to high variability in prices, mainly in the lower tail of price distribution. The evidence from 2009 high domestic production suggests that prices fall sharply in rural surplus regions with an increase in domestic production. Pursuing a self-sufficiency policy requires an aggressive stockholding policy to procure surplus wheat from rural surplus regions in order to support producer prices. Hence, pursuing a self-sufficiency policy may increase the costs of the stabilization programs.

CHAPTER 3. DEMAND FOR WHEAT AND FLOUR

Wheat is an important staple food in Afghanistan. Average wheat consumption is about 162 Kilograms (Kg) per capita per year, accounting for about 60 percent of caloric intake of the population (Chabot and Dorosh, 2007; Persaud, 2010). Chabot's estimates are based on NRVA 2003 household survey data from CSO[7]. However, per capita consumption for wheat appears to decline over time as income increases, and people start to shift to high-value protein diets. The same household data from NRVA 2007/8 shows per capita wheat consumption has declined to 155 Kg, and it is even lower based on the estimates from the NRVA 2011/12 data, at 146 Kg per capita per year.

The decline in per capita wheat consumption might be due to the increase in wheat prices. The real prices of wheat products have increased rapidly since 2003. The price of wheat flour was about $200 per metric ton in 2003, while it was about $700 and $500 in 2007 and 2012, respectively. Thus, there was a huge increase in flour prices since the NRVA survey was first conducted in 2003, with some variability. We will estimated the price elasticity of demand later in this chapter to assess the demand behavior with respect to prices.

The Afghan economy has experienced rapid growth since 2002. Nominal GDP grew at an annual rate of 17% over the period 2002-2009. GDP per capita grew at an annual rate of 13% over the same period (UN, 2010). The effects of an income increase on per capita wheat consumption can be either negative or positive, depending on whether wheat is a normal or inferior good. Formal estimates of demand elasticities for

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[7] NRVA stands for National Risk and Vulnerability Assessment. This household survey was conducted in 2003, 2007/08 and 2011/12. CSO stands for Central Statistic Organization of Afghanistan. The NRVA survey is a comprehensive nationwide survey conducted by CSO in Afghanistan.

wheat in Afghanistan are not available in the literature. In this section, I use the household survey data from NRVA 2011/2012 to estimate the demand for per capita wheat consumption in Afghanistan. The estimated elasticities will be used in the simulation model to generate parameters for the regional demand functions.

3.1 Data

The household survey data used here are from the National Risk and Vulnerability Assessment (NRVA) 2011/2012, conducted by the Afghanistan Central Statistics Organization (CSO). The survey was administered during the period between April 2011 and August 2012. The survey covered 20,828 households in 345 districts all over the country. The household sampling was drawn from a national household listing that contains every house in the country. The sample was selected following a stratified, multi-stage design (CSO, 2012).

There are three different components in the 2011/12 NRVA survey. A household questionnaire has 20 sections including consumption, income, expenditures, education, and demography. There are also a community questionnaire and a district market price questionnaire.

A key good feature about this survey is its stratification across time. The sample data drawn from each quarter represent the overall composition of the country. This should allow us to observe seasonality effects on prices and consumption of wheat in each region.

The effective sample size is 20,032 households; about 86 percent are rural and 14 percent reside in urban areas. We had to drop some households due to unavailability of prices in those districts. The average household size is about 7.6 members.

Monthly nominal per capita total consumption expenditure for Afghan households is AFN (Afghanistan's currency unit) 1,961 (about US$34). However, there is a huge difference in the per capita monthly expenditure across urban and rural areas; urban households spend 41 percent more than those living in rural areas. In Afghanistan, households spend on average about 66 percent of their total expenditure on food.

Households in rural areas and the nomadic Kuchi population spend even a higher share of their expenditure on food compared to urban households. Table 3-1 shows average monthly expenditure, share of expenditure on food, and expenditure share of important food items for households across rural, urban and Kuchi areas.

Table 3-1: Monthly per Capita Expenditure and Share of Expenditure on Food Items

	National	Urban	Rural	Kuchi
Average monthly expenditure (AFN)	1961	2800	1839	1515
Average monthly food expenditure (AFN)	1302	1564	1265	1154
Share of food expenditure (%)	66.39	55.86	68.79	76.17
Expenditure share of key food items (%)				
1. Grain	40.80	33.72	41.96	40.39
a. Wheat (share of grain)	63.84	55.17	65.19	65.36
b. Rice (share of grain)	23.43	29.14	22.59	20.79
2. Meat	12.27	15.43	11.75	12.53
3. Dairy Products	13.08	8.87	13.61	17.84
4. Fat & Oil	10.79	12.34	10.55	10.19
5. Vegetables	10.46	12.92	10.10	9.18
6. Fruits	6.70	10.20	6.26	4.01
7. Sugar	5.84	6.48	5.74	5.84

Source: NRVA (2011/12) data from CSO.

The Kuchi term refers to the 1.5 million nomadic people of Afghanistan who migrate semi-annually with their sheep, goats, and camels. The Kuchi population data have been included in the analysis so that our sample represents the entire population of Afghanistan. Normally the Kuchi population are assumed as part of the population living in rural areas.

Households spend a large portion of their food budget on wheat in Afghanistan. About 40 percent of the food budget is spent on grain, which is mostly (64%) wheat products. Dairy products and meat come next in the food budget, with shares of 13 and 12 percent, respectively.

3.2 Empirical Specification

To assess the impacts of price and income on per capita demand for wheat in Afghanistan, we estimate the demand for per capita wheat consumption in the country. We use the Ordinary Least Square Regression (OLS) model for estimating these elasticities. D'Souza and Jolliffe (2012), use a similar log-log model with 2007/08 data for estimating per capita wheat demand in Afghanistan. Our model is distinguished by including the price of substitutes, and income. The basic specification of our model is captured in equation 3.1:

$$\ln(x_h) = \beta_0 + \beta_1 \ln(pflour_{apq}) + \beta_2 \ln(p - rice_{apq}) + \beta_3 \ln(ppasta_{apq}) + \beta_4 \ln(y_h) + \alpha HH + \theta Area + \varepsilon_h \qquad 3.1$$

X_h is weekly per capita wheat consumption of wheat flour for household h. $pflour_{apq}$ is the price of flour averaged by area a (urban or rural), province p, and quarter q. Average prices are calculated for each area within each province for each season. This can help mitigating potential biases caused by measurement errors in the price data.

The variables p-rice and ppasta are the price of rice and price of pasta, respectively, included in the model as close substitutes to wheat flour. Pasta is made of durum wheat and imported mostly from Iran. Pasta consumption and imports have increased in Afghanistan recently. Per capita pasta consumption is about 2.5 kg annually. Afghanistan imports its pasta requirement mostly from Iran. Pastas imports from Iran were about 70 thousands metric tons in 2013.

The variable HH denotes household level characteristics like number of kids, household size, and whether the household owns agricultural land or not. Area is the dummy variables for rural and Kuchi populations included in the model. Y is the annual income of household h, and ε is the error term. All data are from NRVA 2011/2012.

The coefficients of interest in this model are the own-price elasticity and income elasticity of demand, β_1 and β_4, respectively. Our prior assumption is that per capita consumption of wheat declines as flour prices rise. Thus we expect a negative sign for β_1. The effects of income on per capita flour consumption depend on whether flour is a normal or inferior good. If it is normal, an increase in income implies a higher consumption per capita of flour, but the opposite is true if flour is an inferior good.

The evidence from the overall data suggests that flour is not a normal good. Per capita consumption of wheat has decreased over the 2003-2012 period, while income has increased rapidly over the same period. Moreover, people with high income consume less flour than those with low income. Per capita flour consumption is lower in urban areas where income is high than in rural areas with low income.

Rice and pasta are considered to be close substitutes for bread. It is expected that an increase in the price of rice or pasta is associated with an increase in per capita consumption of flour. Thus, we expect a positive sign for the cross-price elasticities.

Weekly per capita consumption is computed as consumption of flour in Kg divided by effective number of household members. The effective number of household members are all household members who were resident in the household during the last seven days of the survey time, including guests and children. Children under five years old either do not consume bread or consume much less than adults. Thus, the actual per capita consumption of flour is higher for a household with a higher number of children than what has been estimated. To take care of this, the number of kids (age under five) are included in the model. The prior belief is that per capita consumption is lower in the households with higher numbers of kids. Ag variable is a dummy variable showing whether a household is agricultural or not. Most agricultural households produce wheat in Afghanistan. This variable is used as a proxy to see the difference, if any, in per capita consumption of wheat across wheat producers and wheat buyers.

Table 3-2 shows the summary statistics of the data used for this demand analysis. Consumption per capita is measured in Kilograms consumed of flour per capita in a week. In the consumption section of the questionnaire, some households reported the amount of flour in Kg consumed, and some reported loaves of bread consumed during the last seven days. Number of bread have been multiplied by 0.2 kg to convert to kg flour consumption. Each loaf of bread is about 0.2 kg in Afghanistan. All prices are nominal in AFN per kg of each commodity. The prices are not deflated, given the short one year period of time. Income data are measured as annual AFN per household.

Table 3-2: Summary Statistics on Prices, Income and Consumption

Variable	Obs	Mean	Std. Dev.	Min	Max
Consumption Per capita	20427	2.80	1.29	0.05	14.00
Flour Price	20589	25.34	9.87	14.64	95.00
Rice Price	20809	42.94	12.78	20.00	125.00
Pasta Price	18610	15.54	15.00	98.33	54.98
Income	20722	104344	94216	888	995000

3.3 Demand Estimation Results

Table 3-3 shows the estimated coefficients and standard errors from the OLS regression. The results in column one are from the overall national data that include 20,032 households. Column two results are only based on the rural household observations, and column three estimates are from the urban household data.

Using the national data, all of the coefficients are significant and have the expected sign. The sign of flour price is negative implying an increase in the price of wheat reduces demand for wheat products, in line with the basic economic law of demand. The same is true when using only rural data. The own-price elasticity is negative and significant.

In urban areas, we observe just the opposite, a positive sign for own-price elasticity for flour. I think this is due to issues in consumption data estimated in urban areas. Most often population in urban areas are purchasing bread from the commercial bakeries, instead of purchasing flour and making bread at home. Flour consumption for urban households is mostly reported as loaves of bread. The average weight for a loaf of bread is about 200 grams, with a price of AFN 10 per loaf. When flour prices change, mostly the price of bread does not change. Instead the size of the loaf of bread changes. When converting loaves of bread into Kg flour, we consider the average net weight, 200g for each loaf. Therefore, most households in urban areas purchasing bread do not respond to changes in the price of flour, in terms of number of bread. The actual per capita consumption of flour changes due to a change in the size of bread. But we do not have rich enough data to keep track of changes in the size of bread produced in urban areas in Afghanistan.

Table 3-3: Estimated Demand Coefficients from the OLS Results

VARIABLES	(1) National	(2) Rural	(3) Urban
Flour price	-0.202***	-0.258***	0.335***
	(0.0201)	(0.0211)	(0.0754)
Rice price	0.0935***	0.116***	0.0893
	(0.0178)	(0.0187)	(0.0655)
Pasta price	0.194***	0.188***	0.0891**
	(0.0146)	(0.0164)	(0.0412)
income	-0.0420***	-0.0429***	-0.0283*
	(0.00510)	(0.00549)	(0.0149)
Number of kids	-0.0159***	-0.0138***	-0.0203**
	(0.00335)	(0.00358)	(0.0103)
Household size	-0.0198***	-0.0231***	-0.00271
	(0.00128)	(0.00139)	(0.00365)
Agriculture dummy	0.0641***	0.0627***	0.0771***
	(0.00803)	(0.00848)	(0.0260)
Rural dummy	0.148***		
	(0.0115)		
Kuchi dummy	0.151***		
	(0.0260)		
Constant	0.936***	1.233***	-0.618*
	(0.103)	(0.113)	(0.335)
Observations	20,032	16,820	2,756
R-squared	0.063	0.057	0.022

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

The coefficients for the price of close substitutes to flour (rice & pasta) have the expected signs. An increase in the price of rice and pasta raises the per capita consumption for wheat as people try to switch from rice and pasta to flour. The coefficients are significant at the 1- percent significance level when using the overall national data, and with rural data. However, the coefficient for rice price is not significant, and for pasta price is significant at the 5-percent level, when using the data for urban households.

The coefficient on income is significant in all three columns, with a negative sign. The negative sign implies that wheat flour is an inferior good in Afghanistan. As income rises people starts to consume more high-value protein diets and less grain. This is true in Afghanistan as well. Per capita wheat consumption has decreased over time, from 162 kg per capita per year in 2004 to 146 kg in 2012. But income per capita has increased rapidly over this period. The spatial differences in income and per capita flour consumption also suggest that populations with high income consume less flour than those with low income. Per capita consumption for flour is 153 kg in rural areas where income is relatively low versus 127 kg in urban areas with relatively high income.

Average per capita consumption for households with a higher number of children are less than others. This make sense, as children under five years old either do not consume bread or consume less than adults. Thus, the coefficient sign is negative as expected, and it is significant at 1-percent significance level using the national and rural data, and at 5-percent level with the urban data. The coefficient of the household size is significant with a negative sign implying per capita flour consumption is lower for the households with large size.

The dummy variable for agriculture households is significant with a positive sign with overall national, rural and urban data. This implies per capita consumption of wheat is higher for the agricultural households which are most likely wheat producers. The data are not rich enough to distinguish wheat producers from wheat buyers. The agriculture dummy has been used as a proxy to estimate the differences across wheat producers versus wheat buyers.

Per capita consumption of wheat is expected to be higher in rural and Kuchi areas. Rural and Kuchi population do not have access to a diverse diet or cannot afford high-value protein diets as urban people. Thus, a higher portion of their food budget is spent on wheat compared to urban populations. Our OLS results are consistent with the theory that per capita consumption of flour is higher in rural and Kuchi areas than in urban areas. The coefficient sign for both rural and Kuchi dummies are positive and significant.

In the above results the price data were averaged over season for each province across rural and urban areas. In some areas price data are not available for all 12 months of the year. Thus, we took the quarterly average to avoid dropping too many observations, and to mitigate potential biases caused by measurement errors in the price data. We thought it would be interesting to see the modeling results with monthly average price data. So, the price data are averaged over month, and the observations with missing price data in given months are dropped.

The ordinary least square results based on the monthly average price data are presented in Table 3-4. The results are consistent with those using the quarterly average price. The own price elasticity of demand for flour is still negative and significant with the national and rural data. The coefficients on prices of close substitute to flour (rice & pasta) are positive and significant, the same as with the quarterly price data. The coefficient on income is negative and significant. The coefficients on agriculture, rural and Kuchi dummies are positive and significant consistent with the results when using quarterly price data.

The number of observation used with the monthly average data are less than what was used for the quarterly average data. Some observation were dropped due to missing monthly price data. Therefore, the modeling results when prices are averaged over season include more observations, and will be used for further analysis when setting up supply and use balance in later chapters and for generating parameters for the demand equations.

Table 3-4: Estimated Demand Coefficients from the OLS Results using Monthly Data

VARIABLES	(1) National	(2) Rural	(3) Urban
Flour price	-0.218***	-0.252***	0.0920
	(0.0186)	(0.0196)	(0.0653)
Rice price	0.127***	0.136***	0.199***
	(0.0168)	(0.0180)	(0.0549)
Pasta price	0.156***	0.160***	0.0724**
	(0.0132)	(0.0147)	(0.0350)
income	-0.0380***	-0.0374***	-0.0258*
	(0.00555)	(0.00604)	(0.0156)
Number of kids	-0.0143***	-0.0132***	-0.0141
	(0.00362)	(0.00389)	(0.0108)
Household size	-0.0193***	-0.0223***	-0.00557
	(0.00138)	(0.00151)	(0.00375)
Agriculture dummy	0.0545***	0.0524***	0.0837***
	(0.00869)	(0.00927)	(0.0270)
Rural dummy	0.142***		
	(0.0123)		
Kuchi dummy	0.151***		
	(0.0272)		
Constant	0.961***	1.178***	-0.206
	(0.100)	(0.108)	(0.326)
Observations	17,230	14,412	2,392
R-squared	0.060	0.055	0.017

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

3.4 Summary

In conclusion, the own price elasticity of demand for flour is between -0.2 and -0.25 in Afghanistan. The positive coefficient on the flour price with urban data is not informative mainly due to measurement error in per capita consumption of flour in urban areas. Per capita consumption of flour in urban areas is measured as number of loaves of bread per household. While the size of bread changes with a change in the price of flour, the survey data does not capture the change in the size of bread.

The income elasticity of demand for flour is negative (-0.038) based on the modeling results, suggesting wheat flour is an inferior good. The descriptive statistics of overall data also show per capita wheat consumption is higher in rural areas where income is lower than urban areas. Time series data also suggest per capita wheat consumption decreases over time in Afghanistan as income increases.

CHAPTER 4. PRICE TRANSMISSION ANALYSIS

The price shocks in international grain market during the 2007-2008 food crisis had a major impact on food security in Afghanistan (D'Souza and Jolliffe, 2012). The increase in wheat prices in Afghanistan was greater than the price increases experienced in the world and regional grain markets. Wheat prices in Afghanistan reached to $700/MT in May 2008, up from $250/MT in May 2007, a 175% increase within one year (Halimi, 2011). The greater increase in wheat prices in Afghanistan in 2008 implies that domestic wheat prices do not adjust quickly to the price changes in the regional or world grain markets.

Variability in wheat prices has increased in Afghanistan since 2008 as a result of Pakistani export restriction policy. This is mainly because wheat markets in the Central Asian region are not as stable as in Pakistan. Thus, some of the variability in the Afghan domestic market is now imported from the Central Asian markets. Figure 4-1 show monthly average wheat prices for Afghanistan, Pakistan, Kazakhstan, and the US Gulf.

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

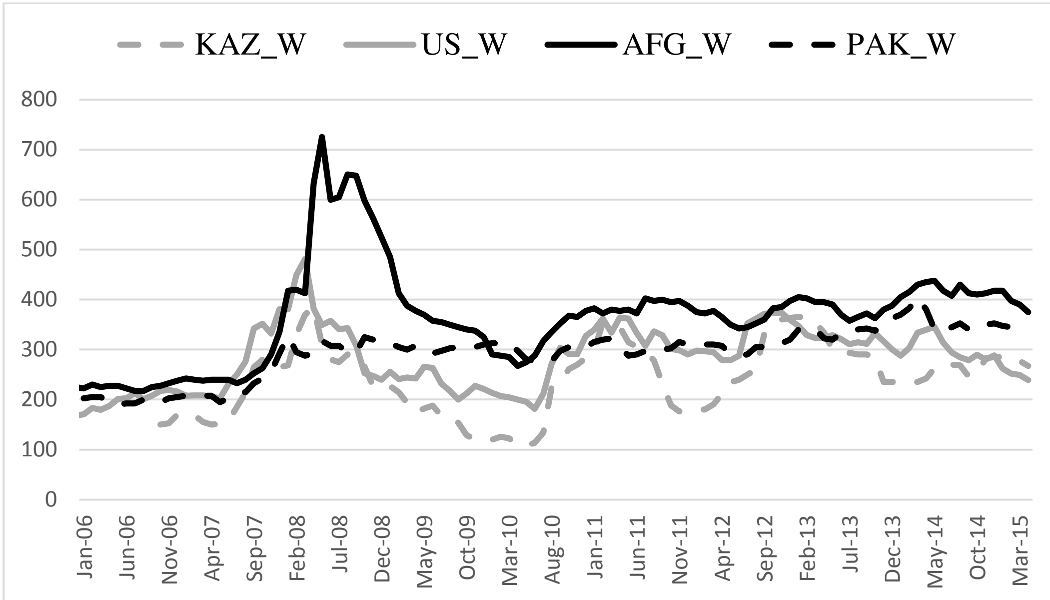

Figure 4-1: Wheat Prices in Afghanistan, Kazakhstan, Pakistan and the US.

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

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

4.1 Characteristics of the Afghan Wheat Market

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

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

Market integration across rural and urban areas in Afghanistan is an important issue that policy makers should consider while thinking about policies to stabilize wheat and flour markets in Afghanistan. Wheat markets across rural and urban areas do not appear to be as well integrated (Halimi, 2011). Figure 4-2 shows the price data across Daykundi and commercial centers. Daykundi is a wheat deficit rural market where we observe that wheat prices are much higher than the prices in commercial centers. The big difference in price series data of Daykundi versus commercial centers suggests there are high transportation and transaction costs associated with moving wheat and flour between rural and urban areas in Afghanistan.

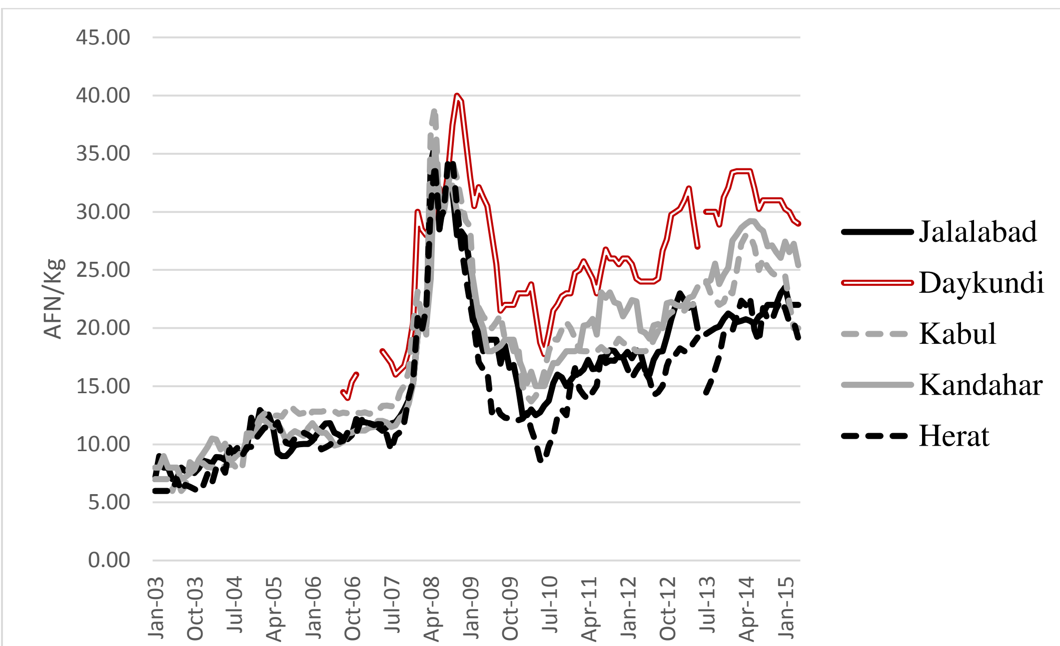

Figure 4-2: Price Data for Wheat across Commercial Centers and in Daykundi

In this chapter we assess the relationships between price data in each of the five commercial centers in Afghanistan along with price sets for Pakistan and Kazakhstan. The five commercial centers are Herat, Jalalabad, Kabul, Kandahar and Mazar. Figure 4-3 shows the location of these commercial centers and the selected rural markets used in our study.

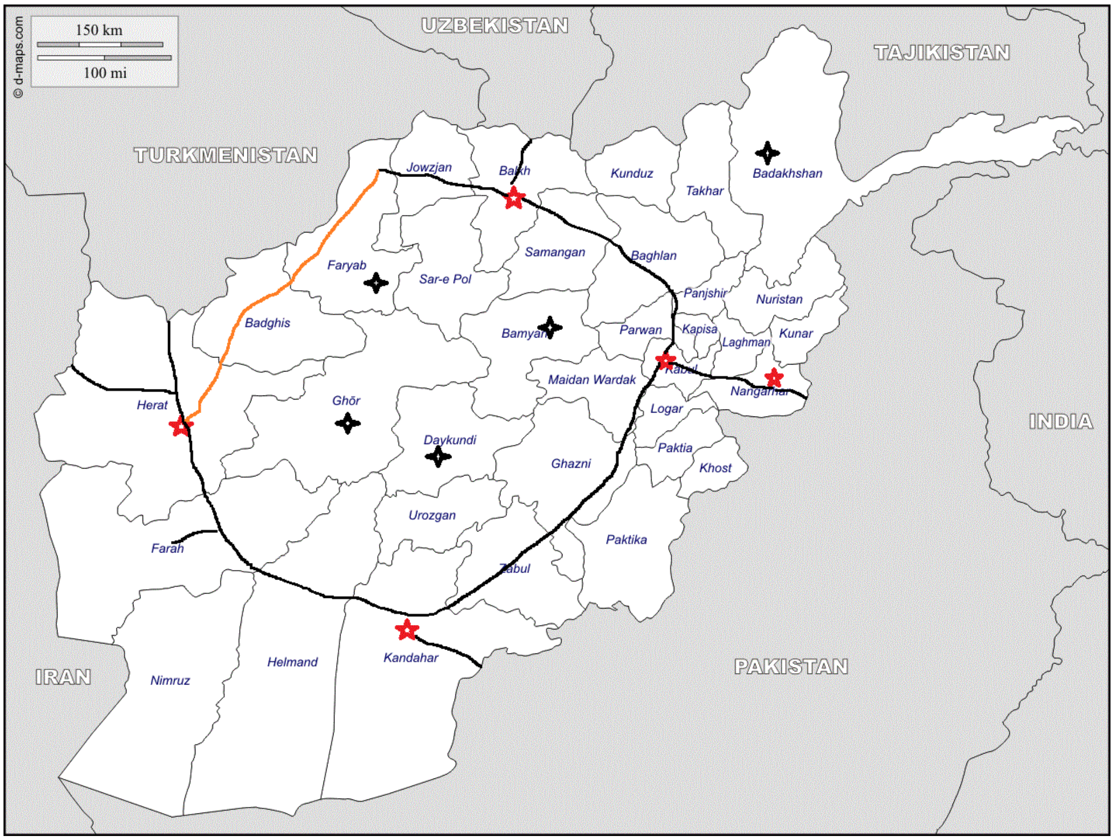

Figure 4-3: Rural Markets and Commercial Centers in Afghanistan

To examine the price transmission of wheat between rural and urban areas, we assess the relationship between price series data of rural areas with their closest commercial center. The selected five rural markets which are partially segmented from the commercial centers and the world market are: Bamyan, Badakhshan, Faryab, Ghor, and Daykundi. The rural areas are selected based on the proximity to commercial centers and the availability of monthly price data for the given rural markets from WFP (2015).

Moreover, Daykundi and Bamyan are in wheat deficit areas, while the others are wheat surplus markets in a normal production year. Bamyan is close to the central Kabul, Badakhshan is at the north-east close to Mazar, Faryab is at the north-west close to Herat and Mazar, Ghor is close to Herat at the west central, and Daykundi is close to Kandahar in the south. The local markets may not be equally segmented from commercial centers, given different distance and road conditions between these local markets and their closest commercial centers. Considering the distance to the closest commercial center, Badakhshan appears to be less integrated with its commercial center than other rural markets.

4.2 Price Transmission Model

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

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

The VECM model can be used if each variable is nonstationary but integrated to degree 1, written as I (1). This implies that the variable is nonstationary in levels, but its first difference is stationary. Also, VECM requires that variables are cointegrated. This means that a linear combination of the variables is stationary. Hence, the residual from regressing one nonstationary variable on another needs to be stationary (Minot, 2011).

Thus, cointegration analyses are done with all price series using the level model. We will use the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests to examine the stationarity of price series data and their corresponding linear combination.

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

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

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

$$p_t^d = \mu + \beta p_t^w + \varepsilon_t \qquad 4.1$$

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

Once the long-run elasticity of price transmission (β) is estimated from equation 4.2, we use the residual from the levels model to estimate the VECM. The simplified form of VECM is presented in equation 4.2, following Minot (2011);

$$\Delta p_t^d = \alpha + \theta(p_{t-1}^d - \hat{\beta} p_{t-1}^w) + \delta \Delta p_t^w + \rho \Delta p_{t-1}^d + u_t \qquad 4.2$$

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

The economic interpretation of the coefficients in equation 4.2 are as follows: The coefficient (β) is estimated in the level model in logarithmic form as in equation (1), and is the long-run elasticity of price transmission. The expected value of (β) is between zero and one. If equal to unity, (β) implies that prices are cointegrated, and all proportional changes in the international price will be transmitted to the domestic price in the long-run. The coefficient on the error correction term (θ) is called the speed of adjustment. The expected value is between zero and negative one. The larger (θ) is in absolute value, the more quickly the domestic price adjusts to changes in the world price. The coefficient on the first-difference of the world price (δ) is the short-run elasticity of price transmission. It is interpreted as the percentage adjustment of domestic price to a change in the world price in the current period. Its expected value is less than the long-run elasticity of price transmission (β), and greater than zero. The last coefficient in equation 4.2 is (ρ). This is the autoregressive term, interpreted as the changes in the domestic price due to changes in the domestic price in the previous period.

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

4.3 Data

The data for this study are monthly price series measured in US$ per metric ton for Afghanistan, Pakistan and the Central Asian region. The domestic monthly price data for four commercial centers (Kabul, Kandahar, Jalalabad and Herat) are available from FAO

GIEWS for the period January 2000 to April 2015 (FAO, 2015). The monthly price series data for commercial center Mazar and the five rural markets are obtained from WFP (2015).

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

4.4 Price Transmission Results

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

All price series data are nonstationary in levels, but their first differences are all stationary, based on the Augmented Dicky-Fuller and Phillips-Perron tests. Table A2 in the appendix shows the results of stationarity tests on the price series data and their first differences. The cointegration test results on the residuals of a regression of corresponding price series data are presented together with corresponding regression results using equations 3 and 4. The results from the ADF (Augmented Dicky-Fuller) and PP (Phillips-Perron) tests are mostly consistent. However, in some cases, especially with a small number of observation, the ADF test shows cointegration between price series, but PP does not. The PP test is based on asymptotic theory (Phillips and Perron, 1988), and thus it may not be as powerful with small datasets.

4.4.1 Domestic and Regional Prices Related to US Wheat Prices

As discussed earlier, we are interested in which of the major wheat supplier countries to Afghanistan, Pakistan or Kazakhstan, is better integrated with the world wheat market. We also examine the degree of price transmission from the world market to commercial centers in Afghanistan. We start presenting our modeling results with the analysis on market integration of Pakistan, Kazakhstan and Afghanistan with the world wheat market. We use US prices as the world price in this analysis. The modeling results show that Kazakh and Afghanistan wheat prices have a stronger linkage than Pakistani prices with the US gulf prices. Modeling results assessing Pakistan, Afghanistan and Kazakhstan price linkages with the world market are presented in Table 4-1. The ADF and PP cointegration test results suggests that Pakistan wheat prices do not follow world wheat prices in the long run, but Afghan and Kazakh wheat prices are cointegrated with the US prices.

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

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

Table 4-1: Pakistan, Kazakhstan and Afghanistan Wheat Prices Related to US Gulf Prices

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

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

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

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

4.4.2 Price Transmission from Regional to Domestic Markets

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

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

Based on the results from the levels model, the Afghan-Kazakh price linkage for wheat is not as strong as expected. Modeling results for the Kazakh and Afghan price relationship are presented in Table 4-2. The long-run elasticity of price transmission ranges between 0.35 and 0.55, implying less than 50% of variability in the Kazakh wheat prices are eventually transmitted to Afghanistan's domestic markets. The values for R-squared are also small, ranging between 0.24 and 0.47, suggesting less than 50% of variation in domestic prices are explained by changes in Kazakh prices. The ADF test results indicates domestic prices in all commercial centers follow Kazakh prices in the long run. However, the results from the PP test are less significant than those from the ADF, and do not show strong cointegration between the two countries.

Table 4-2: Domestic Prices of Wheat Related to Kazakhstan's Wheat Prices

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

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

Note: Dependent variable is the domestic wheat price in each commercial center, and the independent variable is the Kazakh wheat price. The long-run adjustment coefficient (β) and R-squared (Level) are estimated using the level model, as in equation 4.1. The coefficients for short-run adjustment (δ), speed of adjustment (θ), autoregressive term (ρ), and R-squared (VECM) are estimated from the VECM model. ADF is the Augmented-Dickey Fuller test and PP is the Phillips-Perron test

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

The level regression results show a stronger linkage between Afghanistan and Kyrgyzstan flour prices, compared to the Afghan-Kazakh wheat price linkage. The results examining the relationship between Kyrgyzstan's flour prices and domestic prices of flour in four commercial centers are presented in Table 4-3. All coefficients are statistically significant at a 1% level, and close to unity. Kabul has the closest coefficient to one (0.99), implying all of the variation in Kyrgyzstan flour prices is eventually transmitted to flour prices in Kabul. R-squared values are also fairly high, all greater than 0.72. Mazar was dropped from the table since its price data for flour are not available. The ADF t-statistics are significant at the 1% level for all commercial centers, ranging between -3.8 and -4.2. The results from the PP test are consistent here with the ADF test.

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

Table 4-3: Domestic Prices of Flour Related to Kyrgyzstan's Flour Prices

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

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

Note: Dependent variable is the domestic flour price in each commercial center, and the independent variable is the Kyrgyzstan flour price.The long-run adjustment coefficient (β) and R-squared (Level) are estimated using the level model, as in equation 4.1. The coefficients for short-run adjustment (δ), speed of adjustment (θ), autoregressive term (ρ), and R-squared (VECM) are estimated from the VECM model. ADF is the Augmented-Dickey Fuller test and PP is the Phillips-Perron test.

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

In terms of R-squared values, the price linkage for flour is stronger than for wheat between Afghanistan and Pakistan. Using flour prices, the R-squared values ranges between 0.67 and 0.73, implying about 70% of variability in domestic prices of flour are explained by changes in Pakistani prices. But for wheat price data between Afghanistan and Pakistan the R-squared values are smaller, ranging between 0.33 and 0.76. Most of the imports from Pakistan are in terms of wheat flour, rather than wheat grain.

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

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

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

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

Note: Dependent variable is the domestic wheat price in each commercial center, and the independent variable is the Pakistani wheat price. The long-run adjustment coefficient (β) and R-squared (Level) are estimated using the level model, as in equation 4.1. The coefficients for short-run adjustment (δ), speed of adjustment (θ), autoregressive term (ρ), and R-squared (VECM) are estimated from the VECM model. ADF is the Augmented-Dickey Fuller test and PP is the Phillips-Perron test

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

Table 4-5: Domestic Prices of Flour Related to Pakistan's Flour Prices

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

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

Note: Dependent variable is the domestic flour price in each commercial center, and the independent variable is Pakistani flour price. The long-run adjustment coefficient (β) and R-squared (Level) are estimated using the level model, as in equation 4.1. The coefficients for short-run adjustment (δ), speed of adjustment (θ), autoregressive term (ρ), and R-squared (VECM) are estimated from the VECM model. ADF is the Augmented-Dickey Fuller test and PP is the Phillips-Perron test.

Based on the modeling results, some variability in prices both in Pakistan and the Central Asian region are eventually transmitted to Afghanistan domestic markets. The linkages of Afghan flour prices are stronger than wheat prices with both Pakistan and the

Central Asian region. Results are consistent with our expectation, as most wheat imports to Afghanistan are conducted in the form of wheat flour rather than wheat grain (Persaud, 2013).

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

4.4.3 Structural Changes and Pakistani Policy Reform

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

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

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

Our hypothesis is that the price linkage between Pakistan and Afghanistan is stronger in the pre-reform period than in the post-reform period. We expect that the Afghanistan wheat market has become more integrated with the Central Asian market after the 2007-08 food crisis. Table 4-6 presents the modeling results for the pre-reform versus post-reform period flour price linkages between Afghanistan and Pakistan, and Table 4-7 for Afghanistan and the Central Asian region.

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

Table 4-6: Pre-Reform versus Post-Reform Flour Price Linkage with Pakistan

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

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

Note: We do not estimate VECM for Pakistan's post-reform data, as they are not cointegrated with Afghan prices in the post-reform period. See Table 4-5 for comparison with overall data results and variable definitions.

Table 4-7: Pre-Reform versus Post-Reform Flour Price Linkage with Kyrgyzstan

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

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

Note: We do not estimate VECM for Kyrgyzstan’s pre-reform data, as they are not cointegrated with Afghan prices in the pre-reform period. See Table 4-3 for comparison with overall data results, and variable definition.

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

We use VECM with the pre-reform period data of Pakistan and compare with the results from the overall data presented in Table 4-5. Although the number of observation are considerably smaller in the pre-reform period, compared to overall data, the results are informative to some extent. With the sub-period data, the speed of adjustment coefficient is larger compared to the results using overall data for all commercial centers. However the coefficient using Kabul and Jalalabad prices are less significant in the pre-reform period compared to the results with overall data. This can be due to the small number of observations in the pre-reform period. Also, the results in the pre-reform period show there is not instant price transmission from Pakistan to Afghanistan domestic markets. However, the short-run adjustment coefficient is significant using overall data. The 4-month price adjustment is higher for the pre-reform period than for the overall period in all commercial centers except Kabul.

Regression analysis from the levels model reveals that the price linkage between Afghanistan and Kyrgyzstan is stronger in the post-reform period than in the pre-reform period, as expected. The modeling results for both periods are presented in Table 8. The long-run elasticity of price transmission coefficient is significantly larger for all commercial centers in the post-reform period compared to the period before 2008. The larger coefficient with the post-reform period data implies a larger portion of the variability in the Kyrgyzstan prices is transmitted to prices in Afghanistan compared to the pre-reform period. The ADF test results are consistent with our expectation that

Afghanistan has become more integrated with the central Asian region after 2008. The t-statistics from the ADF test are highly significant for post-reform data, while none of them are significant with the pre-reform data. The results from the PP test are mostly consistent with the ADF test results.

