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# The Impacts of El Niño and La Niña on Large Grain Producing Countries in ECA: Yield, Poverty and Policy Response

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# Europe and Central Asia

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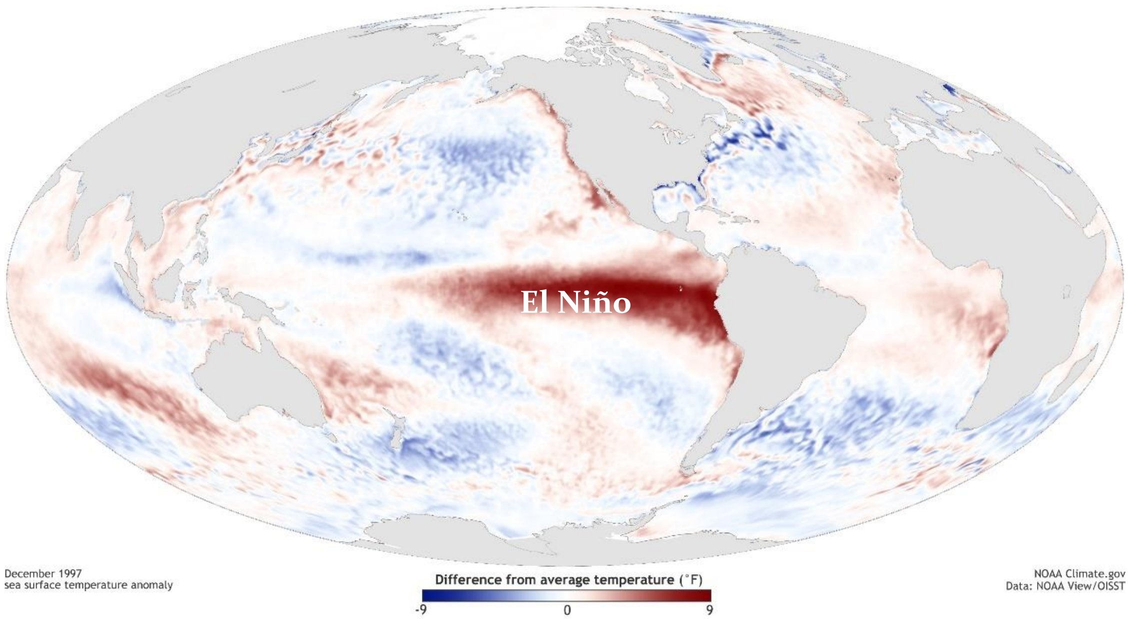


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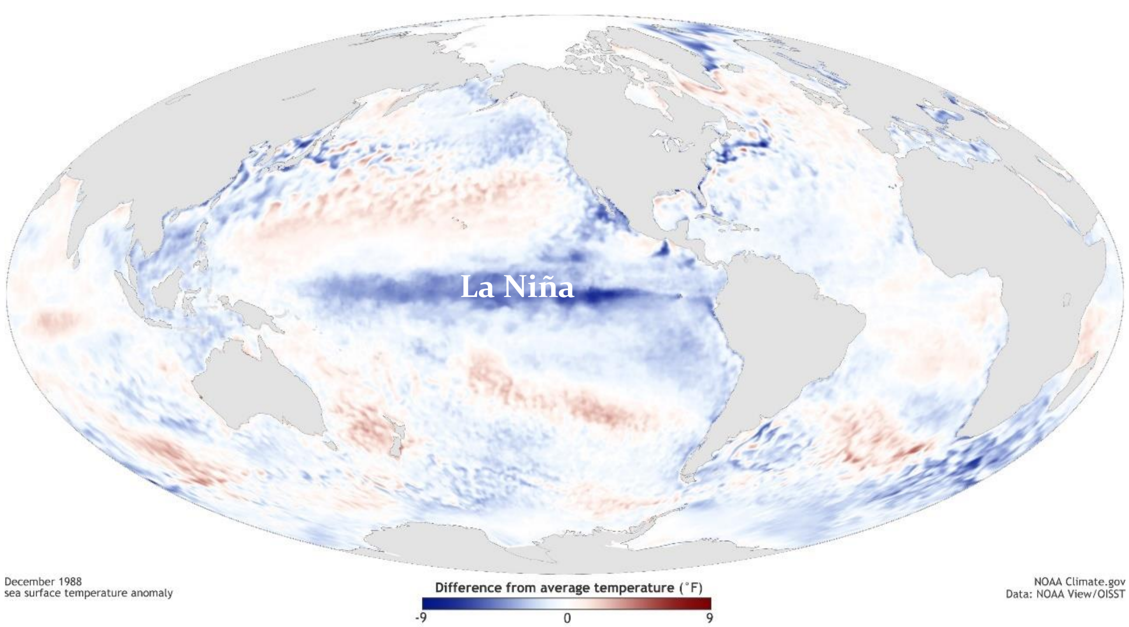

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# Abbreviations

| | |
|---|---|
| ASI | Agriculture Stress Index |
| ASIS | Agriculture Stress Index System |
| HBS | Household Budget Survey |
| CA | Central Asia |
| DIX | Drought Index |
| ECA | Europe and Central Asia |
| ENSO | El Niño-Southern Oscillation |
| EOS | End of season |
| EU | European Union |
| FAO | Food and Agriculture Organization |
| IFC | International Finance Corporation |
| LTY | Long-term Yield |
| MENA | Middle East and North Africa |
| MT | Metric tons |
| NDIX | Normalized Drought Index |
| NOAA | National Oceanic and Atmospheric Administration |
| OECD | Organization for Economic Co-operation and Development |
| ONI | Oceanic Niño Index |
| PTM | Pricing-to-Market |
| RDE | Residual Demand Elasticity |
| ROW | Rest of the world |
| RUK | Russian Federation, Ukraine and Kazakhstan |
| SC | South Caucasus |
| SOI | Southern Oscillation Index |
| SOS | start of season |
| UGC | United Grain Company |
| US | United States of America |
| USDA | United States Department of Agriculture |
| VHI | Vegetation Health Index |
| WMO | World Meteorological Organization |
| WTO | World Trade Organization |

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# Executive Summary

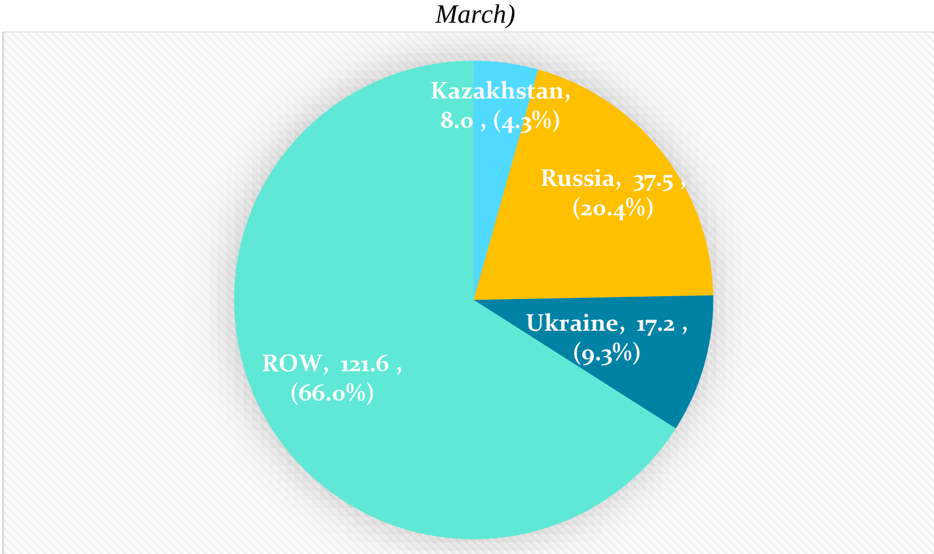
## Objective

**There is a need to further examine and enhance knowledge concerning the relationship among El Niño and La Niña cycles, drought events, and grain production in the Russian Federation, Ukraine and Kazakhstan (RUK) region, which accounts for more than one third of total wheat exports.** This report contributes to close this knowledge gap. A data-driven analysis is utilized to gain a better understanding of (a) the potential impact on grain production of droughts linked to the El Niño/La Niña phenomenon in RUK, (b) RUK governments' policy response to those events and how domestic and regional grain markets are affected, and (c) the implications for food security and poverty in the RUK region. The empirical work provides evidence to support recommendations on how the RUK region could further increase its resilience to climate variability and contribute to regional and global food security.

## RUK is a leading player in the world grain market

**The (RUK) region is now a leading producer and exporter of grains (wheat) in the world.** Its share in the global wheat export market rose from two percent in 1991, to 17 percent in 2007, and to 29 percent of total wheat exports in 2016/17. Preliminary estimates from the USDA indicate that the RUK region has reached 34 percent of the world's wheat and flour exports as of March 17/18. The main grain exported by the RUK region is wheat, accounting for more than 70 percent of their grain exports (followed by barley with 20 percent).

*Figure ES1: RUK accounts for 34 percent of the world's wheat and flour exports (Million MTs, 2017/2018 March)*




*Source: USDA (2018)*
*Note: Rest of the world (ROW)*

**The Russian Federation is projected to be the world's largest exporter of wheat and flour in 2018, with exports totaling 37.5 million metric tons from March 2017 to March 2018 (20**

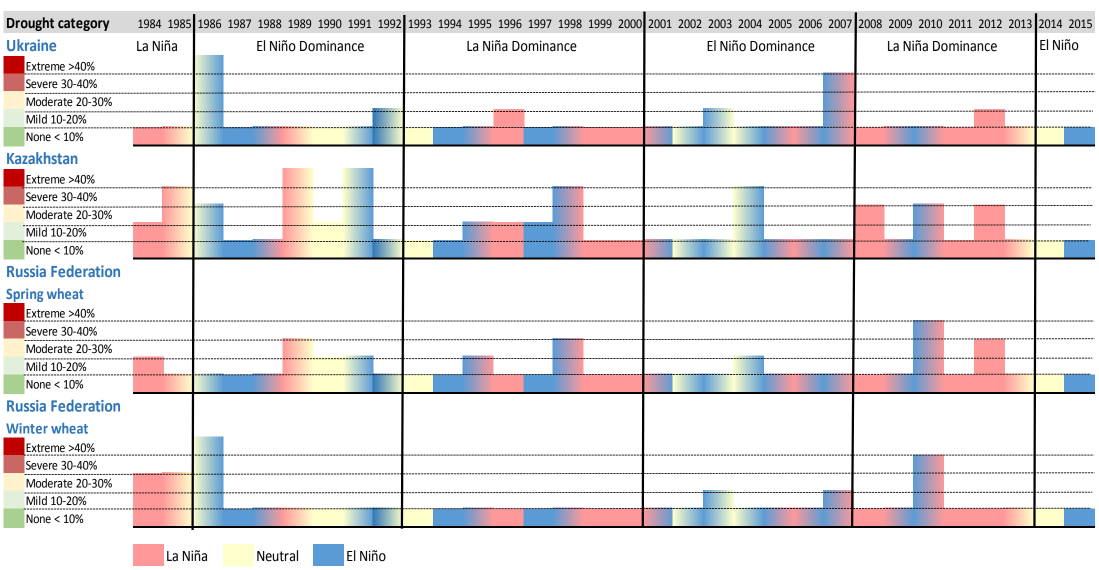
**percent of the world's wheat exports)**. The Russian Federation became the top wheat and flour exports in 2015/16. In 2016/17, Ukraine was the fifth largest wheat and flour exporter in with record exports totaling 18.1 million metric tons. Kazakhstan was the eighth largest exporter with wheat and flour exports of 7.3 million metric tons in 2016/17. From March 2017 to March 2018, Ukraine exported 17.2 million MTs and Kazakhstan 7.5 MTs of wheat and flour to global markets (USDA, 2018 and Figure ES1).

## El Niño and La Niña events cause droughts and threaten grain production in the RUK

**Droughts and climate change are significant threats to grain production in the RUK region and for global food security.** Repeatedly severe droughts significantly affect wheat production in RUK, thus understanding the impacts of droughts and climate change on the RUK's grain production is essential for predicting its potential as a reliable grain supplier in the future.

**Atmospheric and oceanic cycles can induce climate anomalies such as the El Niño and La Niña phenomena, which impact agricultural activity and yields.** El Niño and La Niña events are a natural part of the global climate system. They occur when the Pacific Ocean and the atmosphere above it change from their neutral (or normal) state for several seasons. El Niño events are associated with a warming of the central and eastern tropical Pacific, while La Niña events are associated with a sustained cooling of these areas. This report documents the frequency and intensity of droughts and provides evidence that the RUK region has been affected by frequent and severe droughts that were caused El Niño and La Niña events (see Figure ES2) that significantly impacted grain production in the RUK.

*Figure ES2: The RUK Region is more likely to experience droughts during La Niña years than during El Niño years*




*Source: Rojas et al. (2018).*

*Note: The bars denote intensity of water stress leading to droughts.*

**In the Russian Federation the extension of agricultural area affected by droughts is relatively small, but the frequency of droughts that are usually caused by El Niño and La Niña events pose a significant problem for grain production.** The impact of droughts is particularly strong in the Central Volga (included Volgogradskaya Oblast in the South) and Ural regions, and has caused significant drops in wheat yield during droughts in 1998, 2010 and in 2012. The frequency and intensity of droughts have different impacts during the winter and spring wheat. For instance, while the entire RUK region suffered from drought during the moderate El Niño 1986-87, the impact over this period on wheat yields (winter wheat) in the Russian Federation was catastrophic, with a severe drought that reduced snow cover during the winter months and affected approximately 85 percent of the winter wheat areas in the country.

**The northern area of Kazakhstan, in particular, is more sensitive to La Niña than to El Niño events and has experienced severe droughts.** Overall, drought has been identified as the biggest risk to agricultural production. Suffering from drought in 11 out of the 20 years between 1986 and 2006, Kazakhstan incurred significant agricultural losses, with five consecutive drought years between 1994 and 1998 (World Bank, 2006). There were also extreme-severe droughts in 2008, 2010 and 2012. The risk of drought is higher for rain-fed crop production in Northern Kazakhstan where grain production suffers from drought in two out of five years (World Bank, 2015).

**Compared to Kazakhstan and Russia, Ukraine has experienced fewer and less intense drought events, but the country is affected by both El Niño and La Niña events.** The most recent droughts happened in 2007 (El Niño dominance**)** and 2012 (La Niña dominance). The Southern area, which has large areas dedicated to grain production, was affected by the 2007 and 2012 droughts and, in general, is subject to considerable risks of severe droughts that may impact grain production.

## Drought-induced agricultural stress reduces grain production and increases poverty

**There is a strong correlation between agricultural stress (ASI) induced by droughts and grain yield in the RUK region.** The severity and intensity of drought events as well as their impact on grain yield vary within regions of the same country and across countries. For instance, during the 2010 drought in Russia, winter wheat yield declined approximately 50 percent in the Volga region – which experienced an extreme drought - compared to a decline of 5 percent in the south region where there was no water stress. Similar patterns are also observed in Kazakhstan and in Ukraine. In addition, spring wheat production decreases in Kazakhstan and Russian Federation during the period in which climate is driven by La Niña. Winter wheat production in Ukraine, however, increases during La Niña events. The results, however, are mixed for winter wheat in Russian.

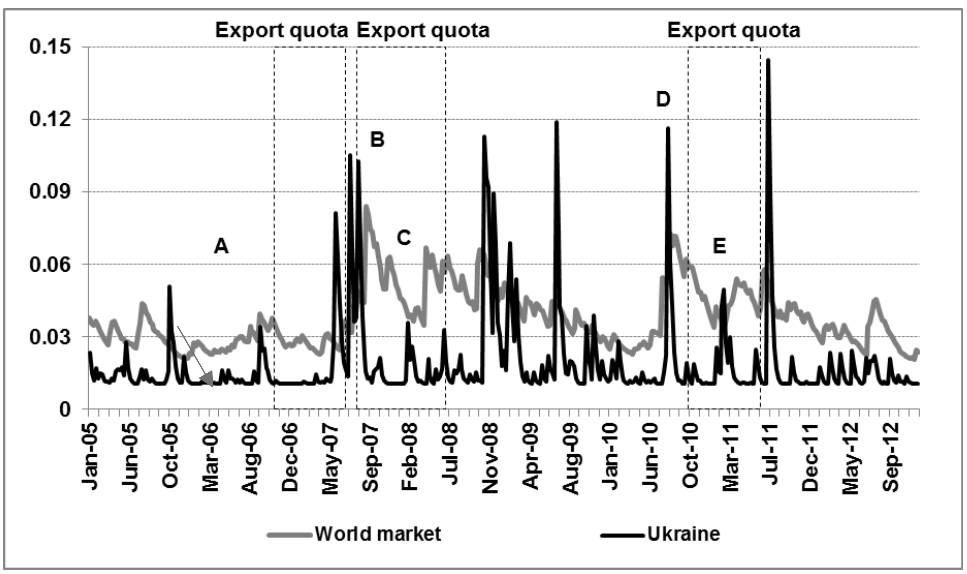
**In the RUK region, El Niño and La Niña-induced agricultural stress is associated with increased poverty in both rural and urban areas and the effects on poverty goes beyond the regions that are large grain producers.** The effect of the agricultural stress on poverty is more pronounced in rural than in urban areas. The impact on poverty rates is larger in Kazakhstan than in Russia and Ukraine.

## The current policy toolkit to respond to droughts is ineffective

**Export controls are the main response to mitigate the price increasing effects of drought induced production shortfalls in the RUK region.** The most recent examples of temporary export restrictions were in the years 2007–2008 and 2010–2011: between July and October 2007, Ukraine introduced a total grain quota of only 12,000 tons (3,000 tons each for wheat, barley, rye and corn), which virtually meant an export ban. In 2008, Russia implemented an export tax of 40 percent on wheat and Kazakhstan applied an export ban from April to September 2008. In 2010, both Russia and Kazakhstan considered the introduction of bans on grain exports and, while Kazakhstan finally refrained from export restrictions, Russia implemented an export ban from August 2010 to June 2011. Ukraine opted for a grain export quota of 6.2 Mt in total from October 2010 to July 2015 and then introduced export taxes of 9 percent for wheat, 12 percent for maize and 14 percent for barley from July to December 2011 (OECD 2011; OECD 2013b).

**Export restrictions often have limited price-dampening effects, but can cause significant by-product distortions including market uncertainty and price volatility** (Figure ES3)**.** The effectiveness of export restrictions in RUK to stabilize domestic agricultural and food prices is, however, questionable. This is particularly the case for wheat, which is transformed to an end consumer product (i.e. bread) in a complex supply chain with several intermediaries. In addition, export controls induce welfare losses for producers and traders by not profiting from the high global market prices. They can increase uncertainty and impact famers' production plans in the future. Ad hoc policy changes significantly increase market risk for domestic producers, processors and traders, which ultimately decreases domestic production and exports to the world market.

*Figure ES3: Export controls have limited impact on price volatility in the wheat market in Ukraine*




*Source: Götz et al. (2015).*

**Export restrictions are not effective to protect consumers and vulnerable individuals during climate-induced periods of reduced grain production.** The trade measures introduced in several periods to control exports and thereby domestic prices in RUK have not been effective in keeping down prices for consumers and protecting vulnerable individuals from increased poverty risks during years or droughts. Besides the well-known static welfare effects of export restrictions and their negative consequences for importing countries, this report shows that policy and market risks increase and affect the allocation on the domestic market. This policy also fails to mitigate the impacts on poverty, particularly in rural areas of the RUK region.

**Trade partners are strongly affected by export controls.** Import strategy where most grain imports are from one country -- Russia for South Caucuses (SC) countries and Kazakhstan for Central Asia (CA) countries – is associated with higher grain price volatility for both CA and SC countries during the periods of RUK wheat export restrictions and droughts. Disproportional increases of consumer prices can have negative effects on domestic food security, and thus represent a great challenge for CA and SC countries.

## Policy response must change from reactive to preventive and predictive

**The results from the analysis support the following recommendations for grain producers:**

i. **The RUK region's response to climatic events including droughts must change from reactive to preventive and predictive.** Predicting the life cycle and strength of the El Niño and La Niña events is critical to develop effective strategies to cope with and mitigate theirs effects on grain production, on agriculture in general, and on food security. To tap into this potential, significant investments and concerted efforts among governments, agricultural input and service providers, advisory service networks, and farmers would be required to develop and implement a national strategy focused on resilience and preparedness to face the odds of increased climatic volatility and drought events.

ii. **Emerging digital technologies offer unique predictive and diagnostic capabilities that can be coupled with climate-smart agriculture to improve resilience to El Niño and La Niña events.** Digital technologies and climate-smart agriculture can enable and potentialize the benefits of tools and farming practices developed to mitigate the impacts of climatic variability (e.g. droughts) including water-saving technologies, heat and drought-resistant seeds, as well as improve monitoring and response to weather variations and soil degradation. A public-private interface could be utilized to develop or enhance existing agricultural information systems and create a market to develop and deploy digital agricultural technologies that could improve resilience to climate variability, reduce transaction costs, and increase productivity.

iii. **Consider a broad range of interventions to manage risk.** A developed insurance market is important to assist producers to cope with drought risks, but the current model where RUK governments have purred the development of insurance markets through significant subsidies is inefficient and not sustainable. Alternative options to mitigate risks in agriculture must be considered including (a) functioning futures markets, (c) diversification of production, (c) training of farmers, traders, consultants and (d) provision of quality extension services.

**The findings of the report also suggest that import-depending countries need to re-examine their trade diversification strategy.** Import-depending countries that diversify imports (e.g. Georgia) face lower domestic price increases during periods of grain production crises in the RUK region. Import diversification does not only increase the number of alternative suppliers, but also strengthens competition between exporters. For countries in which trade diversification comes at high costs, governments may develop strategies on how to increase domestic production and/or increase domestic grain stocks.

**Overall, both RUK and regional trade partners would have to leverage private and public investments in infrastructure to reduce transportation costs, increase trade, and strengthen market integration.** Substantial investment deficits in roads, rails, harbors, and storage capacity strongly affect the integration of domestic markets within and across international markets. Market integration fosters competition and leads to more fair, transparent and predictable prices for producers, trader, processors, and consumers.

**In conclusion, this report makes a case that severe droughts and climate variability are a threat to grain production in RUK and, thus, to regional and global food security because the region accounts for one third of global wheat exports.** The region's response to the potentially damaging impacts of droughts and climate variability must include predictive and preventive interventions instead of relying on reactive distortionary policies including export controls.

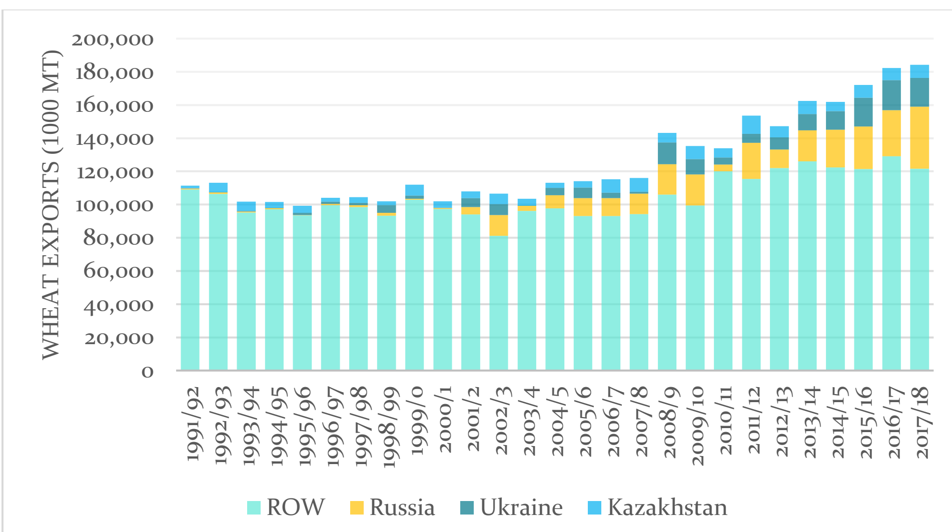
# 1. Introduction

## 1.1. BACKGROUND AND RATIONALE

1.1. **The Russian Federation, Ukraine, and Kazakhstan (RUK) are now major global grain exporters**. Jointly these three countries represented 34 percent of total wheat exports in 2017/18[1], up from approximately 17 percent in 2007/08 and from two percent in 1991 (Figure 1.1). The main grain exported by the RUK region is wheat, accounting for more than 70 percent of their grain exports (followed by barley with 20 percent).

1.2. **The Russian Federation is projected to be the world's largest exporter of wheat and flour in 2018, with exports totaling 37.5 million metric tons from March 2017 to March 2018** (20 percent of the world's wheat exports). The Russian Federation became the top wheat and flour exports in 2015/16. In 2016/17, Ukraine was the fifth largest wheat and flour exporter in with record exports totaling 18.1 million metric tons. Kazakhstan was the eighth largest exporter with wheat and flour exports of 7.3 million metric tons in 2016/17. From March 2017 to March 2018, Ukraine exported 17.2 million MTs and Kazakhstan 7.5 MTs of wheat and flour top global markets (see Figure 1.1 and USDA, 2018). The RUK region is a region with potential to strengthen global food security by expandisng grain production and exports (Swinnen and Van Herck, 2011).

*Figure 1.1: RUK's share of wheat exports has increased significantly, 1991-2018 (Million MT)*




*Source: USDA FAS*
*Note: Rest of the world (ROW)*

[1] In 2008, the OECD and FAO [under] estimated that the three countries had the potential to reach 15 percent of global exports by 2016/17.

1.3. **The emergence of RUK as a large player on grain markets reflects the region's internal market dynamics and comparative advantage in grain production**. The main reasons for this increase in grain output are the combination of an increase in yields and the contraction of grain demand for the livestock sector during the economic transition of the 1990s and 2000s as a result of more open market economies (rather than importing grain to feed livestock, for which they had no comparative advantage, all three countries started importing meat). The increase in yields was driven by productivity improvements and farm-level improvements such as the development of large agro-holdings and other new operators, many of them specializing in grain production[2] (Liefert et al, 2013).

1.4. **Climate-induced agricultural stress (e.g. droughts or floods) is a threat to grain production in the RUK region and, thus, to global food security.** Grain production has rebounded since the 2000s in the three countries with the exception of several years with unfavorable weather, including the severe droughts of the years 2010 and 2012 (see Figure 1.2). The heat wave and drought of 2010 affected all major grain producing areas of RUK, cut grain yields in the Russian Federation by a third compared to the previous year (the Volga Region, which is one of the largest producers, was the most severely hit with its harvest dropping by 70 percent, while production dropped by 54 percent in the Central Region). In Ukraine, droughts are now occurring on average once every three years (FAO, 2014). As a result, Ukraine is characterized by volatile wheat and coarse grain productivity, and on average wheat production changes by 20 percent every three years, with a major impact on Ukraine's exports.

***Box 1.1: The Agriculture Stress Index (ASI)***

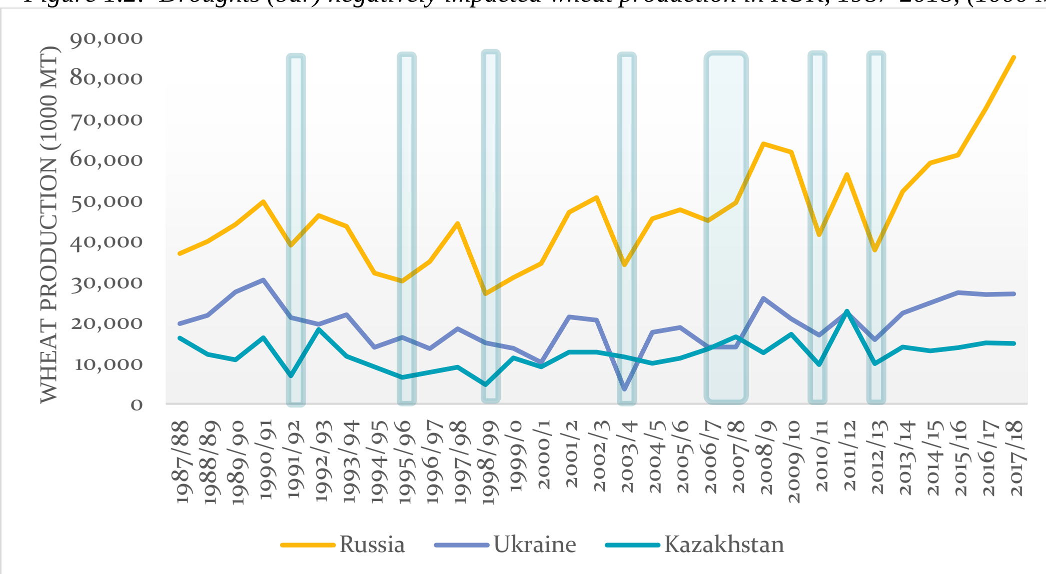
The ASI is an indicator that highlights anomalous vegetation growth and potential drought in arable land during a given cropping season. It integrates the Vegetation Health Index (VHI) in two dimensions that are critical to assess a drought event in agriculture: temporal and spatial. The ASI assesses the temporal intensity and duration of dry periods and calculates the percentage of arable land affected by drought. Pixels with a VHI value below 35 percent were identified as a critical level in previous studies to assess the extent of a drought (Kogan, 1994; Unganai and Kogan, 1998). The whole administrative area is classified according to the percentage of arable area affected by drought conditions (Rojas, et al. 2011; Roel, et al. 2016).

1.5. **In Kazakhstan, drought has been identified as the biggest risk to agricultural production.** Kazakhstan incurred agricultural losses from drought in 11 of the 20 years between 1986 and 2006, with five consecutive drought years between 1994 and 1998 (World Bank, 2006). Three additional severe droughts occurred between 2006 and 2012. The risk of drought is higher for rain-fed crop production in Northern Kazakhstan where grain production suffers from drought in two out of five years (World Bank, 2015). Although the impact of the 2012 drought were not as high as in 2010, persistent droughts have continued during the past three years throughout the entire grain producing area of Central Eurasia (Lioubimtseva, Dronin et al, 2015).

[2] There is no consensus in existing research/literature as to whether the observed trends will be sustained in the medium- to long-term. There is also diverging evidence on the performance of large agro-holdings beyond a certain size (beyond 3,000 ha).

1.6. **The relationship between El Niño/La Niña events and climate variability (e.g. drought incidence) is not well documented including their impact on grain production in RUK**. Some El Niño events have, in the past, been associated with droughts across Ukraine, the Russian Federation and Kazakhstan with reports of a significant impact on wheat crops. In addition, in years when El Niño has been followed by La Niña (which has happened 5 times out of 11 over the past strong El Niño events on record), below average wheat crops in the Black Sea area (Russian Federation, Ukraine and Kazakhstan) followed by poor US corn and soybean crops has been known to trigger a spike in grain and oilseed prices. Furthermore, reduced grain yield and high grain prices may affect the rural labor market and the livelihoods of those living in rural and urban areas, particularly those who are more vulnerable to poverty.

*Figure 1.2: Droughts (bar) negatively impacted wheat production in RUK, 1987-2018, (1000 MT)*

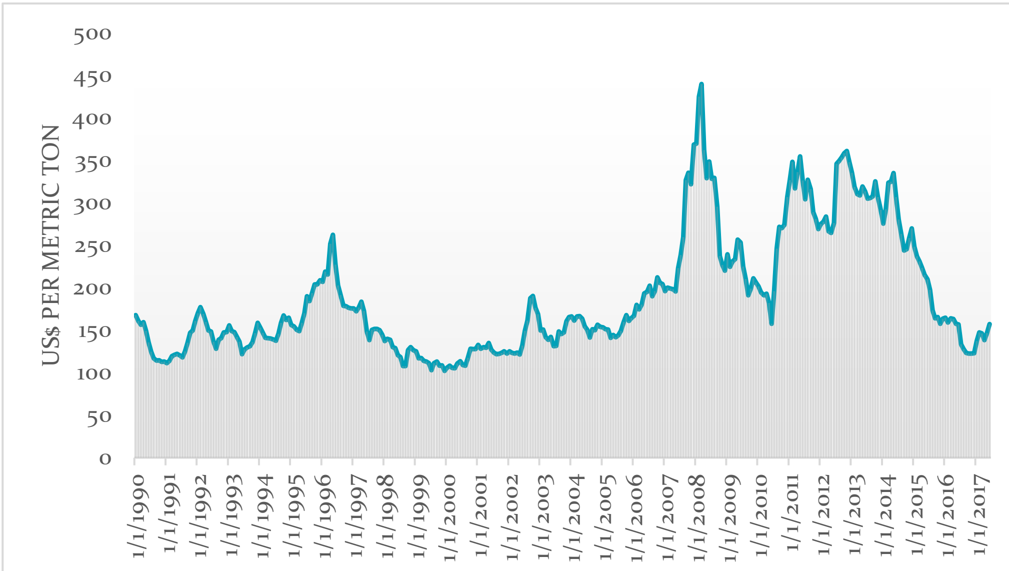



*Source: FAS/USDA.*
*Note: The vertical bar denotes that a drought occurred in one or more of the RUK countries.*

1.7. **There is no consensus on the impact of climate change and of the El Niño / La Niña on grain production in RUK.** Existing studies based on crop and climate modelling have led to different conclusions – with some studies suggesting that grain production in the RUK agro-ecological belt could increase due to warmer temperatures, longer growing seasons and the positive impact of higher atmospheric concentration of $CO_2$, while other studies indicate a decline of the region's agricultural potential due to increasing frequency of droughts (Lioubimtseva, Dronin et al, 2015; FAO Investment Centre, 2014).

1.8. **The impact of droughts on grain markets in the RUK region has been influenced by a history of government intervention.** All three countries have imposed some sort of export controls during the 2007/08 and 2010 droughts and high grain prices. Such export restrictions were not repeated in the summer of 2012, however extensive drought in key producing regions (US, Russian Federation and the Balkans) induced a pronounced, discreet supply shock into commodity markets – global agricultural prices rose by 6 percent in July 2012, and wheat price increased by 19 percent (Figure 1.3). The food price crisis of 2008 and the 2010 drought event in the Russian Federation have shown that policy responses in exporting countries, in the form of bans or other export restrictions, play a significant role in the severity and duration of food price increases. Providing analysis to policy makers in RUK to support evidence-based policy responses to high food prices is critical to improving preparedness and response to probable future crises.