The VECM results for Kyrgyzstan flour in the post-reform period are also presented in Table 4-7. The speed of adjustment coefficients for all commercial centers are larger in the post-reformed period compared to the overall period for Kyrgyzstan. The larger coefficient of (θ) in the post-reform period, compared to the overall period, suggests price signals in Central Asian region are transmitted to Afghan domestic markets faster after 2008 than in the pre-reform period. The 4-month price adjustment ranges between 75 in Kandahar and 96 percent, in Herat for the post-reform period. But the 4-month adjustment is less than 60 percent with the overall data. Although price series data are shorter here, R-squared values are larger with the post-reform period data, compared to the overall series. The short-run adjustment coefficient (δ) is statistically significant with Herat and Kabul prices, suggesting price variability in Central Asian region is quickly transmitted to Herat and Kabul. The short-run adjustment coefficient is not significant with any commercial centers with the overall data. Using the post-reform data the results show Herat, followed by Kabul, is more integrated with the Central Asian markets. This make sense as Herat and Kabul are closer than other commercial centers to the Central Asian region.

4.4.4 Wheat Price Relationships between Rural and Urban Markets

We use the levels model in logarithmic form and the VECM to examine price transmission across rural and urban centers, as well. Price data for rural markets are available only for wheat. The rural-urban price linkages examined are: Baymyan-Kabul, Badakhshan-Mazar, Ghor-Herat, Faryab-Mazar, and Daykundi-Kandahar. See Figure 4-3 for a map of the rural markets and commercial centers used in our model. Table 4-8 presents the modeling results for rural-urban price linkages.

Table 4-8: Rural Wheat Prices Related to Urban Wheat Prices

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

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

Note: Dependent variable is the wheat price in rural markets, and the independent variable is the wheat prices in the closest commercial center to the rural market. The long-run adjustment coefficient (β) and R-squared (Level) are estimated using the level model, as in equation (1). The coefficients for short-run adjustment (δ), speed of adjustment (θ), autoregressive term (ρ), and R-squared (VECM) are estimated from the VECM model. ADF is the Augmented-Dickey Fuller test and PP is the Phillips-Perron test.

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

The cointegration test shows prices in rural markets are moving together in the long-run, with the prices in the closest commercial centers, except for Ghor. We use VECM to examine price relationships across rural and urban areas for the rural markets with statistically significant ADF t-statistics. The speed of adjustment coefficient (θ) is statistically significant at 1% for Badakhshan, Faryab and Daykundi, and it is significant at the 5% level with Bamyan. The price series for Bamyan and Ghor are shorter than for the other three rural markets. The short-run adjustment coefficient is significant for Badakhshan, Faryab and Daykundi, at a 1% level, implying a portion of the price shocks from commercial centers is transferred to these rural markets in the current period. The autoregressive term is significant only for Daykundi and Faryab price series. The 4-month price adjustment ranges between 72% in Badakhshan and 90% in Faryab. Although it is difficult to determine which rural market is more integrated to its closest commercial center as the number of observations are not the same for all rural markets, Faryab and Daykundi appear to be more integrated than other rural markets with their closest commercial centers. The results are consistent with our expectations when considering the geographical locations of the rural markets, poor transportation infrastructure and distance from the commercial centers, (see Figure 4-3). Badakhshan has the longest distance to its commercial center, (Mazar) and its price adjustment to changes in price in Mazar is the slowest. Ghor and Bamyan appear to have the shortest routes to their commercial centers, but the number of observations for these markets are substantially less than for other rural markets.

4.4.5 Wheat and Flour Price Linkages across Commercial Centers

Wheat and flour prices appear to move together across commercial centers and to adjust quickly. We examine Kabul wheat and flour prices versus other commercial centers using both cointegration models and VECM. The results of the VECM and the levels models for flour prices are presented in Table 4-9. Modeling results show that the long-run adjustment, short-run adjustment and the speed of adjustment coefficients are statistically significant at the 1% level for all commercial centers. The ADF and PP tests results also show strong cointegration between Kabul prices and price in all other commercial centers for both wheat and flour.

Table 4-9: Kabul Flour Prices Related to Other Commercial Centers

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

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

Note: Dependent variable is the domestic flour price in each commercial center, and the independent variable is the flour price in Kabul.
The long-run adjustment coefficient (β) and R-squared (Level) are estimated using the level model, as in equation 4.1. The coefficients for short-run adjustment (δ), speed of adjustment (θ), autoregressive term (ρ), and R-squared (VECM) are estimated from the VECM model. ADF is the Augmented-Dickey Fuller test and PP is the Phillips-Perron test.

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

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

Using wheat prices, the results are similar to the flour prices. The results show strong linkages between Kabul and all other commercial centers. With wheat prices, Mazar is added to our analysis, since its prices for wheat are available. It is interesting to notice that Kabul appears to be more integrated with the eastern and southern markets than with the northern market. The results of level regression and VECM for wheat prices are presented in Table 4-10.

Table 4-10: Kabul Wheat Prices Related to Other Commercial Centers

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

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

Note: Dependent variable is wheat price in each commercial center, and the independent variable is the wheat price in Kabul.The long-run adjustment coefficient (β) and R-squared (Level) are estimated using the level model, as in equation 4.1. The coefficients for short-run adjustment (δ), speed of adjustment (θ), autoregressive term (ρ), and R-squared (VECM) are estimated from the VECM model. ADF is the Augmented-Dickey Fuller test and PP is the Phillips-Perron test.

4.5 Summary

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

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

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

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

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

CHAPTER 5. THE TRADER AND MILLER SURVEY

5.1 Survey Objectives

Developing the simulation model presented in Chapter 6 required some primary data and information about the wheat market in Afghanistan. The transportation cost data, wheat flows between regions in the country, milling capacity, and the share of Kazakh and Pakistani wheat and flour in domestic market were required for the model and they were not readily available.

The primary goal of the trader and miller survey was to get the necessary data for the model and get a more in-depth understanding of how markets operate in commercial centers in Afghanistan. Topics covered are:

- Origins and flows of imports for wheat and flour
- Share of Pakistan and Kazakhstan in the Afghan wheat market
- Quality differences across Afghan, Pakistani and Kazakh wheat and flour
- Tariffs and transportation costs for wheat and flour imports
- Milling capacity in each commercial center
- Milling costs
- Constraints and challenges for the milling industry in Afghanistan

This survey was conducted in the summer and fall of 2014 in Kabul, Herat, Mazar, Kandahar and Jalalabad. The survey took place right after the harvest season in Afghanistan. Domestic production is reported to have been above average in that year (U.S. Department of Agriculture, 2015). A total of 46 traders and 14 millers were surveyed in the five commercial centers.

5.2 Findings from the Trader Survey

Based on the trader survey, most urban populations are supplied by imported flour. Domestic wheat and flour is rarely seen in the Kabul market and other commercial centers the even though the survey was conducted right after the wheat harvest season in Afghanistan.

The flow of wheat and flour imports are consistent and happening all through the year, with a slight decline during the harvest time in Afghanistan. Based on the survey, most traders import flour weekly from Pakistan and bi-weekly or monthly from Kazakhstan, as demand is realized in Afghanistan. When asked which season they import the most, most traders said it is the same all through the year, with a slight decrease in imports during the harvest time in Afghanistan. Traders in Afghanistan do not keep stocks of wheat and flour in the country for a long time. Most of the traders reported wheat and flour is sold in advance to wholesalers and millers, and then it is shipped to Afghanistan.

Based on the information from the survey, the share of Pakistan versus Kazakhstan in the Afghan flour and wheat market changes across seasons. Wheat is harvested earlier in Pakistan compared to Kazakhstan. The wheat harvest season starts in April in Pakistan, but it is not harvested until August in Kazakhstan. The share of Pakistani flour is higher in the Afghan market during the period April-August in a normal year. With the beginning of August, when the harvest season starts in Kazakhstan, the price of Kazakh wheat falls normally and its share increases in the Afghan Market.

Most of the wheat imports from Pakistan are in wheat flour. The imports from Kazakhstan used to be more in terms of grain in previous years, but it was being imported more in flour in 2014. Findings from the survey show that imports of wheat flour have increased from Kazakhstan and most of the imports are in wheat flour from Kazakhstan. All traders interviewed in Kabul and Herat imported wheat flour now. Some of them used to import wheat grain from Kazakhstan in previous years but they prefer to import wheat flour now. Wheat flour appears to be more profitable than wheat grain, and there is a wide range of customers for wheat flour in Afghanistan: commercial bakeries, households, and other traders. Wheat grain is sold only to millers. Millers interviewed in

Kabul and Herat said they purchase Kazakh wheat directly from Kazakhstan rather than purchasing from other traders in Afghanistan. Thus, imports of wheat grain from Kazakhstan are carried out mostly by millers in Afghanistan. However, millers in Mazar said they pay trading companies to import wheat for them from Kazakhstan and Uzbekistan.

While traders appear to capture higher profits from flour imports than wheat imports, flour imports are more likely to make Afghanistan dependent on imports and so vulnerable to Pakistan policy changes. Flour cannot be kept in storage for a long periods of time like wheat. So, this makes Afghanistan more dependent on frequent imports. Flour imports create major problems for millers and farmers in Afghanistan. Afghan millers cannot compete with subsidized flour imports from Pakistan, given the same ad valorem tariffs for both flour and wheat imports. Afghan millers have suggested removing the tariffs on wheat imports in order to increase the share of wheat imports and decrease flour imports. This policy will help millers, and it may not have significant effects on farmers. Most millers in Afghanistan blend the high quality Kazakh wheat with lower quality domestic wheat during processing. So, an increase in Kazakh wheat imports implies a higher demand for domestic wheat, as well. Most importantly, this policy should not hurt Afghan consumers, as wheat flour prices would fall.

Most of flour markets in Jalalabad, Kandahar, Kabul and Herat are supplied by Pakistani flour. It is unlikely that Pakistani flour moves to the northern market, Mazar. Based on the survey, Pakistan flour is observed in the provinces close to Kabul like Parwan, but it is not observed in Mazar. On the contrary, Kazakh flour is moving to all commercial centers, including Jalalabad and Kandahar. But demand for Kazak flour is less in Jalalabad and Kandahar than in Mazar and Herat, mainly due to higher transportation costs. The price of Kazakh flour is about $90 higher than Pakistani flour in Kabul, and the difference gets bigger in eastern commercial centers due to transportation costs.

In spite of the huge differences between the prices of Kazakh, local and Pakistani flour, there is demand for all types of flour in most commercial centers. The demand is driven mainly by the quality differences between Pakistani, Kazakh and local flour. Most commercial bakeries in the cities combine Kazakh flour with local or Pakistani flour.

Kazakh flour contains a higher percentage of gluten compared to local and Pakistani flour. More gluten in flour makes elastic dough, and that is very valuable for commercial bakeries in Afghanistan. It is easier to make bread in different sizes with elastic dough. Thus, there is demand for Kazakh flour in all commercial centers because of its high quality.

Local flour is blended with Kazakh or any other flour with higher gluten in order to make elastic enough dough to make bread. All millers interviewed said they combine local wheat with Kazakh wheat, mostly with shares at 50-50 before processing it. If local wheat is not blended with Kazakh wheat at the milling stage, commercial bakeries or household mix the flour when making dough. Local flour is rarely used without mixing it with other flour in commercial centers. However, in it is used without blending with Kazakh wheat in rural areas.

Pakistan, with a shared border of 1,600 Km with Afghanistan, is an easier option than Kazakhstan for Afghan traders to import flour from. Most traders interviewed said they do not need contracts or any additional arrangements for importing flour from Pakistan. Some traders reported later payment for Pakistani millers, after selling the flour in Afghanistan. Some traders also reported importing flour from Pakistan without paying the whole tariffs. Traders can report less than the actual import level to the customs officials. But the northern border where Kazakh flour comes through is better organized, and it is less likely to import commodities without paying the complete tariffs. It is also much faster to import flour from Pakistan than from Kazakhstan. Most traders said with just making a call today, they can get the shipment two or three days later in Afghanistan. Also, it is not required to purchase a large volume of flour at one time. Traders importing flour from Pakistan said they can make a transaction as small as 100 metric tons with Pakistani millers.

Importing wheat and flour from Kazakhstan is much more complicated than importing from Pakistan. Traders are required to make contracts with the government of Kazakhstan for wheat and flour imports. Usually traders are required to make a fluctuating price contract for a large volume of wheat and/or flour and then start importing. Most of the traders importing wheat and flour from Kazakhstan are much larger traders than the ones importing from Pakistan. Most traders importing wheat and flour from Kazakhstan have contracts of 10,000 to 50,000 MT of wheat and flour with the government of Kazakhstan.

Transportation costs are much lower for flour import from Pakistan than imports from Kazakhstan. Flour imports from Pakistan enter Afghanistan at three different ports: Spin Boldak to Kandahar, Torkham to Jalalabad and through Ghulam Khan Port to Khost province. All the wheat deficit provinces are strategically located next to the Pakistani border. Kabul, the largest flour market in Afghanistan, is close to both Khost and Jalalabad.

Based on the trader survey, the transportation costs of flour imports from Peshawar Pakistan to Jalalabad is $40 per ton, and with an added $10 per ton the shipment gets all the way to Kabul. The route from Khost to Kabul is more cost effective, based on the information from the traders. The transportation costs of flour is $43 per ton from Panjab to Kabul via Khost province. The transportation costs of flour from Quetta Pakistan to Kandahar is about $10 per metric ton. That is the most efficient route to supply all the southern provinces.

Since Afghanistan does not share a border with Kazakhstan, it is costly to trade with Kazakhstan. More importantly, wheat surplus areas in Kazakhstan are mostly in the north, and wheat deficit areas in Afghanistan are central, south and west. That makes the transportation costs even higher. Based on the trader survey, the transportation costs of wheat and flour from Kazakhstan to Mazar are about $110 per metric tons. It costs another $40 for tariffs and taxes until it reaches to Mazar. The transportation costs from northern Kazakhstan to Saryagash, on the border between Uzbekistan and Kazakhstan is about $50 per metric tons, and from there to Hairatan, the border between Afghanistan and Uzbekistan, costs another $50 per metric tons. If it is moving to Kabul, another $35 per metric is added. Thus, the total transportation costs from Kazakhstan where wheat is produced to Kabul is estimated to be $135 per metric tons, excluding tax and tariffs.

5.3 Findings from the Miller Survey

Commercial milling has experienced rapid growth during the last decade in Afghanistan as the population increased in the cities. But the Afghan milling industry has problems competing with Pakistani subsidized flour. A total of 14 commercial mills were interviewed in Kabul, Herat, Mazar, Kandahar and Jalalabad. All of them were operating at less than half capacity, and some were shut down at the time of this survey. Milling industries located in the north are better off than the ones located in the south and east. It is mainly because most wheat is produced in the north and west, and also Pakistani flour is less likely to move all the way to the north. The number of the mills operating in the north and west is higher than in south and east, close to the Pakistani border. There are more than eight mills operating in Mazar, but there is only one in Kandahar and one in Jalalabad. The one in Kandahar has never been able to start operating since it was established, mainly due to cheap subsidized Pakistani flour.

Most Afghan millers were operating at less than half capacity, mainly due lack of domestic wheat and the high price of Kazakh wheat. Afghan millers need low price domestic wheat to blend with high price Kazakh wheat in order to be able to compete with Pakistani subsidized flour. Millers reported they normally have domestic wheat only for the first three months after harvest. When domestic wheat is finished, millers in Kabul use Indian wheat donated to the Afghan government as aid, and millers in Mazar and Herat import low price Uzbek wheat to blend with Kazakh wheat.

Bakhtar mill, with a capacity of 150 MT per day, is the largest commercial mill in Kabul. It was operating only eight hours per day in Fall 2014. The largest mill in Herat is Aria Flour, with a capacity of 220 MT per day. Aria Flour was operating at less than half capacity. Aria Flour has two separate operating units. One was completely shut down, and the other one was operating only eight hours per day in September 2014. There were a number of large mills operating in Mazar. Mustafa Jamal was the largest mill with a capacity of 270 metric tons per day. Mustafa Jamal Mill was operating 12 hours per day. The second largest mill in Mazar is Syed Jamal, with a capacity of 200 metric tons per day. Sayed Jamal was operating below half capacity. Only one unit with a capacity of 50 metric ton per day was operating 16 hours daily. Both Mustafa Jamal and Sayed Jamal blended Kazakh, Uzbek and local wheat during processing. The blending combination is 50% high quality Kazakh wheat, 25% Uzbek wheat and 25% local wheat.

There were seven other small scale mills, with a capacity of 80 to 150 metric tons per day, operating in Mazar. All these mills were operating from 8 to 12 hours daily in Fall 2014. Kabul is one of the largest markets for most millers who were operating in Mazar. But the Kabul market was mostly supplied by Pakistani flour in 2014. Based on the trader survey, lack of domestic wheat and the high price of Kazakh wheat were the main reasons they cannot compete with Pakistani subsidized flour in Kabul.

The costs of milling ranges from $25 to $40 per ton, depending on number of hours of operation per day. If the milling unit operates 24 hours per day, the milling costs are $25 per ton, but with eight hours of operation per day the milling costs increase to $40 per ton. Afghan Millers get good profits at the times when Pakistani bans its flour export to Afghanistan. Also, when domestic production is high, millers have access to cheap domestic wheat and can earn good profit. 2014 was not a good year for most millers. Based on the miller survey, they had domestic wheat only for three months in 2014, and it was hard to compete with subsidized Pakistani flour while importing high price Kazakh wheat.

There is not any policy in place to support the Afghan milling industry. Large imports of Pakistani subsidized flour and lack of domestic wheat are reported as a main constraints against development of commercial milling in Afghanistan. Power shortages and corruption in the government offices are the other problems for Afghan millers.

5.4 Implications for the Simulation Model

Findings from the survey help us develop a model that better fits the current market structure for wheat and flour in Afghanistan. The survey provided us with more accurate parameters for the model. Also, findings from the survey make us better informed on what type of modeling approach can better explain the market behavior for wheat and flour in Afghanistan. A key finding from the survey is on the quality difference between domestic and imported wheat. We cannot consider imported wheat and flour to be perfect substitutes for domestic wheat and flour. This characteristic combined with the imperfect market integration from the price transmission chapter suggest an Armington modeling approach better fits the current wheat and flour market structure in Afghanistan than a competitive spatial equilibrium approach.

A potential policy option to support Afghan milling industry is the removal of tariffs on wheat imports. Currently there is a 5% tariff and another 5% of taxes on both wheat and flour imports. With the current policy Afghan millers cannot compete in the market with subsidized Pakistani flour. I will consider a scenario in my model with no tariffs on wheat imports while tariffs on flour imports stay as they are now to determine the impacts on millers, consumers and producers.

CHAPTER 6. STABILIZATION POLICIES

6.1 Literature Review

The stability of staple food supply and prices has been a concern of many governments. Although there is debate both in favor of and against price stabilization in the literature, many successful developing countries have tried to stabilize food grains prices through different forms of policy intervention (Timmer, 1989). In his recent book, while Timmer expresses a firm belief in the market as the core for solving problems of food insecurity, he puts considerable emphasis on food price stabilization (Timmer, 2015). Stable grain prices can encourage grain producing farmers to diversity their cropping patterns to high-value crops if they could buy grain for consumption at more predictable prices.

Recent spikes in food prices made many developing countries rethink their policies regarding public stockholding, and their reliance on the international market (Dorosh, 2009). The traditional view was that domestic price variability is largely due to domestic factors (Byerlee et al., 2006). Thus, the recommendation has been to use trade liberalization to manage domestic price instability. However the 2007-2008 food crisis proved that the presumption of a relatively stable world market is not always right, and that reliance on international trade does not always guarantee domestic price stabilization (Abbott, 2010; Baltzer, 2014; Dorosh, 2009).

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

6.2 Price Transmission

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

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

The price transmission pattern from international grain markets to domestic markets in developing countries during the 2007-08 food crisis varies across countries (Baltzer, 2014). Using the prices for maize, rice and wheat in 14 developing countries, Baltzer (2014) finds that China and India kept their markets segmented from world market to ensure stability in their domestic prices. Brazil and South Africa stayed well connected to international grain market and let the price shocks pass-through into their domestic markets. The price shocks were much greater in some isolated grain importing countries such as Ethiopia and Nigeria than those in the world grain market.

6.3 Price Variability and Food Security

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

6.4 Policy Choices

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

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

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

Following this literature review, we will assess the government intervention through public stockholding and trade policies in the Afghan wheat market. Stockholding policy as an alternative to trade policy is expected to be a costly option. However, stocks are required to clear domestic markets and stabilize prices if the small country assumption does not hold due to imperfect integration into the world market, or when the domestic prices are inside parity bounds, in which case spatial price differentials are less than transfer costs and as a result trade does not occur.

Stocks are essential to manage short run dynamics due to delays in import delivery and seasonal price dynamics in the isolated rural markets. Stockholding policy may also be effective in stabilizing domestic markets in the case of imperfect integration into the world market. Stockholding policy is likely to be more effective than a trade policy to stabilize prices in the rural areas where wheat is produced. However, stockholding policy might be less cost-effective than variable levy.

Given that Afghanistan is a landlocked country, the transactions costs to bring imports from the world market are high, and it became even higher when Pakistan banned it wheat exports in 2008. Moreover, markets do not appear to be well integrated across urban and rural areas in Afghanistan. Given this assumed market structure for

Afghanistan, stocks may play a significant role to stabilize prices in extreme cases. However, weak market integration may limit the stabilization effects of stocks only to the areas where stocks are held.

CHAPTER 7. MODEL SPECIFICATION

Using the findings from the price transmission analysis in Chapter 4 and the trader and miller survey in Chapter 5, we develop a modeling framework to be used in analyzing the trade and agricultural policy options for the wheat subsector in Afghanistan. The modeling framework is required to contain spatial, dynamic and stochastic aspects for our analysis. We develop a two-year Armington modeling approach to analyze the impacts of trade and stockholding stabilizing policy options on the annual equilibrium in the wheat market.

An Armington model recognizes that commodities may not be perfect substitutes and markets are not perfectly competitive nor perfectly integrated across space. Based on our trader survey results and price transmission analysis, imported wheat and flour are not perfect substitutes for domestic wheat and flour. Also, findings from the price transmission analysis suggest domestic markets are now not well integrated with Pakistan and Kazakhstan wheat markets, and rural markets within the country are segmented from urban markets. However, markets are tightly integrated between commercial centers. Thus, we use the Armington model for import flows and flows between rural and urban areas. The competitive spatial equilibrium approach is used for flows between commercial centers, since they are tightly integrated.

7.1 Regional Specification

In our model, Afghanistan is divided into seven regions, defined by commercial centers. Each region is divided into a rural and an urban zone. Similar provinces in terms of climate, wheat production, and wheat prices are grouped as a region. Breaking each region into provinces would not add important value to the modeling results. Moreover, grouping 34 provinces into seven region will simplify the model. Therefore, we use regions instead of provinces in our model. Three of the seven regions are surplus regions and the remaining four are in deficit. Surplus areas are in northern Kunduz and Mazar, and Herat in the west. Deficit areas are in the south, center and east.

There are five official ports that supply wheat and flour to the commercial centers. Commercial centers are Mazar, Kabul, Jalalabad, Kandahar, Herat, Kunduz, and Khost. Commercial centers are supplied by five ports, inter-regional flows between these centers, and marketed surplus from rural areas. Rural areas are supplied by their own production and flour inflows from commercial centers. Surplus wheat in rural areas is either accumulated as stocks or carried to commercial centers and distributed to other urban centers.

The five official entry points or ports that wheat and flour come through are Hairatan, Tourkham, Spin Boldak, Tourghundi, and Khost. Three of the five entry points are on the Pakistani border, suppling wheat and flour to southern Kandahar, eastern Jalalabad and Khost, and central Kabul. Kazakh and Uzbek wheat and flour come via Hairatan to Mazar and through Tourghundi to Herat. There is an official port to the west with Iran but rarely wheat and flour come from that port because Iran itself is a wheat deficit country.

Figure 7-1represents regions, provinces, commercial centers, ports and wheat flows in Afghanistan. Commercial centers are defined by the star sign. Thick arrows show import flows from ports. Interregional flows are mostly from surplus to deficit regions. Wheat surpluses from Kunduz and Mazar regions are mostly exported to Kabul. The flows change depending on domestic production, and export policy of foreign suppliers. Following the 2007-2008 food crisis, Pakistan closed the border for wheat and flour exports to Afghanistan. Flows of wheat and flour changed in the country after Pakistani export restriction policy. Central Kabul started to import Kazakh wheat from the north.

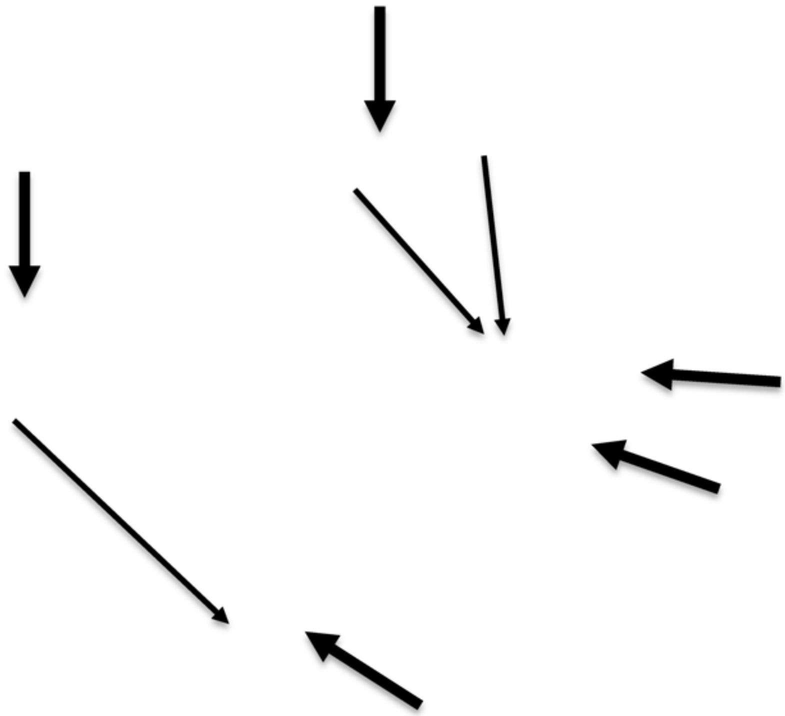

Figure 7-1: Afghanistan Regional Map

In this model, we assume surplus wheat from rural areas comes to urban centers in the form of grain and is milled in commercial centers. On the other hand, only flour flows from commercial centers to rural areas. This assumption is realistic, as large and modern milling industries are located in commercial centers. We also assume there is no wheat flow from rural zones to urban centers in deficit regions. But there are flour flows from urban centers to rural areas in all regions.

7.2 Model Indices

To implement this model, indices found in the equations need to be used for ports, regions, zones, and year. Table 7-1 show index h for ports:

h ports:

Table 7-1: Border Points

Code	Name	Location
HAIR	Hairatan	Northern Port connecting Mazar to Central Asia (Kazakhstan)
TOUR	Tourkham	Eastern port connecting Jalalabad to Pakistan
BOLD	Spin Boldak	Southern Port connecting Kandahar to Pakistan
TGDI	Tourghundi	Western Port connecting Herat to Central Asia (Kazakhstan)
KHST	Khost	Eastern port connecting Khost to Pakistan

Table 7-2 shoes index r for regions:

r Regions defined by commercial centers:

Table 7-2: Regions used in our Model

Code	Name	Location	Status	Provinces
HER	Herat	West	Surplus	Herat, Farah, Badghis, Ghor
JAL	Jalalabad	East	Deficit	Nangarhar, Laghman, Kunarha, Nooristan
KAB	Kabul	Center	Deficit	Kabul, Parwan, Panjsheer, Kapisa, Logar, Wardak, Bamyan
KAN	Kandahar	South	Deficit	Kandahar, Helmand, Zabul, Mimroz, Uruzgan,Daikunde
KDZ	Kunduz	North Eastern	Surplus	Baghlan, Kunduz, takhar, Badakhshan
KST	Khost	South Eastern	Deficit	Paktya, Paktika, Khost, Ghazni
MAZ	Mazar	North	Surplus	Faryab, Juzjan, Sari Pul, Balkh, Samangan

Sub-indices for surplus and deficit regions, and for rural versus urban zones are presented below:

j(r) surplus regions: HER, KDZ, MAZ

d(r) deficit regions: JAL, KAB, KAN, KST ty years = 1, 2

z zone : 1 = urban, 2 = rural

w exporter countries Pakistan and Kazakhstan: PAK, KAZ

These indices are used to define the specification and implementation of the model.

7.3 Model Notation

Table 7-3 summarizes the notation and variable definitions used in equations of the simulation model.

Table 7-3: Notation for our Model

Endogenous Variables	Description
Xw(j,d,ty)	Interregional wheat flows from center j to d
Xf(j,d,ty)	Interregional flour flows from center j to d
XwR(r,ty)	Wheat flows from a rural zone to its urban center
XfU(r,ty)	Flour flows from an urban center to its rural zone
Xwm(h,r,ty)	Wheat import flows from port h to center r
Xfm(h,r,ty)	Flour import flows from port h to center r
C(r,z,ty)	Consumption in region r and zone z, z = 1 urban , 2 rural
M(r,z,ty)	Quantity of wheat going to milling in region r zone z
ST(r,z,ty)	Private carry out stocks in region r zone z
PS(j,z,ty)	Public stocks in rural zones of surplus regions
Q(r,ty)	Realized production by region
Qe(r,ty)	Expected wheat production by region
A(r,ty)	Realized area planted by region
Ae(r,ty)	Expected area planted by region
PwWe(h,ty)	Wheat price at border points h after tariffs
PwRZ(r,z,ty)	Domestic wheat price in region r zone z
PfWe(h,ty)	Flour price at border point h after tariffs
PfRz(r,z,ty)	Domestic flour price in region r zone z
Exogenous Variables and Parameters	**Description**
Si(r,z)	Beginning private stocks in region r and zone z
Sm(r,z)	Minimum private stocks in regions r and zone z
Ye(r,ty)	Expected yield of wheat in region r
Y(r,ty)	Realized yield in region r
cXm(h,r)	Costs of wheat and flour import flows from port h to center r
cX(j,d)	Costs of interregional flows from region j to d
cXw(r)	Costs of wheat and flour flows between rural and urban areas
Tw(h)	Tariff on wheat imports (ad valorem tax)
$\sigma_{h,r}$	Elasticity of substitution between imported and domestic wheat
$\rho_{r,z}$	Elasticity of substitution between rural and urban areas

7.4 Model Equations

7.4.1 Equilibria

The model is based on supply and use balances for wheat and flour in rural and urban areas of each region on an annual basis. Given the supply and use equilibrium in regions, flows are determined based on price ratios and transportation costs. There are separate supply and use balance specifications for rural and urban areas, for deficit and surplus regions, and for wheat and flour commodities.

Certain flows are assumed to be zero in our model, as normally flows are not observed on those routes, and these assumptions simplify our model. First, there are no flour flows from rural areas to commercial centers, since flows from rural zones to commercial centers are in the form of grain. Second, there are no wheat flows from commercial centers to rural areas, as normally flows to rural areas are observed in the form of flour. Third, we force wheat and flour flows from rural areas to commercial centers in deficit regions to be zero, as surplus wheat is not observed in rural areas of deficit regions. Finally, there are zero wheat and flour flows from commercial centers of deficit regions to commercial centers of surplus regions. Given the above conditions, we specify supply and use balance using different equations across surplus and deficit regions, rural versus urban zones and wheat versus flour.

Supply and use equilibrium for wheat in rural areas in *surplus region j* is set as: beginning private stocks plus beginning public stocks plus quantity produced of wheat equals the sum of public and private carry-out stocks, outflows from the rural zone to commercial centers, wheat going to milling in rural areas and the quantity used for seed. The mathematical form of this is written in equation 7.1:

$$Si(r,z) + Q(r,ty) = St(r,z,ty) + Ps(r,z,ty) + XwR(r,ty) + M(r,z,ty) \qquad 7.1$$

Where r = j, z= rural, Si is beginning stocks, Q is domestic production, St is carry out stocks, Ps is public stocks, XwR is wheat flows from rural to urban centers and M is the quantity of wheat milled. Carry-in stocks are the ending stocks from the previous period. Hence, the beginning stocks are treated as exogenous in the initial period.

Supply and use balance for wheat *in deficit rural* areas is similar to surplus regions, with the exception that there are no public stocks and there is no wheat flow from rural to urban centers. Supply and use balance in rural deficit regions is presented in equation 7.2:

$$Si(r,z) + Q(r,ty) = St(r,z,ty) + M(r,z,ty) \qquad 7.2$$

Where r = d, z = rural, Si is beginning stocks, Q is production, St is carry out stocks, and M is wheat quantity milled.

Wheat equilibrium in *urban centers of surplus regions* is set as: beginning private stocks plus wheat imports from ports and wheat coming from rural areas equals carry out stocks, wheat going to mills in urban centers and wheat going to deficit regions. The supply and use balance is captured in equation 7.3.

$$Si(r,z) + \sum_{h} Xwm(h,r,ty) + Xwr(r,ty) = St(r,z,y) + M(r,z) + \sum_{d} Xw(r,d,ty) \qquad 7.3$$

Where r = j, and z = urban

In *urban centers of deficit regions*, supply and use balance is similar to balances in surplus regions. There is no flow from rural to urban centers in deficit regions and there is no outflow from deficit to surplus regions. Instead there is inflow from surplus to deficit regions as shown in equation 7.4:

$$Si(r,z) + \sum_{j} Xw(j,r,ty) + \sum_{h} Xwm(h,r,y) = St(r,z,ty) + M(r,z,ty) \qquad 7.4$$

Where Xw is wheat flow from surplus to deficit regions, and Xwm is wheat imports from ports to deficit regions.

Similarly, there are equations that capture supply and use balance for flour in regions and zones in our model. Supply and use equilibrium for *flour in rural areas* is set as: the extraction rate times the wheat going to milling in rural areas and the quantity of flour coming from urban centers equals consumption in rural areas. We assume the extraction rate is constant and it is the same across all rural and urban areas. There are not carry out stocks in flour form. The supply and use balance for flour is the same between surplus and deficit rural regions. It is presented in equation 7.5 for rural zones:

$$FER * M(r,z,ty) + Xfu(r,ty) = C(r,z,ty) \qquad 7.5$$

Where r include both j and d, and z = rural, FER is the extraction rate, M is wheat milled, Xfu is flour inflow from urban centers and C is consumption.

Supply and use balance for *flour in urban centers* is somewhat different between surplus and deficit regions as surplus regions can only export flour to deficit regions and are not allowed to import from those regions, while deficit regions may only import flour from surplus regions and are not allowed to export flour to surplus regions. In surplus regions, flour imports from ports and flour produced in the urban center are equal to consumption, outflows to deficit regions and outflow to rural areas in the same region. The supply and use balance of flour in urban surplus regions is presented in equation 7.6, and for deficit urban region is presented in equation 7.7:

Surplus regions:

$$FER * M(r,z,ty) + \sum_{h} Xfm(h,r,ty) = C(r,z,ty) + \sum_{d} Xf(r,d,ty) + Xfu(r,ty) \qquad 7.6$$

Where r = j, and z = urban

Deficit regions:

$$FER * M(r,z,ty) + \sum_{h} Xfm(h,r,ty) + \sum_{j} Xf(j,r,ty) = C(r,z,ty) + Xfu(r,ty) \qquad 7.7$$

Where r = d, and z = urban

7.4.2 Supply Equations

We use the price elasticities of supply estimated in Chapter 2 to generate parameters for the supply functions used in the model. The relationship between the expected area planted of wheat and price is captured in equation 7.8. Equation 7.9 shows the expected production as a function of area and yield:

$$Ae(r,ty) = as(r) + bs(r) * PwRz(r,z,ty) \qquad 7.8$$

$$Qe(r,ty) = Ae(r,ty) * Ye(r,ty) \qquad 7.9$$

Where z is rural, as and bs are the intercept and slope of the area function with respect to price, and slopes and intercept are calculated using the elasticities estimated in the supply section presented in Chapter 2 plus base year data on regional area, yield and production.

In order to capture the stochastic elements of the production function, the variance-covariance matrix of the error terms generated in chapter 2 are used. We use a Cholesky transformation to create correlated error realizations for Monte Carlo simulation. Using this method we produce realized area of wheat planted and realized yield in each Monte Carlo iteration. These relationships are captured in equation 7.10 and 7.11:

$$A(r,ty) = Ae(r,ty) * \exp(\varepsilon A) \qquad 7.10$$

$$A(r,ty) = Ae(r,ty) * exp(\sum_{r}(LA(r,s) * Nq(0,1)))$$

$$Y(r,ty) = Ye(r,ty) + \varepsilon Y \qquad 7.11$$

$$Y(r,ty) = Ye(r,ty) + \sum_{r}(LY(r,s) * Nq(0,1))$$

Where A(r,ty) is realized area, Ae(r,ty) is expected area, εA is the error realization in a specific case and LA(r,s) is the Cholesky transformation matrix generated from the variance-covariance of the area planted error terms, and Nq(0,1) is the matrix of normal random number with mean zero and variance equal to one. Y(r,ty) is realized yield, Ye(r,ty) is expected yield, εY is yield error realization and LY(r,ty) is the Cholesky transformation from the yield variance-covariance matrix[8]. Area is stochastic and endogenous so the variance-covariance of the error terms are used to capture the stochastic element of the estimated area planted. Yield is stochastic and exogenous to our model, so the variance-covariance matrix of the historical yield data are used. Monte Carlo simulation is used to generate error realizations of area planted and yield following the distributions estimated from historical data. We use the realized area and realized yield to generate realized production in each iteration as in equation 7.12.

$$Q(r,ty) = A(r,ty) * Y(r,ty) \qquad 7.12$$

7.4.3 Border Prices

Similar methodology is used to capture the stochastic element in world prices. Historical price data suggest that Kazakh and Pakistani prices are correlated. Price data for Kazakhstan and Pakistan are used to generate a variance-covariance matrix, and so the Cholesky transformation matrix. GAMS random number generator is used to generate random normal errors with mean zero and variance equal to one. The Cholesky transformation matrix for the Kazakh and Pakistani price is multiplied by the matrix of random normal realizations Np(0,1), and added to the mean of the prices to generate realized actual prices in each iteration. This relationship is captured in equation 7.13:

$$Pw(w,ty) = Pwe(w,ty) + \varepsilon Pw \qquad 7.13$$

$$Pw(w,ty) = Pwe(w,ty) + \sum_{w}(LPw(w,wa) * Np(0,1))$$

[8] The CHOL add-in in Microsoft Excel is used to generate the Cholesky transformation matrices (LA & LY) from the variance-covariance matrices in Chapter 2.