*Figure 1.3: International wheat price is affected by droughts, FOB Gulf of Mexico, US Dollars per Metric Ton (1990-2017)*

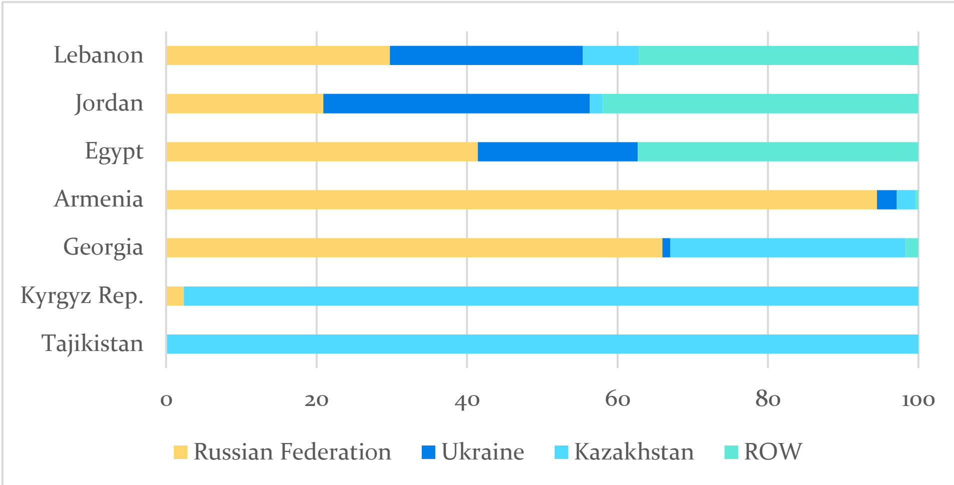



*Source : https://www.quandl.com/data/ODA/PWHEAMT_USD*

1.9. **The impact of RUK grain exports on grain markets and food security is felt beyond the region.** For ECA, drought-induced shortages and related price increases for grains are likely to impact import-dependent countries across the region, most notably in Central Asia, the Southern Caucasus and to a lesser level the Balkans. These impacts could be magnified by governments' lack of fiscal space for spending on safety nets. Beyond the ECA region, some of the countries which are highly dependent on wheat imports from RUK could also be affected. The Black Sea region has become the major source of wheat for Middle-East importers, from Libya, Egypt, Lebanon and Syria (the latter primarily buys wheat from Ukraine), to Saudi Arabia and Yemen:

- Tajikistan depends heavily on imports to meet its cereal consumption needs. More than 90 percent of its grain imports is of wheat, which is imported almost exclusively from Kazakhstan. A similar dependency on wheat imports from Kazakhstan is observed in the Kyrgyz Republic.
- Armenia and Georgia source, respectively, over 90 percent and 60 percent of their wheat imports from the Russian Federation, and over 95 percent from the RUK.
- Egypt (the world's largest importer of wheat) and Lebanon source over 60 percent of their wheat imports from RUK, and Jordan close to 60 percent (Figure 1.4).

*Figure 1.4: The RUK region is the main supplier of wheat to CA and SC countries (average 2011-2013)*




*Source: ITC (Intracen)*

## 1.2. OBJECTIVE AND SCOPE

1.10. **There is a need to further examine and enhance knowledge about the relationships between El Niño/La Niña, drought events, and grain production in RUK; and how these relationships impact grain markets, food security, and poverty.** This would allow developing recommendations on how the RUK region could become a more reliable supplier of grain on world markets, including during El Niño/La Niña years, and to understand RUK's potential as a major grain supplier in the future.

1.11. **This report contributes to close this knowledge gap.** A data-driven analysis is utilized to gain a better understanding of (a) the potential impact on grain production of droughts linked to the intensity, duration or onset of the El Niño/La Niña phenomenon across regions in RUK, (b) RUK governments' policy response to those events and how domestic, regional and global grain markets are affected, and (c) the implications for food security and poverty in the RUK region.

1.12. **This report also develops recommendations for agricultural policies and identifies investment opportunities for limiting the effects of El Niño/La Niña -induced droughts on RUK's grain production and exports.** In addition, the report provides policy recommendations for grain-import dependent neighboring countries in South Caucuses (SC) and Central Asia (CA) to mitigate the effects of disruptions of RUK's grain export policies and to improve food security. Overall, the report's empirical work provides evidence to support recommendations on how the RUK region could further increase its resilience to climate variability and contribute to regional and global food security as large and reliable grain exporters.

## 1.3. METHODOLOGY

1.13. **The methodology utilized to prepare this report includes a desk review and multi-disciplinary quantitative approaches** including a) the calculation of the ASI from 1984 to 2015 and examination of the correlation between El Niño  indices and the ASI, b) the frequency and effect of the ASI on grain production across regions in RUK, c) a regime-switching model is utilized to assess the effectiveness government response to droughts and associated decline of grain production in RUK, d) the gravity model is utilized to examine trade patterns and the pricing-to-market (PTM) and residual demand elasticity (RDE) approaches are used to examine variations in grain price during drought events, and e) a panel data-analysis model is utilized to examine the effects on the ASI on rural and urban poverty rates in the RUK region.

1.14. **The report uses datasets from the Household Budget Survey (HBS), FAO (e.g. ASI), and from several scientific projects including GERUKA[3], AGRICISTRADE[4], MATRACC[5], and KHOREZM[6].** These databases cover wheat, flour and bread prices for nine selected ECA countries. Among the regional wheat importing countries, price data is available for Kyrgyz Republic, Tajikistan, and Uzbekistan in CA, and Armenia, Azerbaijan and Georgia in the SC region. For the wheat exporting countries, we use the data for Russia, Ukraine, and Kazakhstan. Furthermore, to represent international markets, this report also uses wheat prices and trade volumes for some the major player on the world wheat market, among them France and the USA.[7]

[3] http://projects.iamo.de/geruka/
[4] www.agricistrade.eu
[5] www.projects.iamo.de/matracc
[6] www.zef.de/khorezm
[7] The standalone outputs by Rojas et al. (2018) and Glauben et al. (2018) provide detailed information regarding the data and methodology utilized to prepare this report.

# 2. The El Niño Phenomenon and Grain Production[8]

## 2.1. EL NIÑO /EL NIÑA EVENTS

2.1. **El Niño and La Niña are opposite phases of a natural climate pattern across the tropical Pacific Ocean that swings back and forth every 3 to 7 years on average.** El Niño and La Niña events change the likelihood of climate patterns around the globe, but the outcomes of each event are not the same. While there is generally a relationship between the global impacts of El Niño and La Niña event and their intensity, there is always potential for an event to generate serious localized impacts in some regions irrespective of its intensity.

2.2. **The potential impacts of El Niño/La Niña events on agricultural yield and food security depend on the intensity, duration or onset of the phenomenon.** Some countries and regions within the same country are, however, more vulnerable to the impact of El Niño and La Niña events. Predicting the life cycle and strength of El Niño and La Niña is critical for helping policymakers and individuals to plan for, avoid, or mitigate potential negative effects, particularly in sectors in which extreme climatic events have the potential to cause major disruption in production such as agriculture and fishery.

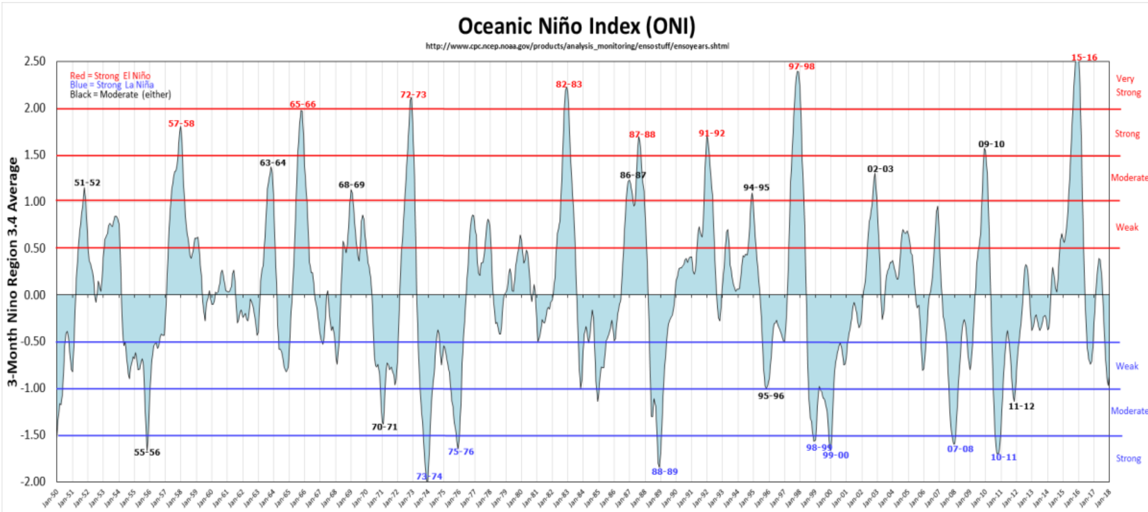
***Box 2.1: El Niño/ La Niña***

The Oceanic Niño Index (ONI) has become the de facto standard that the National Oceanic and Atmospheric Administration (NOAA) uses to identify El Niño (warm) and La Niña (cool) events in the tropical Pacific.

During El Niño events, sea temperatures at the surface in the central and eastern tropical Pacific Ocean become substantially higher than normal. In contrast, during La Niña events, the sea surface temperatures in these regions become lower than normal. These temperature changes are strongly linked to major climate fluctuations around the globe and, once initiated, such events can last for 12 months or more (WMO, 2014). During the last three decades, 10 El Niño events and 10 La Niña events have occurred.

[8] This section of the report is based on Rojas et al. (2018).

*Figure 2.1: El Niño / La Niña events happen every 3-7 years, 1951-2018*




*Source: http://ggweather.com/enso/oni.htm*

## 2.2. THE AGRICULTURAL STRESS INDEX

2.3. **The Agriculture Stress Index (ASI) is an indicator that highlights anomalous vegetation growth and potential drought in arable land during a given cropping season.** The ASI integrates the Vegetation Health Index (VHI) in two dimensions that are critical to assess a drought event in agriculture: temporal and spatial. ASI assesses the temporal intensity and duration of dry periods and calculates the percentage of arable land affected by drought. Pixels with a VHI value below 35 percent are identified as a critical level in previous studies to assess the extent of the drought (Kogan, 1994; Unganai and Kogan, 1998). The whole administrative area is classified according to the percentage of arable area affected by drought conditions (Rojas, et al. 2011; Roel, et al. 2016).

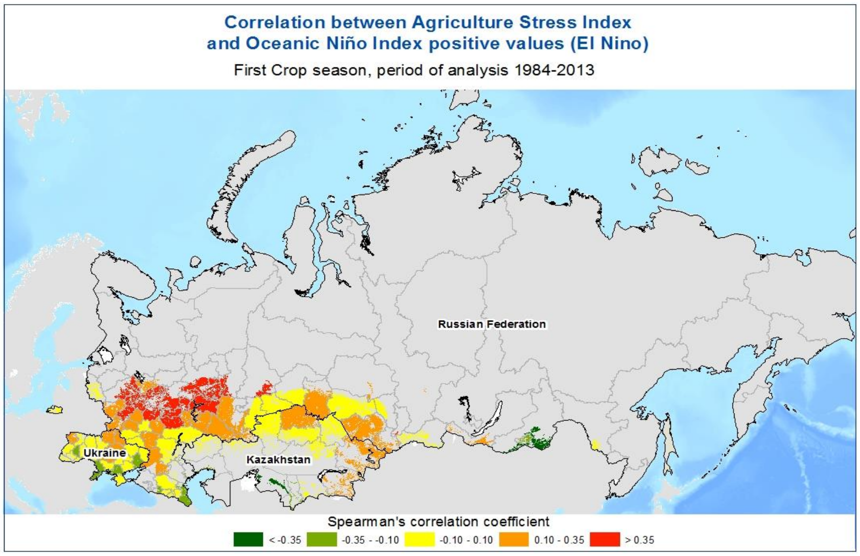
2.4. **Agricultural stress -- measured by the ASI --is correlated[9] with El Niño indices (ONI and SOI[10]).** The red areas on Figure 2.2 and Figure 2.3 show agricultural areas in the RUK region that are more sensitive to droughts during El Niño years. Green areas show an inverse correlation during El Niño years, which indicates that in these areas, favorable climatic conditions seem to prevail during El Niño years and an increased crop production is expected. Overall, the analysis show that the RUK region is more likely to experience droughts during La Niña years than during

[9] The ASI at subnational level were divided into two data sets: one containing the positive values of each El Niño event and one dataset with the negative values. The positive values of ONI represent El Niño years (in the case of SOI the negative values) and negative values of ONI represent La Niña years (positive values of SOI). If the agricultural area affected by drought tends to increase when ONI increases, the Spearman correlation coefficient is positive (negative in the case of SOI due to negative values). If the agricultural area affected by drought tends to decrease when the ONI index increases, the Spearman correlation is negative. The color red is assigned to the positive correlation because the area affected by drought increases at GAUL level 1 (region/oblast level) when ONI increases.

[10] The Southern Oscillation Index (SOI) gives an indication of the development and intensity of El Niño or La Niña events in the Pacific Ocean. The SOI is calculated using the pressure differences between Tahiti and Darwin.

El Niño years. In addition, droughts triggered by the El Niño are localized mainly on Central and Volga regions of Russian Federation. The rest of the RUK area does not show to be sensible to El Niño events.

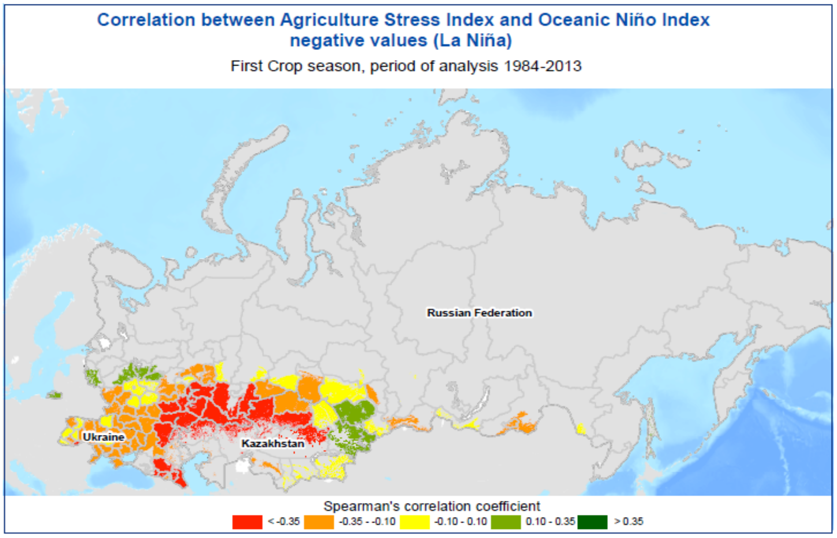
*Figure 2.2: There is a strong correlation between ASI and ONI positive (El Niño), RUK region*




*Source: Rojas et al. (2018).*

2.5. **The northern area of Kazakhstan is sensitive to La Niña events that trigger droughts in the most productive areas of the country (Figure 2.3).** Moreover, areas close to the border between Kazakhstan, Southern and North Caucasus in Russia are also sensitive to droughts triggered by the La Niña phenomenon.

*Figure 2.3: There is a strong correlation between ASI and ONI negative (La Niña), RUK region*



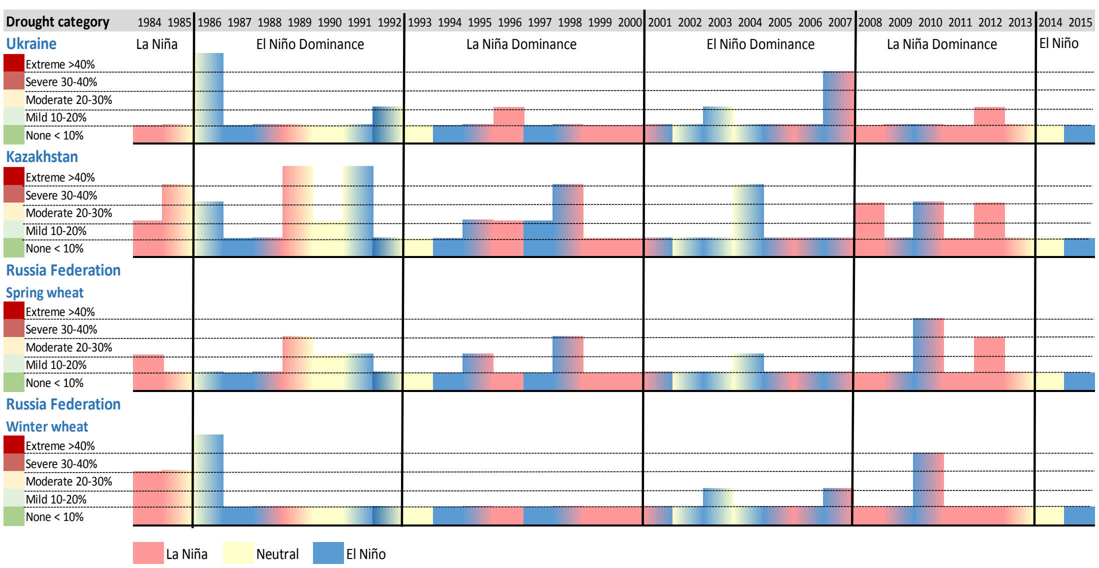

*Source: Rojas et al. (2018).*

## 2.3. MEASURING DROUGHT INTENSITY

2.6. **The intensity and duration of droughts determine their impacts on agriculture.** The ASIS database is utilized to calculate the DIX[11] and the Normalized Drought Index (NDIX),[12] which determine the intensity and duration of droughts and help to identify drought hotspots (Cumani and Rojas, 2016). The NDIX is utilized to produce the Drought-gram, which allows classifying categories of drought: Extreme, Severe, Moderate, Mild and None (assume that less than 10 percent of the area is affected by a climatic event).

2.7. **El Niño and La Niña dominance are cycles where consecutive years are under the influence of a warm (El Niño) or cold (La Niña) phase**. The Drought-gram offers information about the cycle (El Niño or La Niña dominance phase) and whether a particular year affected by drought corresponds to an El Niño, Neutral, or La Niña event (see Figure 2.4).For instance, from 1984 to 1992 the El Niño phase was dominant; from 1993 to 2000 the La Niña phase was dominant; from 2001 to 2007 El Niño was dominant and from 2008 to 2013 La Niña was dominant (see Figure 2.4). However, El Niño events may occur during a La Niña dominance cycle and La Niña events may occur during an El Niño cycle. The Drought-gram shows that 1998, 2007 and 2010 were years of severe water stress (droughts) in the RUK region. The 1998 and 2010 droughts happened under the influence of La Niña cycles while the 2007 drought happened during an El Niño cycle.

*Figure 2.4: Drought-Gram for Russian Federation, Ukraine and Kazakhstan (RUK) Region*



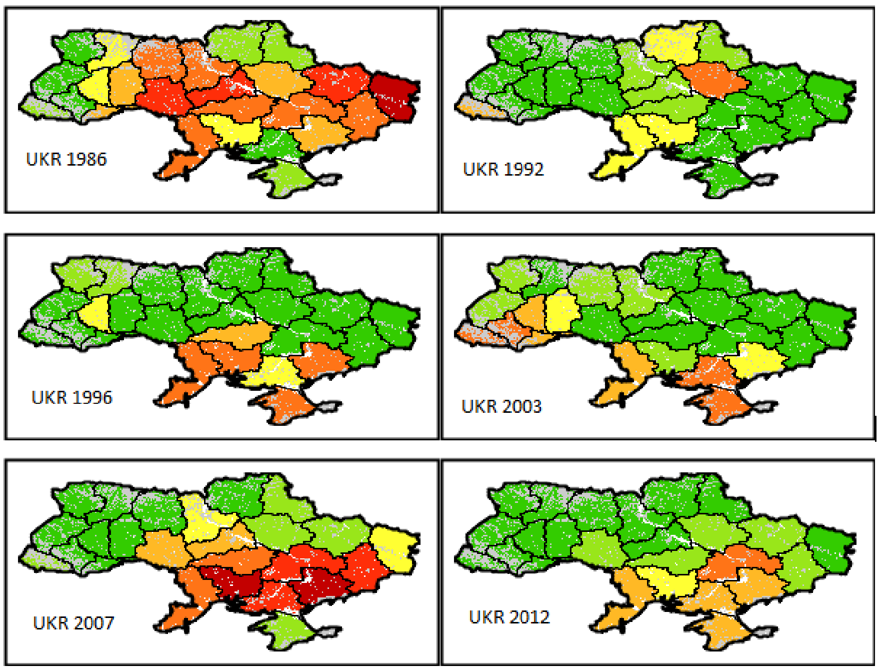

*Source: Rojas et al. (2018).*
*Note: The bars denote intensity of water stress leading to droughts.*

[11]The agriculture Drought Index (DIX) was calculated using magnitude and frequency of drought occurrence. Both of these metric descriptors indicate the severity and the recurring incidences of the drought phenomenon. It accounts for both the level of impact over the same area and, its extent and time of the natural spatial-temporal hazard such as drought. The magnitude is defined as the total of all ASI mean values extracted for administrative unit. The frequency is calculated based on the number of events which have occurred during the respective years.

[12] The Normalized Drought Index is scaled between 0 and 100. It was designed to re-scale the drought index aiming at indicating the distribution of drought occurrence hotspots worldwide.

2.8. **Some areas of RUK are more sensitive to El Niño and others to La Niña events. Overall, Kazakhstan is affected by more intense and frequent droughts** (see Figure 2.4). The droughts in Kazakhstan during the 32 years of the analysis are more related to La Niña than to El Niño phenomena. Three cases were related to El Niño: in 1986 and 1991 -- years that are classified as moderate El Niño -- and 2004, which is classified as a weak El Niño. Ukraine has experienced fewer and less intense drought events with no clear influence of El Niño or La Niña (Figure 2.5).

*Figure 2.5: Annual Agricultural Stress Index (ASI) for selected years in Ukraine*




*Source: Rojas et al. (2018).*

2.9. **In the Russian Federation, droughts are less frequent for spring wheat[13] than in Kazakhstan.** While the entire RUK region suffered from drought during the moderate El Niño 1986-87, the impact on wheat yields (winter wheat) in Russian Federation was catastrophic, with a severe drought that reduced snow cover during the winter months and affected approximately 85 percent of the winter wheat areas in the country. There is a clear increase of drought events on the winter wheat during the dominance of El Niño in Russian Federation, but not drought events that affected the spring wheat over these years. However, significant drought episodes occurred during La Nina events that strongly impacted the winter in 2008 and 2010 as well as the spring wheat also in 2012. At the country level, there is no clear relationship between El Niño and La Niña. However, there is noise in the analysis due to different areas that plant spring and winter wheat (mix vegetation signal). The temporal differences between both crop seasons are exposed to El Niño or La Niña on different ways and produce different levels of impacts.

[13] "Spring wheat" refers to wheat planted and harvested from May to August and "winter wheat" refers to wheat planted and harvested from August to July (which includes a dormancy from Nov to Feb). For additional details see Rojas *et al.* (2018).

## 2.4. GRAIN PRODUCTION AND EL NIÑO/LA NIÑA EVENTS

2.10. **Neutral and La Niña years during the dominance of El Niño behave as El Niño years, causing extended droughts that affect agriculture at the global level.** The most severe drought that occurred in the last 30 years, during the first crop season, corresponds to La Niña (1989) under the influence of an El Niño's dominant cycle, which affected 20 percent of the agricultural surface. On the other hand, an El Niño year that takes place during La Niña's dominance seems to have less impact on crop areas. This could explain why the El Niño in 1997/98 affected only four percent of the total agricultural area.

2.11. **The effects of El Niño and El Niña events on grain yield depend on planting dates and the crop cycle lengths.** For instance, Russian Federation plants and produces 50 percent of winter wheat from August to July and the remaining 50 percent of spring wheat from May to August. Kazakhstan produces most of spring wheat during the period of May to August. Wheat in Kazakhstan represents a roughly 80 percent of the cereals production value share. The impact on wheat crop in RUK in 1998 was influenced on the geographical position and time (defined by the water requirements of the phenological phase of wheat) that are sensitive to El Niño and/or La Niña. Ukraine, however, appears to be neutral to this transition - from warm to cold event. Kazakhstan and the Russian Federation, however, experienced an increase in the agricultural area affected by droughts, with a higher intensity for spring wheat in Kazakhstan. A very similar situation happened in 2010, but the most affected agricultural areas were in the Russian Federation. Finally, 2007 depicts a similar transition, but in this case only Ukraine was affected.

2.12. **The time the climatic event (El Niño or La Niña), intensity of the event, the local climate events that could mitigate El Niño/La Niña, the phenological phase of the crop during the peak of rainfall reduction, and the geographical epicenter of the El Niño/La Niña event determine their effects and differences across neighboring regions.** In addition, snow cover is related to drought during winter. If there is a reduction of the depth of snow, winter wheat could be affected during the dormancy period.[14] Low precipitation, resulting in diminished snow cover, would reduce the protection of dormant wheat plants against frost kill temperatures (usual below -18°C) during winter months. Low precipitation and thin snow cover have also jeopardized the soil moisture availability for the post-dormant growing period.

2.13. **Spring wheat production decreases on average in Kazakhstan and Russian Federation during the period that climate is driven by La Niña** (Figure 2.6). During the winter wheat in Ukraine, wheat production increases during La Niña events. The results, however, are mixed during winter wheat in Russian.

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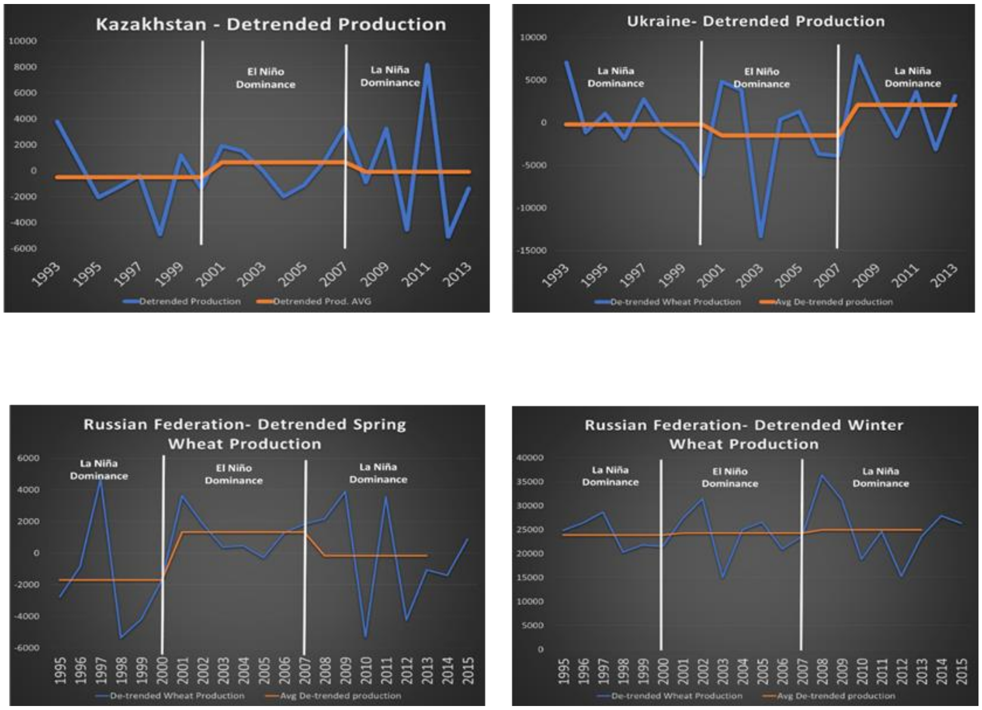
[14] Dormancy is a period in an organism's life cycle when growth, development, and (in animals) physical activity are temporarily stopped. This minimizes metabolic activity and therefore helps an organism to conserve energy. Dormancy tends to be closely associated with environmental conditions.

*Figure 2.6: El Niño/La Niña dominance on the wheat production in RUK region*




*Source: Rojas et al. (2018).*

2.14. **The analysis of the severity of drought events and impact on gran production is presented at the regional level (Oblast), by plotting the ASI and the yield gap, which is calculated as the difference between the grain yield per hectare in years of droughts compared to a long-term yield/ha (LTY) average.** The LTY is calculated using available data. More precisely, for Kazakhstan and Russia the LTY is calculate using annual data from 1995 to 2015 and for Ukraine from 2000 to 2014. In addition, drought severity is indicated by the ASI. To facilitate the interpretation of the results, this report uses an ad hoc classification of the severity of the drought where ASI values ≥65 percent indicate an extreme drought, 40 ≤ ASI < 65 indicates a severe drought, 30 ≤ ASI < 40 indicates a moderate drought, 10 ≤ ASI < 30 indicates a dry period, and if the ASI < 10 there is on water stress.

### 2.4.1. Ukraine

2.15. **The winter wheat and maize crops represent approximately 80 percent of total cereal production in Ukraine**; each crop accounts for about 40 percent. Wheat is grown throughout the country, but central and south-central Ukraine are the major wheat production zones. About 95 percent of Ukraine wheat is winter wheat, planted in the fall and harvested during July and August of the following year**.** On average, approximately 15 percent of fall-planted crops fail to survive the winter. The amount of winterkill varies widely from year to year, from 2 percent in 1990 to a staggering 65 percent in 2003, when a persistent ice crust smothered the crops. The ASI captures the areas affected by winterkill when resuming tillering[15] in spring. The difference between

[15] The tillering stage begins with the emergence of lateral shoots (tillers) at the base of the main stem of the plant. The tillering stage usually begins when a plant has three or more fully developed leaves—the height

vegetation reflectance than normal is interpreted by ASI as a drought, which in this specific case represents the decrease in biomass due to winterkill.

*Table 2.1: Drought levels AS1 and winter wheat yield, Ukraine, 2007 and 2012*

| Area (Production Share) | Oblast | Production Share | ASI Average (2007 and 2012) | Average Yield Change Compared to previous year | |
|---|---|---|---|---|---|
| | | | | 2007 | 2012 |
| Southern - Centre (38%) | Khersons'ka | 7% | 67% | -26% | -43% |
| | Dnipropetrovs'ka | 3% | 64% | | |
| | Zaporiz'ka | 6% | 64% | | |
| | Mykolayivs'ka | 7% | 63% | | |
| | Odes'ka | 7% | 53% | | |
| | Kirovohrads'ka | 6% | 42% | | |
| | Donets'ka | 2% | 44% | | |
| Central (30%) | Vinnyts'ka | 6% | 33% | 3% | -1% |
| | Krym | 6% | 32% | | |
| | Cherkas'ka | 5% | 28% | | |
| | Kharkivs'ka | 4% | 22% | | |
| | Luhans'ka | 1% | 20% | | |
| | Poltavs'ka | 4% | 16% | | |
| | Kyyivs'ka | 4% | 13% | | |
| Northern-West (30%) | Sums'ka | 4% | 10% | 16% | 8% |
| | Ternopil's'ka | 3% | 5% | | |
| | Chernihivs'ka | 2% | 3% | | |
| | Khmel'nyts'ka | 6% | 3% | | |
| | Zhytomyrs'ka | 2% | 2% | | |
| | Rivnens'ka | 2% | 2% | | |
| | Chernivets'ka | 3% | 2% | | |
| | L'vivs'ka | 3% | 1% | | |
| | Ivano-frankivs'ka | 2% | 0% | | |
| | Volyns'ka | 3% | 0% | | |

*Source: Rojas et al. (2018).*

2.16. **The empirical analysis shows a strong correlation between agricultural stress (ASI) and grain yield in Ukraine** (Table 2.1).[16] The Southern area, which accounts for 38 percent of the grain production in Ukraine, has been the region mostly affected droughts. The average of ASI in 2007 and 2012 indicates "extreme" or "severe" droughts during these years, which caused a decline in winter wheat yield of 26 percent in 2007 and 43 percent in 2012. The Central area together with Krym, which account for 30 percent of grain production, recorded low agricultural stress (ASI

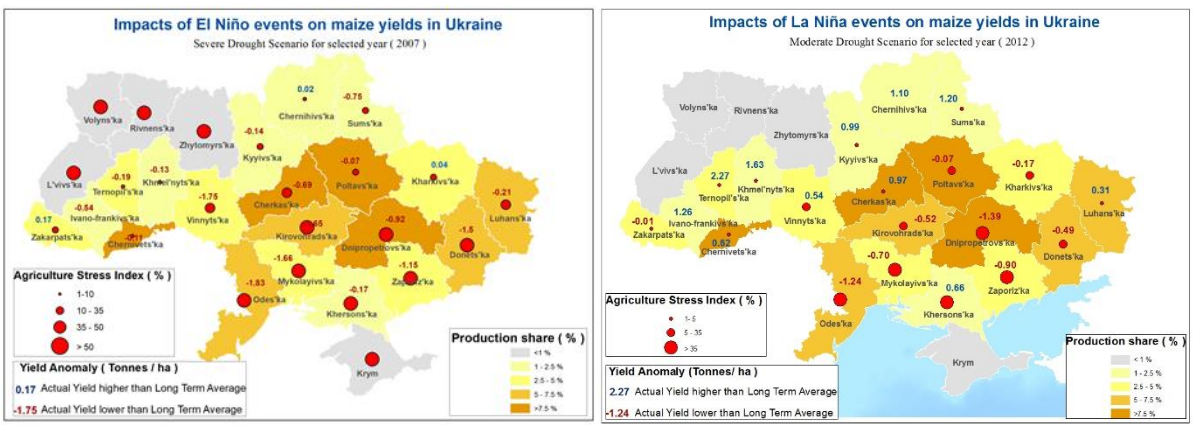
of the plant does not matter, only the number of leaves. Each tiller has the potential to produce a grain head, which is why it is so important to have as many as possible. Tillers form primarily in the fall or early winter. Tiller growth then either slows or stops during the coldest winter months and starts again briefly when the weather warms again. (During the spring, there is a short period of vegetative growth before small grains switch from producing tillers to starting reproductive growth.)

[16] The data is organized by sorting out the geographical area from the highest ASI values ("Extreme" – "Severe" drought) to the lowest ("No water stress").

between 10 percent and 40 percent) and a slight decrease of one percent in winter wheat yield in 2012 only. The ASI indicates no water stress or droughts in the Northern-West region, which experienced increased yield in 2007 and 2012.

2.17. **Agricultural stress also impacts maize production and there are major regional variations in yield changes due to the severity of the drought events (**see Figure 2.7**).** The ASI indicates that **t**he Centre-Southern area experienced extreme/severe droughts in 2007 and 2012, which led to reduction of maize yield of 33 percent and 43 percent in 2007 and 2012, respectively. The Centre-Northern experienced a relatively dry period (no drought) with ASI between 10 and 30 percent and yield decrease of 28 percent in 2012. The Northern-West area experienced no water stress (ASI less than 10 percent) with no reduction in maize production. The Southern-Central region, which accounts for over 40 percent of maize production, is the region most vulnerable to droughts in Ukraine. The Southern-Central region was the most affected area in both the 2007 and 2012 droughts, with ASI values above 50 percent and significant decreases in maize yield (-1.8 t/ha in 2007 and -1.39 t/ha in 2012 compared to the long-term yield average).

*Figure 2.7: Agricultural stress reduces maize yield, Ukraine, 2007(left) and 2012 (right)*

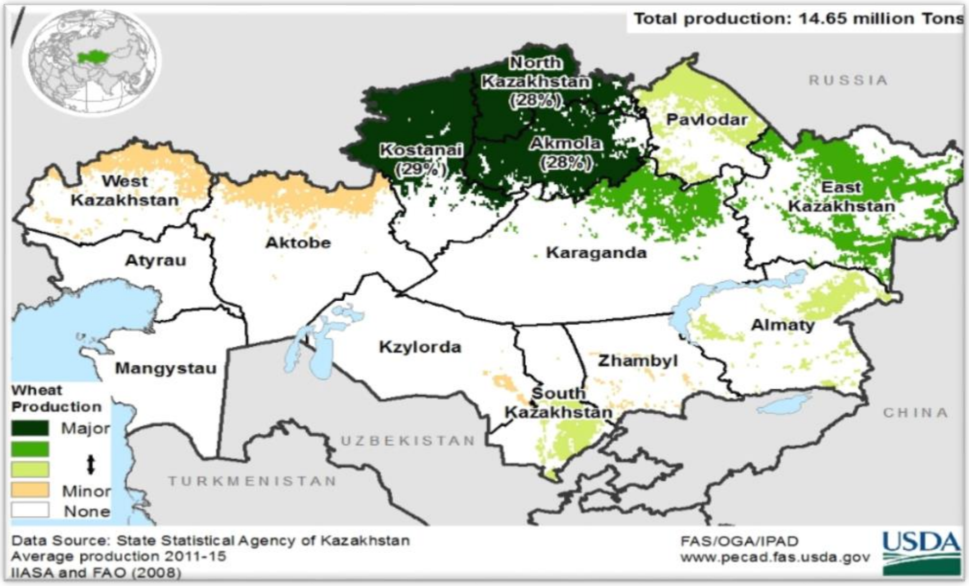



*Source: Rojas et al. (2018).*

### 2.4.2. Kazakhstan

2.18. **In Kazakhstan, approximately 75 percent of the country's wheat is produced in three oblasts in north-central Kazakhstan: Kostanai, Akmola, and North Kazakhstan** (Figure 2.8). Minor grains include spring barley and oats (which are grown in the same region as spring wheat), winter wheat (Southern Kazakhstan), and rice (Southern Kazakhstan, mostly in Kzyl-Orda oblast).