Where Pw(w,ty) is the realized prices in Pakistan and Kazakhstan, Pwe(w,ty) the average (expected) prices over the period 2007- 2015, εPw is the error realization in a specific case, LPw(w,wa) is the Cholesky transformation of the world price variance-covariance matrix for Kazakhstan and Pakistan and Np(0,1) is the matrix of normal random number with mean zero and variance equal to one for prices. The variance-covariance matrix of prices is presented in Table 7-4, where prices are measured in US$/MT. Kazakh prices are more variable than prices in Pakistan. The correlation coefficient between Pakistan and Kazakh prices is approximately 0.31.

Table 7-4: Variance-Covariance Matrix of Wheat Prices for Kazakhstan and Pakistan.

	Kazakhstan	Pakistan
Kazakhstan	2715	497
Pakistan	497	1014

7.4.4 Stocks

Carry-out private stocks are estimated based on the approximated L shaped stock function presented in equation 7.14 below. St is carry-out stocks, PwRz is realized wheat price, α is a constant fitting this pricing relationship to observed market data, Pm and Sm are exogenously assumed minimum price and minimum stocks, respectively. The stock function is very elastic at low prices as large quantities of stocks are accumulated, and it becomes inelastic at high prices when stocks are depleted. However, stocks are never zero, as small quantities of stocks are always maintained in practice. We take this into account by adding the last term in equation 7.14, which represents the minimum stock level.

$$St(r,z,ty) = \frac{\alpha}{PwRz(r,z,ty) - Pm} + Sm(r,z) \qquad 7.14$$

A similar L shaped function is used for the public stockholding policy. As normally the minimum support price of a public stockholding program is higher than the minimum market price, the minimum price used in the public stocks function is higher than the price used in the commercial stock function. The functions for the private and public stocks are described in more detail in Chapter 8 where public stockholding policy is investigated.

7.4.5 Demand for Flour Consumption

The price elasticity of demand estimated in Chapter 3 is used here to estimate parameters for the flour consumption function. For simplicity, we assume the demand for regional consumption is linear. The consumption function is presented in equation 7.15:

$$C(r,z,ty) = ac(r,z) + bc(r,z) * PfRz(r,z,ty) \qquad 7.15$$

Where C is consumption, ac is the intercept, and bc is the slope. Regional consumption functions are generated from the estimated per capita demand function using regional population data and per capita consumption data. The slope (bc) is based on the estimated demand elasticity and base data.

7.4.6 Trade Flows

Based on the results from the price transmission analysis, markets are well integrated between commercial centers. Therefore, for the flows between commercial centers we assume spatial competitive equilibrium. Thus, the price difference between commercial centers are not allowed to exceed the transportation costs between them. Complementary slackness conditions for flows from surplus to deficit urban centers are presented in equation in 7.16:

$$Xw(j,d,ty) \geq 0 \quad 7.16$$

$$\mathrm{Pwrz(d,1,ty)} \leq \mathrm{Pwrz(j,1,ty)} + \mathrm{cX(j,d)}$$

$$\mathrm{Xw(j,d,ty)} * \left(\mathrm{Pwrz(j,1,ty)} + \mathrm{cX(j,d)} - \mathrm{Pwrz(d,1,ty)}\right) = 0$$

These conditions ensure that competitive price linkages between commercial centers hold. If there is flow between two urban centers then the price difference must be equal to transportation and transaction costs between them. The price difference between two commercial centers must be less than the transportation costs if there is no flow between the two given urban centers. The commentary slackness conditions are used, as there are occasionally zero flows between certain commercial centers. Thus, the price difference does not necessarily need to be equal to transportation costs.

For the import flows and flows between rural and urban areas we use an Armington specification. That is, we assume imperfect substitutes between domestic and imported wheat, and that some markets are not well integrated. An Armington model appears to better explain the market structure and trade flows in Afghanistan, based on our price transmission analysis. This is a model which was developed by Armington and has been used to analyze world grain trade when prices are not perfectly correlated across space (Armington, 1969). The results from our price transmission analysis also suggest the Armington model is a better choice than competitive spatial equilibrium to assess the impacts of trade policy options on wheat market outcomes in Afghanistan.

The supply and use balance in an Armington model is the same as in the spatial equilibrium model. The complementary slackness conditions used in spatial equilibrium model, however, are replaced by demand for imported wheat and flour in each region using the Armington specification. Imported wheat is differentiated from domestic wheat by an assumed elasticity of substitution. The demand for the imported wheat is a function of the initial import flow, the world to domestic price ratio and the elasticity of substitution between imported and domestically produced wheat.

$$Xwm(h,r,ty) \quad = Xwmo(h,r)(\frac{Pw(h,ty) + tw + cXm(h,r)}{Pwrz(r,z,ty)})^{-\sigma_{h,r}} \qquad 7.17$$

Equation 7.17 presents the import flows of wheat from ports to commercial centers. Xwm is the endogenously determined wheat imports, Xwmo is the initial (base) quantity of wheat imports, Pw is border wheat prices, Tw is tariffs on wheat, CXm is the transportation costs from border points to commercial centers, Pwrz is wheat price in commercial centers, and σ is the Armington elasticity. Import flows increase as the difference between the world and domestic price increases, and vice versa.

$$Xfm(h,r,ty) \quad = Xfmo(h,r)(\frac{Pf(h,ty) + tf + cXm(h,r)}{Pfrz(r,z,ty)})^{-\sigma_{h,r}} \qquad 7.18$$

Equation 7.18 represents the import flow of flour from ports to urban centers in a given year. Equation 7.18 is identical to equation 7.17, except the earlier is for wheat flows and the later one is for flour imports (Xfm).

$$Xwr(j,ty) = Xwro(j)(\frac{Pwrz(j,2,ty) + cXwz(j)}{Pwrz(j,1,ty)})^{-\rho_{2,1}} \qquad 7.19$$

Equation 7.19 shows wheat flows from rural to urban centers in surplus regions. where 1 is the index for urban areas and 2 is the index for rural zones. Xwr is endogenously determined wheat flows from rural to urban areas, Xwro is the initial wheat flow from rural to urban centers, Pwrz is endogenously determined wheat prices in urban and rural areas, cXwz is the transportation costs between rural and urban areas, and ρ is the urban rural zones Armington elasticity. This equation is only for the surplus regions, as deficit regions do not supply wheat to commercial centers.

$$Xfu(r,ty) = Xfuo(r)(\frac{Pwrz(r,1,ty) + cXwz(r)}{Pwrz(r,2,ty)})^{-\rho_{1,2}} \qquad 7.20$$

Flour flows from commercial centers to rural areas are captured in equation 7.20. Based on our trader survey, flour flows from commercial centers to rural areas are observed in all regions, including the northern surplus regions. Thus, equation 7.20 represents flour flows from commercial centers to rural areas in all regions.

A higher Armington elasticity implies better integrated markets across space. Using the elasticity of price transmission results we estimated the Armington elasticity of price substitution for different trade flows. A detailed description on how these elasticities are estimated are explained in the benchmarking section of the following chapter.

CHAPTER 8. MODEL IMPLEMENTATION

In this chapter we present the data used to benchmark our simulation model. We explain how the Monte Carlo method is implemented. Following description of the Monte Carlo method, different static alternative scenarios under which the model is implemented are explained. We start implementing the model with the base static case. Then the model is implemented under various alternative scenarios and the impacts of the stabilization policies are assessed in static cases. In the base static case, we assume zero error terms for all stochastic variables (area harvested, yield, and world price). In the high and low production scenarios we assume specific error realizations for the stochastic variables that matches those scenarios. All results in this chapter are from the static model, and we present the results from the stochastic model in chapter 9.

8.1 Benchmarking

In this section we present the data used to benchmark the static model. The supply side of our model is benchmarked to the wheat production data from MAIL over the period 2010-2013, the most recent regional production data available to us. The average over this period appears to represent a normal recent mean for production, area and yield. The benchmark data for production, area planted and yield are presented in Table 8-1.

Table 8-1: Benchmark Data for Production, Area, and Yield

Region	Production(MT)	Area(Hectare)	Yield(MT/Ha)
HER	643,487	404,486	1.59
JAL	321,974	108,143	2.98
KAB	424,695	162,312	2.62
KAN	547,382	204,259	2.68
KDZ	962,638	568,484	1.69
KST	322,626	115,897	2.78
MAZ	1,082,374	850,595	1.27
Total	4,305,176	2,414,175	2.23

Source: Ministry of Agriculture, Irrigation and Livestock (MAIL)

Population data and per capita consumption for wheat are obtained from the Central Statistics Organization of Afghanistan (CSO). Population data estimated by the government of Afghanistan are said to be under estimated and they are lower than the population estimates by the World Bank (2015) and the United Nations (2015). We obtained the national population data from the World Bank (2015) for the year 2013 and allocate this population estimate across regions and zones using the data and information from the Central Statistics Organization of Afghanistan (2014). Population data across regions between rural and urban areas in million people are presented in Table 8-2.

Table 8-2: Population Data across Rural and Urban Areas.

Region	Urban	Rural
HER	0.5148	2.5658
JAL	0.2174	2.8036
KAB	3.435	4.2174
KAN	0.4097	4.6425
KDZ	0.2436	4.0256
KST	0.16	3.0873
MAZ	0.4633	3.8951

Source: Central Statistics Organization of Afghanistan. Units are in Million people.

Annual per capita consumption of flour is 150Kg, based on the household surveys data (NRVA, 2012). Per capita consumption of flour, population, average prices and the price elasticities are used to benchmark regional demand function across rural and urban areas.

Data for regional commercial stocks are not available for Afghanistan. However, national beginning stock data for Afghanistan are available in the (U.S. Department of Agriculture, 2015) database. We allocate the total national quantities of beginning stocks proportional to the production level of each region in the country. The beginning stocks quantities measured in metric tons are presented in Table 8-3. We assume equal stocks across rural and urban areas in deficit regions. In surplus regions, higher quantities of stocks are observed in rural areas than in urban areas, as wheat is produced in rural areas and mostly retained as stocks by farmers there. Beginning stocks in rural surplus regions are assumed to be almost twice as much as those in urban areas.

Table 8-3: Beginning Stocks.

Region	Urban	Rural
HER	7000	13000
JAL	5000	5000
KAB	10000	10000
KAN	7000	8000
KDZ	7000	13000
KST	5000	5000
MAZ	7000	13000

Source: USDA. Units are in MT

Transportation costs data are from our trader survey presented in Chapter 5. Transportation costs of wheat and flour flows from Kazakh port at Saragash to the western and northern Afghan border is about $60 per metric ton. The transportation costs for Pakistani wheat and flour flow to the Afghan border is $20 per metric ton. The average transportation costs between rural and urban areas ranges between $20 and $30 per metric ton, depending on the region. Transportation costs for the inter-regional flows are presented in Table 8-4. The transportation costs of $100 are used for the routes on which wheat and flour flows are observed only in extreme cases. Wheat and flour flows from northern regions to eastern Khost only in cases where Pakistan restricts its exports. Wheat and flour flows have never been observed on routes with a transportation costs of $200/MT.

Table 8-4: Transportation Costs for Inter-regional Flows.

Region	JAL	KAB	KAN	KST
HER	200	100	40	200
KDZ	60	40	80	100
MAZ	60	40	80	100

Source: Trader and Miller Survey (2014). Units are in $/MT

The data for milling processing costs are both from our trader and miller surveys and from the observed difference between wheat and flour prices. The costs of milling are lower in Pakistan compared to Afghanistan and Kazakhstan as the government of Pakistan subsidizes its milling industry. The same milling costs are used for Afghanistan and Kazakhstan, as the wheat and flour price difference suggests milling costs are not different in these two countries. The milling processing costs in Afghanistan and Kazakhstan are $80 per metric ton, and it is $50 per metric ton in Pakistan.

Import flows for wheat and flour are obtained from the Trade Statistics for International Business Development database of International Trade Center (2016). The database only shows the import flows from Pakistan and Kazakhstan to Afghanistan. We use the information from the trader survey to allocate the import flows through each entry point and to each commercial center in the country. Wheat and flour imports measured in metric tons are presented in Table 8-5. The quantity of flour imports are much larger than wheat flows from both Kazakhstan and Pakistan. Kazakh imports come to Afghanistan mostly through the northern HAIR port, and some through the western TGDI port. Pakistan wheat and flour flows to Afghanistan through three ports, with about equal quantity through each.

In an Armington model, initial flows are important. An initial flow set to zero means there will not be a trade flow in any scenario. There are routes on which normally wheat and flour flows are not observed, but in extreme cases a trade flow does occur. We use small numbers for those routes to allow wheat and flour flows in extreme cases. For example, wheat flows from Pakistan to central Kabul are rarely observed, as most of imports are in the flour form. Only large price differences will force trade flows along those routes.

Table 8-5: Base Wheat and Flour Imports.

Port/Region	HER	JAL	KAB	KAN	KDZ	KST	MAZ
Flour Imports							
BOLD	10,000	-	-	230,000	-	-	-
HAIR	-	-	200,000	-	90,000	-	100,000
TGDI	80,000	-	-	1,000	-	-	-
TOUR	-	120,000	140,000	-	-	-	-
KHST	-	-	90,000	-	-	180,000	-
Wheat Imports							
BOLD	-	-	-	15,000	-	-	-
HAIR	-	-	10,000	-	10,000	-	50,000
TGDI	10,000	-	-	1,000	-	-	-
TOUR	-	15,000	100	-	-	-	-
KHST	-	-	100	-	-	15,000	-

Source: Trader and Miller Survey (2014). Units are in MT

We specify parameters for the supply, demand and stocks functions in our model. The parameters for the supply function used in our model are generated from the estimated supply elasticities in Chapter 2 and base supply data. Supply functions are different across regions based on their estimated elasticities. Similarly, parameters for the demand curve used in our model are obtained from the estimated price elasticity of demand in chapter 3 and the base per capita consumption data.

Other key parameters used in our model are the Armington elasticities between imported and domestic wheat and also between commercial and rural areas within the county. These elasticities are important, as they define the level of market integration across space. A high Armington elasticity implies well integrated markets across space, and vice versa. The Armington elasticities are estimated based on the price transmission elasticities estimated in the price transmission analysis.

We used the observed price data and estimated the long-run price transmission elasticities for international versus domestic market, and between rural and urban areas within the country in chapter 4. We used an assumed Armington elasticity for import flows, and flows between rural and urban areas. We ran the model over 1000 iterations and got the world and domestic prices from the simulation model. Then the price data from the simulation modeling was used to estimate the long-run price transmission elasticities. We adjusted the assumed Armington elasticities until we got fairly close price transmission elasticities from the simulated price data compared to the ones from the observed data. The elasticity of substitution between imported and domestic goods, and rural and urban areas ranges between four and five. We use an elasticity of 5 for import flows of wheat and flour and 4 for wheat and flour flows between rural and urban areas.

8.2 Monte Carlo Simulation Strategy

Area harvested, yield and border prices are treated as stochastic variables in the model of Afghanistan's wheat market. Given the uncertainty in production and the world price, measurement of changes in market outcomes are examined through Monte Carlo simulations using estimated distributions for regional yield, area planted and border prices. Market equilibrium is estimated with one thousand repetitions of the two year equilibrium sequence, mapping out the distribution of market outcomes when stochastic elements are randomly generated based on those assumed distribution.

In each repetition specific values for stochastic variables (error realizations) are set to generate market equilibrium. A random number generator establishes for each iteration a realization of each error term. The distributions of the normal random numbers

Nq (0, 1) and Np(0,1) have a mean zero and standard deviation equal to one. The Cholesky transformation is used to transform Nq(0,1) and Np(0,1) into error realizations so that the distribution of the error terms over a 1000 iterations follows closely the observed distribution, and its variance-covariance matrix.

The distributions of domestic wheat yields and area planted are correlated across regions, based on historical production data. We generated a full variance-covariance matrix for the production related error terms from historical data (in Chapter 2) and use the Cholesky transformation to generate correlated error realizations for the Monte Carlo simulations. The same method is used for Kazakh and Pakistani prices to generate realized Afghan border prices for imports from Pakistan and Kazakhstan in the Monte Carlo simulations.

Prior to running the simulation, we run the model with no stochastic element (all $\varepsilon = 0$) in it to make sure supply and use balance holds and the market outcomes are consistent with the benchmark data. In the base static model we assume the error terms for the stochastic variables are zero. The base values for stochastic variables are their long run expectations. Also, the impacts of trade and stockholding policies are assessed with the static model to make sure the model produces results consistent with our expectations. In the static results we are mainly concerned with trade flows and prices in different scenarios. The impacts of trade and stockholding policies on the welfare of producers and consumers will be discussed in detailed later in Chapter 9, where we look at the distribution of market outcomes under alternative policies.

8.3 Alternative Scenarios

Prior to presenting the results under various alternative scenarios, we explain each scenario with its critical assumptions. A list of scenarios used in the static and/or stochastic model are presented in Table 8-6.

Table 8-6: Alternative Scenarios

Scenario	Explanation and Key Assumptions
Static Base	Assuming average prices and normal production. Error realization are assumed to be zero in the static base case. No export restrictions from Pakistan and Kazakhstan. There is only 10% ad valorem tariffs on wheat and flour imports.
Export Restriction	Pakistani export restriction policy is in place. We assume the transportation costs for Pakistani imports increases from $20 to $150 per metric ton. Everything else is the same as in the static base case.
Stochastic Base	The same as static base, but Pakistani export restrictions kicks in when the Kazakh price exceeds the $370/MT threshold.
Export Restriction plus low domestic production	Domestic production is assumed to be low as in 2008 and Pakistani export restriction policy is in place. Kazakh and Pakistani prices are high as in 2008.
High Production	Domestic production is assumed to be high as in 2009 and in 2013. Error realization adjusted for this static case.
Variable Levy	Border prices after import tax are fixed at all border points. A variable levy is adjusted to capture the variability in the world prices and stabilize domestic prices.
Modified Variable Levy	In the modified variable levy assumption, prices are not fixed at the Pakistani border when the Pakistani export restriction policy is in place. The variable levy on imports from Pakistan is the same as the one on imports from Kazakhstan when the export restriction policy is in place. When export restriction does not occur, fixed prices are maintained at all ports.
Public Stockholding Policy with a MSP of $200 (Stock1)	Wheat procurement policy is implemented in rural surplus regions with a minimum support price (MSP) of $200 with a primary objective to support producer prices. Stocks are also accumulated in rural surplus areas.
Public Stockholding Policy with a MSP of $250 (Stock2)	Wheat procurement policy is implemented in rural surplus regions with a minimum support price (MSP) of $250 with a primary objective to support producer prices. Stocks are also accumulated in rural surplus areas.
Stockholding policy in commercial centers	Stocks are maintained and released in commercial centers to stabilize consumer prices. The primary objective of stockholding policy here is to prevent price spikes.
Variable Levy plus stockholding policy	Also referred to as variable levy plus stock1 in the text. This is the combination of variable levy plus stockholding policy with a MSP of $200
Modified variable levy plus stockholding policy	Also referred to as modified levy plus stock2 in the text. This is the combination of modified variable levy plus stockholding policy with a MSP of $250.

8.4 Static Base Case

National supply and use balance for wheat from this static model is presented in Table 8-7. The results from the static model show that supply and use balance holds and market outcomes are close to the benchmark values. Quantities are measured in the form of wheat grain for both wheat and flour. In the initial import data, about 90% of the imports are in the form of flour. Flour imports appears to dominate wheat imports in the foreseeable future as neighboring Pakistani continues to subsidize it milling industry. Also, Kazakh high quality flour is preferred relative to its wheat in the Afghan market, and the share of flour imports relative to wheat imports from Kazakhstan have increased. The benchmark value for national production is 4.3 MMT and modeling results show the same quantity for production. The benchmark values for flour and wheat imports are 1.49 MMT and 0.125 MMT, respectively. The import quantities for flour and wheat imports from the modeling results are consistent with the benchmarking values.

Table 8-7: Modeling Results for National Supply and Use

Use		Supply	
Consumption	4,860,464	Production	4,325,650
Carry out Stocks	243,865	Flour Imports	1,522,951
Post-harvest Losses	648,848	Wheat Imports	111,976
Seed	322,400	Carry-in Stocks	115,000
Total	6,075,577		6,075,577

Includes flour imports expressed in wheat equivalent[9].

Regional supply and use balances from the static model are presented in Table 8-8. Similar to the national supply and use balance, quantities are measured in terms of wheat grain for both wheat and flour. On the supply side, Qe is net production (production minus post-harvest losses), Si is beginning stocks, and import is the sum of

[9] The conversion factor of wheat to flour is 0.9. Hence, 1MT of wheat equals 0.9 MT flour.

all domestic and international imports from Pakistan and Kazakhstan in each region. On the demand side, we have consumption, carry out stocks, exports to other regions and wheat used for seed in a given region. Wheat exports on the supply side refers to inter-regional flows from surplus to deficit regions. Beginning stocks and seed use are exogenous variables, and other variables are determined by the model. Modeling results represent that supply and use balance holds for all regions.

Table 8-8: Regional Supply and Use Balance.

Region	Supply			Use			
	Production	Si	Inflow	Consumption	St	outflow	Seed
HER*[10]	537,749	20,000	78,373	494,439	43,181	49,302	49,200
JAL	303,295	10,000	198,090	463,450	29,035		18,900
KAB	380,124	20,000	861,329	1,205,989	28,264		27,200
KAN	468,720	15,000	389,442	804,853	29,409		38,900
KDZ*	813,011	20,000	84,405	686,871	41,702	114,343	74,500
KST	286,607	10,000	256,372	500,308	29,671		23,000
MAZ*	887,298	20,000	124,947	704,553	42,605	194,388	90,700

Includes flour imports expressed in wheat equivalent. Inflow is the quantity of wheat and flour flows from surplus to deficit regions plus imports from the world market. Units are in MT.

In the base case, there are wheat and flour flows from all surplus regions to deficit regions, with Kunduz and Mazar supplying Kabul and Herat supplying Kandahar. The eastern Jalalabad and Khost regions are supplied by Pakistani wheat and flour and domestic production in their own regions. Wheat and flour from northern and western surplus regions does not flow to the eastern regions of Khost and Jalalabad. Thus, the

[10] The star sign (*) next to region name indicates surplus regions.

outflow from Herat is received in Kandahar, and the outflow quantities from Mazar and Kunduz go to Kabul.

The inflow column represents the combined import flows and flows from other regions for both wheat and flour measured in the wheat form for deficit regions. Since the surplus regions do not receive wheat or flour from other regions, the inflows represents only national imports for those regions. The imports to the northern Mazar and Kunduz are all from Kazakhstan, and imports to the western Herat are mostly from Kazakhstan but some from Pakistan. Wheat and flour inflows to regions from different sources are presented in Table 8-9.

Table 8-9: Wheat plus Flour Inflows: Base Case.

Region	Inflow from Surplus Regions	Import from Pakistan		Imports from Kazakhstan
HER*		7,165		71,208
JAL		198,090		-
KAB	308,737	304,100		248,499
KAN	49,302	338,555		1,586
KDZ*		-		84,405
KST		256,372		-
MAZ*		-		124,947
Total	358,038		1,104,282	530,644

Includes flour imports expressed in wheat equivalent. Units are MT

The inflow to the four deficit regions are mostly from Pakistan. The imports to eastern Khost and Jalalabad regions are all from Pakistan. Kabul, the largest deficit region, is supplied by Kazakh, Pakistani and domestic wheat and flour. About 308 thousand MT of the total deficit of 861 thousand MT is supplied by domestic wheat from Mazar and Kunduz. The remaining Kabul deficit is supplied roughly half by Pakistan, 304 thousand MT, and nearly another half by Kazakhstan, 248 thousand MT. Kandahar is the second largest deficit region supplied mostly by Pakistan and partially by domestic wheat from Herat and small quantities from Kazakhstan.

Prices from the base model are presented in Table 8-10. Modeling results suggest price variation is low across urban centers, ranging between $364/MT in Herat and $415/MT in Kabul. Normally higher prices are observed in deficit regions than in surplus regions. High variation in prices are observed in rural areas across regions, ranging between $300/MT in the surplus region of Mazar to $486/MT central Kabul.

Table 8-10: Wheat Prices across Rural and Urban Areas

Region	Urban	Rural
HER	364	303
JAL	411	464
KAB	415	486
KAN	404	464
KDZ	375	311
KST	402	461
MAZ	375	300

Units are in US$/MT

8.5 Pakistani Export Restrictions

The base model was developed initially based on the assumption that there are no export restrictions from the exporting countries, Pakistan and Kazakhstan. However, historically Pakistan has used export restriction policy during periods of high world prices. The appropriate dating of Pakistani export restriction policy reform is not clear, but often it has occurred when there are price spikes in the world market. Although the Pakistani export restriction policy increases the price difference between Afghanistan and Pakistan, it cannot prevent flour movement from Pakistan to Afghanistan. The very high price in the deficit regions close to the Pakistani border and low prices on the other side of the border in Pakistan forces unofficial trading and smuggling wheat and flour from Pakistan to Afghanistan. While the Pakistani export ban increased the transactions costs of importing flour from Pakistan, it did not prevent flour movements into Afghanistan (Persaud, 2013). Although export ban was in place in 2008, Pakistani wheat and flour exports were the highest in 2008, and the country exported large quantities of flour to Afghanistan through unofficial channels (Persaud, 2013; Prikhodko and Zrilyi, 2013). Moreover, the imports of wheat and flour from Kazakhstan in 2008 was not high enough to meet all the wheat deficit in Afghanistan. The imports from Kazakhstan in 2008 were less than one million MT, implying wheat and flour imports from Pakistan continued to supply the eastern deficit regions in spite of the export restrictions from Pakistan.

In order to capture that scenario in our static model, we use a high transportation costs for wheat and flour imports from Pakistan. Hence, in the static export restriction case everything is the same as in the base case, except the transportation costs for wheat and flour imports from Pakistan increases.

To capture this scenario in the stochastic model, we use two different values for transportation costs for wheat and flour imports from Pakistan, conditional on Kazakh prices. Based on the realized Kazakh price data and the observed occurrence of export restriction policy, a threshold is defined. If Kazakh prices are below the threshold level, the actual transportation costs for Pakistani wheat and flour is used in the model. If Kazakh prices exceed the threshold level, the high value of transportation costs on Pakistani wheat and flour imports is used to capture the export restriction from Pakistan. Hence, the export restrictions in the stochastic model occurs only during the period of high world prices. However, world prices are the same as the base case in the static export restrictions scenario.

It is difficult to predict how often Pakistan restricts its wheat exports to Afghanistan. The key point to note is how the market outcomes look in the cases when Pakistan restricts its wheat exports. Based on the current threshold set for Kazakh prices, in less than 2% of iterations Pakistan restricts its wheat exports to Afghanistan.

Wheat plus flour flows from the static modeling results in the base case versus the static export restriction case are presented in Table 8-11. Modeling results show the export restriction policy has a large impact on the wheat and flour imports in Afghanistan. The Pakistani export restriction policy leads to a large decrease in imports from Pakistan, and an increase in wheat and flour imports from Kazakhstan. Imports from Pakistan fall from 1.1 MMT in the base case to 0.62 MMT in the export ban case. Imports from Kazakhstan increases from 0.53 MMT in the base case to 0.81 MMT in the export ban case. Central Kabul is mostly supplied by Pakistani wheat and flour in the base case. In the export restrictions case, the share of Kazakh wheat and flour become larger than the share of Pakistani wheat and flour in the Kabul Market.

Also, more wheat and flour from the northern surplus regions flows to the eastern deficit region in the export restrictions case than in the base case. Total national imports of wheat and flour fall and this forces domestic wheat from rural surplus regions to flow to deficit regions where prices are high. Wheat and flour flows from surplus to deficit regions increase from 358 thousand MT in the base case to 603 thousand metric tons in the export ban scenario. In the base case, wheat and flour flows from surplus regions are observed only to Kabul and Kandahar, and eastern Khost and Jalalabad are supplied by Pakistani flour. With the Pakistani export restriction policy in place, wheat and flour flows from surplus regions to all deficit regions, including those close to the Pakistani border are observed.

Table 8-11: Wheat plus Flour Flows: Base case versus Export Restrictions case.

	Region	Inflow from	Import from	Import from
Base Case	HER*		7,165	71,208
	JAL		198,090	0
	KAB	308,737	304,100	248,499
	KAN	49,302	338,555	1,586
	KDZ*		0	84,405
	KST		256,372	0
	MAZ*		0	124,947
	Total	358,038	1,104,282	530,644
Export Restriction Case	HER*		4,424	155,682
	JAL	71,320	98,242	0
	KAB	368,907	120,739	344,136
	KAN	161,494	186,695	3,424
	KDZ*		0	120,803
	KST	1,597	207,745	0
	MAZ*		0	181,979
	Total	603,318	617,846	806,024

Includes flour imports expressed in wheat equivalent (in MT).

Pakistani export restriction policy leads to an increase in wheat prices in the Afghan domestic markets, with relatively large increases in urban areas. Wheat prices in the base case versus the export ban scenario from the static model are presented in Table 8-12. The largest increase in prices are observed in Khost region, as this region is segmented from the northern surplus regions and highly dependent on Pakistani wheat and flour. Pakistani export restriction policy leads to a large price increase in southern Kandahar region and western Herat, as well. Although Herat is not primarily dependent on wheat and flour imports from Pakistan, prices increase there as all surplus wheat in Herat region flows to Kandahar. Similarly, the increase in wheat prices in the northern surplus regions is due the fact that all surplus wheat there flows to deficit regions in central Kabul and the eastern regions of Khost and Jalalabad.

Table 8-12: Wheat Prices: Base Case versus Export Restrictions Case.

	Base Case		Export Ban Base		% Change	
Region	Urban	Rural	Urban	Rural	Urban	Rural
HER	364	303	410	328	12.72	8.08
JAL	411	464	447	486	8.74	4.80
KAB	415	486	427	496	2.93	2.07
KAN	404	464	450	503	11.46	8.37
KDZ	375	311	387	318	3.25	2.19
KST	402	461	487	527	21.13	14.30
MAZ	375	300	387	306	3.25	2.18

Units are in US$/MT

8.6 Export Restrictions plus Low Domestic Production

Low domestic production combined with export restrictions by Pakistan in 2008 led to high wheat prices in Afghanistan. Also, Kazakh wheat prices were high and it took time for the Kazakh wheat to flow to Afghanistan and so stabilize prices. We are interested in assessing a similar scenario like the one in 2008, when Pakistan restricts its wheat exports and domestic production is low in Afghanistan. For this purpose we use the realized production and border price data of 2008. We adjust the error realizations for area, yield and prices to represent a scenario similar to 2008.

An export restriction combined with low domestic production leads to high wheat prices in Afghanistan. Wheat prices from the base case versus the export restriction combined with low production scenario are presented in Table 8-13. Price increases in rural areas are greater than those observed in urban areas. Domestic production is low and it is costly to carry imported flour to rural areas. Modeling results suggest that wheat prices in rural areas of surplus regions increase more than 100% due to the export restrictions from Pakistan combined with low domestic production. Results are consistent with the observed price data in 2008, as the highest price spikes were observed in rural areas during 2007-08 food crisis. Highest prices are observed in the rural zone of the Khost region, as this region is primarily dependent on Pakistan for its wheat consumption.

Table 8-13: Wheat Prices: Export Restrictions plus Low Domestic Production Case.

	Base Case		Export Ban plus Low Production		% Change	
Region	Urban	Rural	Urban	Rural	Urban	Rural
HER	364	303	539	605	48.18	99.62
JAL	411	464	589	619	43.34	33.42
KAB	415	486	569	632	37.22	29.91
KAN	404	464	579	629	43.41	35.55
KDZ	375	311	545	633	45.36	103.23
KST	402	461	597	655	48.38	42.16
MAZ	375	300	529	586	41.19	95.64

Units are in US$/MT

With a low domestic production and export restrictions from Pakistan, imports from Kazakhstan increase. Results are similar to the observed market outcomes in 2008. Imports from Kazakhstan increases from 530 thousand metric ton in the base case to about 1.17 MMT in this low production scenario. Trade flows for wheat and flour from the export ban plus low production scenario are presented in Table 8-14. Modeling results show that Kabul is mostly supplied by Kazakh wheat and flour in this scenario, with imports of 483 thousand MT from Kazakhstan only to central Kabul. Even in the export restriction case, eastern and southern deficit regions are mostly supplied by Pakistani flour.

Table 8-14: Wheat Flows for the Export Restrictions plus Low Production Case.

Region	Inflow from Surplus Regions	Import from Pakistan	Import from Kazakhstan
HER*	-	6,420	196,607
JAL	10,418	143,843	-
KAB	90,153	187,550	483,023
KAN	79,865	244,877	4,287
KDZ*	-	-	208,594
KST	-	221,517	-
MAZ*	-	-	279,022
Total	180,436	804,207	1,171,533

Includes flour imports expressed in wheat equivalent.

8.7 High Production Scenario

Following the food crisis in 2008, Afghanistan produced a record amount of approximately 5 MMT of wheat in 2009. High production combined with large imports from Kazakhstan led to price falls in rural surplus areas in Afghanistan. The Afghan government did not have any policy in place to stabilize producer prices in that year. In this scenario we assess the market outcomes under a high domestic production assumption. For this purpose, we use the realized production and border price data of 2013. Similar to 2009, Afghanistan produced more than 5 MMT of wheat in 2013. Kunduz region in the north had the largest wheat surplus in 2013. Error realizations for area and yield are set to replicate a case similar to 2013 in the static model. World prices used in this scenario are the same as in the base case.

Wheat prices from the base case versus the high production scenario are presented in Table 8-15. Modeling results show severe declines in wheat prices in rural surplus regions, particularly in the northern Kunduz region. Although prices in commercial centers are close to each other, high variability in prices of rural areas are observed in the high production case. Prices in commercial centers ranges between $314/MT in northern Kunduz and $374 in eastern Jalalabad, as the price difference is equal to transportation costs in this case. Prices in rural areas vary from a low $172/MT in Kunduz to $424 in Central Kabul. Wheat prices in rural areas of the Kunduz region fall from $301/MT in the base case to $172/MT in the high production scenario. The second largest decline in prices are observed in rural areas of the Mazar region. Higher domestic production reduces prices in central Kabul, but does not have a large impact on prices in the eastern regions close to Pakistan.

Table 8-15: Wheat Prices: Base Case versus High Production Case

	Base Case		High Production		% Change	
Region	Urban	Rural	Urban	Rural	Urban	Rural
HER*	341	291	327	266	-4.12	-8.65
JAL	388	449	374	409	-3.50	-8.91
KAB	396	470	354	424	-10.46	-9.86
KAN	381	444	367	406	-3.69	-8.59
KDZ*	356	301	314	172	-11.64	-42.76
KST	377	440	367	414	-2.50	-5.95
MAZ*	356	289	314	238	-11.64	-17.58

Units are in US$/MT

Given the weak market integration, wheat surpluses are mostly retained as stocks in rural areas and do not fully replace wheat imports. In the high production case wheat output is about 700 thousand MT higher than in the base case. The decrease in imports is about 400 thousand MT in the high production scenario, compared to the base case. Wheat plus flour flows expressed in wheat equivalent are presented in Table 8-16. The major difference is observed in central Kabul, where wheat surpluses from the northern regions replace about 200 thousand MT of imports in this region in the high production scenario. The decrease in imports from Pakistan versus Kazakhstan is similar in quantity, with a slightly higher decrease in Kazak imports than in Pakistan imports. Most of the surplus wheat is generated in the northern and western regions which are mainly supplied by Kazakh wheat in the periods of low production.

Surplus wheat from northern regions does not move to the eastern deficit regions close to Pakistan. Only a small quantity of wheat flows to eastern Jalalabad are observed. The urban price difference between northern surplus regions and eastern Khost is not large enough to establish a trade flow between northern regions and the eastern Khost region.

Table 8-16: Wheat plus Flour Flows: Base versus High Production Case.

	Region	Inflow from Surplus Regions	Import from Pakistan	Import from Kazakhstan
Base Case	HER*		7,165	71,208
	JAL		198,090	0
	KAB	308,737	304,100	248,499
	KAN	49,302	338,555	1,586
	KDZ*		0	84,405
	KST		256,372	0
	MAZ*		0	124,947
	Total	358,038	1,104,282	530,644
High Production Case	HER*		6,046	59,832
	JAL	358	170,532	-
	KAB	523,824	192,906	156,940
	KAN	46,962	289,571	1,337
	KDZ*		-	50,695
	KST		230,724	-
	MAZ*		-	73,116
	Total	571,144	889,778	341,919

Includes flour imports expressed in wheat equivalent.

8.8 Trade Policy

We assessed the market outcomes under four different static scenarios which are likely to be repeated in the wheat and flour markets in Afghanistan. Two of the four cases were extreme, exhibiting characteristics of the observed scenarios of the 2008 food crisis and the 2009 bumper harvest. We examine the impacts of stabilization policies in these extreme cases, as the main objective of stabilization policies is trimming the tails of distribution and preventing occurrence of those extreme cases. Although the expected impacts of these policies on market outcomes will be discussed in detail in the stochastic model results presented in the following chapter, here we look at how these policies affect prices and trade flows under specific alternative cases. We will also look at the costs of these policies in these extreme cases.