*Figure 2.8: Wheat Production in concentrated north-central areas of Kazakhstan, Average 2011-2015*

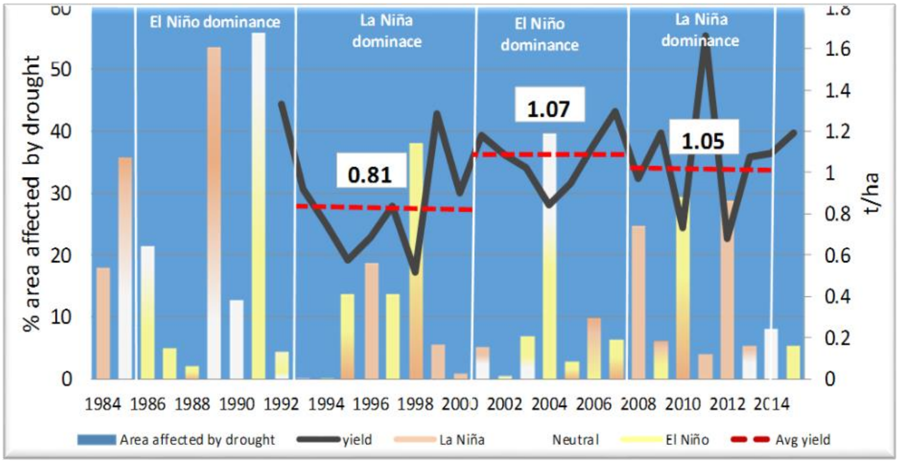



2.19. **Spring wheat accounts the vast majority of the total wheat area in Kazakhstan and virtually all of the wheat is produced in the three north-central oblasts.**[17] From 1995 to 2015, Kustanayskaya accounted for 29 percent of the national wheat production, followed by Severo-Kazachstanskaya with 27 percent, and Akmolinskaya with 25 percent, compared to 19 percent in all other regions of Kazakhstan.

2.20. **In Kazakhstan, wheat yield per hectare is lower than in Russia and Ukraine.** The spring wheat production is more vulnerable to droughts due to the lack of snow contribution to soil moisture. From 1992 to 2015, the lower wheat yield in Kazakhstan was due to droughts, which were more frequently related to La Niña events than to El Niño events. During the dominance of La Niña, the wheat yield tends to decrease and, during the El Niño dominance, it tends to increase (Figure 2.9).

[17] Spring grain planting typically begins in mid-May and finished by early June. The crops advance through the reproductive stage during mid-July, when temperatures climb to their highest levels and grains are most vulnerable to heat stress. Grain harvest begins in late August and continues through October (USDA, 2010). Therefore, episodes of El Niño that run during May, July can cause drought conditions that strongly affect the crops' growing season in this country.

*Figure 2.9: Percentage area affected by drought, Kazakhstan, 1984-2014*

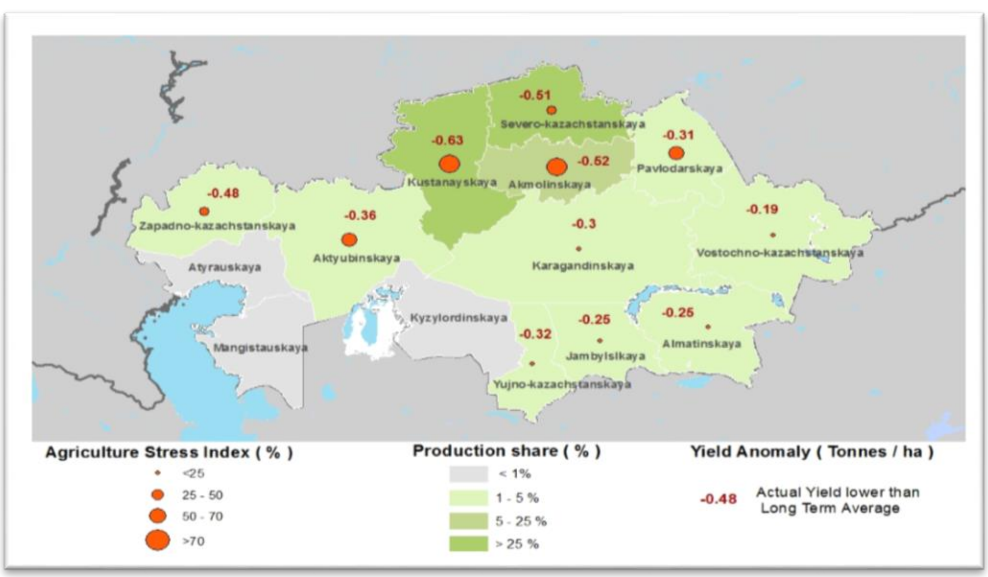



*Source: Rojas et al. (2018).*

2.21. **The ASI indicates that agriculture was most affected by droughts in 1998, 2008, 2010 and 2012, which affected the entire country and caused significant gran yield losses**. Yield losses were significant in the northern Oblasts, followed by moderate yield reductions in West Oblasts. Yield losses were much lower in the Southern-East oblasts, which experienced *moderate* droughts to *dry* periods.

2.22. **In Kazakhstan, the effects and intensity of droughts vary significantly by region.** In 1998 there was a severe drought in the country, where the Northern area -- the most vulnerable region - experienced ASI values above 50 percent (Severe/extreme drought) and corresponding significantly lower yield compared to the Long-Term Yield average (1995-2015 average) (Figure 2.10).

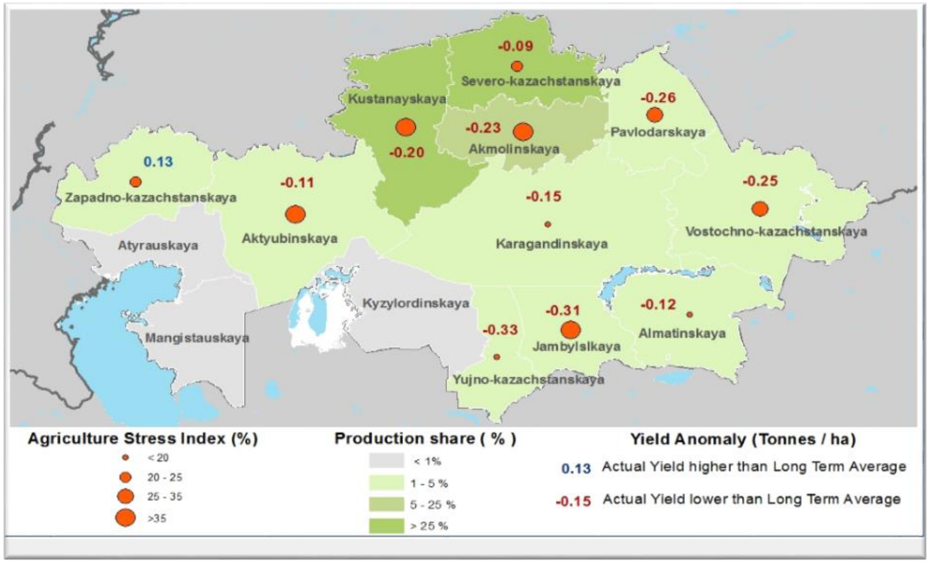
*Figure 2.10: Severe drought reduced wheat yield significantly in Kazakhstan, 1988*




*Source: Rojas et al. (2018).*

2.23. **The 2008, 2010, and 2012 droughts were relatively moderate where the ASI stayed below 50 percent across all regions of Kazakhstan**. However, Akmolinskaya, with an ASI of 37 percent, and Kustanayskaya with an ASI of 35 percent, experienced significant drops in wheat yield in those years compared to the LTY (Figure 2.11).

*Figure 2.11: Moderate drought impacted wheat yield in Kazakhstan, 2008, 2010 and 2012*



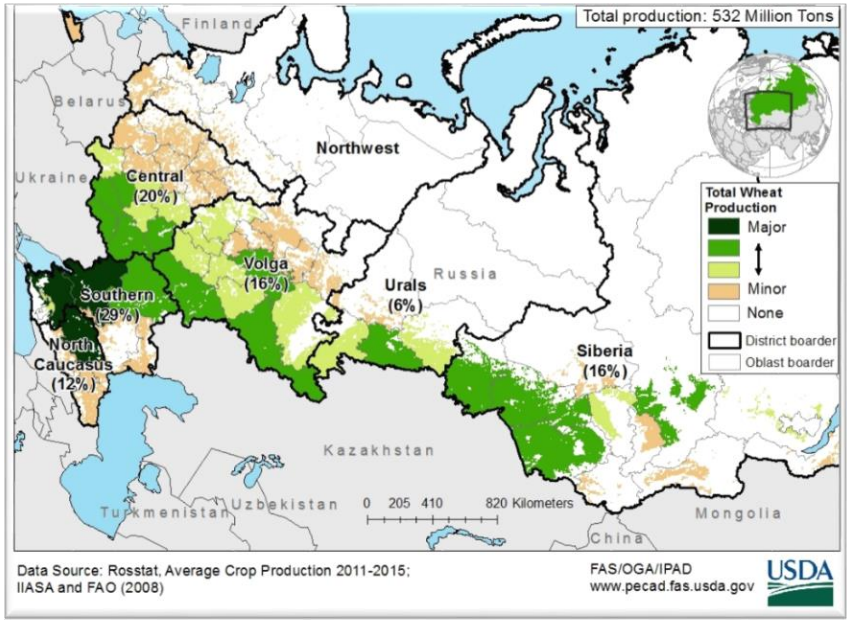

*Source: Rojas et al. (2018).*

### 2.4.3. Russian Federation

2.24. **In Russia, wheat production is determined by climatic conditions and, thus, geographically concentrated (**see Figure 2.12). Cereals are produced in moderate zones. Wheat, for instance, is very vulnerable to cool weather and soil acidity. Both factors limited the geographical distribution of the wheat crop to the wooded steppe and steppe zones. The winter wheat crop is cultivated mainly in the Northern Caucasus and the Black Earth regions (Voronezh Oblast, Lipetsk Oblast, Belgorod Oblast, Tambov Oblast, Oryol Oblast and Kursk Oblast), where conditions for winter crops were most favorable. On the other hand, the climatic conditions to the east (South of Western Siberia and northern Kazakhstan), with late and hot summers, dry autumns, and frequently a light snow cover in the winter, are proper for winter wheat.[18] The climate also favors the hard-red grain as against the soft wheat, the former characterized by a shorter growing season and a lower yield (White, 1987).

[18] In these regions, spring wheat was also planted, although its average yield was approximately half of that of winter wheat (Kruchkov and Rakovskaya, 1990).

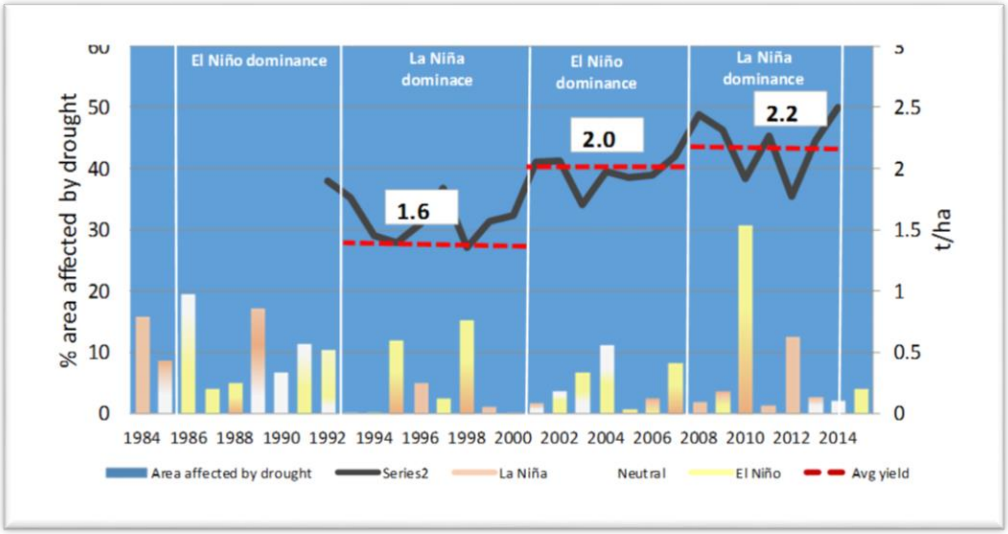
*Figure 2.12: Total Wheat Production, Russian Federation, Average 2011-2015*




2.25. **The extension of agricultural area affected by droughts are relatively small, but the frequency of droughts poses a significant problem for grain production in Russia (**see Figure 2.13). In addition, there are more drought events that affect the spring wheat production than the winter wheat production.[19] The production value of wheat accounts for 80 percent of the total cereal production (FAO, 2017), of which the winter wheat accounts for 50 percent and the spring wheat for the other 50 percent (USDA, 2016). The regions most affected by droughts are at the same time the ones with the highest levels of grain production, which are in the Southern -West area of the country, bordering the Northern Kazakhstan area.

[19] To solve the problem of mix signal captured by satellite, due to spring and winter wheat, the ASI value spatial was averaged for the most representative areas of winter and spring wheat (Figures are not shown).

*Figure 2.13: A Relatively small area is affected by droughts from total wheat area, Russian Federation, 1984-2014*




*Source: Rojas et al. (2018).*

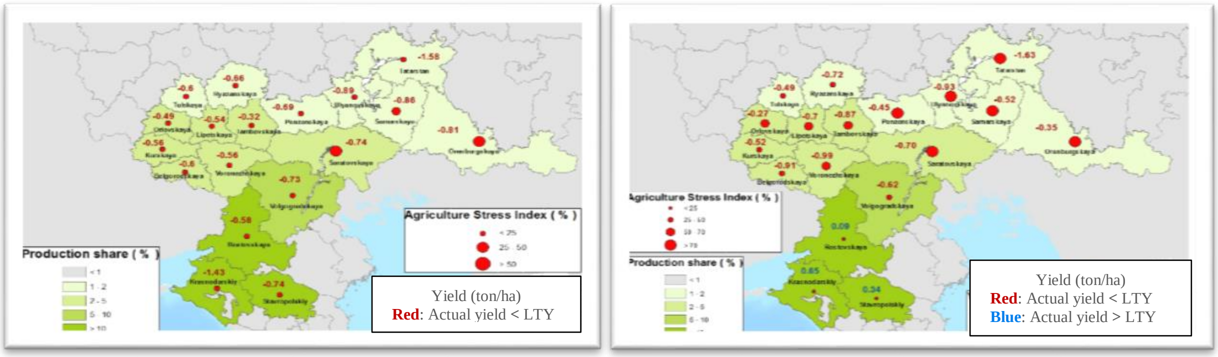
2.26. **Drought events have not had a significant impact on winter wheat yield in the Southern-Central area but. However, droughts impacted winter wheat yield in the Central area and Volgogradskaya oblast as well as in the most vulnerable regions in the Southern region, Ural, Siberia, and the Volga areas, causing significant drop in spring wheat yields.** The analysis below focuses only on regions that produce at least one percent of the winter wheat winter or spring wheat production.

a) Winter wheat crop

2.27. **The Southern area, which accounts for over half of the winter wheat production, experienced no water stress during the 1998 and 2010 droughts**. Thus, yield losses during this period were likely caused by other factors. The exception, however, was the Volgogradskaya Oblast, where the ASI indicates a "moderate" drought and relatively large drops in wheat yield (yield difference of -0.73 t/ha and -0.65 t/ha compared to LTY in 1998 and 2010, respectively) (see Figure 2.14).

2.28. **The 1998 and 2010 droughts were severe in the Volga and Central regions of the Russian Federation, causing large wheat yield decreases**. The ASI was above 50 percent in the Volga and Central area, where yield reduced significantly compared to Long-term yield (1995-2015 average). The highest ASI values were observed in the Volga area (Tatarstan Republic, Saratovskaya Oblast, Samarskaya Oblast), where LTY were respectively -1.6 t/ha, -0.7 t/ha, and -0.5 in 2010.

*Figure 2.14: Agricultural stress reduces winter wheat yield, Russian Federation, 1998(left) and 2010 (right)*



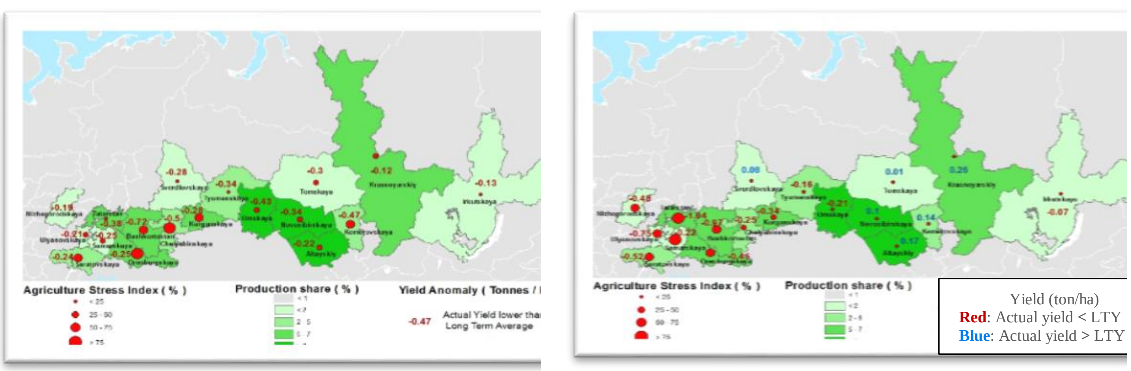

*Source: Rojas et al. (2018).*

b) <u>Spring wheat crop</u>

2.29. **There were serious drought events in 1998, 2010 and 2012 that strongly affected spring wheat yield in the Southern-Volga, Ural and Siberian areas.** Some Oblasts in the Volga and Ural areas experienced ASI values above 50 percent during these drought events. In particular, the droughts were severe in the Bashkortostan Republic and Chelyabinskaya, where average yield variations from the LTY were -0.7 t/ha and -0.5 t/ha respectively. In 2010, the Tatarstan Republic was particularly affected and had the highest negative yield variation (-1.6 t/ha from TTY).