8.8.1 Variable Levy

In the variable levy scenario, we set a fixed price at border points, after the tariffs, for both imports from Pakistan and Kazakhstan. As prices in Kazakhstan and Pakistan change, the variable levy is adjusted in order to keep border prices fixed. Now domestic markets face a fixed border price for imports, as the variability in the world price is captured by the variable levy. We assume that the Afghan government continues subsidizing wheat and flour imports from Pakistan even when Pakistani export restrictions are in place.

A variable levy may result in revenue or costs for the government depending on the world prices and the policy setting the domestic prices. If the world prices are lower than the domestic prices, a positive variable levy can generate revenue for the government. If world price is high, a variable levy leads to large import subsidy costs. We will discuss this in more detail with the stochastic model results presented in chapter 9.

A variable levy is expected to be mainly effective in the cases of high world prices and low domestic production, similar to 2008. While public stockholding can also be effective in trimming the upper tail of the price distribution, its key objective is trimming the lower tail of price distribution and preventing producer price falls as in 2009. Therefore, in this part we assess the impacts of the variable levy on prices, assuming low domestic production and high world prices.

A variable levy does stabilize prices both in rural and urban areas. Wheat prices from the base case, export ban plus low production case, and the from this variable levy case are presented in Table 8-17. Comparing the prices from the export ban plus low production case with the prices in the variable levy case shows the impacts of the variable levy on prices. The effects of variable levy on prices are more pronounced in urban areas than in rural zones. Also, consumers in eastern and southern deficit regions close to Pakistan are better off relative to the northern regions, as we assume here the variable levy fully compensates the increase in prices due to export restrictions from Pakistan.

Table 8-17: The Effects of a Variable Levy on Wheat Prices.

	Base Case		Export Ban plus Low Production		Variable Levy	
Region	Urban	Rural	Urban	Rural	Urban	Rural
HER	364	303	539	605	411	488
JAL	411	464	589	619	398	491
KAB	415	486	569	632	433	521
KAN	404	464	579	629	395	473
KDZ	375	311	545	633	455	543
KST	402	461	597	655	386	478
MAZ	375	300	529	586	417	483

Units are in US$/MT

We assume the government continues to subsidize wheat and flour imports from Pakistan in spite of the Pakistani export restriction policy in place. However, the costs of the import subsidy surge in such scenarios. In this scenario, the level of import subsidy on wheat and flour imports from Pakistan is $147/MT, and it is $58/MT on imports from Kazakhstan. A high level of import subsidy combined with a large volume of wheat and flour imports leads to huge costs to the government. In this scenario the import level from Pakistan is 1.3 MMT and from Kazakhstan is almost 1 MMT. Given the import quantity and the high level of import subsidy, the costs of subsidy on imports from Pakistan is about US$193 million, and it is approximately US$58 million on imports from Kazakhstan in this extreme scenario of low production and high world prices.

8.8.2 Modified Variable Levy

Normally, it is not practical for a government with a large fiscal deficit to pay such huge costs for import subsidies. The Afghan government may not consider fully subsidizing wheat and flour imports from Pakistan in the export restriction cases. We assume the government cannot keep prices fixed at the mean at the Pakistani border during the periods when Pakistani export restriction policy is in place. Therefore, we now assume there will be an import subsidy on wheat and flour imports from Pakistan equal to the subsidy on imports from Kazakhstan. This will reduce the costs of the import subsidy on wheat and flour imports from Pakistan, and at the same time will reduce extreme price shocks but not as effectively as the variable levy case.

Wheat prices from the export restriction case versus variable levy and modified variable levy cases are presented in Table 8-18. In the modified variable levy case prices are higher compared to the variable levy case, but lower than the prices in the export restrictions case with no government intervention. Wheat prices are approximately $100/MT higher in regions supplied by Pakistani flour in the modified variable, compared to the variable levy case. In the modified variable levy case, the level of import subsidy is $58/MT and it is the same for both imports from Pakistan and Kazakhstan. Consumers are worse off in the modified levy case compared to the earlier variable levy case, especially consumers in the eastern and southern deficit regions. The impacts of this policy on the welfare of consumers and producers will be discussed in detail in chapter 9.

Table 8-18: Wheat Prices: Variable Levy Case versus Modified Variable Levy Case.

	Export Ban plus		Variable Levy		Modified Levy	
Region	Urban	Rural	Urban	Rural	Urban	Rural
HER*	539	605	411	488	439	515
JAL	589	619	398	491	491	559
KAB	569	632	433	521	471	553
KAN	579	629	395	473	479	548
KDZ*	545	633	455	543	455	543
KST	597	655	386	478	486	567
MAZ*	529	586	417	483	431	495

A reduction in the level of import subsidy on wheat and flour imports from Pakistan in the modified levy case leads to a decrease in imports from Pakistan and an increase in imports from Kazakhstan. Imports from Pakistan decreases from 1.3 MMT in the variable levy case to 0.9 MMT in the modified levy case, and this is partially compensated by an increase of approximately 244 thousand MT from Kazakhstan. Total national imports decline as prices are higher in the modified levy scenario and so consumption and stocks are lower compared to the variable levy case. In the modified levy case, the costs of the import subsidy are much lower (US$124 million) than in the variable levy case (US$251 million).

8.9 Public Stockholding Policy

Public stocks are carried for different objectives and based on those objectives different rules might be defined for accumulation and release of public stocks. Public stocks aiming to stabilize commodity prices are called buffer stocks. The key objectives of buffer stocks is to protect producers from price drops and/or consumers from price spikes.

Some governments carry food stocks for the purpose of providing social safety nets for the most food insecure people. These social safety stocks are different from buffer stocks, as they pursue different objectives and have different rules. There is another type of public food stocks, called emergency stocks, which are kept to provide assistance during food shortages and crises caused by sudden supply shocks, such as natural disasters.

Prior to implementation of public stockholding, it is important to define the objective or objectives of carrying public stocks. It is possible that stockholding policy pursues multiple purposes. However, the costs of stockholding policy increase and stockholding policy is likely to fail as this policy pursues multiple objectives. Some of the common objectives that public stockholding policy may pursue are contradictory in nature. For instance, improving food security by lowering consumer prices is not in line with supporting producer prices. Thus, pursuing multiple purposes is identified as one of the key causes leading to failure of stockholding policies (Dorosh, 2009; Goyal, 2012).

In our analysis, public stocks refers to buffer stocks with the objectives to stabilize wheat prices annually. A set of operating rules for the model are specified in order to capture the behavior of government policy institutions as they respond to varying market conditions. Policy response rules are needed for both stockholding and alternative trade strategies.

We are interested in evaluating the effects of stockholding policies on the distribution of wheat prices and on producer and consumer welfare. The main purpose of stocks policy here is to stabilize inter-annual price and consumption variability. This policy is expected to stabilize the wheat market and mainly support producers by preventing price falls below a certain level. This policy can also help stabilize inter-seasonal price variability by procuring wheat in the post-harvest period when prices are low and sell in the next pre-harvest or shortage period. Due to lack of data we develop an annual model and the focus here is to stabilize inter-annual prices only.

In order to stabilize prices, the stocks policy must be responsive to price movements. A common type of public stock rule is to define a minimum support price and accumulate all surplus at that price. This policy does not allow prices to fall below the price floor. The government intervenes and procures all surplus to keep the price above the minimum support price. Public stocks are released during production shortfalls and high prices. Based on the above description we develop a downward sloping stocks function for public stock which gets very elastic at low prices and it is very steep and close to zero with high prices. Both public and private stocks functions are presented in Figure 8-1.

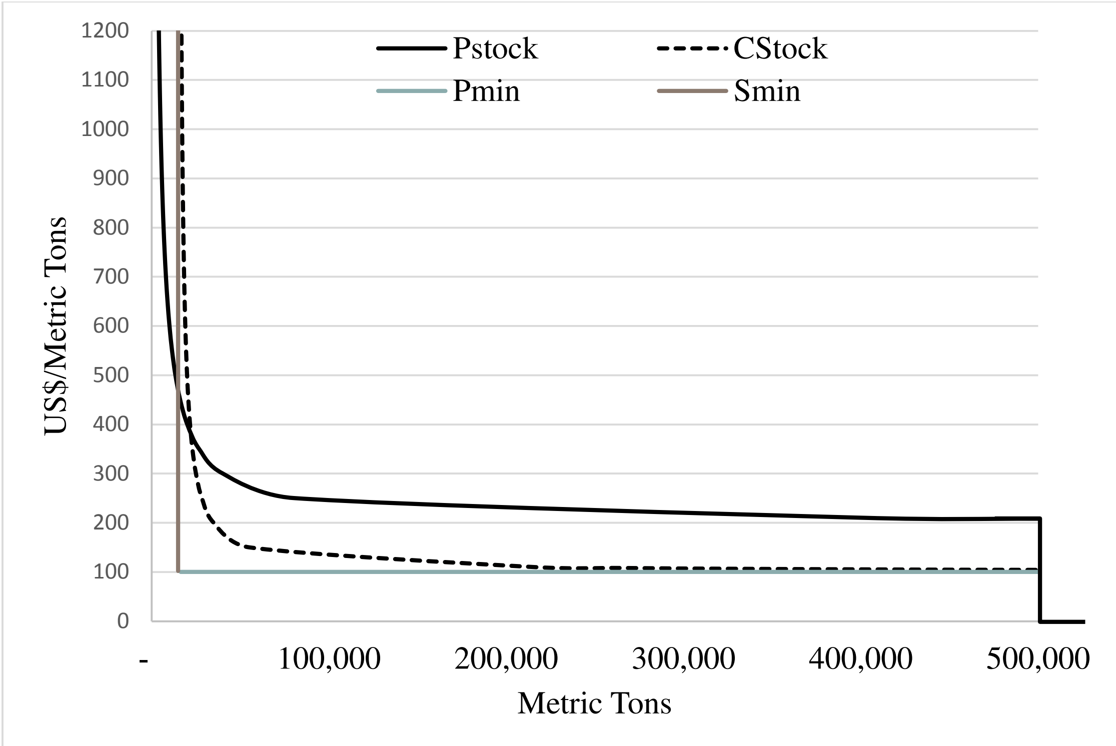

Figure 8-1: Public and Commercial (private) Stocks Functions.

Without government intervention there are only commercial (private) stocks, which are presented with the dashed line. The minimum support price (MSP) is assumed to be $100 per metric ton in the absence of government intervention. Public stocks are presented with the solid black line which prevents price falls below the minimum price (MSP) of $200 per metric ton. The stock model does not force a price floor or price ceiling. Stocks are modeled[11] based on the approximated L shaped stock function presented in Figure 8-1. The minimum support price for public stocks is set based on the price distribution in the market. In practice it is decided by the government and normally it is announced during planting season of wheat to farmers. The Minimum support price

[11] Stocks are modeled using a smooth continuums function that approximates the L-shaped, kinked behavior derived from storage theory. Under this approximation prices asymptotically approach the MSP from above, getting closer as stocks become larger. This approximation better fits observed market behavior and is much easier to model in GAMS.

is typically estimated based on open market prices, including prices in the international wheat market.

We assume public stocks are built only from domestically produced wheat. Thus, public stocks are held only in the surplus regions, Herat, Kunduz, and Mazar. The maximum public stock level is 0.5 MMT in each of the three surplus regions, Kunduz, Mazar and Herat. Maximum capacity is set based on the expected maximum quantity of surplus wheat in each region.

The objective of the stock function presented in Figure 8-1 is mainly trimming the lower tail of price distribution and supporting producer price. Public stocks can also be used to prevent price spikes by setting a price ceiling and does not allow prices to exceed the price ceiling as longs as stocks are available. However, large quantities of stocks are required in extreme cases in order to stabilize consumer prices.

Figure 8-2 represents the public stocks function with a price ceiling and price floor. Approximately 300 thousand MT of public stocks are the "normal" capacity assumed in each region. Public stocks are released in extreme cases of low domestic production and high world prices in order to keep the prices below or at the price ceiling. Thus, public stocks are zero at a price of $600/MT in principle. Similarly, more public stocks are accumulated in extreme cases of high domestic production in order to keep prices above or at price floor. This type of public stockholding policy which pursue two objectives, supporting producer price and stabilizing consumer prices, is very costly. Large quantities of public stocks are required to be maintained in order to prevent price spikes below the price ceiling.

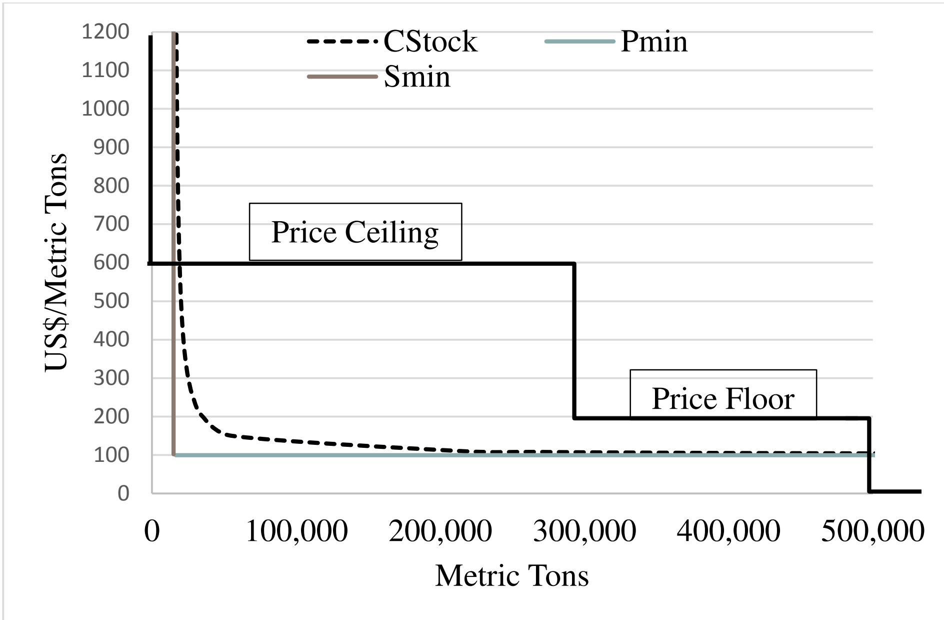

Figure 8-2: Public Stocks with Price Ceiling and Price Floor

8.9.1 Costs of Stockholding Policy

A major downside of stabilization policy through public stocks is the costs associated with carrying large quantities of stocks over time. Stockholding programs carry large direct costs to the agencies holding those stocks. The direct costs for public stocks include storage costs, transport costs, management costs, acquisition costs and the costs associated with distribution. These costs surge as the government increases its stocks and/ or broaden the objectives of stockholding policy. The costs of public stockholding increases if the government tries to help both producers and consumers.

Data and information regarding public stockholding are not available for Afghanistan. However, there are data available on the costs of public wheat storage in Pakistan. Pakistan procures wheat from farmers at a minimum support price during the harvest season, April and May, and the government stores wheat in its own or rented private storage. The government normally release the wheat to millers from early October until the next harvest in April (Prikhodko and Zrilyi, 2013).

Public storage costs are calculated based on the costs estimates of public storage in Pakistan. Costs of public storage for wheat in Pakistan are presented in Table 8-19. The total costs to the government from carrying stocks are $44 per metric ton, assuming the release price is $16/MT higher than the MSP. If the release price is the same as the MSP, the government has to pay the whole costs of carrying public stocks, which is $60/MT. The costs of the stockholding policy for the government depends on how this policy is implemented. Setting a high release price reduces the costs of stockholding policy for the government. Instead the consumers have to pay a high price for wheat. The largest share of the public stockholding costs come from the interest on financing the wheat procurement program.

Table 8-19: Costs of Public Wheat Storage in Pakistan in 2010/11

	PKR/Ton	US$/Ton
Minimum Support Price	23750	279
Storage Costs	825	10
Bagging, transportation, labor, etc.	896	11
Interest on commercial bank financing	3279	39
Total Costs	5000	60
Total Costs plus price	28750	338
Release price to millers	25000	294
Cost/Revenue	-3750	-44

Source: (Prikhodko and Zrilyi, 2013).

If Afghanistan decides to implement public stockholding policy for wheat, the costs of the policy might not be very different from the policy implemented in Pakistan. Thus, the costs estimates for public wheat storage in Pakistan can be used as a rough estimate for the costs of public stockholding policy in Afghanistan. Procurement and release prices may differ between Pakistan and Afghanistan. Hence, the distribution of the costs for the stockholding policy across agents may be different depending on how the policy is implemented.

8.9.2 Static Results from the Public Stockholding Policy

In this part we assess the impact of public stockholding policy on trade flows of wheat and flour and on prices. However, it is difficult to see the impacts of stockholding on market outcomes in full picture from a static case. Stabilization policies, including trade and stockholding policies, are mainly effective in extreme cases where domestic production is extremely high or low. The effects of the stockholding policy can be better captured in a stochastic model, which is presented in the following chapter. From this static model we want to see how much public stocks are required to be accumulated in high production cases and how this policy then affects trade flows and prices. Also, we will investigate how much public stocks are required to be released to stabilize prices and ensure food security in periods of low production plus high world prices, similar to 2008.

In the high production case, the largest wheat surpluses were observed in the northern Kunduz region. With a minimum support price of $200/MT, the total public stock accumulation is about 300 thousand MT, with 200 thousand MT in Kunduz and the remaining in Herat and Mazar. If the objective of the stockholding policy is mainly stabilizing producer prices, it can be achieved by carrying an average of 200 thousand MT of wheat annually. However, this quantity of stocks is about 5% of total wheat requirement and it is unlikely to be enough to trim the upper tail of the price distribution during the periods of low domestic production and high world prices. We will discuss the impacts of the stockholding on price distribution in more detail in stochastic model in chapter 9.

Modeling results suggest public stockholding policy is potentially effective in preventing extreme price falls in rural surplus regions. Prices from the high production scenario while public stockholding policy is in place are compared with the base case and the high production case in Table 8-20. In the high production case prices reach as low as $172/MT in surplus regions. With the public stockholding policy with MSP of $200, prices do not fall below $220/MT.

Table 8-20: Wheat Prices: Base Case versus High Production and Public Stocks Case.

	Base Case		High Production		High Production & Public Stock	
Region	Urban	Rural	Urban	Rural	Urban	Rural
HER	364	303	327	266	331	295
JAL	411	464	374	409	374	409
KAB	415	486	354	424	377	443
KAN	404	464	367	406	371	410
KDZ	375	311	314	172	337	220
KST	402	461	367	414	367	414
MAZ	375	300	314	238	337	266

8.9.3 Stockholding Policy in Urban Areas

Stockholding policy may also be used to trim the upper tail of price distributions and stabilize consumer welfare. However, carrying large quantities of public stocks possibly for a long period of time is required to stabilize prices for consumers. Also, a stockholding policy with an objective of stabilizing consumer prices is required to maintain large quantities of stocks, mainly in commercial centers of deficit regions instead of surplus regions.

In this section, we assess how much public stocks are required to stabilize prices in the periods of high world prices and low domestic production, similar to 2008. We implement the public stockholding policy in the low domestic production plus export restriction case. Here, we assume a price ceiling similar to Figure 8-2 and release stocks to maintain price below a price ceiling.

In the earlier section we assessed the impacts of the variable levy on price in that extreme scenario of low production plus export restriction. Here, we assume instead of a variable levy, prices are stabilized by releasing public stocks in commercial centers of each regions. We assume the objective of the public stockholding policy is stabilizing consumer prices and thus stocks are held in commercial centers in this scenario. We assume also that the necessary stocks have been accumulated earlier.

In each commercial center the levels of stocks release are determined and adjusted exogenously until the prices are stabilized at a level similar to the price levels from the variable levy scenario. The key point is to determine the level of public stocks release that can achieve the same stabilization objective achieved with a variable levy in the static low production plus export restrictions scenario.

Modeling results show that the same price stabilization level achieved with a variable levy can be reached by releasing large quantities of public stocks in commercial centers. Wheat prices from both variable levy and public stocks cases along with the stocks quantity are presented in Table 8-21. Prices are very similar across the variable levy and public stocks scenarios in both rural and urban areas.

Table 8-21: The Effects of Variable Levy versus Public Stocks on Prices.

	Export Restrictions plus Low Production		Variable Levy		Public Stocks		Stocks Release (000 MT)
Region	Urban	Rural	Urban	Rural	Urban	Rural	Urban
HER*	539	605	411	488	407	485	140
JAL	589	619	398	491	398	491	215
KAB	569	632	433	521	442	529	650
KAN	579	629	395	473	398	477	380
KDZ*	545	633	455	543	453	542	180
KST	597	655	386	478	389	481	275
MAZ*	529	586	417	483	415	481	190
TOTAL							2,030

Prices are measured in US$/MT

Either of these two policy options can be used to prevent price shocks like the ones in 2008 food crisis. However, public stockholding policy appears to be more costly than a variable levy. In order to stabilize prices in the periods of low domestic production plus export restrictions from Pakistan, carrying (having on hand) more than 2 MMT of annual public stocks in commercial centers are required. About half of these stocks are required to be accumulated in central Kabul and southern Kandahar. Assuming similar holding costs of $60/MT as in Pakistan, this policy creates an annual costs of about $120 million for the government. Although these costs are less than the costs of a variable levy in that specific year, a variable levy is more cost effective than a stockholding policy, as variable levy is positive most of the time. With a public stockholding policy carrying about 2MMT of public stocks are required for several years until that extreme scenario occurs. The government has to pay the costs of an import subsidy only with the periods of high world prices. We will discuss in details the likelihood of those extreme cases with the stochastic model results presented in the following chapter. The problem with the stockholding policy is that stocks have to be maintained annually until an extreme scenario (a significant production shortfall) occurs and public stocks are released to stabilize prices. Moreover, stocks are ineffective if that extreme scenario of low production occurs two years in a row, as stocks are depleted in the first year of a low production.

8.10 Modified Variable Levy versus Public Stocks

Earlier in section 8.3.7 we explained that modified variable levy is less aggressive in stabilizing prices than a standard variable levy. In the modified variable levy case imports from Pakistan are not fully subsidized to keep border prices fixed during the periods of export restrictions. Prices are more variable in the modified levy case than in the variable levy scenario, where border prices are maintained fixed even during the periods of export restrictions by Pakistan. The costs of the import subsidy in the modified levy scenario were less than the costs in the variable levy case.

We assess here how much public stocks must be released in each commercial center to stabilize prices at a level similar to the modified variable levy. We expect that level of price stabilization can be reached with smaller quantities of public stocks than in the previous case, where public stocks stabilized prices the same as a variable levy. Modeling results suggest large quantities of public stocks are required even to reach a stabilization level close to the modified variable levy. The level of public stocks along with the prices from the public stockholding policy versus the modified variable levy are presented in Table 8-22. Approximately 1.6 MMT of public stocks are required to be released, mainly in Kabul and Kandahar, to stabilize prices at a level that could be achieved with a modified variable levy. The costs of the import subsidy in the modified levy case is about the half of the costs of the subsidy in variable levy scenario: US$ 124 million in the modified levy case versus US$ 251 million in the variable levy. Allowing for some variability in prices through a trade policy reduces the costs of the import subsidy substantially. The level of the stocks does not change significantly when allowing for some variability in prices as in the modified levy scenario. The level of the total public stocks drops from 2 MMT in the previous scenario to about 1.6 MMT in the current case, where price are stable at a level that could be achieved with the modified variable levy. Therefore, a variable levy is more cost effective than a public stockholding policy in stabilizing consumer prices at different stabilization levels.

Table 8-22: Wheat Prices: Modified Variable Levy Case versus Public Stocks Case.

	Export Restrictions plus Low Production		Modified Levy		Public Stocks		Stocks Release (000MT)
Region	Urban	Rural	Urban	Rural	Urban	Rural	Urban
HER	539	605	439	515	439	517	100
JAL	589	619	491	559	489	558	135
KAB	569	632	471	553	472	554	550
KAN	579	629	479	548	477	547	280
KDZ	545	633	455	543	453	542	180
KST	597	655	486	567	488	569	175
MAZ	529	586	431	495	432	497	160
TOTAL							1,580

Prices are measured in US$/MT

8.11 Differential Tariff on Wheat versus Flour

Findings from the trader survey suggest that the Afghan milling industry cannot compete with imported flour from Pakistan and Kazakhstan under the current policy regime, which is equal tariffs on wheat and flour imports. Some of the Afghan millers proposed removing the 10% tariffs on wheat imports to reduce flour imports and increase wheat imports. This policy may not have a large impact on the Afghan wheat producers, as imported wheat is required to be blended with the low quality domestic wheat in the milling process. Based on our trader survey, flour produced only from local wheat is not preferred by most consumers, especially in urban areas. Our model specifications assume imported wheat flour is an imperfect substitute to domestic wheat and flour when we assess the impacts of differential tariffs across actors in the market.

In this section, we assess the effects of removing the tariffs on wheat, while leaving the flour tariffs fixed at 10%. We expect this policy will lead to a reduction in flour imports and an increase in wheat imports. However, the effects are unlikely to be large, as in a framework of imperfect market integration trade policy is not as effective as in a competitive spatial equilibrium. The Armington framework captures the elasticity of substitution across flour types.

The effects of removing wheat imports tariffs on total wheat milled, imports of wheat versus flour, and on domestic production are presented in Table 8-23. As expected, the policy increases wheat imports and reduces flour imports, which subsequently leads to an increase in wheat milled domestically. Total wheat milled goes up by approximately 1.27%. Wheat imports from Pakistan and Kazakhstan increase by 48% and 38%, respectively. Modeling results suggest this reduces wheat production by approximately 1%. The impacts of this policy are not economically significant, since the initial wheat imports are much lower than flour imports.

Table 8-23: Effects of Differentials Tariffs on Wheat versus Flour.

Variables	Base	No Tariffs on Wheat	Difference	% change
Total wheat milled	3,337,513	3,379,752	42,239	1.27
flour import Pakistan	954,486	931,262	(23,224)	-2.43
wheat import Pakistan	43,742	64,834	21,092	48.22
flour import Kazakhstan	416,170	405,657	(10,513)	-2.53
wheat import Kazakhstan	68,234	94,315	26,081	38.22
Domestic Production	4,365,669	4,321,198	(44,471)	-1.02

Units are MT

Removing the 10% ad valorem tariffs on wheat imports leads to a decrease in wheat prices in both rural and urban areas. Wheat prices from the base case versus the zero tariff scenario are presented in Table 8-24. As expected, a higher difference in prices between the two cases are observed in urban areas than in rural zones. The effects of this policy on the border are more pronounced in urban commercial centers than in rural areas. Removing the 10% tariffs on wheat imports leads to a decreases of about 6% in prices in commercial centers, and approximately 4% in rural areas, on average.

Table 8-24: Wheat Prices: Base Case versus Zero Tariffs on Wheat Imports.

	Base Case		Zero Tariffs on Wheat Imports		% Change	
Region	Urban	Rural	Urban	Rural	Urban	Rural
HER	364	303	339	290	-6.89	-4.36
JAL	411	464	385	446	-6.45	-3.82
KAB	415	486	393	468	-5.27	-3.79
KAN	404	464	379	442	-6.21	-4.71
KDZ	375	311	353	299	-5.83	-3.95
KST	402	461	375	438	-6.87	-5.00
MAZ	375	300	353	288	-5.83	-3.92

A differential tariff on wheat versus flour is expected to affect the welfare of producers and consumers, as well. On average, this policy reduces producer welfare by 5%, from $115 million in the base case to $109 million in the zero wheat tariff scenario. Since there are price decreases, modeling results show an increase of $6 million in consumer surplus as a result of removing wheat tariffs. Consumer welfare increases from $283 million in base case to $289 million in the zero tariff scenario. So, the gains to consumers are roughly equal to producer losses. The revenue of millers increases by $3.8 million as a results of tariff removal on wheat.

CHAPTER 9. STOCHASTIC MODEL RESULTS

In this chapter we present the results from the stochastic model, assessing the expected effects of different policy options on wheat and flour markets in Afghanistan. We begin with the comparison of *base & no export restrictions case* which does not capture the Pakistani export restriction policy with the stochastic *base case*[12] that incorporates the scenario of Pakistani export restrictions when world prices exceeds a high threshold. Then we assess the impacts of stockholding policy on prices and welfare of producers and consumers. The effects of a trade policy (such as a variable levy) on market outcomes is assessed, following the stockholding policy. After the results from the stockholding and the trade policy, we present the combined effects of these policies when implemented simultaneously.

9.1 Export Restrictions versus Base

As explained in the previous chapter, the transportation costs for wheat and flour imports from Pakistan increase when the Pakistani export restriction policy is in place. In the stochastic model, we assume the export restriction policy kicks in when the Kazakh prices exceeds a given threshold. We compared the results with base and no export restriction scenario.

Price distributions from the modeling results in the base case versus the base with no export restrictions scenario are presented in Figure 9-1. Prices are stable in urban centers close to Pakistan (JAL, KAB, KAN and KST) in the base & no export restrictions

[12] The Export restriction case is explained in detail in Chapter 8. In the base case for stochastic scenarios Pakistani export restrictions apply when world prices exceeds a given threshold.

case. Prices have been stable in Pakistan historically and the transportation costs for wheat and flour flows from Pakistan to Afghanistan are low, assuming no export restrictions from Pakistan. Thus, stable prices in Pakistan combined with low transportation costs between Pakistan and Afghanistan lead to fairly stable prices in southern and eastern regions in Afghanistan.

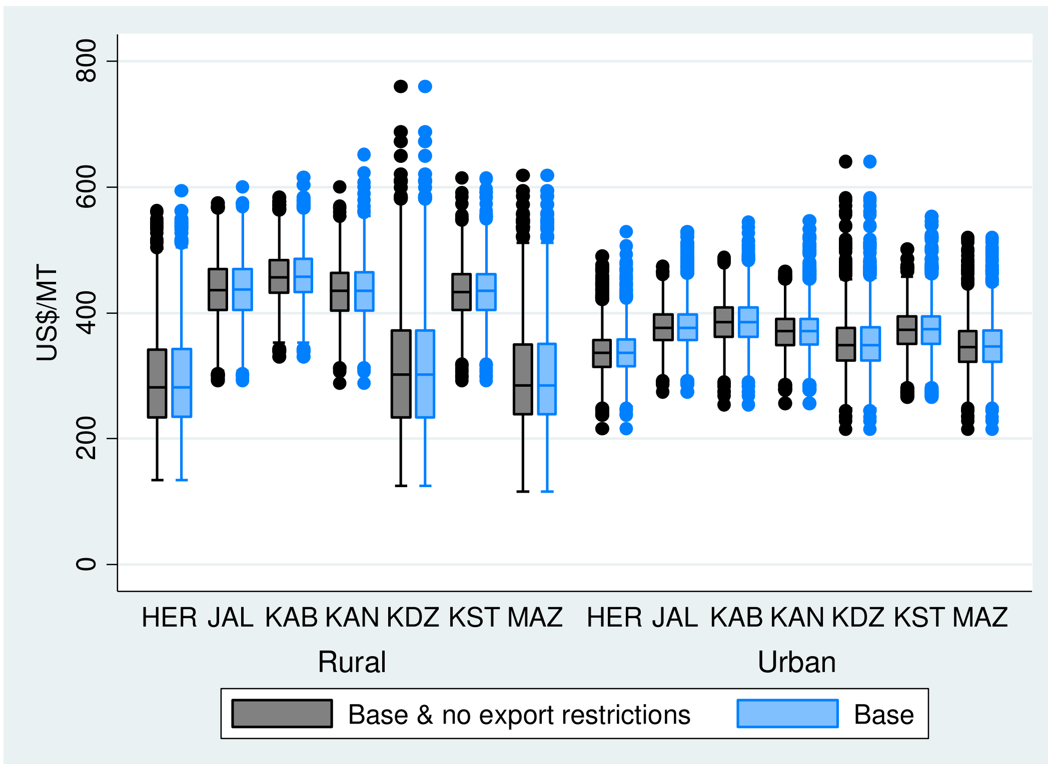

Figure 9-1: Price Distribution: Base Case versus Base & no Export Restrictions Case. [13]

Higher variability in prices is observed in regions mainly supplied by Pakistani wheat and flour when the export restriction policy is captured in the model, however. The

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[13] Regions with the star signs (*) indicates surplus areas. The bottom and top of the box are the first and third quartiles, and the band inside the box is the median. The ends of the whiskers represent the lowest datum still within the 1.5 interquartile range of the lower quartile and the highest datum still within the 1.5 interquartile range of the upper quartile. Interquartile range is the difference between upper and lower quartiles. The dots outside the whiskers represent outliers for 2000 repetitions that exceed the 1.5 interquartile range.

box plots with light color exhibit prices distributions assuming export restrictions from Pakistan during periods of high world prices. The export restriction policy by Pakistan does not affect the price distribution in northern Mazar and Kunduz as Pakistani flour does not flow to northern regions of Afghanistan. The effects of the Pakistan export restriction policy are more pronounced in deficit urban centers, and to some extent the price shocks are transmitted to rural areas of deficit regions as well. The modeling results from this scenario that assume export restrictions from Pakistan appears to better fit the observed price distribution. Price spikes are observed in deficit regions close to Pakistan in historical price data. Therefore, the model that assumes export restrictions from Pakistan is used as the base for our subsequent analysis.

The distributions of observed prices for wheat are shown in Figure 9-2. These are monthly price data obtained from FAO and WFP. Thus, we may observe higher variability in the distributions of observed prices than the ones from the modeling results, as modeling results are annual prices. The price data for urban centers are for a longer period of time, 2000-2015, and thus have lower means. The price data for rural areas are for a short period of time, as they are not available for a longer period. Also, price data for the urban center of Kunduz region are not available. The observed rural prices are only for a specific market in rural areas and might not represent the average rural prices in a given region. The key point to notice is that the highest price spike is observed in a rural market of the Kunduz region. Price data from the modeling results are consistent with the observed prices, as modeling results also suggests high price shocks in rural surplus regions. Also, some variability in urban deficit regions close to Pakistan is observed which supports the assumption of export restrictions from Pakistan.

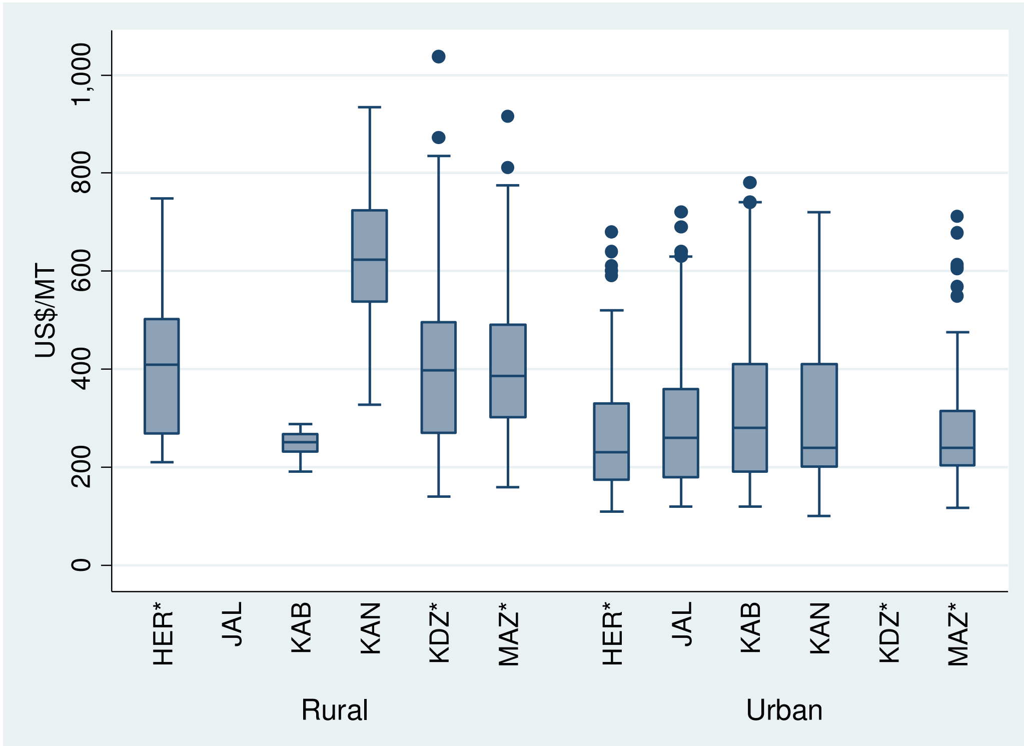

Figure 9-2: Observed Price Distribution for Wheat.

Prices are more volatile in the northern Kunduz region than in other regions. A shortfall in domestic production combined with high prices in Kazakhstan lead to price spikes in northern Kunduz and Mazar regions. The transportation costs are too high for Pakistani flour to flow all the way to the northern regions. Domestic production is more volatile in surplus northern and western regions than in southern and eastern deficit regions, as there is large rainfed wheat production in surplus regions depending directly on the amount of rainfall. Therefore, volatility in domestic production creates variability in wheat prices. Moreover, northern and western regions are mostly supplied by imported wheat and flour from Kazakhstan. Kazakh wheat prices are more variable than Pakistani price, as seen in Figure 9-3. Therefore, some of the variability in prices is imported from Kazak prices.

Pakistani government historically has been implementing stabilization policies mainly through stockholding. The government of Pakistan procures wheat at minimum support prices to support farmer incomes and subsidizes wheat sales to flour mills or directly to consumers with the objective of stabilizing prices at levels affordable to consumers (Dorosh and Salam, 2008). Pakistani stabilization policies lead to stable prices in the Afghan wheat markets mainly supplied by Pakistani wheat and flour for most of the time. However, during periods of high world prices Pakistan restricted its wheat exports to Afghanistan and this led to price spikes in the Afghan wheat markets.

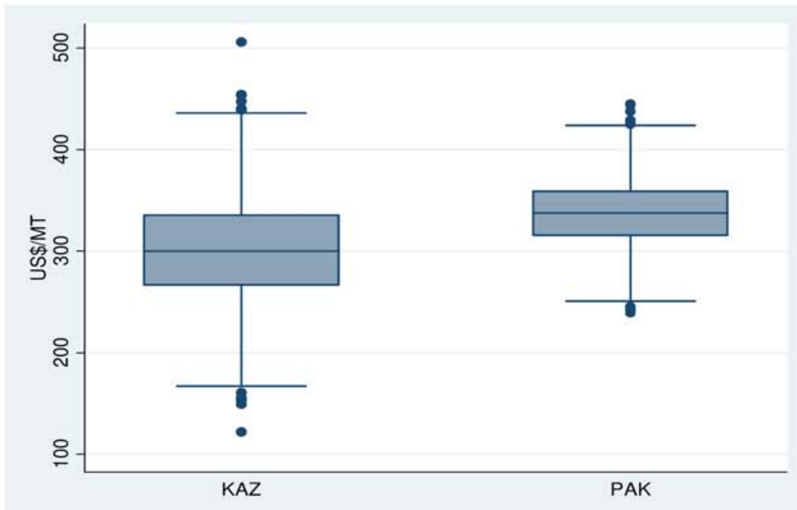

Figure 9-3: Price Distributions in Kazakhstan and Pakistan.

9.2 Public Stockholding Policy

We assess here the effects of public stock policy on price distributions and the welfare of producers and consumers across rural and urban areas in Afghanistan. The expectation is that public stockholding policy will help producers in surplus areas when prices fall, and it helps consumers by preventing price shocks. The primary objective of the stockholding policy examined now is supporting producer prices, and thus stocks are held in rural surplus regions. We assume public stocks are held in rural surplus areas where domestic surplus wheat is available. We assume the primary objective of the public stockholding policy is to trim the lower tail of the price distribution and help wheat producers during the periods of high production. Therefore, public stocks are accumulated only from domestic wheat. The analysis on public stocks are done under two scenarios of domestic production and two different levels of the minimum support price: normal production with a MSP of $200/MT (Stock1) versus high domestic production with a MSP of $250/MT (Stock2).

9.2.1 Public Stockholding Policy with a MSP of $200 (Stock1)

The public stockholding policy is effective in stabilizing prices, mainly in rural surplus areas where the stocks are held. The lower tail and somewhat the upper tail of the price distribution are trimmed when public stocks are introduced as seen in Figure 9-4. Dark color boxplots shows the price distribution from the base case, and the price distribution from the public stock scenario is presented with the light color boxplots. Changes in means and standard deviations of prices as a result of public stocks are presented in Figure 9-4.

Public stocks reduce the variability in prices in all regions where stocks are held, and in central Kabul as well. However, the larger effects are observed in rural surplus areas. The decrease in the standard deviation of the prices ranges between 11 and 14 percent in rural surplus areas, while it is between 6 and 7 percent in urban surplus regions. The effects of public stocks are observed in Kabul due to the fact that Kabul is the closest deficit commercial center to the northern surplus regions and it is often supplied by surplus wheat from the northern regions. Eastern deficit regions are mostly supplied by Pakistani flour and surplus wheat from the northern regions does not often move to the deficit regions close to Pakistan. Thus, a public stockholding policy implemented in the northern surplus region is unlikely to have a significant impact on the market outcomes in the eastern deficit regions.

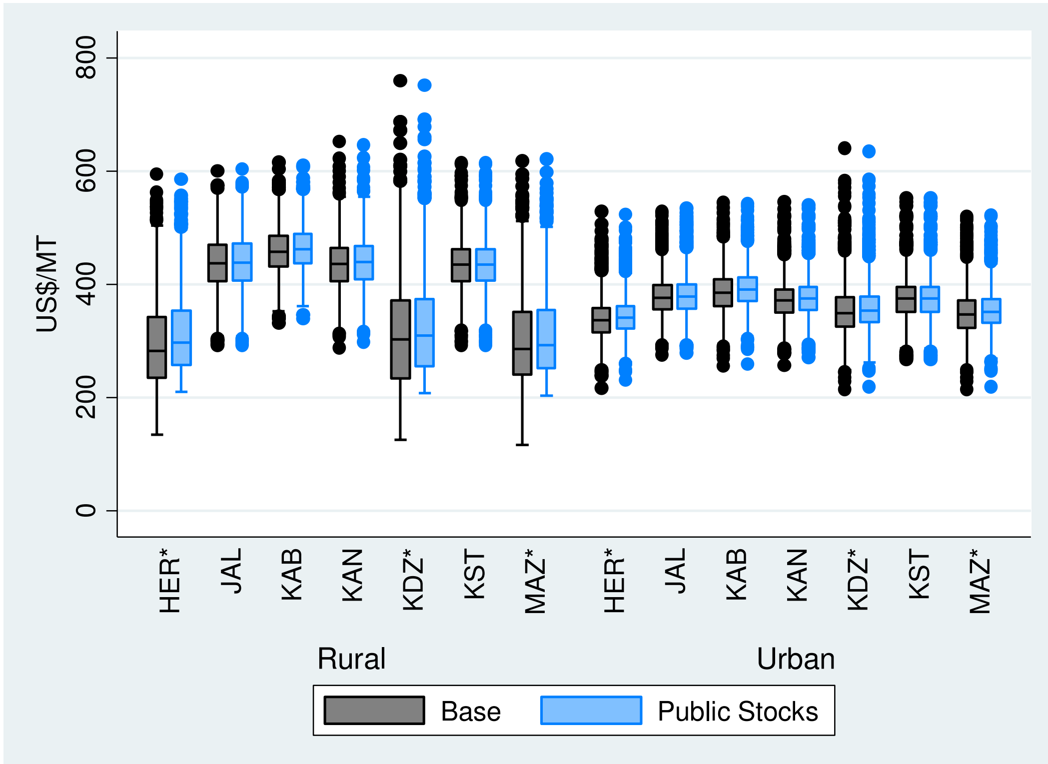

Figure 9-4: Price Distribution: Base Case versus Public Stocks Case

Public stock policy does not change the mean of the prices significantly, on national average. However, a considerable increase in the mean of the prices in rural surplus areas is observed, with the largest a 6 percent increase in Herat. This is due to the fact that the public stocks are more effective in trimming the lower tail of the price distribution than the upper tail. Therefore, a public stock policy based on domestically produced wheat may support producers more than consumers in Afghanistan.

Table 9-1: Wheat Prices: Base Case versus Public Stocks Case

Region		Base		Public Stocks		% Change	
		Rural	Urban	Rural	Urban	Rural	Urban
HER*	Mean	292	338	310	343	6.16	1.47
	Std. Dev.	77	37	66	34	-13.92	-5.89
JAL	Mean	437	377	439	379	0.32	0.50
	Std. Dev.	48	33	49	33	0.94	0.00
KAB	Mean	459	385	464	391	0.99	1.36
	Std. Dev.	40	36	38	33	-4.69	-7.40
KAN	Mean	434	371	438	375	0.84	1.10
	Std. Dev.	45	33	45	32	-1.30	-3.93
KDZ*	Mean	311	353	324	357	4.17	1.30
	Std. Dev.	96	45	85	42	-12.05	-6.60
KST	Mean	434	374	434	374	0.03	0.05
	Std. Dev.	44	35	45	35	0.27	0.42
MAZ*	Mean	297	348	307	353	3.23	1.41
	Std. Dev.	78	39	69	36	-11.00	-7.45
Total[14]	Mean	381	364	388	368	1.89	1.02
	Std. Dev.	96	41	88	39	-8.23	-4.64

Units are in US$/MT

Although public stockholding is effective in stabilizing prices in rural surplus areas, price shocks are observed in some rural areas of northern Kunduz and Mazar even after implementing the stockholding policy. These are the cases when there are production shortfalls for two years in sequence, and there are not enough stocks in the second year to prevent price shocks. Stocks cannot completely eliminate the upper tail of the price distribution. A stockholding policy with a primary objective to support producer prices are not large enough to prevent price shocks in the extreme cases of low domestic production and high world prices.

Modeling results suggest public stocks are not as effective in stabilizing prices in deficit regions as in surplus regions. Markets are not well integrated between rural and

[14] The mean and standard deviation in this row (Total) are from the overall data, including all regions. The standard deviations in this row are typically higher than those in each specific region, since the standard deviations in this row is across regions.

urban areas and this limits wheat flows from rural surplus regions where wheat is stored to deficit regions. Moreover, on average public stocks are not carried over time in large quantities as normally large surpluses are not available. Although public stock accumulation reaches as high as 0.5 MMT in Mazar and Kunduz, the average public stocks is approximately 62,000 metric tons in each region, as seen in Table 9-2. The distributions of the public stocks suggest stock accumulations are normally less than 100 thousand MT in each of the surplus region, as seen in Figure 9-5. Public stocks accumulation exceeds 150 thousand MT in each region only in 8% of repetitions.

Table 9-2: Public Stocks Accumulation

Region	Mean	Std. Dev.
HER	57,615	46,522
KDZ	61,873	63,266
MAZ	67,169	67,402
Total	62,212	59,854

Units are in MT

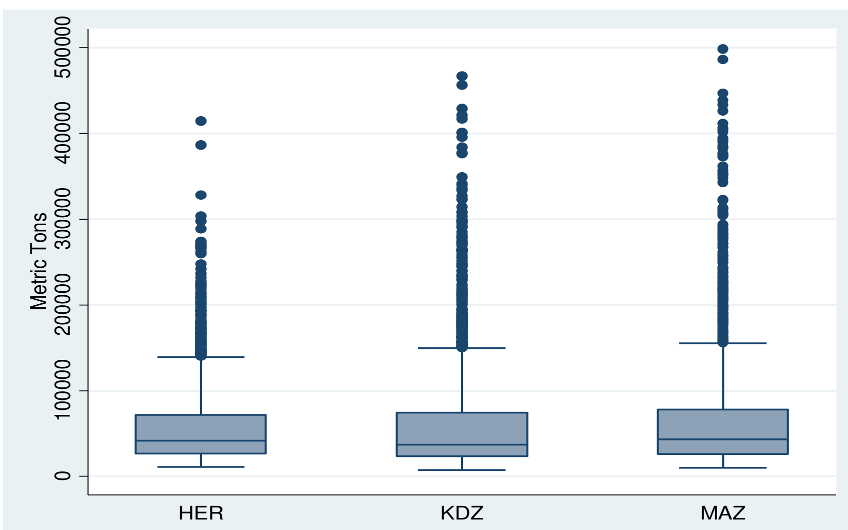

Figure 9-5: The Distribution of Public Stocks in Surplus Regions.

Although the main objective of stabilization policies is not changing the mean of the market outcomes, the distributional impacts of such policies often lead to changes in the means of producer and consumer surplus. Trimming the lower tail of the price distribution with public stocks is likely to improve producer welfare in our model. Modeling results show that producer welfare increases on average for all regions. A larger increase in producer welfare is observed in surplus regions where stocks are held. As public stockholding policy is more effective in trimming the lower tail of price distribution than the upper tail, this leads to an increase in the mean of prices, especially in surplus regions. The increase in mean of prices subsequently increases the mean of producer welfare.

Table 9-3: Producer Surplus: Base Case versus Public Stocks Case

Region	Base		Public Stocks		% Change	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
HER*	89.20	9.74	96.77	8.75	8.49	-10.17
JAL	75.59	7.99	75.95	7.91	0.48	-1.05
KAB	101.51	12.55	102.88	12.22	1.35	-2.70
KAN	117.08	12.32	118.23	12.12	0.98	-1.65
KDZ*	137.88	16.33	146.03	14.24	5.91	-12.83
KST	72.02	8.52	72.05	8.53	0.04	0.11
MAZ*	144.91	15.49	152.66	16.81	5.35	8.47
Average	105.46	29.47	109.22	31.62	3.23	-2.83

Public stockholding reduces the variability of producer surplus in most cases. With the exception of Khost and Mazar, the standard deviation of producer welfare decreases when the public stockholding policy is active, compared to the base case for all regions, as shown in Table 9-3. Variability in producer welfare increases in Mazar where public stocks are held. The increase in variability of producer welfare in Mazar is mainly in the upper tail of the welfare distribution. Domestic production in Mazar is more volatile than in other regions. A large production combined with stable prices leads to high welfare gains for producers. With no public stock intervention, prices often decline during years of large production and this does not allow producer welfare to surge. Welfare distributions for producer surplus in the base case versus public stock scenario is presented in Figure 9-6.

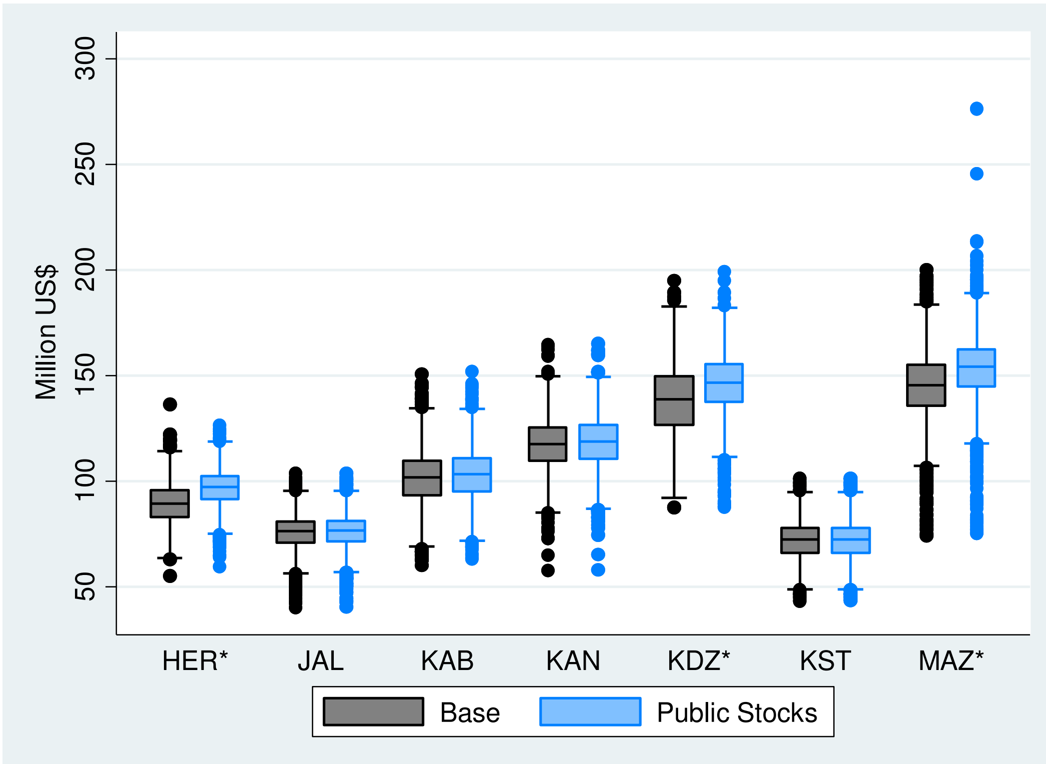

Figure 9-6: Producer Surplus: Base Case versus Public Stocks Case

Modeling results show that public stockholding policy as implemented in this case is in favor of producers in Afghanistan. Procurement of wheat surplus from farmers with a minimum price not only stabilizes, but also increases producer welfare on average.

As public stockholding policy stabilizes prices, it reduces the variability in consumer welfare. However, its distributional effects lead to a small decrease in the mean of consumer welfare, as well. The mean and standard deviation of consumer surplus from the base case versus the public stock scenario are presented in Table 9-4.

The distributional effects of a stockholding policy are expected to be larger in the rural areas than urban centers. Public stockholding is less likely to affect prices in urban centers. As seen in Table 9-4, the changes in consumer surplus in urban centers are very small, approximately 0.5%, on average, in most cases. However, the decrease in consumers' welfare in rural surplus areas is higher, ranging between 1.68% in Kunduz and 2.31% in Herat.

Table 9-4: Consumer Surplus: Base Case versus Public Stocks Case

Region		Base		Public Stocks		% Change	
		Rural	Urban	Rural	Urban	Rural	Urban
HER*	Mean	303.87	57.40	296.85	57.03	-2.31	-0.65
	Std. Dev.	28.88	2.70	24.50	2.53	-15.18	-6.26
JAL	Mean	352.41	29.20	351.86	29.14	-0.16	-0.21
	Std. Dev.	19.10	1.05	19.27	1.05	0.88	-0.05
KAB	Mean	584.64	512.94	581.87	510.24	-0.47	-0.53
	Std. Dev.	23.91	18.34	22.73	16.93	-4.92	-7.68
KAN	Mean	706.19	66.15	703.70	65.90	-0.35	-0.38
	Std. Dev.	30.84	2.06	30.39	1.97	-1.46	-4.11
KDZ*	Mean	480.79	27.52	472.71	27.35	-1.68	-0.60
	Std. Dev.	56.18	1.56	48.73	1.45	-13.26	-6.93
KST	Mean	389.47	21.57	389.41	21.57	-0.02	-0.02
	Std. Dev.	19.44	0.83	19.49	0.83	0.26	0.40
MAZ*	Mean	472.60	52.65	466.83	52.32	-1.22	-0.63
	Std. Dev.	44.48	2.60	39.18	2.40	-11.92	-7.79
Total	Mean	470.00	109.63	466.18	109.08	-0.81	-0.51
	Std. Dev.	31.83	4.16	29.19	3.88	-8.32	-6.76

Consumer surplus is more stable in the public stockholding case compared to the base case, as seen in Figure 9-7. As public stocks stabilize prices, this policy regime trims the upper tails and somewhat the lower tails of the consumer welfare distribution. The effects are more visible in surplus regions where stocks are held. Modeling results show that public stock policy lead to a reduction of 15%, 13% and 12% in the standard deviation of consumer surplus in Herat, Kunduz, and Mazar, respectively.

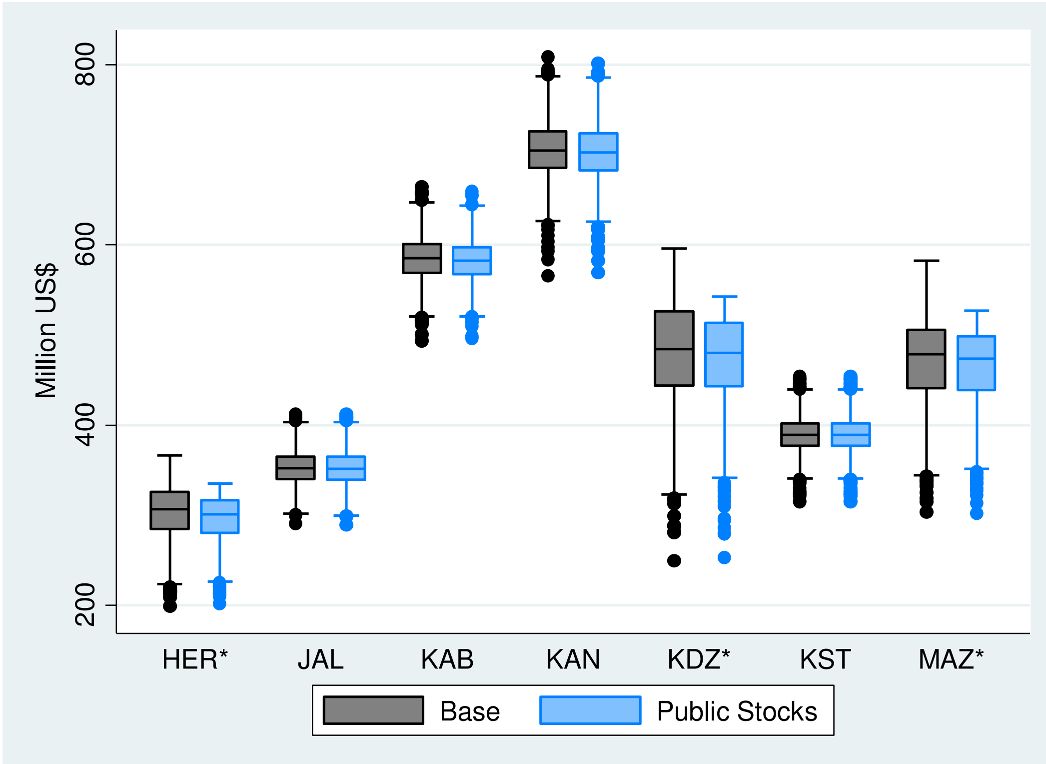

Figure 9-7: Consumer Surplus: Base Case versus Public Stocks Case

There are some distributional effects associated with the public stockholding policy across producers and consumers. The increase in producer surplus from the stockholding policy roughly equals the welfare loss in consumer surplus. However, there are other agents in the market, in addition to producers and consumers that can be affected by stockholding policy. Public stocks policy is likely to reduce welfare of traders who hold commercial stocks and the government, which pays the costs of carrying public stocks over time.

Public stocks often works as a substitute for commercial stocks. When government intervenes in the market through stockholding, it limits the accumulation of commercial stocks by traders or farmers. However, in Afghanistan commercial stocks for wheat are not significant. Surplus wheat is accumulated in rural areas by farmers in most cases. The quantity of commercial stocks are affected by public stocks as presented in Figure 9-8.

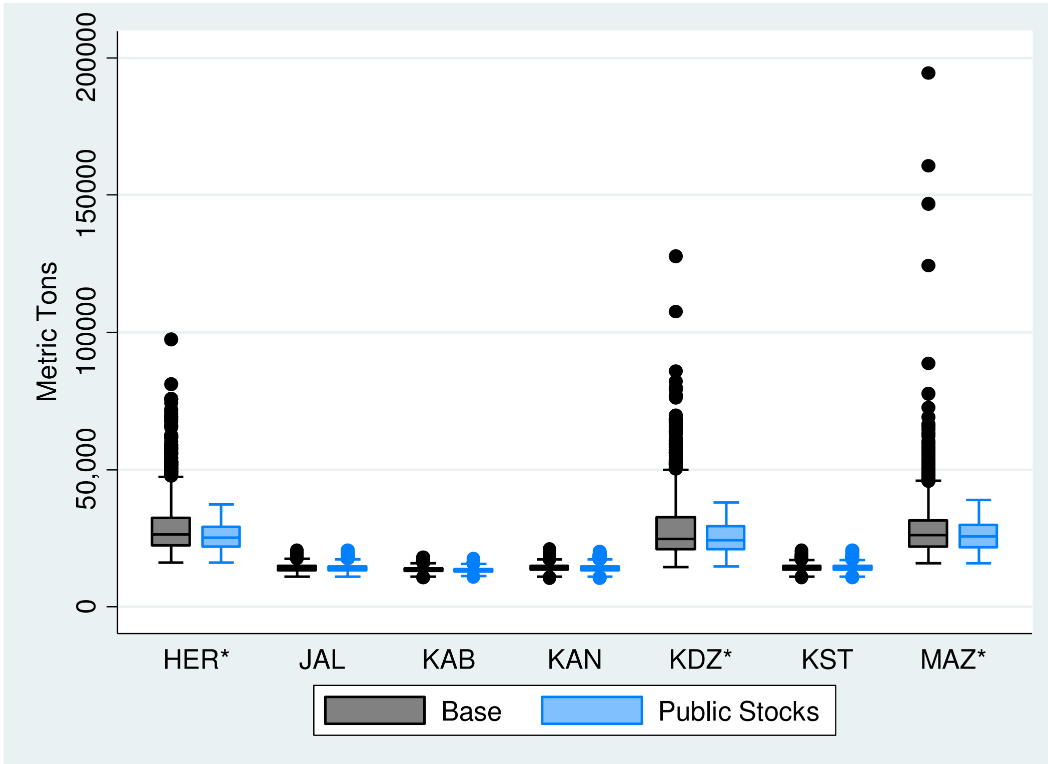

Figure 9-8: Commercial Stocks: Base Case versus Public Stocks Case.

Commercial stocks are much larger in the base case compared to the scenario when public stock policy is active. Extreme cases are observed only in surplus regions. As expected, the difference in commercial stocks between the two cases are observed only in surplus areas where public stock policy is implemented.

Assuming the same per metric ton costs as in Pakistan for carrying public stocks in Afghanistan, the annual average storage costs are about US$8 million. The total costs of the stockholding policy can reach as high as US$34 million in the periods of high domestic production and accumulation of a high level of public stocks. The level of public stocks and the costs associated with the public stockholding policy are presented in Table 9-5. On average, approximately 186 thousand MT of public stocks are carried annually, with a maximum of 780 thousand MT and a minimum of 45 MT.

Table 9-5: The Costs of the Public Stockholding Policy.

Variable	Obs	Mean	Std. Dev.	Min	Max
Public Stocks (000 MT)	2000	186.27	111.00	44.55	780.23
Costs (Million US$)	2000	8.20	4.88	1.96	34.33

Nationally, the effects of public stocks are small on most variables on average, but they are more pronounced on wheat and flour imports. Table 9-6 shows the effects of public stocks on key variables at the national level. With the public stock intervention, imports for wheat and flour increase as domestic production is accumulated in government stocks. There is an increase of 3% and 5% in flour imports from Pakistan and Kazakhstan, respectively. Similarly, wheat imports from Pakistan and Kazakhstan increase, as well. There is also a 2.27% decrease in quantity of wheat milled domestically as wheat accumulated in public stocks is mostly replaced by imported flour. Domestic production increases slightly as a result of an increase in the mean of the prices.

Table 9-6: Public Stocks Effects on Key Variables

Variable	Base		Public Stocks		% Change	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Consumption	4,381,641	87,843	4,364,090	78,552	-0.40	-10.58
Production	4,295,443	355,703	4,323,076	376,646	0.64	5.89
Flour Imports_p	901,706	195,946	930,126	194,774	3.15	-0.60
Wheat imports_p	40,433	7,272	41,434	7,162	2.48	-1.52
Flour Imports_k	443,829	185,838	466,706	189,297	5.15	1.86
wheat imports_k	77,405	43,351	81,917	43,468	5.83	0.27
Wheat milled	3,373,452	266,200	3,296,954	232,694	-2.27	-12.59

The suffix p indicates imports from Pakistan and k indicates imports from Kazakhstan

9.2.2 Public Stockholding Policy with a MSP of $250 (Stock2)

The role of public stockholding policy on price stabilization become more visible as the policy becomes more aggressive and high stocks are accumulated. In this section we increase the minimum support price from $200/MT to $250/MT. Everything else is the same as in the stock1 case.

Modeling results show that public stockholding becomes more effective with a high minimum support price. Large stocks not only trim the lower tail of price distribution, but also the upper tail. Price distribution from the base case versus the public stock2 case are presented in Figure 9-9.

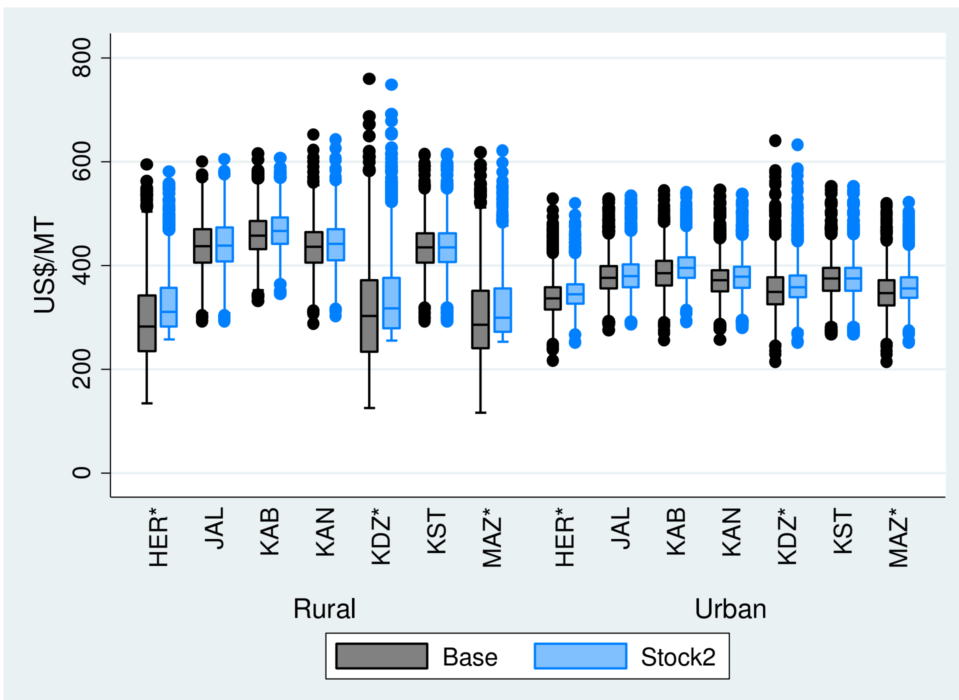

Figure 9-9: Price Distribution: Base Case versus Stock2 Case

Modeling results also show that public stockholding policy can stabilize prices in urban centers of the surplus regions as well. The impacts of the public stocks on price stabilization is more pronounced in Kunduz region, where domestic production is high, compared to other regions. This implies the effects of public stockholding policy on prices stabilization increases with an increase in minimum support price and stock accumulation.

Large public stocks lead to a larger decrease in price variability, especially in surplus regions where stocks are held. Changes in the standard deviation of prices due to this stockholding policy are presented in Table 9-7. Stock1 represents the effects of public stocks with a minimum support price of $200. Stock2 represents the effects of public stockholding policy with a minimum support price of $250. Modeling results show that the effects of stockholding policy on price stabilization in stock2 case is twice as much as in the stock1 scenario in rural areas of surplus regions.

Table 9-7: Changes in Price Variability: Stock1 Case versus Stock2 Case

Region		% Change Stock1		% Change Stock2	
		Rural	Urban	Rural	Urban
HER*	Mean	6.16	1.47	11.51	2.49
	Std. Dev.	-13.92	-5.89	-28.53	-10.04
JAL	Mean	0.32	0.50	0.49	0.77
	Std. Dev.	0.94	0.00	1.94	1.19
KAB	Mean	0.99	1.36	1.83	2.52
	Std. Dev.	-4.69	-7.40	-6.47	-10.56
KAN	Mean	0.84	1.10	1.36	1.78
	Std. Dev.	-1.30	-3.93	-1.25	-4.49
KDZ*	Mean	4.17	1.30	8.51	2.38
	Std. Dev.	-12.05	-6.60	-24.27	-10.64
KST	Mean	0.03	0.05	0.05	0.07
	Std. Dev.	0.27	0.42	0.36	0.50
MAZ*	Mean	3.23	1.41	7.25	2.61
	Std. Dev.	-11.00	-7.45	-25.29	-11.20

Assuming a high minimum support price increases stocks accumulation and the costs associated with the stockholding policy. With a minimum support price of $250/MT, public stocks accumulation is twice as much as in the normal production case. In stock1 case the stock accumulation is about 186 thousand MT, and it is approximately 337 thousand MT in stock2 case. Subsequently, the costs of the stockholding policy in stock2 case is doubled, with an annual average of US$15 million and a maximum annual costs of US$72 million. Public Stocks accumulation along with the costs of public stockholding policy are presented in Table 9-8.

Table 9-8: Costs of Public Stocks: Stock1 Case versus Stock2 Case.

Variable	Case	Mean	Std. Dev.	Min	Max
Public Stocks (000 MT)	MSP $200 (Stock1)	186.27	111.00	44.55	780.23
Costs (Million US$)		8.20	4.88	1.96	34.33
Public Stocks (000 MT)	MSP $250 (Stock2)	337.30	212.20	49.73	1634.29
Costs (Million US$)		14.84	9.34	2.19	71.91

9.3 Trade Policy

We now assess the effects of a variable levy on the distributions of prices and the welfare of producers and consumers. The variable levy is expected to stabilize prices in commercial centers supplied by imported wheat and flour. Similar to the static model, the effects of a variable levy versus modified variable levy on market outcomes are assessed in the stochastic model, as well.

9.3.1 Variable Levy

Price distributions from the base case versus the variable levy scenario are presented in Figure 9-10. As expected, prices are much more stable with a variable levy compared to the base case. The variable levy is more effective in stabilizing prices in urban centers than in rural areas. Commercial centers are more integrated with the world market compared to the rural areas. Thus, a fixed price at border points is very effective in stabilizing prices at commercial centers. Moreover, a variable levy is more effective in stabilizing prices in deficit regions than in surplus regions. In the urban center of deficit regions prices are mainly determined by the world price, but in surplus regions prices are partially determined by domestic production.

The variable levy is more effective in trimming the upper tail of price distribution than the lower tail. The variability in the lower tail is mainly due to high domestic production. In addition to stabilizing prices, a variable levy may lead to a change in the mean of the prices in Afghanistan. Thus, the variable levy is expected to result in distributional impacts across producers and consumers. The policy is designed to have minimal distributional effects across producers and consumers, however.

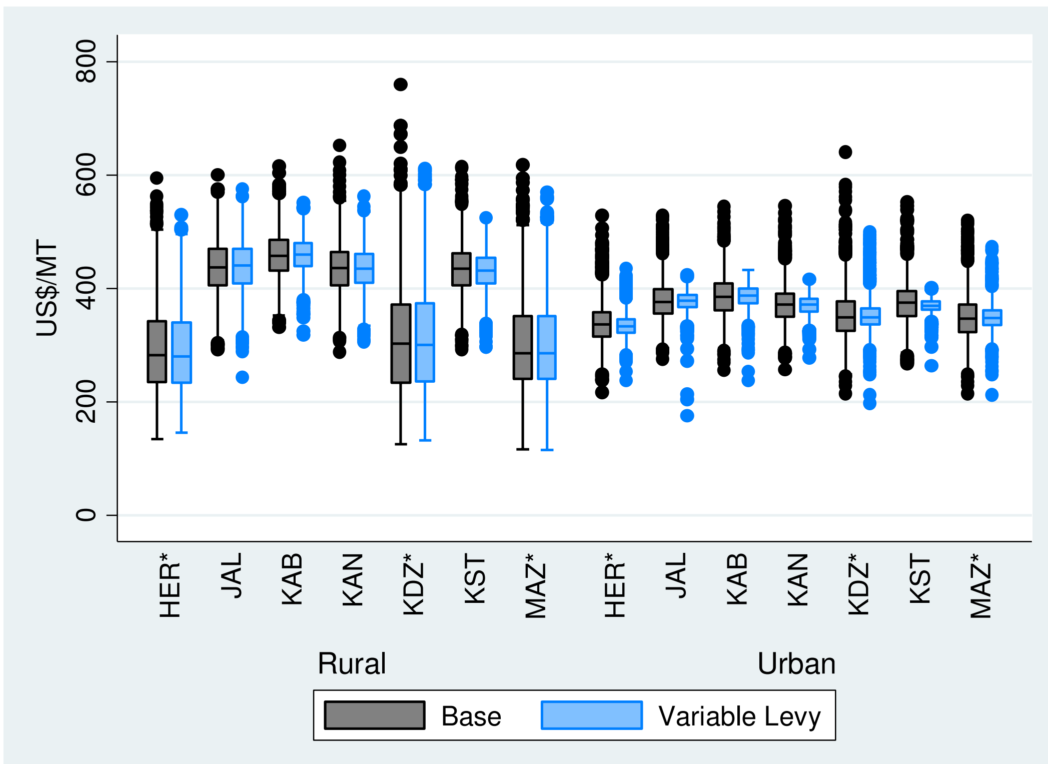

Figure 9-10: Price Distribution: Base Case versus Variable Levy Case.

The mean and standard deviation of prices are presented in Table 9-9. A variable levy leads to a large decrease in standard deviation of prices in urban centers. The largest decrease is observed in eastern deficit regions close to Pakistan. The standard deviation in prices decreases by 65% in eastern Khost, 48% in Jalalabad and Kandahar and 43% in

Kabul. Thus, a variable levy appears to be very effective in stabilizing prices in urban centers.

Modeling results suggest the distributional impacts of a variable levy are not large, as the variable is designed to have minimal distributional effects. On average, the change in mean of prices as a result of variable levy is less than 0.5 percent. A variable levy leads to a slight decrease in the mean of prices in most cases. Thus, this policy might result in small decrease in producer surplus.

Table 9-9: Wheat Prices: Base Case versus Variable Levy Case

Region		Base		Variable Levy		% Change	
		Rural	Urban	Rural	Urban	Rural	Urban
HER*	Mean	292	338	289	334	-0.84	-1.19
	Std. Dev.	77	37	73	22	-4.76	-39.60
JAL	Mean	437	377	438	378	0.20	0.01
	Std. Dev.	48	33	45	17	-5.40	-48.81
KAB	Mean	459	385	459	385	0.06	-0.04
	Std. Dev.	40	36	30	21	-24.25	-43.03
KAN	Mean	434	371	433	370	-0.18	-0.35
	Std. Dev.	45	33	38	17	-16.95	-48.55
KDZ*	Mean	311	353	310	352	-0.10	-0.20
	Std. Dev.	96	45	93	31	-3.89	-32.07
KST	Mean	434	374	430	369	-0.96	-1.41
	Std. Dev.	44	35	35	12	-22.21	-65.59
MAZ*	Mean	297	348	297	348	0.10	-0.07
	Std. Dev.	78	39	76	24	-2.12	-37.60
Total	Mean	381	364	380	362	-0.24	-0.46
	Std. Dev.	96	41	93	27	-3.00	-32.97

Modeling results suggest that variable levy stabilizes consumer surplus. Consumer surplus from the simulation modeling is present in Table 9-10. The effects of variable levy are more pronounced in urban areas, as it has higher impacts on prices in urban centers than in rural areas. On average, a variable levy leads to a decrease of 42% and 9% on in the standard deviation of consumer surplus in urban and rural areas, respectively. Similar to the results for the price distribution, consumer welfare is stabilized more in eastern and southern urban centers which are mostly supplied by imported wheat and flour.

The change in the mean of consumer surplus as a result of the variable levy is insignificant. This implies the distributional impacts of variable levy are not large between consumer and producer welfare. On average, the change in the mean of consumer surplus as a result of variable levy is less than 0.07%. Thus, distributional impacts of variable levy are less than from public stocks, based on modeling results. On average, a variable levy has better impacts than public stocks on stabilizing prices. However, a variable levy is more effective in urban areas than in rural zones, and the public stock is more effective in rural zones than in urban centers.