2.30. **The Siberian area, which represents 46 percent of the spring wheat production, experienced "no water stress" or a "dry periods".** Yield losses, thus, were not due to droughts.

*Figure 2.15: Agricultural stress reduces spring wheat yield, Russian Federation, 1998/2012(left) and 2010 (right)*




*Source: Rojas et al. (2018).*

## 2.5. SUMMARY OF FINDINGS

2.31. **This section provides evidence that there is a strong relationship between El Niño/La Niña events and droughts in the RUK region.** In Russia the extension of agricultural area affected by droughts are relatively small, but the frequency of droughts that are usually caused by El Niño and La Niña events pose a significant problem for grain production, particularly in the Central, Volga and Urals regions and has caused significant drops in wheat yield during droughts in 1998, 2010 and in 2012. The frequency and intensity of droughts also increase for the winter wheat. For instance, while the entire RUK region suffered from drought during the moderate El Niño 1986-87, the impact on wheat yields (winter wheat) in Russian Federation was catastrophic, with a severe drought that reduced snow cover during the winter months and affected approximately 85 percent of the winter wheat areas in the country over this period. However, significant drought episodes occurred during La Niña, in 1998, 2010 and 2012, that strongly affected the winter wheat in 1998 and 2010 and the spring wheat also in 2012.

2.32. **There is a robust correlation between agricultural stress (ASI) induced by droughts and grain yield in the RUK region.** The severity and intensity of drought events as well as their impact on grain yield vary within regions of the same country and across countries. For instance, during the 2010 drought in Russia, wheat yield declined approximately 50 percent in the Volga region – which experienced an extreme drought - compared to a decline of 5 percent in the south region where there was no water stress. Similar patterns are also observed in Kazakhstan and in Ukraine. In addition, Spring wheat production decreases in Kazakhstan and Russian Federation during the period in which climate is driven by La Niña. Concerning the winter wheat in Ukraine, the production considerably decreases in the southern regions during La Niña events. The results, however, are mixed during winter wheat in Russian.

2.33. **The northern area of Kazakhstan, in particular, is sensitive to La Niña events and has experienced severe droughts.** Overall, drought has been identified as the biggest risk to agricultural production. Suffering from drought in 11 out of the 20 years between 1986 and 2006, Kazakhstan incurred significant agricultural losses, with five consecutive drought years between 1994 and 1998 (World Bank, 2006). There were also severe droughts in 2008, 2010 and 2012. The risk of drought is higher for rain-fed crop production in Northern Kazakhstan where grain production suffers from drought in two out of five years (World Bank, 2015).

2.34. **Compared to Kazakhstan and Russia, Ukraine has experienced fewer and less intense drought events, but the country is affected by both El Niño and La Niña events.** The most recent droughts happened in 2007 (El Niño dominance) and 2012 (La Niña dominance). The Southern area, which has large areas dedicated to grain production, is subject to considerable risks of severe droughts that may significantly impact grain production (similar to what happened during the 2007 and 2012 droughts).

2.35. **To ensure a stable supply of grains and improve food security, it would important to develop analytical tools and leverage emerging technologies to better predict and respond to El Niño and La Niña events in the RUK region.** For example, the methods utilized to produce the data presented in this section can be applied to generate sub-national information to help farmers, advisory service agencies, and policymakers to increase their understanding and knowledge about the impacts of extreme events on agriculture production and prepare accordingly to respond to climatic variability due to the El Niño and La Niña events.

# 3. Policy Response to Droughts in the RUK Region

## 3.1. INTRODUCTION

3.1. **For mitigating the economic effects of droughts including reduced domestic production and high food prices, RUK countries have utilized trade policy interventions and domestic price regulations.** Each of the RUK countries intervened at least once in their wheat market by introducing export restrictions during recent periods of severe droughts and skyrocketing world market prices. The most recent examples of temporary export restrictions were in the years 2007–2008 and 2010–2011: between July and October 2007, Ukraine introduced a total grain quota of only 12,000 tons (3,000 tons each for wheat, barley, rye and corn), which virtually meant an export ban. In 2008, Russia implemented an export tax of 40 percent on wheat and Kazakhstan applied an export ban from April to September 2008. In 2010, both Russia and Kazakhstan considered the introduction of bans on grain exports and, while Kazakhstan finally refrained from export restrictions, Russia implemented an export ban from August 2010 to June 2011. Ukraine opted for a grain export quota of 6.2 MT in total from October 2010 to July 2015 and then introduced export taxes of 9 percent for wheat, 12 percent for maize and 14 percent for barley from July to December 2011 (OECD 2011; OECD 2013b). Some of the CA countries also introduced wheat export restrictions despite the fact that they were net wheat importers, such as Tajikistan and Kyrgyz Republic in 2008/09.

3.2. **Domestic price regulation policies have been widely used in Europe and Central Asia (ECA) during periods of droughts as a measure to mitigate domestic food inflation.** Domestic wheat prices were regulated through state intervention purchases or emergency selling of intervention purchases (e.g. in RUK). Furthermore, all RUK countries intervened on their domestic markets by regulating (mainly fixing) the price of bread and other products. The traditional argument is that these policies were implemented in order to feed the population and protect poor consumers. Besides trade policy interventions and domestic price regulations, all RUK countries have crop-insurance programs that are supposed to mitigate the effects of unfavorable weather conditions. However, these insurance programs are characterized as insufficient (Bobojonov et al., 2014), and thus do not represent a proper risk-management tool.

3.3. **The substantial dependence of South Caucuses (SC) and CA countries on wheat imports from RUK raises significant concerns about competition and market power, particularly during drought-created crisis periods.** RUK may be able to increase the margin for exported wheat especially during crisis periods, when importing countries face few alternatives. Therefore, RUK export policies may represent a significant threat to food security in import-dependent countries in the region. Underdeveloped or outdated grain transportation and storage infrastructure restricts international trade of SC and CA countries and makes imports of wheat from RUK almost the sole option.

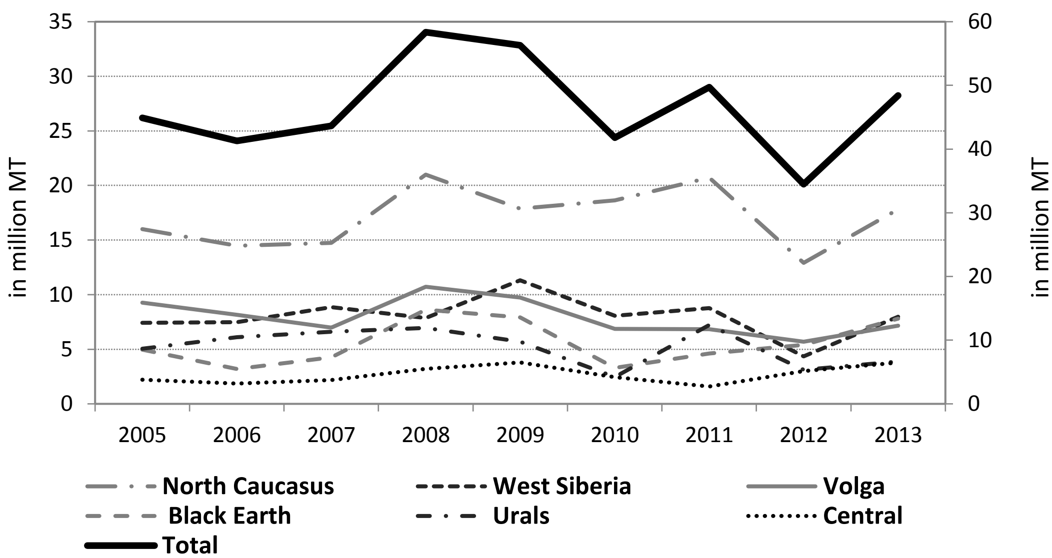
## 3.2. GRAIN PRODUCTION, POLICY INTERVENTIONS, AND TRADE IN THE ECA WHEAT SECTOR

3.4. **Volatility of the grain production in the ECA region is generally associated with temperature and precipitation extremes.** There were several weather-extreme cases observed between 2003 and 2013, which led to significant reduction in grain harvests and exports. This section provides an overview of the RUK regional wheat production disruptions caused by severe droughts; indicate the existing infrastructural issues in each RUK country; describe the chronology of the policy interventions implemented in selected ECA countries during the observed periods of severe droughts; and present wheat-trade patterns for each selected ECA country.

### 3.2.1. Russia

3.5. **Grain production in Russia is split between several separate production regions (Figure 3.1). Between 2005 and 2013, North Caucasus accounts for an average of 37 percent, West Siberia and Volga for 17 percent, respectively, Black Earth and Urals each for about 12 percent and Central for 6 percent of Russian grain production (Rosstat, 2014).** At the same time, figure 1 also reflects the different regional production conditions and the resulting differences in vulnerability to climate events. For example, in 2010/11grain production was 4 percent above average in North Caucasus in 2010/11, whereas the regions Volga, Urals and Black Earth were severely hit by the drought and realized a grain production of 66, 62 and 54 percent below average, respectively. These significant regional differences emphasize the importance of having an effective risk management tool (e.g. crop-insurance program), adequate local storage capacities, and inter-regional trade to balance supply and demand within the country.

*Figure 3.1: Grain production is regionally concentrated in Russia, 2005-2013*




*Note: "Total" refers to secondary axis.*
*Source: Rosstat (2014).*

3.6. **Generally, Russian producers can participate in risk management via a crop-insurance program. Even though insurance premiums are subsidized by 50 percent by the Russian government, only 11 percent of the crop area is insured (Rosstat, 2017).** The expert interviews conducted by Bobojonov et al. (2014) indicate that the main reasons for the low participation of the Russian farmers in the insurance program are high operational costs and limited risk management effects.

3.7. **About 70 percent of the wheat storage facilities in Russia are outdated and their regional distribution is not matching current market requirements.** The United Grain Company (UGC) established by the Russian government plays an important role in procuring, storing, processing and distribution of grain in Russia, especially during the crisis periods (i.e. severe droughts). The UGC has purchased more than 11 million MT of grain for its reserves in 2009/10 due to low prices associated with high amount of harvest in 2008 (OECD, 2011). Limited amounts of grain were released in 2010 and 2011 due to high prices associated with drought in 2010. Between October 2012 and February 2013, the UGC sold 1.5 million MT of high-quality wheat from its reserves mainly to reduce grain prices for livestock producers (thecropsite, 2013).

3.8. **The main obstacles to interregional and international trade activities are the large trading distances between domestic grain producing and grain consuming regions and also between the remote grain producing regions and the world market.** In addition, due to a weak network of domestic waterways, the relatively cheap barge transport is of low importance and grain has to be transported mainly by trucks and trains which involve substantial transport costs. Further, underdeveloped (outdated) grain train transport infrastructure poses an additional challenge. Due to a lack of investments into roads, almost all wheat cargo transfers to destinations that are more than 400 kilometers away use railway transport, which is mainly controlled by the government. Insufficient cargo wagons and sometimes very high governmental transportation tariffs represent a great burden for trades, especially so during harvest periods. As a result, significant delays in delivery are common. The average distance for inter-regional trade in Russia is about 1.6 thousand kilometers, common trade routes linking Volga and Black Earth regions (major wheat producers) to the North Caucasus (the main wheat exporting region) and the Central region (the region with the highest consumption). West Siberia and the Urals mainly supply wheat to the domestic market, especially to the Central region.

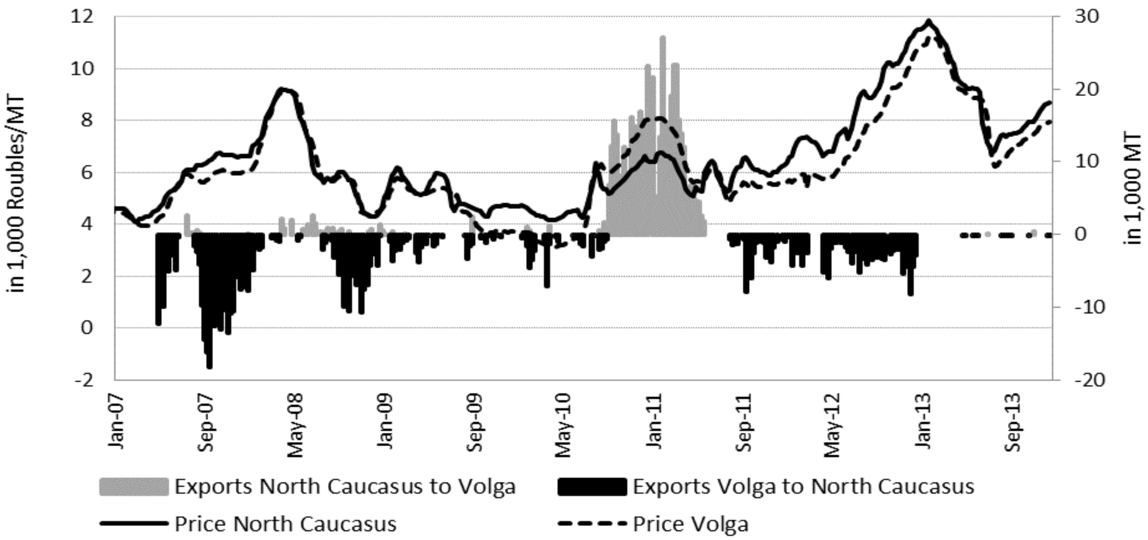
3.9. **Due to significant production shortfalls in some of the wheat producing regions during the severe droughts in 2010/11, some of the abovementioned common trade routes changed directions to supply wheat to drought-affected regions.** Supported by government transport subsidies, large amounts of wheat were for instanced supplied by North Caucasus to the Volga region (see Figure 3.2). As presented in Table 3.1, in particular North Caucasus exported large amounts of grain via train to Central, Black Earth, Volga and Ural, while West Siberia exported grain to the Urals, Volga and Central districts.

*Table 3.1: Inter-regional grain trade quantities (in MT) by train, Russia, 2010 - 2011*

| to… from… | **North Caucasus** | **West Siberia** | **Black Earth** | **Central** | **Volga** | **Urals** |
|---|---|---|---|---|---|---|
| **North Caucasus** | -2,494,506 | | 534,336 | 1,205,324 | 453,936 | 300,910 |
| **West Siberia** | | -1,180,827 | | 73,107 | 101,444 | 1,006,276 |
| **Total imports** | | | 534,336 | 1,278,431 | 555,380 | 1,307,186 |

*Note: exports < 0; imports >0; in metric ton;*
*Source: Rosstat (2014).*

*Figure 3.2: Inter-regional grain trade flows and wheat prices for North Caucasus-Volga, 2007-2013*




*Source: Rosstat (2014).*

3.10. **Also at sea port terminals, infrastructural problems can be observed. Considering that the limited wheat-handling capacities at the sea ports are highly concentrated (mainly in the southern Russia at the port of Novorossiysk), there is an enormous logistic challenge to secure smooth handling of approximately 30 million MT of wheat coming from different regions.** Furthermore, most of the wheat-handling facilities are working at their capacity limits despite constant modernization, which causes delays in wheat shipments, especially in the years of a bumper harvest.

3.11. **As a response to the international commodity price peak 2007/08 and the severe drought in 2010/11, the Russian government imposed export restrictions.** Wheat exports were limited in November 2007 due to an export tax of 10 percent. The export tax was increased to a prohibitive level of 40 percent in December 2007 and removed in July 2008. It should be pointed out that the export tax policy was implemented although domestic wheat production was 7 percent above the preceding three years' average level in the marketing year 2007/08 (Table 3.2). However, due to droughts in other primary global grain production regions and resulting high world market prices, Russia's wheat exports were extraordinarily high (Figure 3.3). In order to reduce grain exports and, thus, to prevent that high world market prices are transmitted to Russian grain markets, the Russian government implemented export restrictions. Nevertheless, in early 2008 domestic prices increased beyond the world market price level in all of the six regions (Figure 3.3).