Table 9-10: Consumer Surplus: Base Case versus Variable Levy Case.

Region		Base		Variable Levy		% Change	
		Rural	Urban	Rural	Urban	Rural	Urban
HER*	Mean	303.87	57.40	304.74	57.68	0.29	0.49
	Std. Dev.	28.88	2.70	27.61	1.64	-4.42	-39.21
JAL	Mean	352.41	29.20	352.04	29.20	-0.10	-0.02
	Std. Dev.	19.10	1.05	18.11	0.55	-5.17	-47.34
KAB	Mean	584.64	512.94	584.38	512.91	-0.04	-0.01
	Std. Dev.	23.91	18.34	18.17	10.52	-24.02	-42.64
KAN	Mean	706.19	66.15	706.63	66.22	0.06	0.10
	Std. Dev.	30.84	2.06	25.69	1.07	-16.69	-48.24
KDZ*	Mean	480.79	27.52	480.85	27.53	0.01	0.05
	Std. Dev.	56.18	1.56	54.31	1.06	-3.34	-31.75
KST	Mean	389.47	21.57	391.20	21.69	0.44	0.56
	Std. Dev.	19.44	0.83	15.22	0.30	-21.71	-64.31
MAZ*	Mean	472.60	52.65	472.38	52.65	-0.05	0.00
	Std. Dev.	44.48	2.60	43.59	1.63	-2.00	-37.42
Total	Mean	470.00	109.63	470.32	109.70	0.07	0.06
	Std. Dev.	31.83	4.16	28.96	2.40	-9.04	-42.45

Modeling results suggest a variable levy also stabilizes producer welfare, but it does not have a major impact on the mean of the producer surplus. Producer surplus from the base case versus the variable levy case is presented in Table 9-11. A variable levy leads to a decrease of 26% in the standard deviation of producer welfare, on average. A variable levy does not have a large effect on the mean of producer welfare. This policy reduces the producer surplus by 0.32%, on average. The stabilization impacts of the variable levy are similar across regions on producer surplus.

As variable levy is more effective in trimming the upper tail of price distribution than the lower tail, it is expected to reduce the variability of consumer welfare from the lower tail and producer welfare from the upper tail. The welfare distributions of consumers and producers from the base case versus the variable levy case are presented in Figure 9-11 and in Figure 9-12, respectively. Mostly the lower tail of the consumer welfare distribution has been eliminated in the variable levy case compared to the base case. The effects of variable levy on producer welfare are more often observed in the upper tail of the welfare distribution than in the lower tail.

Table 9-11: Producer Surplus: Base Case versus Variable Levy Case

Region	Base		Variable Levy		% Change	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
HER*	89.20	9.74	88.33	7.21	-0.98	-25.99
JAL	75.59	7.99	75.66	5.47	0.09	-31.57
KAB	101.51	12.55	101.51	10.28	0.00	-18.15
KAN	117.08	12.32	116.76	9.38	-0.27	-23.84
KDZ*	137.88	16.33	137.74	12.89	-0.10	-21.10
KST	72.02	8.52	71.04	5.98	-1.36	-29.80
MAZ*	144.91	15.49	144.79	9.44	-0.08	-39.10
Average	105.46	11.85	105.12	8.66	-0.32	-26.90

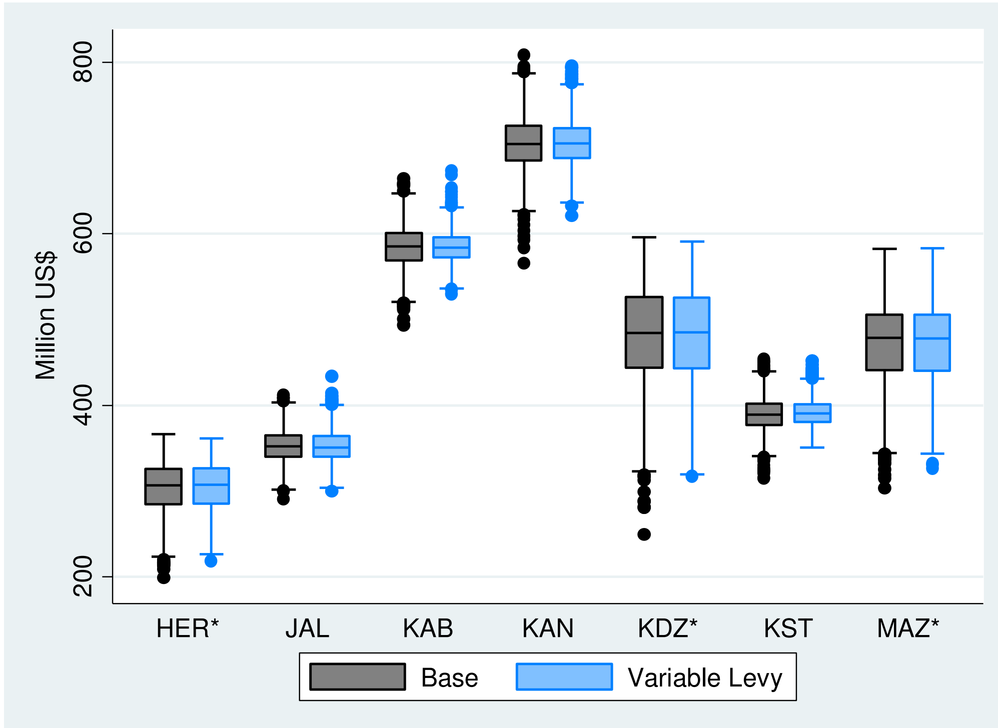

Figure 9-11: Consumer Surplus: Base Case versus Variable Levy Case

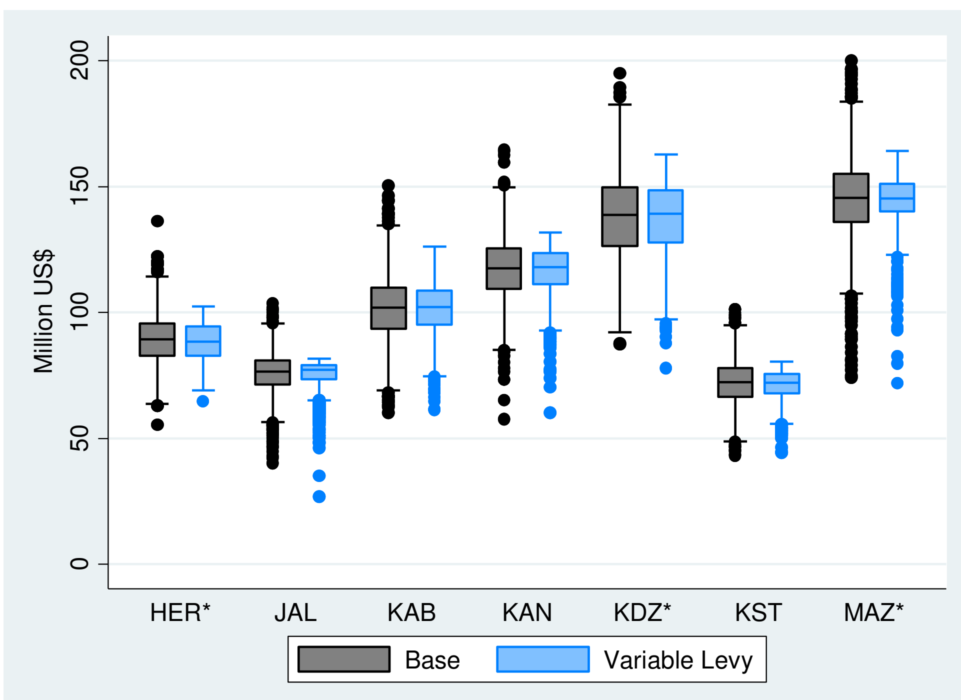

Figure 9-12: Producer Surplus: Base Case versus Variable Levy Case.

Modeling results show a variable levy is more effective than a stockholding policy on price and welfare stabilization in Afghanistan, on average. Moreover, the distributional impacts of variable levy appear to be less than public stocks policy. Normally, a variable levy is a more cost effective policy tool than public stockholding.

The most important costs associate with the variable levy are the costs of the import subsidy in the periods of high world prices. The level of the variable levy in each iteration is multiplied by the import level in that given iteration to estimate the costs/revenue of this policy. Summary statistics of costs/revenue associated with the variable levy from 2000 repetitions are presented in Table 9-12. On average, the government can generate revenue on wheat and flour imports by implementing a variable levy policy, with an amount of US$27 million on imports from Pakistan and about US$7 million on imports from Kazakhstan. However, the costs of the import subsidy are nearly US$ 198 million in extreme cases of high world prices combined with export restrictions from Pakistan.

Table 9-12: Revenue from Variable Levy

Variable	Mean	Std. Dev.	Min	Max
Levy on imports from Pakistan	27.16	34.54	-154.50	163.37
Levy on imports from Kazakhstan	6.90	14.73	-55.02	90.36
Levy on total imports	34.11	38.78	-197.94	176.31

Units are in million US$

Depending on the world price the level of variable levy changes in each iteration. The variable levy on imports from Pakistan is negative in 18% of iterations, and it is negative on imports from Kazakhstan in 30% of iterations. Although the mean of the variable levy is positive, the costs of the import subsidy are extremely high during the periods of high world prices and when there are export restrictions from Pakistan.

Figure 9-13 represents the distribution of the cost/revenue generated from a variable levy, from 2000 repetitions. This distribution is the sum of revenue/costs generated on imports from Pakistan and imports from Kazakhstan. The likelihood of the extreme cases which requires large import subsidy costs are small, as the distribution shows. On average, about 15% of the time the revenue from a variable levy is negative. There are only 17 cases out of 2000 iterations where the costs of the import subsidy exceeds US$100 million.

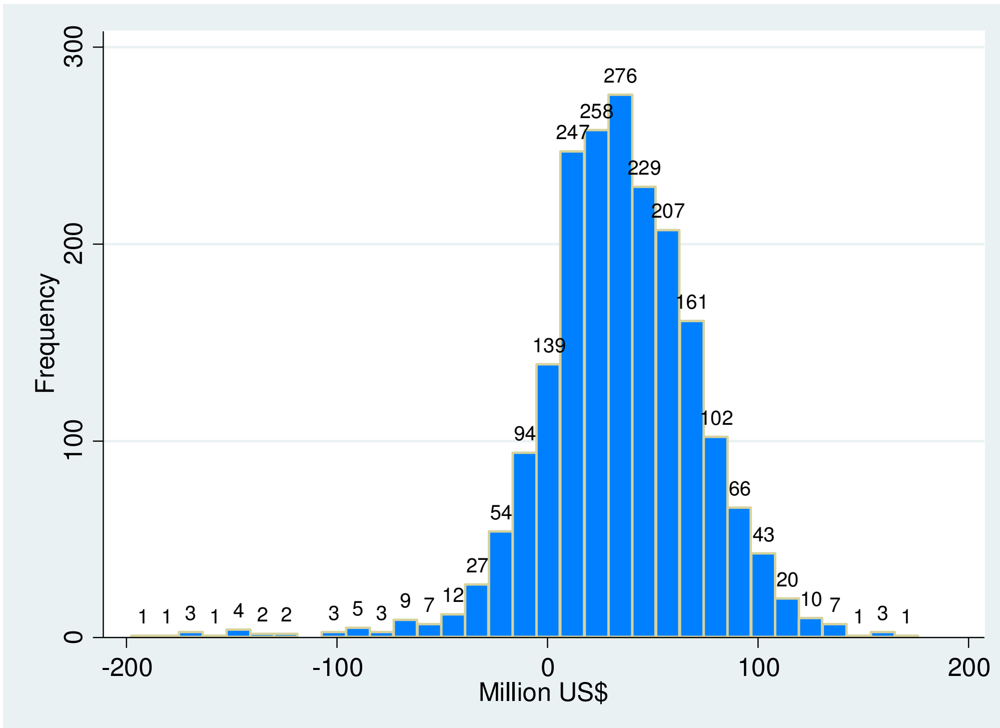

Figure 9-13: The Distribution of Variable Levy Revenue.

The level of the costs associated with the variable levy policy depends on what level the government wants to fix domestic prices. Fixing domestic price at a high level will increase tax revenue as the government can charge a high variable levy, and vice versa. But changing the mean of domestic prices can lead to distributional impacts on expected welfare across consumers and producers. The price fixed at the border in our model is the average price over the period 2010-2013, so it does not now have large distributional impacts on the welfare of producers and consumers.

Given the small chances of extreme cases where an import subsidy is required, a variable levy is more cost effective than a public stockholding policy in stabilizing consumer prices. Modeling results show the total revenue from a variable levy is negative in approximately one out of seven years. The costs of import subsidy are higher than releasing stocks in that given scenario of high world prices and low domestic production. However, stocks are required to be maintained annually until that specific scenario of low production and high world prices occurs. Adding up the costs of carrying public stocks for seven years is much higher than the costs of an import subsidy for one year.

9.3.2 Modified Variable Levy

In the first scenario for the variable levy, we assumed that the Afghan government continued subsidizing wheat and flour imports from Pakistan even when Pakistani export restrictions were in place. However, this becomes very costly for the Afghan government as the import subsidy increases sharply in order to keep border domestic prices fixed. This also appears to be impractical to subsidize imports from Pakistan while Pakistani governments restricts exports to ensure food security for its own nation. Thus, this assumption might not be practical in the real world. In this section, we modify this assumption. We assume the Afghan government does not fully subsidize wheat and flour imports from Pakistan during the periods of export restrictions. Prices are no longer fixed at the ports on the Pakistani border. However, there will be an import subsidy equal to the one on wheat and flour imports from Kazakhstan. This modification will undermine the stabilization impacts of variable levy in the cases when Pakistan restricts its wheat and flour exports to Afghanistan.

Under the modified variable levy prices are not as stable as in the variable levy case in regions mostly supplied by Pakistan. Price distributions in the variable levy case versus modified variable levy are presented in Figure 9-14. Under the modified variable levy assumption, the upper tail of price distribution is not eliminated as much as in the variable levy for eastern regions supplied by Pakistan. This difference in price distributions under the two assumptions of the variable levy policies is observed in Jalalabad, Khost, Kandahar and Kabul. The largest (smallest) difference in price distributions is observed in Khost (Kabul). Khost is isolated from the northern wheat market and rarely does domestic and Kazakh wheat flow to Khost, while about 50% of Kabul is normally supplied by domestic and Kazakh wheat. Thus, the Pakistani export restriction policy has smaller effects in Kabul than in eastern Khost. In Figure 9-14, the boxplots with the dark color present the price distribution under the standard variable levy and the ones with the light blue color presents the price distribution under the modified variable levy case.

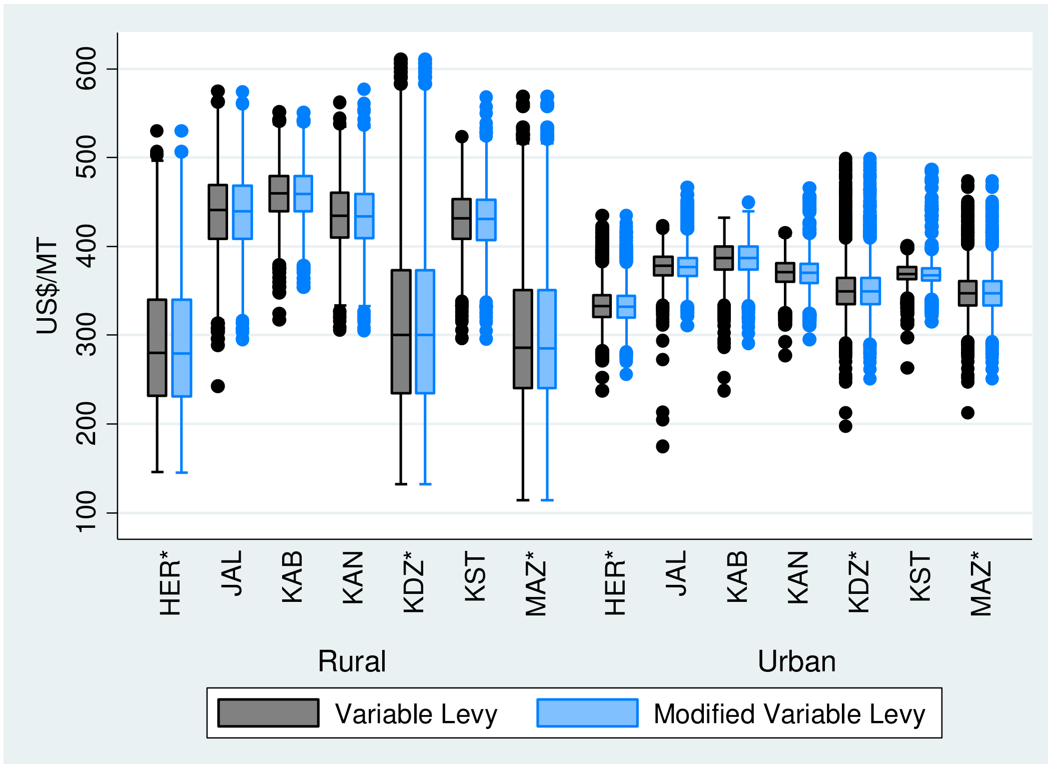

Figure 9-14: Price Distribution: Variable Levy Case versus Modified Variable Levy Case

Price spikes as a result of Pakistani export restrictions are observed mainly in the urban centers of eastern regions. Price signals are not fully transmitted to the rural zones of the eastern regions, as markets are not well integrated between rural and urban regions. Pakistani export restriction policy does not significantly affect prices in the northern and eastern surplus regions either, as Pakistani flour does not flow to the northern surplus regions of Mazar and Kunduz.

Variability in prices is high in the eastern regions supplied by Pakistani wheat and flour under the modified variable levy case, compared to the standard variable levy case.

However, prices are more stable even in the modified variable levy case than in the base case. Under the modified variable levy assumption prices are not fixed at eastern ports on the Pakistan border during periods of export restriction, but there is an import subsidy equal to the subsidy at the northern port and this somewhat prevents price spikes in the eastern region.

Price distributions from the base case versus the modified variable levy case are presented in Figure 9-15. Modeling results show that the modified variable levy stabilizes prices in all regions. The stabilization impacts of the modified variable levy case is more pronounced in urban centers than in rural zones, as urban centers are better integrated than rural areas with the world markets. On average, the impacts of the modified variable levy on price stabilization are higher in the eastern deficit regions than in the northern surplus regions, even with the modified variable levy assumptions (Table 9-13). Trade policy plays a key role in stabilizing prices in regions mostly supplied by imported wheat and flour. The impacts of the trade policy are less significant in the surplus regions in a framework of imperfect market integration.

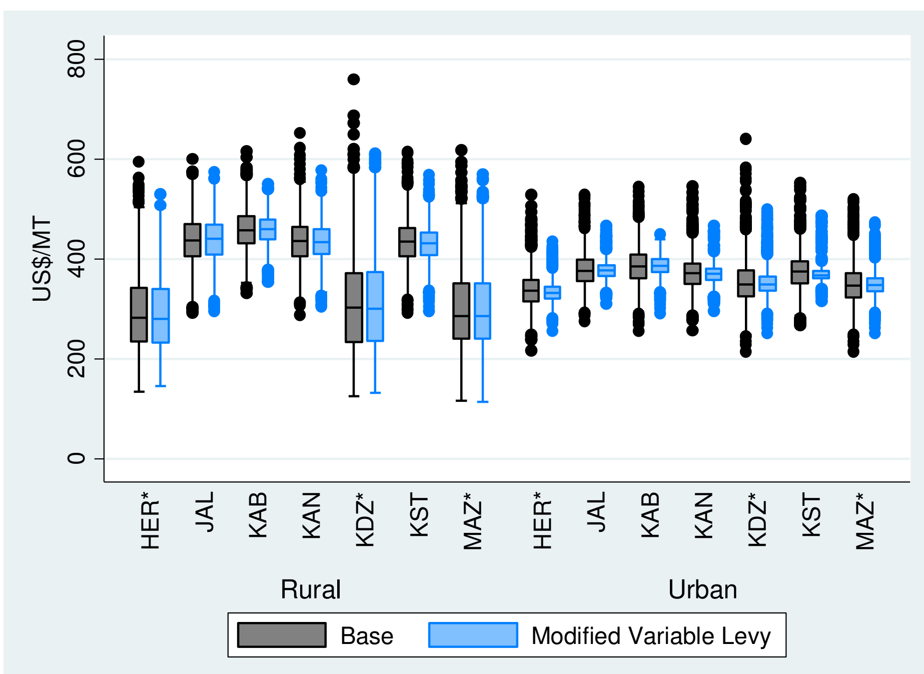

Figure 9-15: Price Distributions: Base Case versus Modified Variable Levy Case

Table 9-13: Wheat Prices: Base Case versus Modified Variable Levy Case

Region		Base		Modified Levy		% Change	
		Rural	Urban	Rural	Urban	Rural	Urban
HER*	Mean	292	338	289.20	333.28	-0.91	-1.28
	Std. Dev.	77	37	72.96	22.81	-4.72	-37.64
JAL	Mean	437	377	438.13	377.17	0.14	-0.08
	Std. Dev.	48	33	45.01	16.12	-6.33	-51.17
KAB	Mean	459	385	459.21	385.35	0.06	-0.04
	Std. Dev.	40	36	29.63	19.94	-25.31	-44.60
KAN	Mean	434	371	432.79	369.18	-0.29	-0.49
	Std. Dev.	45	33	37.91	17.96	-16.41	-46.20
KDZ*	Mean	311	353	310.48	352.16	-0.10	-0.20
	Std. Dev.	96	45	92.43	30.19	-3.98	-32.99
KST	Mean	434	374	429.58	368.51	-1.07	-1.53
	Std. Dev.	44	35	35.20	15.24	-20.69	-56.62
MAZ*	Mean	297	348	297.30	347.74	0.10	-0.07
	Std. Dev.	78	39	75.89	24.21	-2.25	-38.18
Total	Mean	381	364	379.53	361.91	-0.29	-0.52
	Std. Dev.	96	41	92.59	27.32	-3.09	-32.62

The impacts of modified variable levy on price stabilization are not very different from the variable levy case. High price spikes are observed in the eastern deficit regions during the periods when the export restriction policy is in place. However, price spikes are not as high as in the base case. Wheat and flour flows from northern and western surplus to eastern and southern deficit regions are observed in those periods.

An import subsidy stabilizes prices in the northern and western regions supplied partially by Kazakhstan wheat and flour. This does not allow extreme price shocks in the eastern deficit regions even after Pakistan restricts its exports to Afghanistan. However, import flows of Kazakh wheat and flour to eastern deficit regions close to Pakistan are not as effective as import flows from Pakistan in stabilizing prices in these regions. The transportation costs of moving Kazakh wheat to eastern and southern deficit regions are much higher than the transportation costs of import flows from Pakistan.

The costs of the import subsidy in the modified variable levy scenario are less than the costs in the standard variable levy scenario. The largest costs of the import subsidy in the extreme scenario of high world prices combined with the export restrictions is approximately US$110 million, compared to US$ 198 million in the standard variable levy. The distribution of the variable levy revenue on total wheat and flour imports from Pakistan and Kazakhstan is presented in Figure 9-16. In 15% of the repetitions the variable levy is negative, implying an import subsidy is required in one out of seven years to stabilize domestic prices.

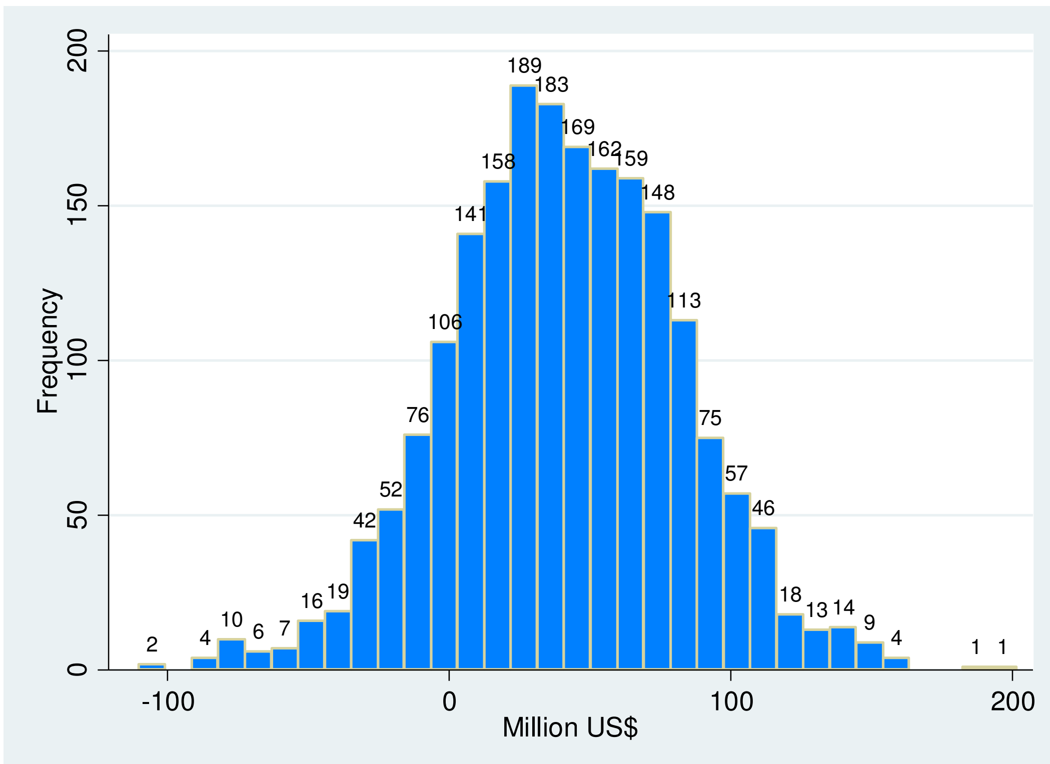

Figure 9-16: The Distribution of Revenue from Modified Variable Levy Case.

The distribution of the revenue from the modified variable levy appears more realistic than the distribution of revenue from the standard variable levy, as the costs of the import subsidy in the modified variable levy case are not extremely high in the periods of high world prices and Pakistani export restrictions. The largest change in the costs of the import subsidy is observed in the imports on Pakistan. As the Pakistani export restriction policy kicks in, the Afghan government does not continue subsidizing imports from Pakistan. This forces more import flows from Kazakhstan and so higher costs of import subsidy on imports from Kazakhstan are observed in the modified levy, compared to the standard variable levy in those extreme cases. Table 9-14 shows the summary statistics on the revenue from the standard variable levy versus the modified variable levy.

Table 9-14: Revenue: Variable Levy Case versus Modified Variable Levy Case.

Variable		Mean	Std. Dev.	Min	Max
Levy on Pakistani imports	Variable Levy	27.16	34.54	-154.50	163.37
Levy on Kazakh imports		6.90	14.73	-55.02	90.36
Levy on total imports		34.11	38.78	-197.94	176.31
Levy on Pakistani imports	Modified Variable Levy	27.69	31.52	-77.17	140.70
Levy on Kazakh imports		13.15	26.92	-104.14	113.09
Levy on total imports		40.84	41.44	-110.33	201.27

Units are in Million US$

9.4 Trade Policy plus Stockholding Policy

Modeling results from the trade policy scenario suggest that a variable levy eliminates mainly the upper tail of price distributions and thus helps consumers more than producers. The results from the stockholding policy scenario indicate that a stockholding policy in surplus regions is more effective in eliminating the lower tail of price distribution and thus mainly improves producer welfare in Afghanistan.

In this section we assess the effects of combining trade and stockholding policy, with both policies implemented simultaneously. Implementing both policies at the same time can in principle reduce variability in prices by cutting both lower and upper tails of price distribution. However, implementing both policies may increase the costs of the stabilization program in the country. In the first part of this section we analyze the combination of a stockholding policy with MSP of $200/MT plus the standard variable levy, which assumes fixed prices at the border all the time. At the end of this section we provide some results from the scenario that combines the modified variable levy plus stock2 case.

9.4.1 Variable Levy plus Stock1

Modeling results suggest the combined effects of trade and stock policies on price distributions are consistent with this principle, and both lower and upper tails of price distributions are eliminated. Price distributions from the base case versus the scenario of combined trade and stocks are presented in Figure 9-17. Prices are more stable with the trade and stock policy compared to the base case in all regions. The effects of the stabilization polices are more pronounced in urban centers compared to rural zones. The variable levy is more effective than the stockholding policy in stabilizing prices. The stabilizing impacts of the variable levy are mostly observed in urban centers, as urban centers are better integrated than rural areas with the world markets. The combined effects of trade and stockholding policy lead to a 40% and 12% decrease in the standard deviation of prices in urban and rural areas, respectively (Table 9-15).

Implementing both policies simultaneously changes the mean of prices too, but the change in the price mean is very small compared to the decrease in variability. The mean of prices increases in most cases in rural areas, and it decrease in urban centers mostly supplied by Pakistani flour. The distributional impacts of both trade and stockholding policies are insignificant compared to their stabilization effects, since we have designed these policies to have minimal distributional effects at mean outcomes.

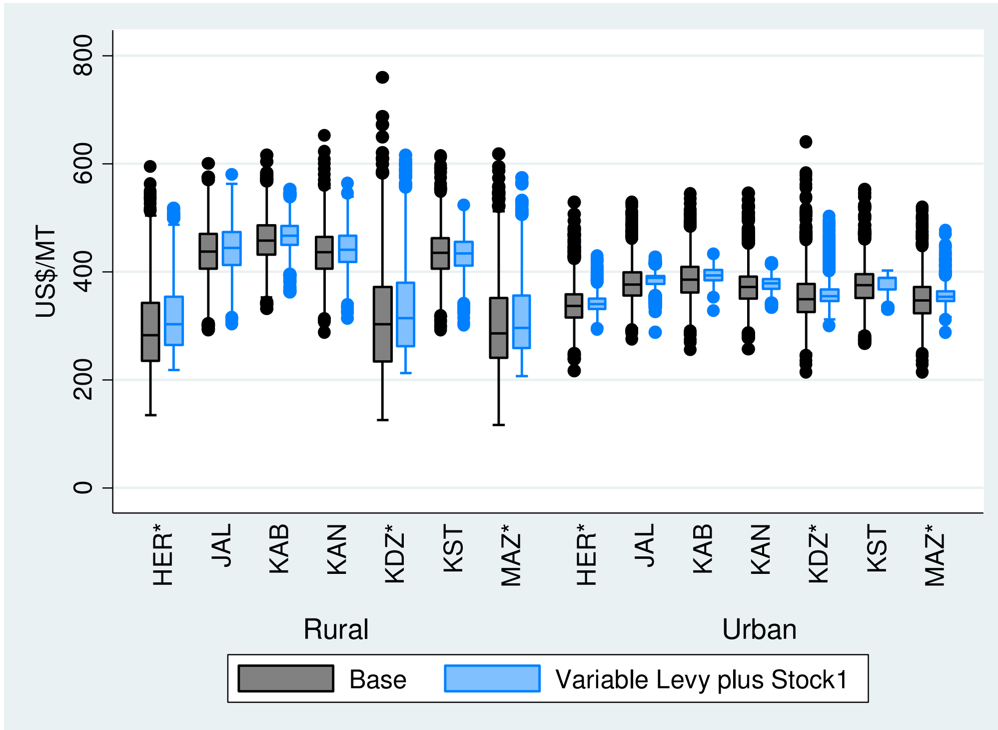

Figure 9-17: Price Distribution: Base Case versus Variable Levy plus Stock1Case

Table 9-15: Wheat Prices: Base Case versus Variable Levy plus Stock1 Case

Region		Base		Levy & Stock1		% Change	
		Rural	Urban	Rural	Urban	Rural	Urban
HER*	Mean	292	338	306	336	4.88	-0.47
	Std. Dev.	77	37	62	19	-18.54	-47.54
JAL	Mean	437	377	438	377	0.08	-0.24
	Std. Dev.	48	33	45	15	-5.47	-53.07
KAB	Mean	459	385	462	389	0.70	0.83
	Std. Dev.	40	36	27	14	-31.72	-59.87
KAN	Mean	434	371	435	372	0.22	0.17
	Std. Dev.	45	33	37	14	-19.46	-58.84
KDZ*	Mean	311	353	322	355	3.54	0.56
	Std. Dev.	96	45	81	26	-16.20	-42.96
KST	Mean	434	374	428	366	-1.49	-2.11
	Std. Dev.	44	35	34	12	-22.76	-65.15
MAZ*	Mean	297	348	305	351	2.85	0.78
	Std. Dev.	78	39	67	19	-13.19	-51.38
Total	Mean	381	364	385	364	1.19	-0.07
	Std. Dev.	96	41	84	24	-11.66	-40.66

The combined effects of stockholding and trade policy on price stabilization is larger than the effects of each of these policies implemented individually. The means and the standard deviations of prices from different scenarios are presented in Table 9-16. Looking at the national average at the bottom of the table, the standard deviation of prices is the smallest for both rural and urban areas in the levy plus stock scenario. However, the combined effects of both polies are much larger on urban prices than on rural prices.

Table 9-16: Price Descriptive Statistics across Scenarios

Region		Base		Public Stocks		Variable Levy		Levy & Stock1	
		Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
HER*	Mean	292	338	310	343	289	334	306	336
	Std. Dev.	77	37	66	34	73	22	62	19
JAL	Mean	437	377	439	379	438	378	438	377
	Std. Dev.	48	33	49	33	45	17	45	15
KAB	Mean	459	385	464	391	459	385	462	389
	Std. Dev.	40	36	38	33	30	21	27	14
KAN	Mean	434	371	438	375	433	370	435	372
	Std. Dev.	45	33	45	32	38	17	37	14
KDZ*	Mean	311	353	324	357	310	352	322	355
	Std. Dev.	96	45	85	42	93	31	81	26
KST	Mean	434	374	434	374	430	369	428	366
	Std. Dev.	44	35	45	35	35	12	34	12
MAZ*	Mean	297	348	307	353	297	348	305	351
	Std. Dev.	78	39	69	36	76	24	67	19
Total	Mean	381	364	388	368	380	362	385	364
	Std. Dev.	96	41	88	39	93	27	84	24

As public stockholding and trade policies trim both the lower and upper tails of price distribution, it is expected to stabilize both producer and consumer welfare. Figure 9-18 compares the distributions of producer surplus from the base scenario and from the case when both trade and public stockholding policies are implemented, and the means and standard deviations of producer surpluses are presented in Table 9-17. Modeling results suggest that stabilization policies are effective in reducing variability in producer surplus in all regions. The combined effects of both trade and stockholding policies lead to a decrease of approximately a 26% in the standard deviation of producer surplus, on average. The impacts of stabilization policies on producer welfare are similar across regions. The largest effects are observed in in Kunduz, with about 29% decrease in standard deviations, and smallest effects are in Mazar, with a decline of 18% in the standard deviation of producer surplus. The effects of stabilization policies are small in in Mazar, as production is volatile there, and volatility in domestic production largely contributes in variability of producer welfare.

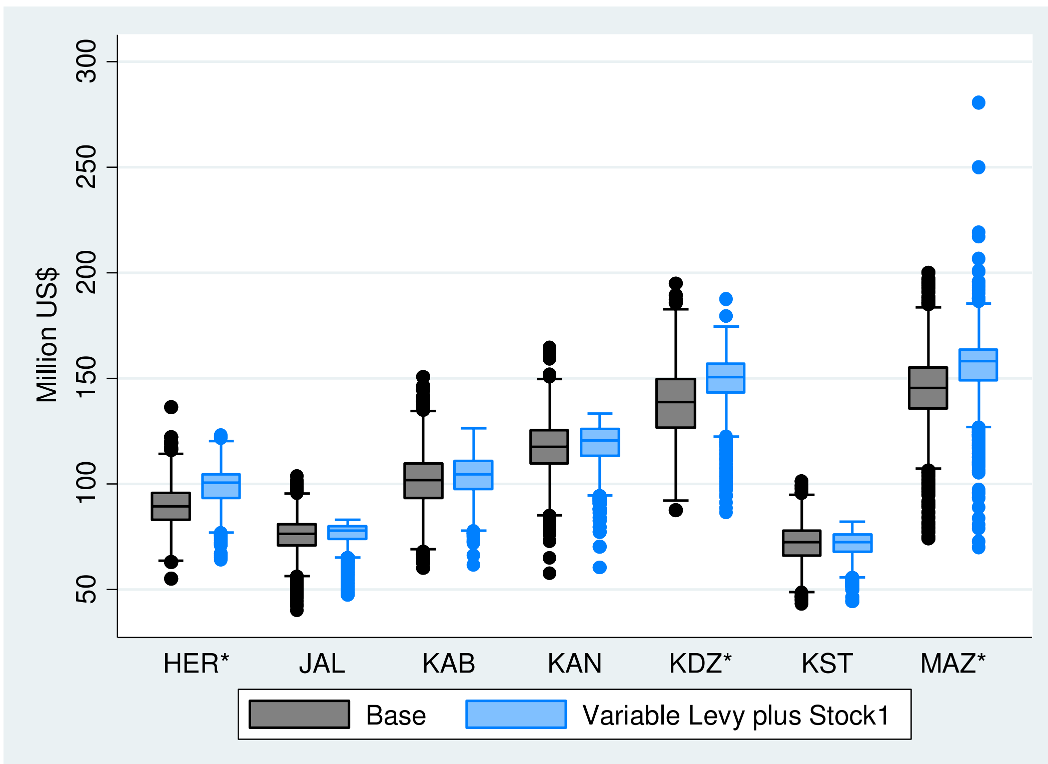

Figure 9-18: Producer Welfare: Base Case versus Variabel Levy plus Stock1 Case

Table 9-17: Producer Surplus: Base Case versus Variable Levy plus Stock1 Case

Region	Base		Levy & Stocks		% Change	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
HER*	89.20	9.74	95.44	7.24	6.99	-25.63
JAL	75.59	7.99	75.49	5.07	-0.14	-36.53
KAB	101.51	12.55	102.40	9.75	0.87	-22.36
KAN	117.08	12.32	117.31	9.04	0.20	-26.60
KDZ*	137.88	16.33	145.13	11.55	5.25	-29.28
KST	72.02	8.52	70.56	6.01	-2.03	-29.48
MAZ*	144.91	15.49	151.65	12.76	4.65	-17.64
Average	105.46	11.85	108.28	8.77	2.68	-25.95

As the combined impacts of both trade and stockholding polices increase the mean of prices, they lead to an increase in the mean of producer welfare, as well. A large increase in producer welfare is observed in surplus regions. Modeling results show a 7% increase in producer welfare in Herat, and about 5% in Kunduz and Mazar. The distributional impacts on producer welfare are small in eastern deficit regions, and even negative in Khost. Wheat and flour does not flow from surplus regions to eastern Jalalabad and Khost regions. Results are consistent with the principle that stockholding policy helps mainly producers in surplus areas. Trade policy stabilizes prices in eastern commercial centers, but the effects of stockholding policy do not flow from northern regions to help producers in deficit regions.

The combined effects of trade and stockholding policies are more pronounced in stabilizing consumer welfare than producer welfare. Price variability is a key contributor in creating variability in consumer welfare. However, volatility in domestic production appears to be a significant factor leading to variability in producer welfare in Afghanistan. Thus, price stabilization is more effective in reducing variability of consumer welfare than producer welfare. Modeling results show that combined trade and stockholding policies lead to a large decrease in variability of consumer welfare in Afghanistan. Descriptive statistics for consumer welfare from the base versus variable levy plus stocks case are presented in Table 9-18. Stabilization policies lead to a decrease of 57% and 18% in standard deviation of consumer welfare in urban and rural areas, respectively.

The combined impacts of stockholding and trade policies are larger on stabilizing consumer welfare in urban centers than in rural areas. Stabilization policies lead to a larger decrease in the standard deviation of consumer welfare in urban centers than in rural zones, in all regions. Urban centers are stabilized mainly by trade policy and stockholding policy stabilizes mostly rural zones. Stockholding policy is less effective than a variable levy, as stocks cannot stabilize prices if there are production shortfalls for two years in sequence. Also, stockholding policy is not aggressive in this scenario, as MSP is $200/MT.

Table 9-18: Consumer Surplus: Base Case versus Variable Levy plus Stock1 Case

Region		Base		Levy & Stocks		% Change	
		Rural	Urban	Rural	Urban	Rural	Urban
HER*	Mean	303.87	57.40	298.21	57.50	-1.86	0.16
	Std. Dev.	28.88	2.70	23.30	1.42	-19.33	-47.43
JAL	Mean	352.41	29.20	352.24	29.23	-0.05	0.08
	Std. Dev.	19.10	1.05	18.09	0.51	-5.27	-51.95
KAB	Mean	584.64	512.94	582.57	511.17	-0.35	-0.35
	Std. Dev.	23.91	18.34	16.33	7.37	-31.70	-59.83
KAN	Mean	706.19	66.15	705.43	66.10	-0.11	-0.08
	Std. Dev.	30.84	2.06	24.90	0.85	-19.27	-58.65
KDZ*	Mean	480.79	27.52	473.75	27.43	-1.46	-0.31
	Std. Dev.	56.18	1.56	46.80	0.89	-16.71	-43.15
KST	Mean	389.47	21.57	392.21	21.76	0.70	0.85
	Std. Dev.	19.44	0.83	15.13	0.30	-22.15	-63.74
MAZ*	Mean	472.60	52.65	467.44	52.44	-1.09	-0.39
	Std. Dev.	44.48	2.60	38.34	1.26	-13.81	-51.60
Total	Mean	470.00	109.63	467.41	109.38	-0.55	-0.24
	Std. Dev.	31.83	4.16	26.13	1.80	-17.93	-56.80

There are some small distributional impacts associated with these stabilization policies. Modeling results suggest on average consumers are worse off and producers are better off as a result of stabilization policy through stockholding plus a variable levy.

Stabilization policies lead to an increase of 2.7% in the mean of producer welfare on average and a total loss of less than 1% in consumer welfare in both rural and urban areas (Table 9-17 & Table 9-18).

The distributional impacts of the trade policy can be managed somewhat by setting different domestic prices at the border. These analyses are based on a fixed average price at the border points. Setting a lower fixed price than the average price at the border point will help consumers, and a higher fixed price than the average will lead to a welfare gain for producers. Moreover, setting a lower fixed price at the border affects the government revenue from taxes on imports.

In addition to producers and consumers, there are other agents in the market that can be affected by the stabilization policies. Government revenue, and the welfare of millers and traders can also be a concern for policymakers to be considered in policymaking decisions. We will assess the impacts of combined trade and stockholding polices on government revenue from the import tax on wheat and flour, and on millers and traders.

Modeling results suggest that the combination of trade and stockholding policies leads to huge costs of import subsidy during the periods of high world prices. The costs of subsidy on wheat and flour imports gets as high as $158 million on imports from Pakistan and $60 million on wheat and flour imports from Kazakhstan. Similarly, the revenues from the tax on wheat and flour imports increases in periods of low wheat prices in Kazakhstan and Pakistan. Therefore, stabilizing wheat and flour markets through a variable levy leads to variability in tax revenue on wheat and flour imports. The costs/revenues associated with the variable levy in the variable levy plus stockholding scenario are presented in Table 9-19. On average, the value of the variable levy is positive on both imports from Pakistan and Kazakhstan, implying this policy generates revenue for the government.

Table 9-19: Revenue from Variable Levy: Variable Levy plus Stock1 Case

Variable	Mean	Std. Dev.	Min	Max
Levy on imports from Pakistan	26.23	36.70	-158.52	159.62
Levy on imports from Kazakhstan	6.80	15.68	-60.09	95.28
Levy on total imports	33.02	41.23	-202.75	172.87

Units are in million US$

The distribution of the revenue generated from a variable levy on total imports are presented in Figure 9-19. The distribution of the revenue from a variable levy implemented along with a stockholding policy exhibits a similar shape as in the variable levy scenario presented in Figure 9-13. This implies implementing a stockholding policy in rural surplus region does not have a major impact on imports. The distribution of the revenue on total imports is left skewed mainly due to the Pakistani export restrictions. The costs of the import subsidy are extremely high during the periods of high world prices when Pakistan restricts its exports. However, the chances of occurrence of such extreme scenarios are low. The revenue from the variable levy is negative in 15% of repetition, and the costs of the import subsidy exceeds US$ 100 million only in 1% of the repetitions.

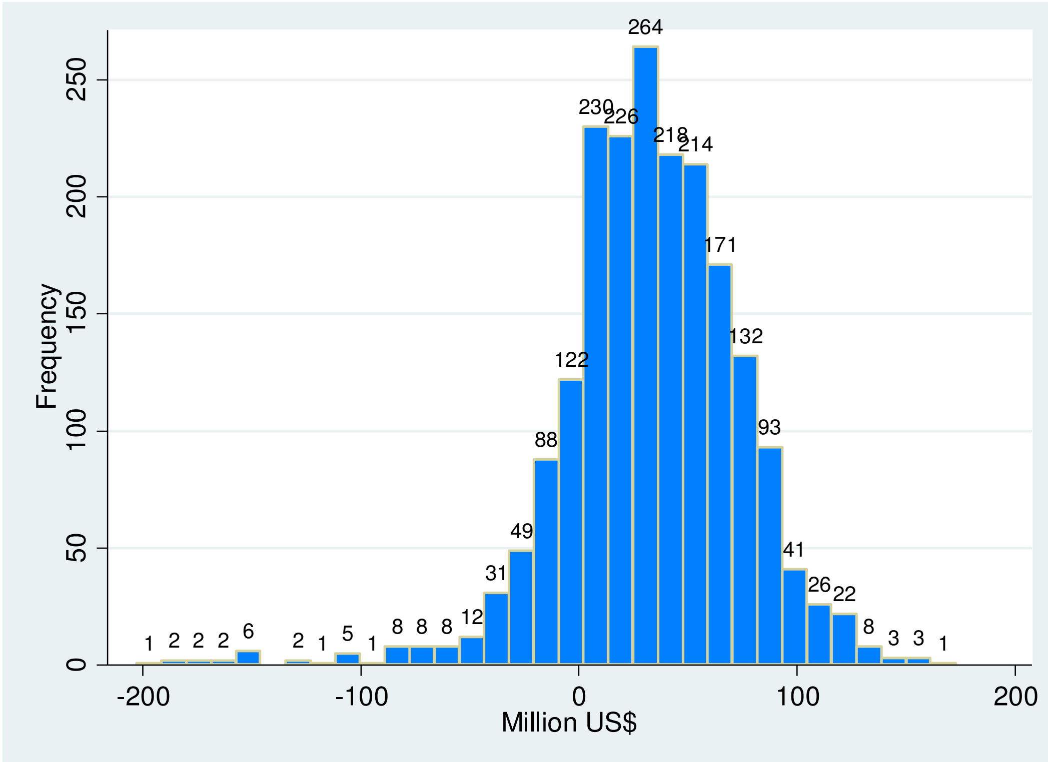

Figure 9-19: The Distribution of Revenue: Variable Levy plus Stock1 Case.

While a variable levy is often positive and generates revenues for the government, there are always annual costs with carrying public stocks. In the current scenario, the government maintains about 190 thousand MT of public stocks annually, with a costs of about $8 million, on average. Public stocks along with costs associated with the stockholding policy are presented in Table 9-20. In extreme cases of high domestic production, the public stocks reaches about 1.26 MMT, with a costs of about $55 million. The stocks accumulation and their costs are slightly higher when implemented along with a variable levy than implemented independently. When stockholding policy is implemented without a variable levy the mean of public stocks is about 186 thousand MT with a maximum of 780 thousand MT in extreme cases of high production (see Table 9-8).

Table 9-20: Public Stocks and Their Estimated Costs: Variable Levy plus Stock1 Case

Variable	Mean	Std. Dev.	Min	Max
Public Stocks (000 MT)	189.81	122.74	41.48	1256.75
Costs (Million US$)	8.35	5.40	1.83	55.30

A public stockholding policy with a primary objective to support producer prices is not very costly most of the time. The costs of carrying stocks in surplus regions with a main objective to trim the lower tail of price distribution is less US$ 20 million in 96% of the repetitions. The distribution of the costs associated with a public stockholding policy in surplus region is presented in Figure 9-20.

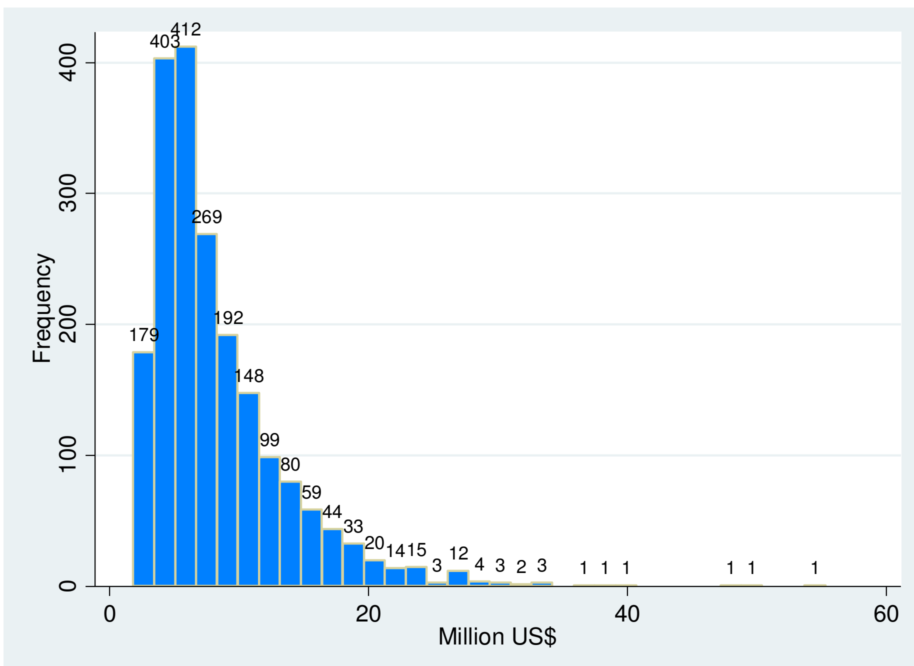

Figure 9-20: The Distribution of Public Stockholding Costs

With the government intervention in the market, opportunities for traders who benefits from price variation are limited. Assuming commercial stocks are retained by traders, those traders will face welfare loss as a public stock policy is introduced in the market. In principle, public stocks substitute for commercial stocks in the market.

Modeling results show public stocks lead to a decrease in commercial stocks, especially in regions where the public stocks policy is implemented. Figure 9-21 show commercial stocks in the base case versus the public stock plus variable levy scenario. Commercial stocks are low in the public stocks plus levy case, as surplus wheat is retained by public stocks in surplus regions. Thus, agents who handle commercial stocks in the absence of government intervention will be worse off with the stabilization policies. The impacts of the stockholding policy on commercial stocks is the same as if implemented without a trade policy as in Figure 9-8, presented in earlier section.

Millers are also key player in the wheat and flour markets in Afghanistan. Stabilization policies have some effects on the milling industry, as the share of wheat and flour imports changes. Stabilization policies through public stocks lead to an increase of flour imports in the country, as domestic wheat is retained in government stocks in surplus regions. Thus, the quantity of wheat milled domestically decreases with stabilization policy through public stocks. However, the change in the quantity of wheat milled domestically is not large. Stockholding policy decreases the quantity of wheat milled domestically from 3.37 MMT in the base case to 3.27 MMT in the stocks plus levy case.

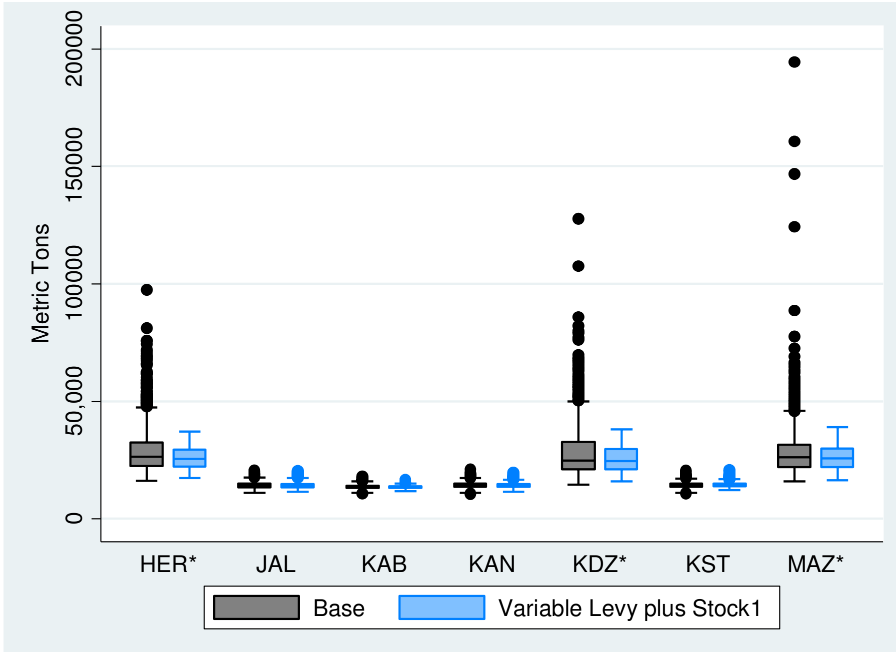

Figure 9-21: Commercial Stocks: Base Case versus Variable Levy plus Stock1

9.4.2 Modified Variable Levy plus Stock2

In the earlier section on trade plus stockholding policy the standard variable levy was combined with a stockholding policy at a MSP of $200/MT. The standard variable levy appears to be too rigorous in stabilizing prices, and continues fixed border prices during the periods of high world prices and export restrictions from Pakistan. Moreover, the stockholding policy with a MSP of $200/MT does not accumulate large enough public stocks to sufficiently trim the upper tail of price distributions in rural zones of surplus regions. Thus, in the earlier combination of trade and stockholding policy, prices were more stable in urban areas supplied mainly by imported wheat and flour than in rural zones of surplus regions. Here we modify the combination of trade and stockholding policy such that higher stabilization levels to be achieved in rural areas of surplus regions, compared to the earlier combination of trade plus stockholding scenario.

In this section, we assess the combination of a less rigorous trade policy plus a more aggressive stockholding policy, compared to the earlier combination of trade plus stockholding policy. In this section we combine the modified variable levy case with a more aggressive stockholding policy. In the modified variable levy the costs of the import subsidy are lower than in the standard variable levy, as the government does not fully subsidize imports from Pakistan during the period of Pakistani export restrictions. We also assume a more rigorous stockholding policy, with a minimum support price of $250/MT in this section. This policy is expected to allow some variability in prices in eastern and southern deficit regions mostly supplied by Pakistan. As stockholding policy is implemented in the northern surplus regions, more stable prices are expected in those regions, compared to the previous scenario of trade plus stockholding policy.

Wheat prices from the previous combination of trade and stockholding policy versus the prices from the modified levy plus the stockholding policy with a MSP of $250/MT are presented in Figure 9-22. The results are consistent with expectations; prices in eastern Khost and Jalalabad, and southern Kandahar regions are more variable in the modified levy plus stock2 scenario than in the variable levy plus stock1 scenario. On the contrary, prices in the rural areas of northern and western surplus regions are more stable in the modified levy plus stock2 scenario than in the variable levy plus stock1 scenario[15]. Stockholding policy plus modified variable levy is more effective here than the earlier case on price stabilization in surplus regions, as large stocks are accumulated with a MSP of $250/MT. A rigorous stockholding policy plus the modified variable levy with a high MSP not only trims the lower tail of price distribution, but also the upper tail.

[15] Variable levy plus stock1 scenario is the combination of the standard variable levy plus a stockholding policy with a MSP of $200/MT. Modified levy plus stock2 case is the combination of the modified variable levy plus a stockholding policy with a MSP of $250/MT.

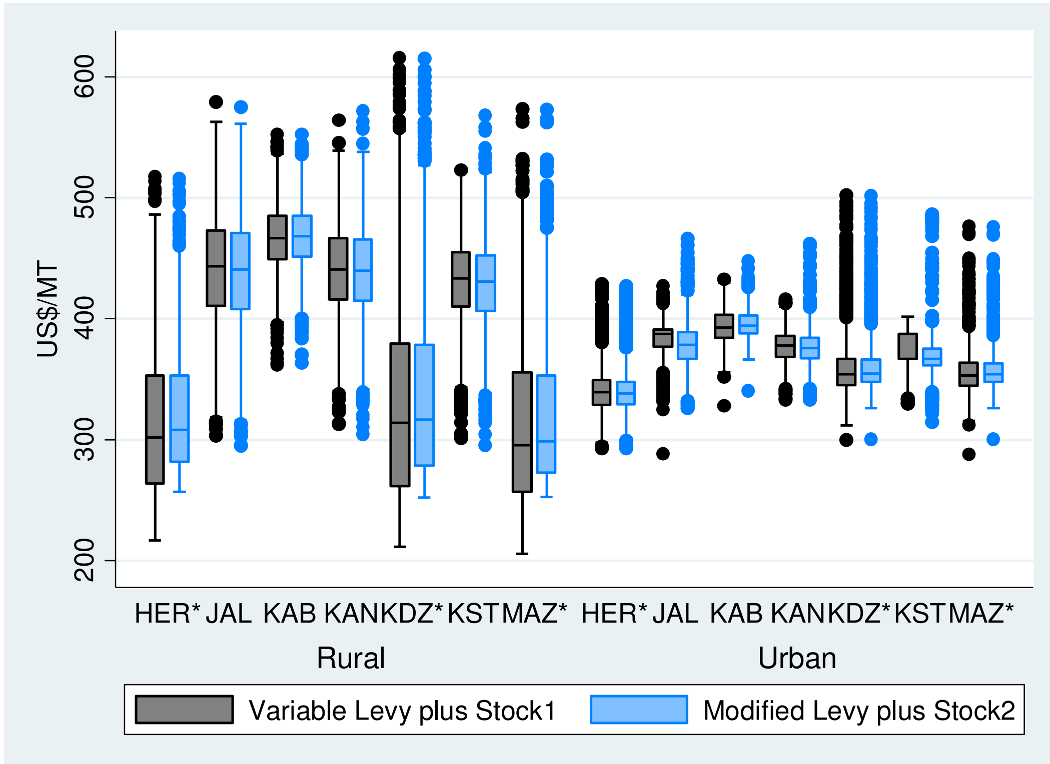

Figure 9-22: Wheat Prices: Variable Levy plus Stock1 Case versus Modified Variable Levy plus Stock2 Case

The stock2 plus modified variable levy policy regime also reduces price variability in central Kabul, as Kabul is partially supplied by northern surplus regions. A stockholding policy with a high MSP combined with the modified variable levy leads to an increase in the mean of prices, especially in regions where stocks are held. The mean and standard deviations of prices from these two types of trade and stockholding policy combinations are presented in Table 9-21. On average, the new combination of trade and stockholding policy is more effective on prices, compared to the earlier case. A rigorous stockholding policy combined with the modified levy leads to a reduction of approximately 9% in the standard deviations of prices in the rural areas, and about 3% in urban areas, compared to the standard variable levy plus stock1. As stockholding policy is more rigorous in the new combination of trade and stockholding policy, impacts are more pronounced in rural areas than in urban areas.

Table 9-21: Wheat Prices: Variable Levy plus Stock1 Case Versus Modified Variable Levy plus Stock2 Case

Region		Variable Levy plus Stock1		Modified Levy plus Stock2		% Change	
		Rural	Urban	Rural	Urban	Rural	Urban
HER*	Mean	306	336	323	341	5.51	1.49
	Std. Dev.	62	19	52	19	-17.13	-2.25
JAL	Mean	438	377	440	379	0.39	0.60
	Std. Dev.	45	15	46	16	1.11	6.48
KAB	Mean	462	389	468	396	1.30	1.79
	Std. Dev.	27	14	26	11	-3.40	-21.92
KAN	Mean	435	372	439	376	0.93	1.23
	Std. Dev.	37	14	37	14	0.48	0.80
KDZ*	Mean	322	355	336	361	4.55	1.78
	Std. Dev.	81	26	70	23	-13.67	-10.20
KST	Mean	428	366	430	369	0.44	0.60
	Std. Dev.	34	12	35	15	2.96	25.43
MAZ*	Mean	305	351	318	357	4.26	1.90
	Std. Dev.	67	19	57	16	-15.76	-16.31
Total	Mean	385	364	393	368	2.16	1.34
	Std. Dev.	84	24	77	23	-9.25	-3.14

Since the new combination of trade and stockholding policy reduces the price variability compared to the earlier combination, it is expected to reduce variability in consumer welfare as well. Consumer welfare from the variable levy plus stock1 versus the modified levy plus stock2 is presented in Table 9-22. Modeling results show that variability in consumer welfare falls in all surplus regions and in central Kabul in the new combination of trade and stockholding policy. The stabilization achieved in surplus regions and central Kabul is mainly due to the aggressive stockholding policy. Since the modified levy is less rigorous than the standard variable levy, prices and consumer welfare are more variable in eastern and southern deficit regions mainly supplied by Pakistan in the new combination of trade and stockholding policy compared to the combination of variable levy plus stock1.

A stockholding policy with a high MSP leads to small distributional impacts across producers and consumers. On average, consumers lose and producers gain in the modified levy plus stock2 case, compared to the variable levy plus stock1 scenario. Changes in consumer welfare are larger in surplus rural areas where public stockholding policy is implemented than in deficit regions. Overall, changes in the mean of consumer welfare are very small compared to the changes in the variability.

Table 9-22: Consumer Surplus: Variable Levy plus Stock1 Case versus Modified Variable Levy plus Stock2 Case

Region		Variable Levy plus Stock1		Modified Levy plus Stock2		% Change	
		Rural	Urban	Rural	Urban	Rural	Urban
HER*	Mean	298.21	57.50	291.75	57.14	-2.16	-0.62
	Std. Dev.	23.30	1.42	19.03	1.40	-18.34	-1.19
JAL	Mean	352.24	29.23	351.61	29.16	-0.18	-0.24
	Std. Dev.	18.09	0.51	18.24	0.53	0.81	5.39
KAB	Mean	582.57	511.17	579.04	507.69	-0.60	-0.68
	Std. Dev.	16.33	7.37	15.76	5.83	-3.51	-20.81
KAN	Mean	705.43	66.10	702.78	65.83	-0.38	-0.41
	Std. Dev.	24.90	0.85	25.07	0.88	0.70	2.81
KDZ*	Mean	473.75	27.43	464.81	27.22	-1.89	-0.79
	Std. Dev.	46.80	0.89	39.74	0.79	-15.09	-10.47
KST	Mean	392.21	21.76	391.40	21.71	-0.21	-0.24
	Std. Dev.	15.13	0.30	15.51	0.37	2.50	21.98
MAZ*	Mean	467.44	52.44	459.79	52.01	-1.64	-0.83
	Std. Dev.	38.34	1.26	31.86	1.06	-16.90	-16.12
Total	Mean	467.41	109.38	463.03	108.68	-0.94	-0.64
	Std. Dev.	26.13	1.80	23.60	1.55	-9.67	-13.73

Producers are better off in all regions with the new combination of trade and stockholding policy, compared to the earlier one with less rigorous stockholding policy. On average, there is approximately a 4% increase to producer welfare in the modified levy plus stock2, compared to the earlier case of variable levy plus stock1. This policy does not reduce variability in producer surplus, as most of the variability in producer welfare is due to the volatility in domestic production. However, the variability in producer welfare is mainly in the upper tail of surplus distribution. High production combined with high prices due to a stockholding policy leads to spikes in producer welfare. Producer welfare from the variable levy plus stock1 versus modified levy plus stock2 are presented in Table 9-23.

Table 9-23: Producer Surplus: Variable Levy plus Stock1 Case versus Modified Variable Levy plus Stock2 Case

Region	Variable Levy plus Stock1		Modified Variable Levy plus Stock2		% Change	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
HER*	95.44	7.24	102.68	10.02	7.58	38.39
JAL	75.49	5.07	75.90	5.05	0.55	-0.49
KAB	102.40	9.75	104.16	9.65	1.73	-1.04
KAN	117.31	9.04	118.55	9.21	1.06	1.80
KDZ*	145.13	11.55	154.19	15.40	6.24	33.30
KST	70.56	6.01	70.96	6.21	0.55	3.43
MAZ*	151.65	12.76	162.36	21.93	7.07	71.88
Average	108.28	8.77	112.68	11.07	4.07	26.12

While a rigorous stockholding policy stabilize prices, it has to accumulate more public stocks and that increases the costs of the policy. The costs of stockholding from the above two scenarios are presented in Table 9-24. On average, the public stock accumulation increases from 190 thousand MT in variable levy plus stock1 case to 336 thousand MT in the modified levy plus stock2 case. The increase in public stocks accumulation leads to an extra cost on average of approximately $6 million, annually ($8.35 million versus $14.79 million). In the extreme cases of high domestic production, the costs of public stockholding increases from $55 million in Stock1 scenario to $71 million in the stock2 case.

Table 9-24: Costs of Public Stockholding Policy: Variable Levy plus Stock1 Case versus Modified Variable Levy plus Stock2 Case

Variable	Mean	Std. Dev.	Min	Max
Variable Levy Plus Stock1				
Public Stocks (000 MT)	189.81	122.74	41.48	1256.75
Costs (Million US$)	8.35	5.40	1.83	55.30
Modified Levy plus Stock2				
Public Stocks (000 MT)	336.20	208.69	55.51	1623.28
Costs (Million US$)	14.79	9.18	2.44	71.42

The costs of the import subsidy on imports from Pakistan is less in the modified levy scenario than in the standard variable levy case in the extreme cases of high world prices plus export restrictions from Pakistan. However, the costs of the import subsidy on Kazakh imports is higher in the new combination of trade and stockholding policy than in the standard variable levy plus stock1 case. Pakistani imports fall in the modified variable levy when Pakistan restricts its exports to Afghanistan, and that is compensated by more imports from Kazakhstan. Therefore the costs of the import subsidy increases on imports from Kazakhstan when the Pakistani export restriction policy is in place. On average, the revenue from variable levy is higher in the modified levy plus stock2 case than in the variable levy plus stock1 scenario, as imports are higher in the earlier scenario than in the later one. A rigorous stockholding policy increases imports, as surplus wheat is retained in public stocks. The revenue from variable levy in the variable levy plus stock1 scenario versus modified levy plus stock2 case is presented in Table 9-25.

Table 9-25: Revenue: Variable Levy Case versus Modified Variable Levy Case

Variable		Mean	Std. Dev.	Min	Max
Levy on Pakistani imports	Variable	26.23	36.70	-158.52	159.62
Levy on Kazakh imports	Levy plus	6.80	15.68	-60.09	95.28
Levy on total imports	Stock1	33.02	41.23	-202.75	172.87
Levy on Pakistani imports	Modified	28.26	34.64	-99.62	144.77
Levy on Kazakh imports	Levy plus	14.48	28.97	-95.04	118.25
Levy on total imports	Stock2	42.72	47.10	-171.99	207.19

Units are in million US$

In summary, a stockholding policy with a primary objective of supporting producer prices is mainly effective in trimming the lower tail of price distribution. If a stockholding policy pursues multiple objectives, supporting producer prices and stabilizing prices for consumers, the costs of the policy surge. A variable levy is more cost effective than a public stockholding policy to stabilize prices for consumers. However, a variable levy does not appear to be effective in trimming the lower tail of price distribution in rural areas where wheat is produced. Therefore, a combination of trade and stockholding policy appears to be a better option to stabilize wheat prices in Afghanistan. A trade policy can be used mainly to trim the upper tail of price distributions and ensure food security in deficit regions. A stockholding policy is used in surplus regions to support producer prices.

The impacts of these stabilization policies across regions, and across producers versus consumers depend on how aggressively these policies are implemented. An aggressive trade policy plus a moderate stockholding policy is more effective in stabilizing prices in deficit regions, compared to surplus regions. An aggressive stockholding policy with a high MSP is mainly effective in stabilizing prices and consumer welfare in surplus regions where stock policy is implemented. A modified variable levy which does not maintain fixed prices on the Afghan-Pakistan border during the periods of Pakistani export restriction appears to be more cost effective than a straight variable levy that maintains fixed prices all the time.

CHAPTER 10. CONCLUSIONS AND POLICY IMPLICATIONS

10.1 Conclusions

The wheat supply chain is now volatile in Afghanistan, mainly due to high variability in domestic production and export restrictions from Pakistan. This puts pressure on the wheat market and creates high variability in wheat prices, especially during the periods of severe shortfalls in wheat production in both Afghanistan and Pakistan. Price shocks in the wheat market have a profound impact on food security, as wheat is the main staple food in the country. The wheat supply chain is likely to remain vulnerable to export restrictions from Pakistan unless countervailing polices are developed in Afghanistan to stabilize domestic wheat markets.

This research explored different trade and stockholding policy options to improve the wheat subsector in Afghanistan. Prior to developing any stabilization policy tool, it is essential to understand how domestic markets are integrated with the main trade partners in the regional markets. A trade policy as a stabilization tool is often a cost effective option if domestic markets are well-integrated with a reliable supplier. However, a stockholding policy or at least procurement in rural areas is required if rural markets are segmented from the commercial centers and regional grain markets.

Price transmission analysis suggests that price signals from Kazakhstan and Pakistan, the key suppliers of wheat and flour to Afghanistan, are transmitted to the domestic markets in the long-run. However, domestic prices do not adjust to price changes in Pakistan and Kazakhstan quickly. The 4-month price adjustment to changes in Kazakh prices is less than 50% for most cases. Moreover, the regression analysis reveals that Pakistan's export restrictions in 2008 broke the price linkage between Afghanistan and Pakistan. After that export restriction policy by Pakistan there was no longer a statistically significant price linkage between Afghanistan and Pakistan. Regression analysis also reveals that wheat markets are not well connected between rural and urban areas. However, prices are strongly linked and move together across commercial centers.

Findings from our trader survey also suggest that domestic wheat and flour are not perfect substitutes for imported wheat and flour. Imported wheat and flour from Kazakhstan has high quality and it is preferred by most commercial bakeries in the urban areas. After Kazakh flour, Pakistani flour is preferred by consumers, and it has a high price in the Afghan markets. Generally, local wheat and flour is the least preferred option for the Afghan consumers and it has the lowest price in the Afghan markets. However, some of the high quality local wheat is preferred over Pakistani wheat. The quality difference between imported and local wheat combined with weak market integration between rural and urban areas suggest that an increase in domestic production will not fully replace imports. Moreover, findings from the trader survey and the results from the price transmission analyses suggest an Armington modeling approach better fits the Afghan wheat market than a competitive spatial equilibrium to assess the stabilization policies. An Armington model recognizes that commodities may not be perfect substitutes and markets are not perfectly competitive across space.

Simulation analyses in a framework of imperfect market integration suggest that using only a trade policy cannot effectively stabilize the welfare of both producers and consumers. A trade policy is effective mainly in trimming the upper tail of price distributions, and thus mostly improving consumer welfare. A trade policy is ineffective in eliminating the lower tail of price distribution, especially in rural areas of surplus regions where wheat is produced. This is largely due to the imperfectly integrated markets between rural and urban areas.

A stockholding policy can be used to support producer prices and/or stabilize prices for consumers, depending on where and how much stocks are maintained annually. Modeling results show that a stockholding policy held in rural areas of surplus regions is mainly effective in eliminating the lower tail of price distributions, and this mostly improves producer welfare. In order to stabilize prices for consumers, large quantities of public stocks are required to be maintained, mainly in commercial centers of deficit regions. About 2 MMT of annual public stocks are necessary to prevent price shocks in extreme cases of low production and high world prices and restore normal prices (as occurred in 2008).

A summary of alternative policy options with their expected impacts on market outcomes are presented in Table 10-1.

Table 10-1: Policy Implications of Alternative Scenarios.

Policy Options	**Policy Implications**
Stockholding policy with MSP of $200 (Stock1)	This policy mainly trims the lower tail of price distribution and mainly helps producers. This policy stabilizes prices and the welfare of producers and to a lesser extent consumers mainly in rural areas of surplus regions where stockholding policy is implemented.
Stockholding policy with a MSP of $250 (Stock2)	This stockholding policy is more aggressive than the earlier one with a MSP of $200. Although this policy is mainly effective in trimming the lower tail of price distribution, it also trims somewhat the upper tail of price distribution. On average, stocks accumulation and costs in stock2 case are twice as much as in stock1 case. The impacts of this aggressive stockholding policy is also observed in commercial centers of surplus regions.
Stocks policy in commercial centers	This stockholding policy maintains large quantities of stocks in commercial centers to prevent price spikes. A stockholding policy can be used to stabilize prices both in rural and urban areas but large quantities of stocks are required to stabilize prices in commercial centers. Therefore, a trade policy is more cost effective than a stockholding policy to stabilize prices in commercial centers.
Variable Levy	A variable levy is mainly effective in trimming the upper tail of price distributions and it is good for consumers. The impacts of a variable levy is more pronounced in commercial centers than in rural areas due to poor urban-rural market integration.
Modified Variable Levy	Prices are more variable in modified variable levy than in variable levy, especially in eastern regions supplied by Pakistan. The costs of the import subsidy in the modified variable levy are about half of the costs in the variable levy in extreme cases of high world prices and export restrictions from Pakistan.
Variable Levy plus Stock1	The combined impacts of a variable levy plus stockholding policy are large in commercial centers and rural areas. Prices and the welfare of producers and consumers are fairly stable when both policies are implemented. However, prices are more stable in commercial centers than in rural areas, since an aggressive variable levy is combined with a moderate stockholding policy.
Modified variable levy plus Stock2	In this scenario a more aggressive stockholding policy and less aggressive variable levy are combined, compared to the earlier case. This combination of trade and stockholding policy effectively stabilizes prices in commercial centers and rural areas. In this scenario prices are more stable in rural areas of surplus regions, compared to earlier combination of trade and stockholding policy.

Implementing stabilization policies is often associated with large costs to the government and distributional effects between rural and urban areas. Trade policy is generally a more cost effective tool than stockholding policy. Trade policy is costly only in the years of high world prices when the government has to subsidize imports to stabilize domestic prices. In other years it generates revenue from taxes on imports. The simulation modeling results show that the total revenue from a variable levy is negative (an import subsidy is required) in 15% of repetitions. Although the costs of import subsidies are high in the periods of high world prices combined with export restrictions from Pakistan, revenue from variable levy is positive on average. The costs of the import subsidy in the modified variable levy plus stock2 is approximately $172 million in extreme cases of high world prices and low domestic production. On average, this policy generates about $42.7 million revenue each year.

In contrast to a variable levy, Public stockholding policy normally leads to a welfare loss to the government. There are always costs associated with carrying stocks over time. The costs of the stockholding policy and the level of public stocks increases if the policy pursues multiple objectives. Stabilizing only producer prices and welfare requires stockholding policy only in rural surplus areas. That objective can be achieved by carrying stocks of about 200 thousand metric tons, on average, with an average annual costs of about $8 million. However, stabilizing consumer prices and preventing scenarios like the food crisis in 2008 with only stockholding policy requires carrying large quantities of public stocks annually (approximately 2MMT). Assuming a holding costs of $60/MT leads to an annual cost of approximately $120 million to the government.

Our simulation analyses suggests a combination of a stockholding policy plus a variable levy is the most cost effective strategy to stabilize wheat markets in Afghanistan. It is preferred that stockholding policy focuses on stabilizing producer prices in surplus regions, while a variable levy is used to stabilize prices in commercial centers and in deficit regions. Given the weak market integration between rural and urban areas, a variable levy cannot effectively stabilize producer prices in rural areas. A stockholding policy may be used to stabilize consumer prices in deficit regions, but carrying large quantities of stocks are required to achieve that objective. Carrying large quantities of stocks for a long period of time in deficit regions to stabilize consumer prices is more costly than achieving the same objective through a trade policy.