*Table 3.2: Wheat export restrictions, grain production and wheat exports in Russia, 2005-2013*

| | 2005/6 | 2006/7 | 2007/8 | 2008/9 | 09/10 | 10/11 | 11/12 | 12/13 |
|---|---|---|---|---|---|---|---|---|
| **Export control** | | | tax | | | ban | | |
| **Production (% of average*)** | 110 | 106 | 107 | 136 | 116 | 71 | 100 | 70 |
| **Exports (% prod.)** | 22 | 24 | 25 | 29 | 30 | 10 | 38 | 30 |

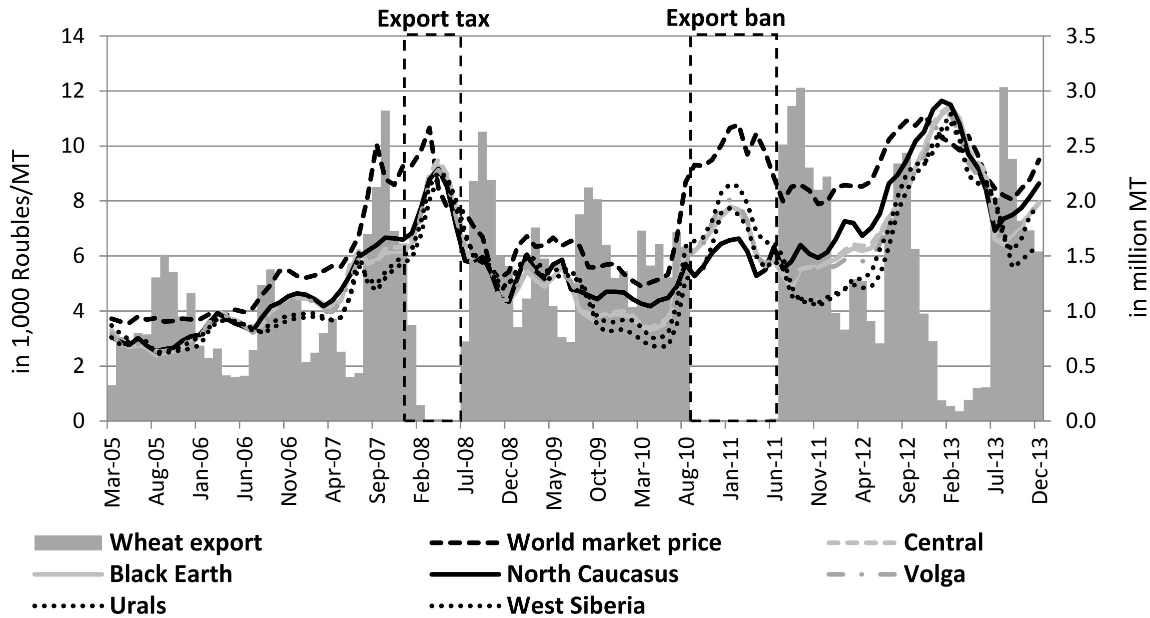
*Note: *Average of the respective 3 previous years.*
*Source: USDA (2015).*

3.12. **Russia again restricted wheat exports during the 2010/11 marketing year, when wheat supply on the domestic market was low due to a severe drought.** Total domestic wheat production was 29 percent below the preceding three years' average, with regional production shortfalls of up to over 60 percent. As illustrated in Figure 3.3, a wheat export ban was implemented in August 2010 to prevent that wheat was further exported to the world market and instead traded only domestically and delivered to the regions experiencing a large harvest shortfall. The export ban was lifted in July 2011.

3.13. **Although Russia's total grain production in 2012/2013 was similar to 2010/11 about 30 percent below average, export controls were not implemented.** However, the pattern of the regional grain production shortfall was different. Production was about average in Central and Black Earth regions, whereas West Siberia, Urals, and North Caucasus were most severely hit by production shortfalls of 54, 49 and 32 percent below average. Similar to 2007/08 and 2010/11, wheat exports to the world market went down in 2012/13 (see Figure 3.3).

3.14. **Besides wheat export restrictions and intervention purchases, the Russian government imposed regulations limits on maximum retail prices for certain food products.** Among others, maximum bread prices were set by the official governmental regulation on July 15, 2010 (USDA, 2010). This regulation was issued in accordance with the Federal law on commercial activities in the Russian Federation that was enforced in early 2010.

*Figure 3.3: Export controls had limited effect on wheat prices, 2005-2013*

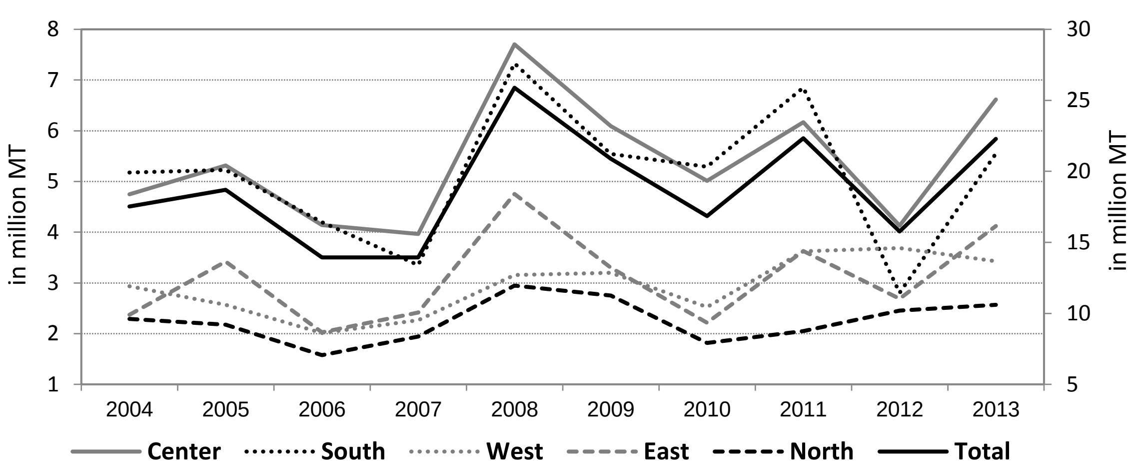



*Sources: GTIS (2013), HGCA (2014), and Russian Grain Union (2014).*

### 3.2.2. Ukraine

3.15. **Grain production is regionally spread across Ukraine.** The main production regions are in Central and Southern Ukraine, accounting for 29 and 27 percent of total production, respectively. Grain production in the Western and Eastern regions account for 16 percent, whereas the Northern Ukraine accounts for 12 percent of total wheat production (Figure 3.4).

*Figure 3.4: Grain production is spread across regions in Ukraine, 2004-2013*




*Note: "Total" refers to secondary axis.*
*Source: Ukrstat (2014).*

3.16. **Although grain production is distributed throughout the whole of Ukraine, the distance between the different production regions is small. Therefore, the production regions are basically affected by similar climatic and weather conditions.** Also, all the production regions are within a 700-kilometer radius to the Black Sea ports.

3.17. **Most of the grain storing and processing facilities are outdated and operate at their capacity limits.** The same holds for grain-handling terminals at the Black Sea ports. Despite the fact that port grain-handling capacities have been upgraded to approximately 45 million MT (grain per year) and are distributed across more than 10 ports along the Black Sea (i.e. Asov coast – Odessa region), experts report that only a limited number of traders (exporters) are allowed to use these ports.

3.18. **In 2003, Ukraine experienced serious crop damage associated with unusually low temperature in December and ice crusting in February and March.** The particularly low planted area in 2003 is also explained by unfavorable weather conditions during sowing winter wheat (FAS USDA, 2003). Another yield shortfall was observed in 2007 (Table 3.3) when there was a low level of production due to high temperature and drought in spring and summer months.

*Table 3.3: Wheat export restrictions, grain production and wheat exports in Ukraine, 2005-2013*

| | **2005/6** | **2006/7** | **2007/8** | **2008/9** | **09/10** | **10/11** | **11/12** | **12/13** |
|---|---|---|---|---|---|---|---|---|
| **Export control** | | quota | quota | | | quota | tax; MoU** | indirect controls; MoU |
| **Production (% avg.*)** | 128 | 110 | 83 | 167 | 117 | 83 | 105 | 79 |
| **Exports (% prod.)** | 35 | 24 | 9 | 50 | 45 | 26 | 24 | 46 |

*Note: *Average of the respective 3 previous years; **Memorandum of Understanding.*
*Source: USDA (2015).*

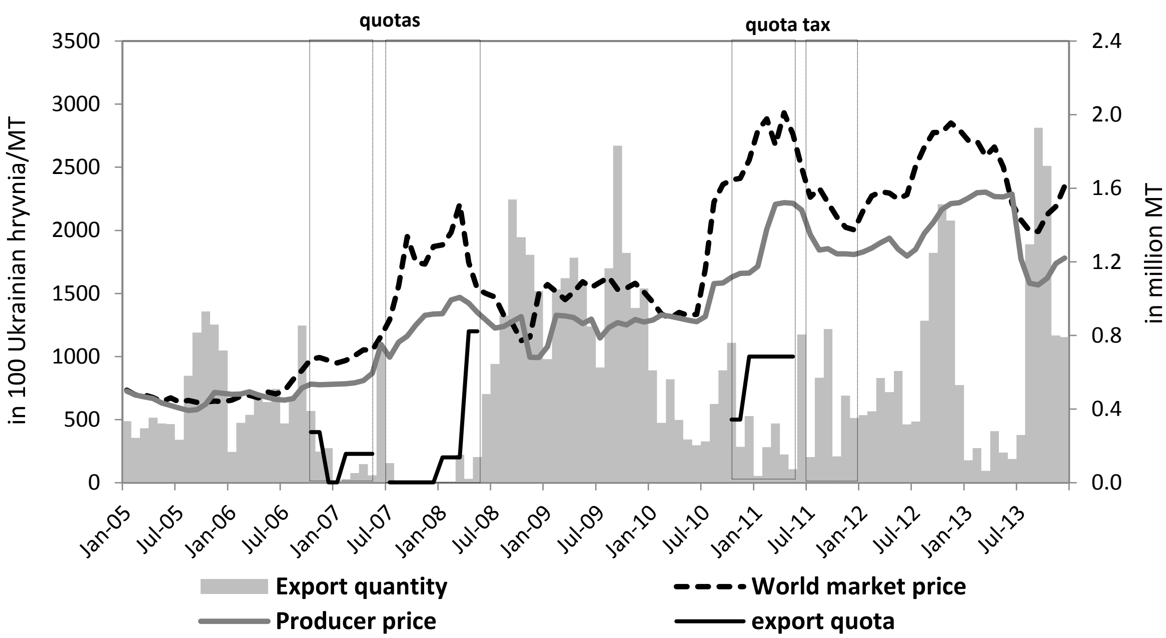
3.19. **As a response to severe droughts and high commodity prices on the world market, the Ukrainian government imposed export quotas within a government license system.** Export quotas varying between 3 thousand MT and 1.2 million MT were in force during several periods between October 2006 and May 2008 and October 2010 and March 2011 (Figure 3.5). In addition, Ukraine implemented a wheat export tax of 9 percent in July 2011, which was removed in October 2011. Following this, the Ukrainian government regularly signed a Memorandum of Understanding (MoU) with the grain exporting companies on the procedures for monitoring grain availability and export practices. Also, it specified the maximum grain exports for which trade remained open. During the 2012/13 marketing year, wheat exports became indirectly regulated by restricting access to train transportation to the harbors and phytosanitary certificates, which are a mandatory requirement for exports.

3.20. **In addition to these export restrictions, the Ukrainian government also intervened on the domestic wheat market by intervention purchases and sales of wheat, and by administrating maximum retail price of certain food products.** The governmental procurement and storage are organized by the Agrarian Fund. Some additional reserves are kept in the State

Reserve Agency for catastrophic disturbances of grain production and supply. During the marketing year of 2007/08, 580 thousand MT were purchased by the state reserves. In 2008/2009, purchases even reached about 1 million MT of grain (FAO and EBRD, 2012). In 2010/11 the state intervention had 1.2 million MT of grain available in its silos which were sold to the bakeries when prices increased (FAO, 2012). Furthermore, Ukrainian Fund was involved in processing and sales of flour to bakeries at an administrative price in order to keep bread prices low in 2009/10 (FAO, 2011; OECD, 2011).

3.21. **Until 2009, wheat producers in Ukraine could claim governmental subsidies for crop-insurance.** Nevertheless, only about 8 to 18 percent of the crop area was insured (IFC, 2017). The overall demand for insurance is declining in the country and efficiency of the insurance program need to be improved in order to make it an attractive risk management tool.

*Figure 3.5: Export controls did not avoid wheat price volatility in Ukraine, 2005-2013*

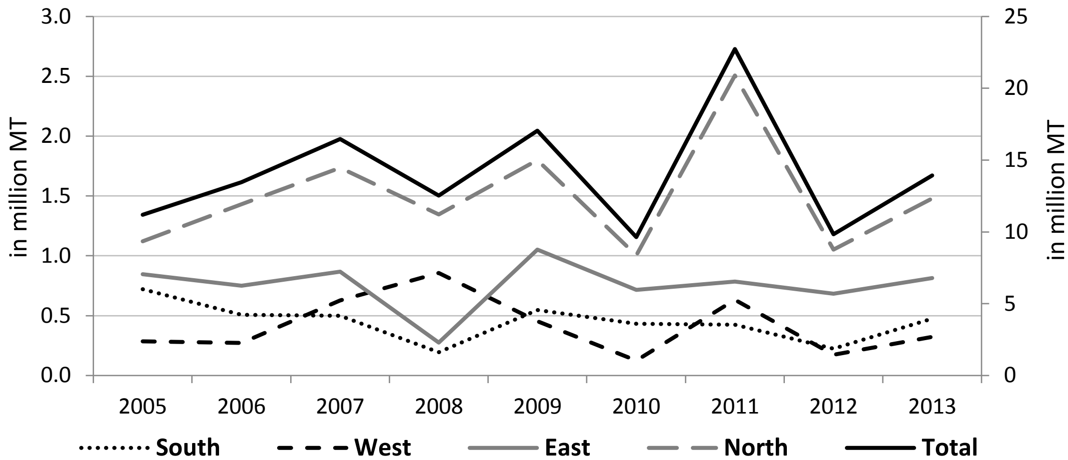



*Sources: APK-Inform (2015), GTIS (2013), HGCA (2014), and Ukrstat (2014).*

### 3.2.3. Kazakhstan

3.22. **Most of the grain in Kazakhstan is produced in Akmola (24.3 percent), Kostanay (23.6 percent) and North Kazakhstan (27 percent) regions (oblasts)** (Figure 3.6). Since these regions are located in the vicinity of Ural and Volga Federal Districts of Russia, joint occurrence of production shortfall in Russia and Kazakhstan in the years of severe droughts can be observed.

*Figure 3.6: Grain production is concentrated in northern Kazakhstan, 2005-2013*




*Note: "Total" and "North" refer to secondary axis.*
*Source: Agency of Statistics of the Republic of Kazakhstan (2013).*

3.23. **The drought in 2010, which hit especially Northwestern Kazakhstan, had severe consequences on domestic wheat production in Kazakhstan** (Table 3.4). According to experts, about 72 percent of the crops in the Aktobe region (West Kazakhstan) were completely destroyed by the drought. Very strong effects of the drought were also recorded in the key wheat producing regions such as Akmola, Kostanay, and North Kazakhstan.

3.24. **Wheat producers in Kazakhstan participate in a mandatory insurance system against almost all main perils identified as the main sources of risk.** The program is subsidized in a way that the state covers 50 percent of the losses of the insurance companies. More than 57 percent of the grain acreage was insured in 2016 (KazAgro, 2016). However, the effect of this insurance program is limited as farmers usually pay very limited premiums (i.e. payment to insurance company), which are just enough to fulfill insurance obligation required by the state. Due to very limited payments obtained from farmers, insurance companies can cover only limited shares of the farmers' losses during extreme events. Thus, overall program does not function as a risk management tool since farmers do not obtain sufficient payments to make up for harvest losses.

*Table 3.4: Wheat export restrictions, production and exports, Kazakhstan, 2005-2013*

| | **2005/6** | **2006/7** | **2007/8** | **2008/9** | **09/10** | **10/11** | **11/12** | **12/13** |
|---|---|---|---|---|---|---|---|---|
| **Export control** | | | licensing system | ban; MoU** | | Indirect ban | | |
| **Production (% avg.*)** | 98 | 124 | 143 | 91 | 120 | 63 | 174 | 60 |
| **Exports (% prod.)** | 35 | 61 | 48 | 49 | 48 | 50 | 52 | 64 |

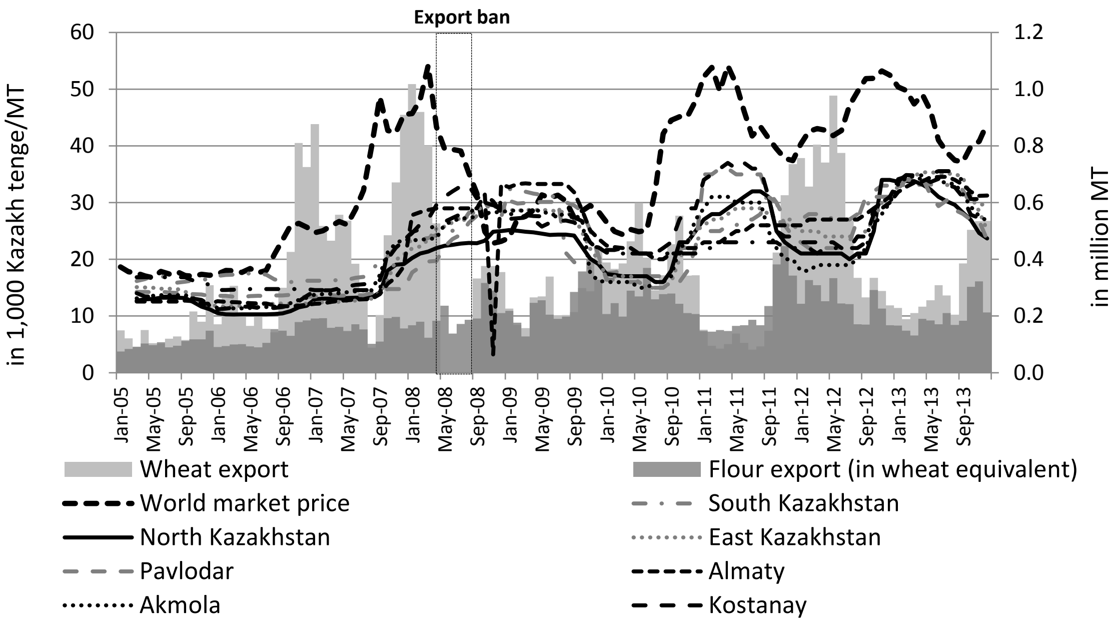
*Note: *Average of the respective 3 previous years, **Memorandum of Understanding.*
*Source: Agency of Statistics of the Republic of Kazakhstan (2013).*

3.25. **In light of strongly increasing wheat exports induced by high world market prices, and regional droughts, the Kazakh government introduced a grain export licensing system in September 2007.** Nonetheless grain and bread prices increased significantly in September 2007. Therefore, the Kazakh government formed a stabilization fund for wheat interventions and signed a MoU with grain traders proclaiming that domestic wheat prices should not increase until the new harvest. Despite the MoU, severe droughts in some regions induced expectations of a low wheat harvest and inducing strong price increasing effects on domestic wheat prices. In order to ensure domestic food supply and to protect the consumers from further increases in flour and bread prices, the Kazakh government imposed a wheat export ban on April 15, 2008, which remained in force until September 1, 2008 (Figure 3.7). Furthermore, The Kazakh government intervened in the domestic market by fixing the retail price of bread in 2007/08 in order to preserve domestic food security (Oskenbayev and Turabayev, 2014; Chernyshova, 2010).