The impacts of the stockholding policy and trade policy on price stabilization are different across regions. Since a variable levy is mainly effective in deficit regions, it improves consumer welfare in the eastern and southern regions of Jalalabad and Kandahar more than in northern surplus regions of Mazar and Kunduz. A stockholding policy implemented in surplus regions mainly stabilizes prices and consumer welfare in the northern and western regions of Mazar, Kunduz and Herat.

Afghanistan has become a member of the World Trade Organization (WTO) in December 2015. This implies trade policies of the country should be in compliance with the WTO general agreements. Under the Uruguay Round Agreement on Agriculture, variable levies have been converted into fixed tariffs. However, countries are allowed to "occasionally" adjust the tariffs within the limits of their bounds in response to fluctuations in world prices. For instance, the European Union (EU) reduced tariffs on cereals to zero in January 2008 in response to high world prices, and reintroduced them in the October of the same year. Although a variable import levy is not allowed for member countries of WTO, there are ways of getting around the general WTO prohibition, and so using trade policies as those examined here.

10.2 Policy Implications

Given the importance of wheat both in terms of production and as a key staple food in Afghanistan, there is considerable interest from the Afghan government and from the donor community to improve the wheat subsector. The policy documents from MAIL show that the government is more interested in pursuing a self-sufficiency program and in implementing a stockholding policy to stabilize prices.

Several policy guidelines emerge from our analysis to improve the current discussion on the wheat subsector in Afghanistan. Our analysis shows there are two key challenges that may slow down the self-sufficiency approach. First, the markets are not well integrated between rural and urban areas. This implies an increase in domestic production does not fully replace imports. Second, our analysis shows domestic wheat production is not a perfect substitute for imported wheat and flour. Imported wheat and flour, especially Kazakh wheat and flour, has higher quality than domestic wheat so imported wheat is preferred by commercial bakeries in urban centers. Therefore, a self-sufficiency policy is unlikely to be successful unless the quality issue and weak market linkages between rural and urban areas are addressed. Pursuing a self-sufficiency policy may also increase the cost of stabilization policies. An increase in domestic production is likely to bring high variability in the lower tail of price distribution in rural zones of surplus regions. This implies an aggressive stockholding policy is required to procure surplus wheat in those regions.

MAIL is also considering the renovation of old silos and building new ones to procure domestic wheat and carry public stocks, presumably to stabilize the domestic grain market. Although the objectives of the stockholding policy are not clearly defined in the wheat policy document by MAIL, building storage in commercial centers indicates the policy may pursue multiple objectives, stabilizing prices for both consumers and producers. This research reveals public that stockholding policy is not a cost effective option to stabilize consumer prices. A trade policy is more cost effective than a stockholding policy to prevent price shocks during the periods of high world prices.

While a variable levy is a more cost effective option than a stockholding policy to stabilize consumer prices in deficit regions, it is ineffective to prevent price falls in in surplus regions in high production scenarios. Therefore, our results suggest that a public stockholding policy should be focused mainly on stabilizing producer prices and it is recommended to be maintained in surplus regions.

10.3 Limitations and Suggestions for Further Research

This research produced valuable results that should be of interest to agriculture policymakers in Afghanistan and readers in the areas of food security and food price stabilization. Numerous variations of the policies examined could be explored to elaborate on tradeoffs policymakers face using this model. However, our simulation model is developed on an annual basis. Short term price dynamics are not captured in this model. Based on our annual model, prices can be stabilized with a variable levy. However, the delays in imports are not considered in this annual model. A key feature of a stockholding policy is stabilizing prices across seasons. The seasonal effects of the stockholding policy cannot be assessed in an annual model. Using a short term model to assess the impacts of the stabilization policies may improve the results. To enhance the projections results a quarterly model is suggested to be used for future research. Data limitation is a key challenge for a quarterly model.

In this model, we assumed all provinces surrounding commercial centers are at equal distance from the commercial centers. However, some of the areas are extremely remote and disconnected from the commercial centers, while some others are located close to the commercial centers and well integrated with the urban areas. Disaggregating rural areas into different groups may also enhance the results.

The time series production, area and price data used to estimate the supply elasticities and to estimate error distributions are only for a short period of time. In addition to prices, potentially there are other variables that might explain the area harvested and yield. We could not get access to the rainfall data for Afghanistan to incorporate in our regression analysis. Using annual data series for a longer period of time, and the rainfall data as an explanatory variable to explain area harvested and yield may improve the results.

The limitations to our research are not expected to have significant impacts on the qualitative results of our model. Addressing those limitations in future research may improve the results in magnitudes but is not expected to change the qualitative conclusions.

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APPENDICES

Appendix A Summary Statistics and Diagnostic Test Results

Table A1: Descriptive Statistics of the Price Series

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

Note: Units of measure are US$ per metric t

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

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

Note: ADF is the Augmented-Dickey Fuller test and PP is the Phillips-Perron test.
*** p<0.01, ** p<0.05, * p<0.1

Table A3: Kyrgyzstan Prices Related to Kazakhstan Prices

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

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

Appendix B GAMS Code

```
*Afghan Wheat Model*
* taking into account Pakistani export restriction scenario

Option nlp = conopt3 ;

SETS
*Location points
  h     ports  / BOLD, HAIR, TGDI, TOUR, KHST /
  r     regions / HER,JAL,KAB,KAN, KDZ, KST, MAZ/
  d(r)  deficit regions /JAL, KAB, KAN, KST/
  j(r)  surplus region /HER, KDZ, MAZ/
  z     urban and rural areas in each region /Urb, Rur/
  w     exporter countries of wheat and flour to Afghanistan /KAZ, PAK/
  k(h)  northern ports for Kazakh wheat and flour /HAIR, TGDI/
  P(h)  eastern ports for Pakistani wheat and flour / BOLD, TOUR, KHST/
*Monte Carlo iteration
  iterM  Monte carlo iterations /1*1000/
*Years
  ty    Iterate years /1*2/
;

Alias (r,s);
Alias (w,wa);

VARIABLES

Xw(r,s,ty)     interregional quantity wheat flows from center r to s
Xf(r,s,ty)     interregional quantity flour flows from center r to s
XwR(r,ty)      wheat flows from rural to urban center in each region
XfU(r,ty)      flour flows from urban center to rural
Xwm(h,r,ty)    wheat import (m) flows from ports to centers
Xfm(h,r,ty)    flour import (m) flows from ports to centers

C(r,z,ty)      consumption in each region r and zone z
Cp(r,z,ty)     consumption per capita in region r and zone z
M(r,z,ty)      metric tons of wheat going to milling in region r zone z
ST(r,z,ty)     private carry out stocks in region r zone z
PS(r,z,ty)     public stocks in surplus regions
Qe(r,ty)       wheat production region r on year ty for year ty+1
A(r,ty)        area with respect to price
Ae(r,ty)       realized area (area times the cholesky matrix)
Obj            objective function value
```

PwWe(h,ty) wheat price at border points before tariffs
PwRZ(r,z,ty) domestic wheat price in region r zone z
PfWe(h,ty) flour price at border points before tariffs
PfRz(r,z,ty) domestic flour price in region r zone z

Sc(r,z,ty) consumer surplus
Sp(r,z,ty) producer surplus
Tr(r,z,ty) trader welfare
;

Positive variables Xw, Xf, XwR, XfU, Xwm, Xfm, C, M, ST,PS, Qe, A, Ae, PfRz,PwRZ;

PARAMETERS
*TRANSPORTATION COSTS
*TO Regions
cXm(h,r) cost of imports from PORTS to URBAN centers in wheat and flour
cXR(r,s) costs of INTERREGIONAL flows from r to s in Wheat
Ptc pakitani wheat transportation costs to Afghan border /20/
ptc2 pakistan wheat trans cost with export restriciton /150/
Ktc Kazakh wheattransportation costs to Afghan border /60/
Fpck flour processing costs kazakhstan /80/
Fpcp flour processing costs pakistan /50/
Fd flour processing costs inside the county /80/

*Unidirection INTER-REGIONAL flows (Wheat to URBAN, Flour only to provinces)
cXWZ(r) costs of wheat flows from RURAL to URBAN center in each region
/HER 30, JAL 20, KAB 20, KAN 20, KDZ 30, KST 20, MAZ 30/
cXfZ(r) costs of FLOUR flows from Urban to provinces

*INITIAL Land Use and Production

Qo(r) base regional net production of whheat in metric tons in 2013
/
HER 643487
JAL 321974
KAB 424695
KAN 547382
KDZ 962638
KST 322626
MAZ 1082374/

```
  Ao(r)       Base area of wheat in hectare in 2013
/
HER       404486
JAL       108143
KAB        162312
KAN        204259
KDZ       568484
KST       115897
MAZ        850595

/

  yo(r)       Base yield of WHEAT in each region in 2013

*FUTURE Area Land and Yield (Note: Expected production is endogenous)
  Ye(r,ty)    Expected net yield in region r in years 2 3 and so forth

*INITIAL WORLD Prices
  Pw(w)        world price of wheat in 2013/ KAZ 256, PAK 313/
  Pwe(w,ty)    world expected price ( Kazakhstan and Pakistan)
  PfWo(h)      Initial world price of flour (FAO) Border prices before tarrifs
  PwWo(h)      Initial world price of wheat 2013 at port (border price)
  Pmax(r,z)         max price

*Average Wheat Prices
  PwR(r)      average wheat prices by region in 2013
  /HER 320, JAL 375, KAB 406, KAN 425, KDZ 327, KST 375, MAZ 327/

*INITIAL Per Capita Wheat Consumption
  Co          Per capita wheat consumption tons per million population /150000/

*SEED Requirement Per Planting
  seeds(r)    Seed requirments for planting per region in 2013
  /HER 49200, JAL 18900, KAB 27200, KAN 38900, KDZ 74500, KST 23000, MAZ
90700/

*Elasticity of Area with respect to price which is = to Elasticity of Quantity

  ESUB(r)        Short run elasticity of area with respect to price
 /HER 0.185, JAL 0.552, KAB 0.337, KAN 0.166, KDZ 0.079, KST 0.261, MAZ 0.307 /

psm   min publick stocks /50/

* elasticity of per capita demand for cosnumption is the same across regions
  es             elasticity of demand per capita for wheat consumption  /-0.2/
```

```
*COST of Mill and Storage parameters
  costS(r,z)  stocks costs handling and finance charges
  costM(r,z)  milling cost


*DEMAND FUNCTION:
  ac(r,z)    aggregate demand function (intercepts)
  bc(r,z)    aggregate demand function (slopes)
  bs(r)    aggregate supply function slope for stocks
  as(r)    aggregate supply function intercept for stocks

LLAREA(r,ty) stochastic term of area;

*Initial average Yield: Y*A=Q
   yo(r) = Qo(r) /Ao(r);

* DATA REQUIREMENT IN TABLES

*INITIAL storage (STOCKS)
table Si(r,z) beginning stocks
            Urb        Rur
HER       7000       13000
JAL       5000       5000
KAB       10000      10000
KAN       7000       8000
KDZ       7000       13000
KST       5000       5000
MAZ       7000       13000
;

table Sm(r,z) min stocks
        Urb    Rur
HER    5000   10000
JAL    5000   5000
KAB    5000   5000
KAN    5000   5000
KDZ    5000   10000
KST    5000   5000
MAZ    5000   10000;
```

*POPULATION (Constant in the time period)
table pop(r,z)

	Urb	Rur
HER	0.5148	2.5658
JAL	0.2174	2.8036
KAB	3.435	4.2174
KAN	0.4097	4.6425
KDZ	0.2436	4.0256
KST	0.16	3.0873
MAZ	0.4633	3.8951;

Table cXJD(j,d) the costs of wheat flow from surplus to deficit regions

	JAL	KAB	KAN	KST
HER	200	100	40	200
KDZ	60	40	80	100
MAZ	60	40	80	100;

Table XWo(j,d) initial wheat flow from surplus to deficit regions

	JAL	KAB	KAN	KST
HER	0	0	1000	0
KDZ	0	50000	0	0
MAZ	50	10000	50	0;

Table Xfo(j,d) initial flour flow from surplus to deficit regions

	JAL	KAB	KAN	KST
HER	0	0	1000	0
KDZ	1000	50000	1000	0
MAZ	50	10000	50	0;

table cXm(h,r) import flow cost from ports to region

	HER	JAL	KAB	KAN	KDZ	KST	MAZ
BOLD	40	1000	1000	20	1000	1000	1000
HAIR	1000	1000	40	1000	30	1000	30
TGDI	20	1000	1000	60	1000	1000	1000
TOUR	1000	20	40	1000	1000	1000	1000
KHST	1000	1000	40	1000	1000	20	1000;

```
table Xmo(h,r) initial flour flow from ports to regions
        HER     JAL     KAB     KAN    KDZ    KST    MAZ
BOLD    10000   0       0       230000 0      0      0
HAIR    0       0       200000  0      90000  0      100000
TGDI    80000   0       0       1000   0      0      0
TOUR    0       120000  140000  0      0      0      0
KHST    0       0       90000   0      0      180000 0;

table Xwmo(h,r) initial wheat flow from ports to regions
        HER     JAL     KAB     KAN    KDZ    KST    MAZ
BOLD    0       0       0       15000  0      0      0
HAIR    0       0       10000   0      10000  0      50000
TGDI    10000   0       0       1000   0      0      0
TOUR    0       15000   100     0      0      0      0
KHST    0       0       100     0      0      15000  0;


table ci(r,z) initial consumtions metric tons per region

        urb     rur
HER     82368   410528
JAL     34784   448576
KAB     549600  674784
KAN     65552   742800
KDZ     38976   644096
KST     25600   493968
MAZ     74128   623216
;

parameter Xwro(j) initial wheat flow from rural to urban in surplus regions
/ HER 50000, KDZ 60000, MAZ 100000/

Xfuo(r) initial flor flows from urban to rural areas
/HER 30000, JAL 100000, KAB 180000, KAN 200000,KDZ 50000, KST 140000, MAZ
80000/

;

*STOCHASTIC PARAMETERS

Table LLPW(w, wa)  Cholesky matrix for the world price

        KAZ           PAK
KAZ     52.10731795   0
PAK     9.543457643   30.37629171;
```

```
Table LLA(r,s)  Cholesky decomposition for the area errors
      HER       JAL      KAB       KAN       KDZ      KST       MAZ
HER  0.12260   0.00000   0.00000   0.00000   0.00000  0.00000   0.00000
JAL -0.03162   0.09744   0.00000   0.00000   0.00000  0.00000   0.00000
KAB  0.04373   0.05118   0.04480   0.00000   0.00000  0.00000   0.00000
KAN  0.01028   0.03777   0.04610   0.04074   0.00000  0.00000   0.00000
KDZ  0.03988  -0.02537   0.04796   0.00743   0.05005  0.00000   0.00000
KST  0.02724   0.04870   0.02297   0.05381  -0.01574  0.04160   0.00000
MAZ  0.10154   0.04010   0.01461  -0.08021  -0.03990 -0.01202   0.01478 ;


table LLY(r,s) cholesky matrix for yield
     HER       JAL       KAB       KAN       KDZ       KST       MAZ
HER  0.28895    0.00000    0.00000    0.00000    0.00000   0.00000   0.00000
JAL  0.16038    0.52694    0.00000    0.00000    0.00000   0.00000   0.00000
KAB  0.11425    0.02128    0.34066    0.00000    0.00000   0.00000   0.00000
KAN  0.23705    0.22153    0.15250    0.20401    0.00000   0.00000   0.00000
KDZ  0.26731    0.00786    0.04411   -0.07435    0.25355   0.00000   0.00000
KST  0.25131    0.19968    0.25591    0.10388   -0.05632   0.10866   0.00000
MAZ  0.23412   -0.00975   -0.10134    0.01418    0.12663    0.02307   0.14450
;

* intercept and slope for demand and supply curve

 bc(r,z) = es*co*pop(r,z)/PwR(r);
 ac(r,z) = co*pop(r,z) - bc(r,z)*PwR(r);
 bs(r)  =   Ao(r)*ESUB(r)/PwR(r);
 as(r)  =   Ao(r)-bs(r)*PwR(r)  ;
 Pmax(r,z) = -ac(r,z)/bc(r,z)
display bc, ac, bs, as, Pmax;


Scalar tw Tariff on wheat /0.1/;
scalar tf tariff on flour /0.1/
scalar Ls post harvest losses 10 percent of total production /0.15/
scalar FER flour extraction rate in rural areas /0.9/  ;
scalar FEU flour extraction rate in urban cities /0.9/;
scalar Pm  min price /100/;
scalar sub pakistan milling subsidy 10 dollar per metric tons /10/;

EQUATIONS
 Object              Objective function is surplus less costs
 URBANw(r,ty)        Supply and use balance for wheat in surplus regions
 URBANf(r,ty)        Supply and use balance for flour in surplus regions
 RURALw(r,ty)        supply and use balance for wheat in rural areas
```

```
 RURALf(r,ty)         supply and use balance for flour in rural areas
 URBANw2(r,ty)        supply and use balance for wheat deficit regions
 URBANf2(r,ty)        supply and use balance for flour in defict regions

 cons(r,z,ty)         demand for consumption
 Storage(r,z,ty)      private storage function
*pubstock             publick storage function
 pro(r,ty)            supply function for wheat
 Area(r,ty)           area as a function of price
 Erea(r,ty)           stochastic area

 WPP(p,ty)            wheat prices at ports close to Pakistan
 WPP2(p,ty)           wheat prices at ports close to Pakistan
 WPK(k,ty)            wheat prices at ports close to Kazakhstan
 FPP(p,ty)            flour prices at ports close to Pakistan
 FPK(k,ty)            flour prices at ports close to Pakistan

 FPU(r,z,ty)          Slackness conditions for milling process in urban areas
 FPR                  Slackness conditions for milling process in rural areas
 FPU1(r,z,ty)         Slackness conditions for milling process in urban areas
 FPR1                 Slackness conditions for milling process in rural areas
 pcap                 per capita consumption
 Scon                 consumer surplus

* the following equations are complentary slackness conditions

CS1       slackness conditions for wheat flows between regions
CS2       slackness conditions for wheat flows between regions
CS3       slackness conditions for flour flows between regions
CS4       slackness conditions for flour flows between regions
CS5       armington equation for wheat imports
CS6       armington equation for flour imports
CS7       armington equation for wheat flow from rural to ruban areas
CS8       armington equation for flour flow from urban to rural areas
CS9       armington equation for wheat flows from rural to urban in region d
;
Object .. obj =e=sum(ty,(sum((r,z),(Qe(r,ty)*pwrz(r,z,ty)))))/2000000    );

*demand for consumption and stocks
cons(r,z,ty).. C(r,z,ty) =e= ac(r,z) + bc(r,z)*PfRz(r,z,ty);
pcap(r,z,ty).. Cp(r,z,ty) =e= C(r,z,ty)/pop(r,z);

STORAGE(r,z,ty).. (ST(r,z,ty)-sm(r,z))* (PwRZ(r,z,ty)-pm)=e= 3000000 ;
*pubstock(j,"rur",ty).. (ps(j,"rur",ty)-psm)*(PwRz(j,"rur",ty)-Pm) =e= 4000000;
```

```
ps.fx(j,"rur",ty) = 0;
*ps.up(j,"rur",ty) = 300000;

*supply function
Area(r,ty).. A(r,ty) =e=  as(r) + bs(r)* PwRz(r,"rur",ty);
Erea(r,ty).. Ae(r,ty) =e=  A(r,ty)* LLAREA(r,ty);
pro(r,ty).. Qe(r,ty) =e=  Ae(r,ty)*ye(r,ty) ;
Scon(r,z,ty).. Sc(r,z,ty) =e= C(r,z,ty)*(Pmax(r,z)-PWRz(r,z,ty))/2000000;
Spro(r,z,ty).. Sp(r,z,ty) =e= Qe(r,ty)*PwRz(r,"rur",ty)/2000000;


* SUPPLY and USE balance in URBAN commercial centers

URBANw(r,ty)$j(r)..
*Initial stock
  Si(r,"Urb")$(ord(ty) eq 1)+ ST(r,"Urb",ty-1)$(ord(ty) gt 1)
*Wheat from port to region + Wheat send from rural to urban (received by urban)
  + Sum(h,Xwm(h,r,ty))
  + XwR(r,ty)
          =E=
*Carry out in urban stock + Wheat converted to flour + interregional flow
  + ST(r,"Urb",ty)
  +  M(r,"Urb",ty)
  + sum(d,Xw(r,d,ty));

URBANw2(r,ty)$d(r)..
*Initial stock
  Si(r,"Urb")$(ord(ty) eq 1)+ ST(r,"Urb",ty-1)$(ord(ty) gt 1)
*Wheat from port to region + Wheat send from rural to urban (received by urban)
  + Sum(h,Xwm(h,r,ty))
  + sum(j,Xw(j,r,ty))
          =E=
*Carry out in urban stock + Wheat converted to flour + interregional flow
  + ST(r,"Urb",ty)
  +  M(r,"Urb",ty);

*Note the change, here was x(r,s) but now it is xf(r,s) because is flour
URBANf(r,ty)$j(r)..
  Sum(h,Xfm(h,r,ty))+ feu*m(r,"Urb",ty)   =E=
    C(r,"Urb",ty)+ sum(d,Xf(r,d,ty))
    +  XfU(r,ty);

URBANf2(r,ty)$d(r)..
  Sum(h,Xfm(h,r,ty))+ feu*m(r,"Urb",ty)+sum(j,xf(j,r,ty))   =E=
    C(r,"Urb",ty)+  XfU(r,ty);
```

```
* supply and use balance in rural areas

RURALw(r,ty)..
*Beginning stock in rural plus initial production

     Si(r,"Rur")$(ord(ty) eq 1)+ST(r,"Rur",ty-1)$(ord(ty) gt 1)
    + PS(r,"Rur",ty-1)$(ord(ty) gt 1)$j(r) + Qe(r,ty) =E=
     ST(r,"Rur",ty) +PS(r,"rur",ty)$j(r)+ XwR(r,ty)$j(r)
     + M(r,"Rur",ty)+ Seeds(r)+Qe(r,ty)*LS;

RURALf(r,ty).. fer*M(r,"Rur",ty) + XfU(r,ty) =E=
             C(r,"Rur",ty)
;

* price linkage from Pakistan and Kazakhistan to border points

WPP(p,ty)$(pwe("kaz",ty)lt 370)..   pwWe(p,ty) =E= pwe("pak",ty) + Ptc +
Pwe("pak",ty)*tw;
WPP2(p,ty)$(pwe("kaz",ty)gt 370)..   pwWe(p,ty) =E= pwe("pak",ty) + Ptc2 +
Pwe("pak",ty)*tw;

WPK(k,ty)..   pwWe(k, ty) =e= pwe("kaz", ty) + Ktc + Pwe("kaz",ty)*tw;

FPP(P,ty)..   PfWe(P,ty) =e= PwWe(P,ty) + Fpcp + Fpcp*tw;

FPK(K,ty)..   PfWe(K,ty) =e= PwWe(K,ty) + Fpck + FpcK*tw;

* price linkage between wheat and flour

FPU(r,z,ty).. PfRz(r,"urb",ty) =L= PwRz(r,"urb",ty) + Fd ;
FPR(r,z,ty).. PfRz(r,"rur",ty) =L= PwRz(r,"rur",ty) + Fd ;
FPU1(r,z,ty).. m(r,"urb",ty)*(PwRz(r,"urb",ty) + Fd- PfRz(r,"urb",ty))=e=0;
FPR1(r,z,ty).. m(r,"rur",ty)*(PwRz(r,"rur",ty) + Fd- PfRz(r,"rur",ty))=e=0;

* wheat flows between commercial centers

CS1(j,d,ty).. pwRz(d,"urb",ty)=L= PwRz(j,"urb",ty)+ cXJD(j,d);
CS2(j,d,ty)..xw(j,d,ty)*( PwRZ(J,"urb",ty)+ cXJD(j,d) - PwRZ(d,"urb",ty))=E= 0;

* flour flows between commercial centers

CS3(j,d,ty).. pfRz(d,"urb",ty)=L= PfRz(j,"urb",ty)+ cXJD(j,d);
CS4(j,d,ty).. xf(j,d,ty)*( PfRZ(j,"urb",ty)+ cXJD(j,d) - PfRZ(d,"urb",ty))=E=0;
```

```
* Armington

CS5(h,r,z,ty).. Xwm(h,r,ty) =e=
Xwmo(h,r)*((Pwwe(h,ty)+ cXm(h,r))/PwRz(r,"urb",ty))**(-5);

CS6(h,r,z,ty).. Xfm(h,r,ty) =e=
Xmo(h,r)*((Pfwe(h,ty)+ cXm(h,r))/PfRz(r,"urb",ty))**(-5);

CS7(j,ty).. Xwr(j,ty) =E=
Xwro(j)*(( PwRz(j,"rur",ty)+ cXwZ(j))/PwRz(j,"urb",ty))**(-4);

CS8(d,ty).. Xfu(d,ty) =E=
Xfuo(d)*((PfRz(d,"urb",ty)+ cXwz(d))/PfRz(d,"rur",ty))**(-4);

CS9(j,ty).. Xfu(j,ty) =E=
Xfuo(j)*((PfRz(j,"urb",ty)+ cXwz(j))/PfRz(j,"rur",ty))**(-15);

* initial conditions
xw.l(j,d,ty) = xwo(j,d);
xf.l(j,d,ty)=  xwo(j,d);
xwm.l(h,r,ty) = xmo(h,r);
xfm.l(h,r,ty) = xmo(h,r);
xfu.l(d,ty) = 1000 ;
c.l(r,z,ty) = ci(r,z) ;
Ae.l(r,ty) = Ao(r);
qe.l(r,ty) = qo(r);
st.l(r,z,ty) = si(r,z);
PwRz.lo(r,z,ty)= Pm+1;
PwRz.up(r,z,ty)= Pmax(r,z);
pwwe.lo(h,ty) = 100;
pfwe.lo(h,ty) = 120;
PfRz.lo(r,z,ty)= Pm+1;

Model Wheat /all/ ;

File Results /Results2.dat/;

*realized parameters
Parameter
AeMC(r,ty,iterM)            stochastic area
yeMC(r,ty,iterM)            stochastic yields
QeMC(r,ty,iterM)            realized production
CMC(r,z,ty,iterM)           consumption
CpMC(r,z,ty,iterM)          consumption per capita
STMC(r,z,ty,iterM)          private stocks
```

```
PSMC                      public stocks
PweMC(w,ty,iterM)         kazak and pakistan prices of wheat
PwWeMC(h,ty,iterm)        prices of wheat at each ports
PFWeMC(h,ty,iterm)        flour prices at ports
pWrZMC(r,z,ty,iterM)      domestic what prices
pFrZMC(r,z,ty,iterM)      domestic flour prices
XWmMC                     wheat imports
XFmMC                     flour imports
XwrMC                     wheat flows to urban centers
XfuMC                     flour flows to rural areas
Xwmc                      wheat flows to deficit regions from surplus
Xfmc                      flour flows to deficit regions
ScMC                      consumer surplus
SpMC                      producer surplus
MMC                       wheat going to milling industry
MS                        model status
tc                        total annual national consumption
tq                        total annual national produciton
tfm                       total annual flour imports
twm                       total annual wheat imports
ts                        total annual stock
tps                       total annual public stock
tm                        total annual milling
xfmp                      total flour imports from pakistan
xfmk                      total flour imports from kazakhstan
xwmp                      total wheat imports from Pakistan
xwmk                      total wheat imports from kazakhstan

Option Seed=1085;

****Here comes the iterations, the years and (the region for the report)***

loop (iterM,

ye(r,ty) = yo(r)+ sum(s,LLY(r,s)*Normal(0,1));
Pwe(w,ty) = Pw(w) + sum(wa,LLPW(w,wa)*Normal(0,1));
LLAREA(r,ty) = exp(sum(s,LLA(r,s)*Normal(0,1)));

Solve Wheat using nlp maximizing obj;

 AeMC(r,ty,iterM)= Ae.l(r,ty);
 yeMC(r,ty,iterM)= ye(r,ty);
 QeMC(r,ty,iterM)= Qe.l(r,ty);
 Cmc(r,z,ty,iterM) =  c.l(r,z,ty);
 CpMC(r,z,ty,iterM) = Cp.l(r,z,ty);
```

```
 STMC(r,z,ty,iterM)= ST.l(r,z,ty);
 PSMC(j,"rur",ty,iterM) = PS.l(j,"rur",ty) ;
 PweMC(w,ty,iterM)= Pwe(w,ty);
 PwWeMC(h,ty,iterM)=PwWe.l(h,ty);
 PFWeMC(h,ty,iterM)=PFWe.l(h,ty);
 PWrZMC(r,z,ty,iterM)=pWrZ.l(r,z,ty);
 PFrZMC(r,z,ty,iterM)=pFrZ.l(r,z,ty);
XWmMC(h,r,ty,iterM) = Xwm.l(h,r,ty);
XFmMC(h,r,ty,iterM) = Xfm.l(h,r,ty);
XwrMC(j,ty,iterM)  =  Xwr.l(j,ty);
XfuMC(r,ty,iterM) =   Xfu.l(r,ty);
Xwmc(j,d,ty,iterM) =  Xw.l(j,d,ty);
Xfmc(j,d,ty,iterM) =  Xf.l(j,d,ty);
ScMC(r,z,ty,iterM) = Sc.l(r,z,ty);
SpMC(r,z,ty,iterM) = sP.l(r,z,ty);
MMC(r,z,ty,iterm)  = m.l(r,z,ty);
MS(iterm) = wheat.modelstat;
tc(ty,iterm)   = sum((r,z), cmc(r,z,ty,iterm));
tq(ty,iterm) = sum(r,qemc(r,ty,iterM));
tfm(ty,iterm) = sum((h,r),xfmMC(h,r,ty,iterM));
twm(ty,iterm) = sum((h,r),XwmMC(h,r,ty,iterM));
ts(ty,iterm) = sum((r,z),stmc(r,z,ty,iterm));
tps(ty,iterm) = sum(j,psmc(j,"rur",ty,iterm));
tm(ty, iterm) = sum((r,z),mmc(r,z,ty,iterm));
xfmp(ty,iterm) = sum((p,r),XFmMC(P,r,ty,iterM));
xfmk(ty,iterm) = sum((k,r),XfmMC(k,r,ty,iterM));
xwmp(ty,iterm) = sum((p,r),XwmMC(P,r,ty,iterM));
xwmk(ty,iterm) = sum((k,r),XwmMC(k,r,ty,iterM));
 );

 display
AeMC,yeMC,QeMC,CMC,STMC,PSMC,PweMC,PwWeMC,pWrZMC,PFWeMC,pFrZ
MC,
 XWMMC, XFMMC, XWRMC, XFUMC, XWMC, XFMC, MS,tc;

execute_unload "test.gdx"
AeMC,yeMC,QeMC,CMC,CpMC,STMC,PSMC,PweMC,PwWeMC,
pWrZMC,PFWeMC,pFrZMC,XWMMC, XFMMC, XWRMC, XFUMC, XWMC,
XFMC, MS,SCMC, SPMC,MMC,
TC,TQ,TFM,TWM,TS,TPS,TM, xfmp, xfmk, xwmp, xwmk
```

Appendix C Trader and Miller Survey Forms

Trader Survey Questionnaire

A. Interviewee information:

Date:__________________ Trader Name: _________________________,

Commodities: ______________________

Market: ____________________, City: _________________________________

Province: ___________________, Other business activities: _________________

B. Sources of wheat purchased and wheat buyers

1. Where do you buy wheat?

Source	Amount	Unit	Time Period	When
Local wheat	___________	_________	___________	___________
Imported wheat	___________	_________	___________	___________
From food aid	___________	_________	___________	____________

2. List the name of provinces that you buy local wheat from and the amount per period.

Province	Amount	Unit	Time period
________________	______________	_________	__________
________________	______________	_________	__________
________________	______________	_________	__________
________________	______________	_________	__________
________________	______________	_________	__________

3. How much of imported wheat do you buy from each country?

Country	Amount	Unit	Time period
Pakistan	______________	________	_______
Iran	______________	________	_______
Turkmenistan	______________	________	_______
Uzbekistan	______________	________	_______
Tajikistan	______________	________	_______
Kazakhstan	______________	________	_______
Other (specify)	______________	________	_______

4. Wheat purchased through Food Aid program, lists the name of country and purchased amount in one year period.

Country

Tons

5. How much storage capacity do you have for wheat (tons)?

   ____

6. On average, how much local wheat do you buy in one transaction?

   ____

7. On average, how much imported wheat do you buy in one transaction?

   ____

8. On average, how much food aid wheat do you buy in one transaction?

   ____

9. Who are your wheat buyers?

Buyers	Amount	Unit	Time period
Sold inside the province	_____________	_________	_____
Export to other provinces	_____________	_________	_______
Export to other countries	_____________	_________	_______

10. Buyers' categories inside the province.

Household	_____________	_________	_______
Bakery	_____________	_________	_______
Wheat millers	_____________	_________	_______
Government organization	_____________	_________	_______
Other traders	_____________	_________	_______

11. If export to other provinces, list the name of those provinces with exported amount.

Province	Amount	Unit	Time period

12. Current prices of wheat in this market.

    Local wheat__________________

    Imported wheat________________

C. Sources of flour purchased and flour buyers

1. Where do you buy flour?

Source	Amount	Unit	Time Period	When
Local flour				
Imported flour				
From food aid				

2. List the name of provinces that you buy local flour from and the amount per period.

Province	Amount	Unit	Time period

3. How much of imported flour do you buy from each country?

Country	Amount	Unit	Time Period
Pakistan	______	____	______
Iran	______	____	______
Turkmenistan	______	____	______
Uzbekistan	______	____	______
Tajikistan	______	____	______
Kazakhstan	______	____	______
Other (specify)	______	____	______

4. Flour purchased through Food Aid program, lists the name of country and purchased amount in one year period.

Country

Tons

5. How much storage capacity do you have for flour (tons)?

____

6. On average, how much local flour do you buy in one transaction?

____

7. On average, how much imported flour do you buy in one transaction?

____

8. On average, how much food aid flour do you buy in one transaction?

____

9. Who are your flour buyers?

Buyers	Amount	Unit	Time period
Sold inside the province	______	____	_____
Export to other provinces	______	____	_____
Export to other countries	______	____	_____

10. Buyers' categories inside the province.

    Household ____________ ________ __________

    Bakery ____________ ________ __________

    Government organization ____________ ________ __________

    Other traders ____________ ________ __________

11. If export to other provinces, list the name of those provinces with exported amount.

Province	Amount	Unit	Time period

12. Current prices of flour in this market.

    Local flour__________________

    Imported flour________________

D. Transportation Costs:

Distance and Direction	Cost Per Ton	Pay others to transport	Use my own trucks

Questionnaire for Flour Mills Survey in Afghanistan

Date: _______________

A. Interviewee Information:

Interviewee Name: ____________________, Interviewee Position: ____________________ Mill Name: ______________________________, Location: __________________________

1. Private
2. Public

B. Milling Operation and Capacity

Month	Number of Employee	Hours of Operation	Wheat Milled (tons)	% of Imported wheat milled	Maximum Capacity
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					

C. Sources of wheat purchased and flour sold

Source	Amount	Unit	Time Period	When
Local wheat	__________	________	__________	__________
Imported wheat	__________	________	__________	__________
From food aid	__________	________	__________	___________

1. List the name of provinces that you buy local wheat from and the amount per period.

Province	Amount	Unit	Time period
________	________	________	________
________	________	________	________
________	________	________	________
________	________	________	________
________	________	________	________

2. How much of imported wheat do you buy from each country?

Country	Amount	Unit	Time period
Pakistan	________	________	________
Iran	________	________	________
Turkmenistan	________	________	________
Uzbekistan	________	________	________
Tajikistan	________	________	________
Kazakhstan	________	________	________
Other (specify)	________	________	________

3. How much storage capacity do you have for wheat (tons)?

   ____

4. How much storage capacity do you have for flour (tons)?

   ____

5. On average, how much local wheat do you buy in one transaction?

   ____

6. On average, how much imported wheat do you buy in one transaction?

   ____

7. Who are your flour buyers?

Buyers	Amount	Unit	Time period
Sold inside the province	____________	________	__________
Export to other provinces	____________	________	__________

8. Buyers' categories inside the province:

Buyers	Amount	Unit	Time period
Household	____________	________	__________
Bakeries	____________	________	__________
Government organizations	____________	________	__________
Traders	____________	________	__________

D. Costs of Milling

Category	**Costs/MT**	**Category**	**Price/ MT**
Variable costs per MT		Domestic wheat	
Fixed costs per MT		Imported wheat	
Total costs per MT		Domestic flour	
		Imported flour	

D. Adjustments to policy changes from Pakistan

1. Is Pakistani subsidized flour a problem for your mill?

2. How can you complete with Pakistani subsidized flour?

3. How do you adjust your capacity when Pakistan bans its flour exports to Afghanistan?

E. What are some key challenges your mill face?

VITA

VITA

Ghulam Hazrat Halimi was born in Farah, Afghanistan. After completing his Bachelor of Science degree in Agricultural Economics at Kabul University, Afghanistan in 2005, he completed an English language course at the American University of Afghanistan, Kabul, Afghanistan, to be followed by a non-degree programme at the Indiana University-Purdue University Indianapolis, in English Language and Cultural Exchange Training. In 2011 he obtained his Master of Science (MSc) degree at Purdue University, Department of Agricultural Economics, West Lafayette, IN, USA. He worked at Kabul University as an assistant professor and at the Ministry of Agriculture, Irrigation and Livestock (MAIL) as a Project Director for the period April 2011-August 2012. In August 2012, he began working towards a Ph.D. at the Department of Agricultural Economics, Purdue University, and successfully completed his Ph.D. degree in May 2016. His research interest lies in the fields of international trade, international development and policy.