3.26. **Despite severe consequences of the drought and political pressure from Customs Union Members (i.e. Russia and Belarus), Kazakh government did not impose export ban in 2010/11.** Instead, the state owned Food Contract Cooperation, sold about 2 million MT of wheat (2/3 of their total reserves) to domestic market to reduce high domestic prices (Galiakpar, 2011).

3.27. **Nevertheless, trade experts confirm that in addition to the lower amount of wheat available for export, exporters faced an unofficial export ban as the national rail company failed to come up to their obligation to provide rail wagons for wheat exports.** Considering the size of the country, wheat transport by railway is far more preferable than transporting wheat by trucks. Kazakh railways and the transport tariff regulations are mainly controlled by the government. Traders usually face shortages of wagons especially after the harvest. Even if the wagons are available, problems with insufficient and outdated elevators exist. Furthermore, considering that Kazakhstan is a landlocked country, the only way of exporting wheat to the world market is to use the territory of Russia and Ukraine (to reach the ports on the Black Sea) that are usually less profitable (or not profitable at all) because of the high transit tariffs. Kazakhstan has only one major port on the Caspian Sea (in Aktau) with a very limited capacity, and is mainly available for selected traders that have a strong governmental support.

*Figure 3.7: Regional wheat prices and export of Kazakhstan, 2005-2013*




*Sources: Agency of Statistics of the Republic of Kazakhstan (2013), GTIS (2013), and HGCA (2014).*

3.28. **Overall, reduced supply caused by the drought, increased demand for Kazakh wheat caused by the traditional importing countries (mainly CA countries), and transport (infrastructure) problems were the main factors pushing the domestic wheat prices upward in 2010.** A very similar situation could be observed during 2012, when droughts and infrastructure problems were the main drivers for the observed strong increase in domestic wheat prices.

### 3.2.4. South Caucasus and Central Asia

3.29. **Besides RUK, some of the SC and CA countries also intervened on domestic wheat markets during periods of severe drought-induced production harvest shortfalls in the Black Sea region or high world market prices.** Although official trade statistics do not report on wheat exports of these countries, trade of flour in small amounts by unofficial merchants is common (e.g. within cross-border trade). Thus, to prevent the unofficial cross-border trade escalation, export bans were imposed by those countries.

3.30. **Tajikistan imports about 60 percent of its grain consumption, whereas substantial grain exports from the country are not known. Nonetheless, the government introduced a wheat export ban in the 2007/08 season to prevent the increase of wheat exports to Afghanistan** (Robinson, 2008). Furthermore, the government distributed food subsidies of about 58 million US$ in May 2008 (FAO GIEWS, 2013). Similarly, Kyrgyz Republic also imports more than 30 percent of its grains and banned grain export on September 25, 2012 for half a year (Ivashenko, 2012; Zalkind, 2012). While official data on grain export from the country do not exist, the only possible export destination for flour from Kyrgyz Republic is Uzbekistan. In any case, export transaction costs are very expensive and the relatively high export tax for trade to Kyrgyz Republic imposed by Uzbek authorities makes export unprofitable (Ivashenko, 2012).

3.31. **The government in Kyrgyz Republic distributed 600 thousand MT of wheat flour to low-income families in March 2011 (FAO GIEWS, 2013) and reduced the value added tax (VAT) for wheat flour for small-scale and large-scale mills from 20 percent to 10 percent (Robinson, 2008).** While there was no official ban on the export of grains from Uzbekistan, there were some cases of informal export barriers (Robinson, 2008). Azerbaijan was the only ECA country that eliminated import tariff for wheat. This measure was implemented between May 2008 and May 2009 and was supplemented by the suspension of VAT on wheat for the same period.

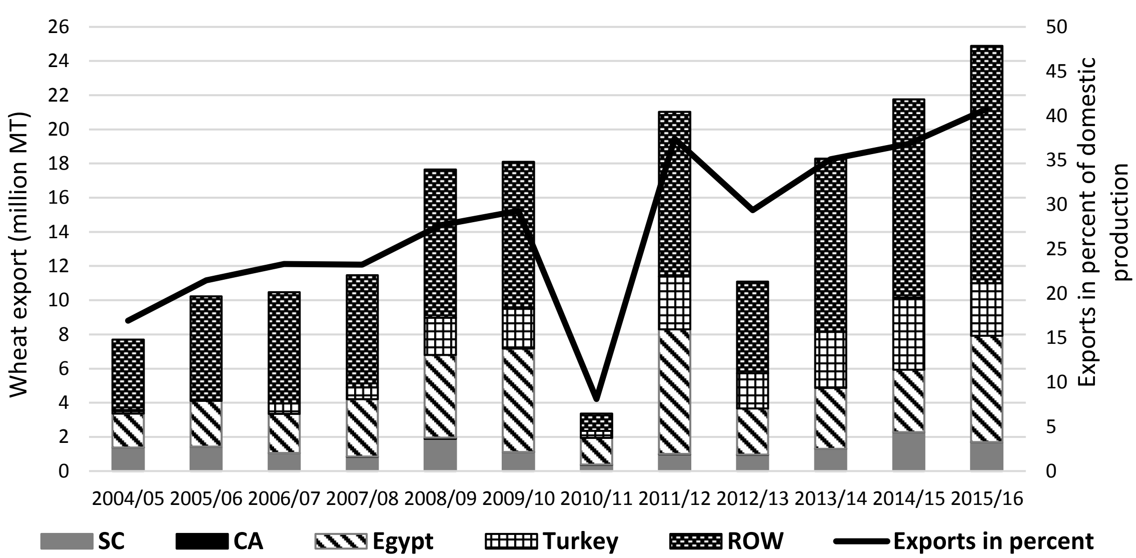
## 3.3. TRADE PATTERNS

### 3.3.1. Russia

3.32. **Wheat exports from Russia tripled between 2004/05 and 2015/16** (Figure 3.8). The largest buyers were Egypt and Turkey, which purchased 26 and 12 percent of the domestic production. About half of the Russian wheat exports go to the Middle Eastern countries and North Africa (MENA). On average, Russia exports 1.2 million MT annually to SC countries, which is 10 percent of total wheat exports. Russian's wheat exports to SC vary significantly between years from 374 thousand MT to 2.3 million MT. Only a very small share of wheat is exported to CA countries (less than 0.1 percent).

3.33. **Russian exports on average account for 28 percent of domestic production.** This share ranges from 8 percent in 2010/11 to 41 percent in 2015/16. The variation is caused by the extreme weather events in central areas of Russia in 2010/11 by which wheat production fell to 42 million MT. In addition, the Russian Government banned wheat exports from August 15, 2010, until June 10, 2011, which lead to a drop of wheat exports to 3.4 million MT.

*Figure 3.8: Wheat export destinations, Russian, 2004-2016*

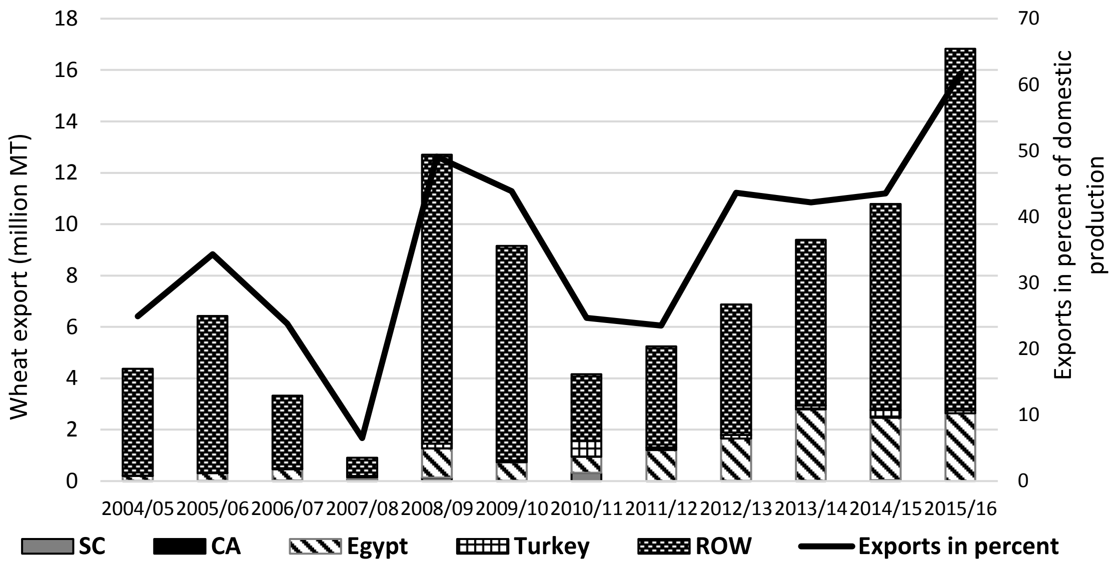



*Note: Exports in percent of domestic production is shown as a line referring to the secondary axis.*
*Sources: USDA (2015) and GTA (2015).*

### 3.3.2. Ukraine

3.34. **Total wheat exports from Ukraine increased from 4 million MT in 2010/11 to 17 million MT in 2015/16** (Figure 3.9). The main reason for this increase was the Ukrainian record wheat harvest of 27 million MT in 2015/16, which exceeded domestic consumption and hence was available as exportable surplus.

*Figure 3.9: Wheat export destinations, Ukraine, 2004-2016*




*Note: Exports in percent of domestic production is shown as line referring to the secondary axis.*
*Sources: USDA (2015) and GTA (2015).*

3.35. **MENA is the main destination of Ukrainian wheat exports (43 percent of total wheat exports).** 16 percent of Ukrainian total wheat exports go to Egypt. ROW destinations account for more than half of Ukrainian wheat exports (55 percent). Recently, also exports to countries in Europe (Spain, Italy, and United Kingdom), East Asia (Bangladesh, South Korea, Philippines, Indonesia, and Thailand) and Africa (Kenya, South Africa, and Ethiopia) could be expanded. Only 2 percent of total wheat is exported to SC countries and only about two thousand MT of wheat are exported to CA countries.

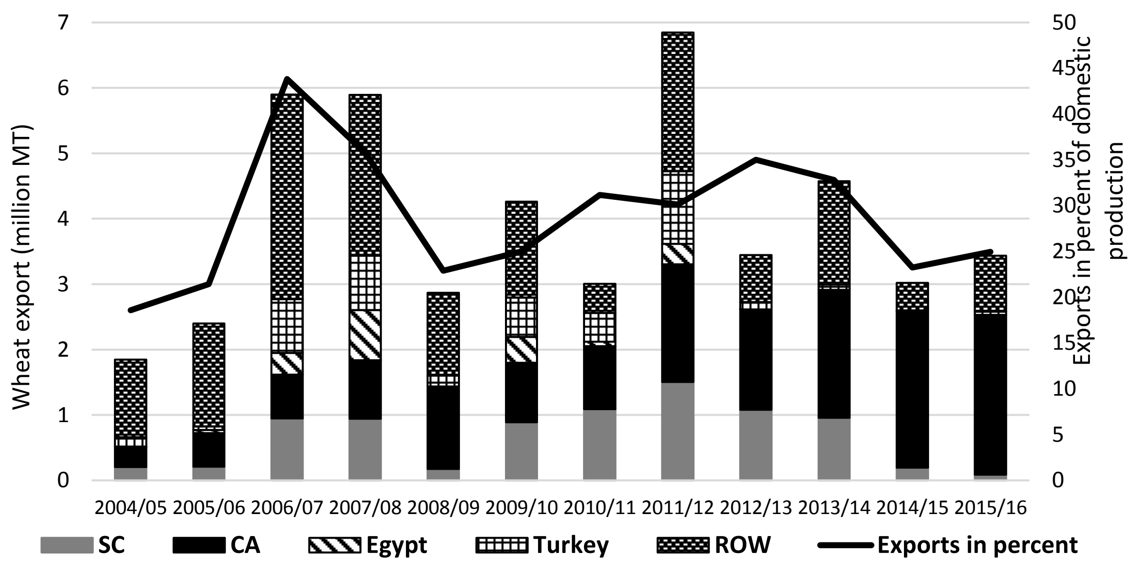
3.36. **The wheat exports in percentage of domestic production shows significant variation and ranged from 7 percent in 2007/08 to 62 percent in 2015/16.** The extreme low exports were caused by low wheat yields in the years of dry weather conditions (2007/08) and export restrictions implemented by the Ukrainian government.

### 3.3.3. Kazakhstan

3.37. **Between 2004/05 and 2015/16, the average annual wheat exports of Kazakhstan were about 4 million MT, fluctuating between 2 million MT in 2004/05 and 7 million MT in 2011/12.** Figure 3.10 reveals frequent changes over time regarding the destination of Kazakh wheat exports. Over this period, Kazakhstan exported annually on average 1.3 million MT (33 percent of total export) to the CA countries, 690 thousand MT to the SC countries (17 percent) and 749 thousand MT to the MENA countries (18.9 percent), respectively. Before 2012/13, Egypt and Turkey were the most important trade partners for Kazakhstan accounting for 4 and 9 percent of total wheat exports, respectively.

3.38. **During the last five years CA imports from Kazakhstan have increased substantially and reached 75 percent of total wheat exports in the last two years, thus making the region the most important destination for Kazakh wheat.** The exports in percent of domestic production are on average 29 percent, ranging from 19 in 2004/05 to 44 percent in 2006/07. The average annual wheat production for this period is 14 million MT and varied from 10 million MT in 2010/11 to 23 million MT in 2011/12. Kazakh wheat production and exports highly depend on the continental weather conditions, which are extremely unstable.

*Figure 3.10: Wheat export destinations, Kazakhstan, 2004-2016*




*Note: Exports in percent of domestic production is shown as line referring to the secondary axis.*
*Sources: USDA (2015) and GTA (2015).*

### 3.3.4. South Caucasus

3.39. **The SC countries account for 1.4 percent of world wheat imports in 2004 to 2016; SC countries imported about 2 million MT of wheat per year** (Figure 3.11). The total wheat import in the SC countries varies from 1.6 million MT in 2005 to 2.6 million MT in 2012 with a decreasing trend during the crisis periods.

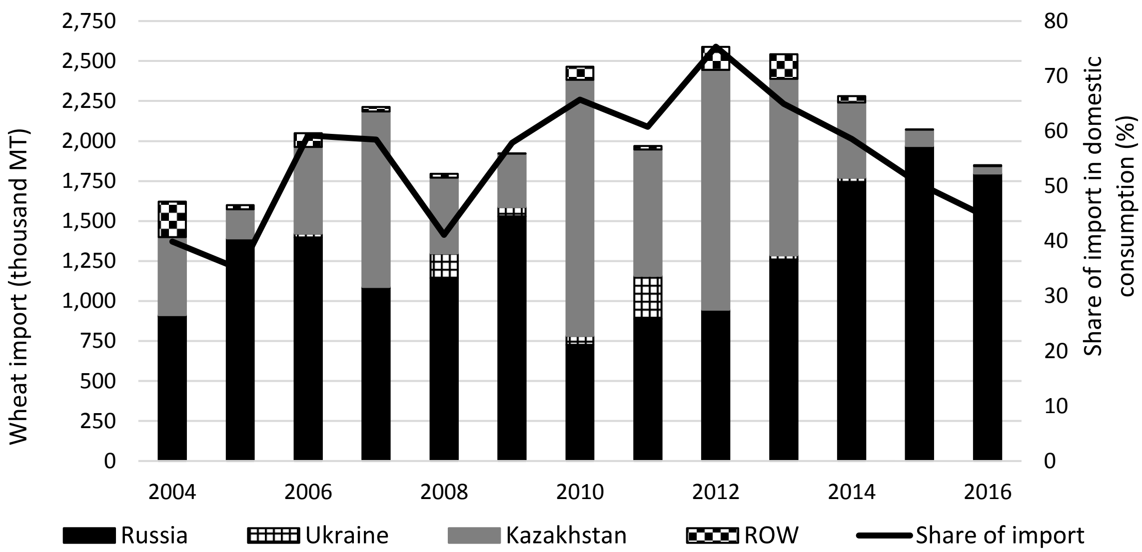
3.40. **In total, the SC countries imported wheat from 26 different countries including Australia, Canada, France, Germany, Kazakhstan, Ukraine, Russia, Turkey, USA, and others.** However, there are only two major players - Russia and Kazakhstan. Since 2004, these two countries accounted on average for 62 and 30 percent of SC wheat import market, respectively (Figure 3.11). The Ukrainian share in the SC market averages just below 3 percent. Since 2010, Russia has rapidly increased its export to the SC countries and reached more than 97 percent of the

SC wheat import market. The Kazakh market share range between 3 percent in 2016 and 65 percent in 2010. Due to the domination of Russian importers, the structure of the SC wheat import market and competition today is by a duopolistic or even monopolistic structure.

3.41. **The largest importer of wheat among the SC countries is Azerbaijan with more than 58 percent of total wheat imports of SC or about 1.2 million MT.** The second-largest importer in SC is Georgia with imports of 620 thousand MT. Armenia imports about 242 thousand MT. All three SC countries reduced their imports of wheat over the last four years.

3.42. **The share of imports in domestic consumption of wheat in the SC countries is relatively high. The shares range from 9 (2005) to 64 percent (2012) for Armenia, 29 (2011) and 49 percent (2010), for Georgia, 35 (2008) and 121 percent (2010) for Azerbaijan. Azerbaijan is most dependent on imports.**

*Figure 3.11: Wheat import markets, South Caucasus, 2004-2016*




*Note: Share of imports in domestic consumption is shown as line referring to the secondary axis.*
*Source: UN COMTRADE (2015) and USDA (2015).*

### 3.3.5. Central Asia

3.43. **The CA countries import about 1.4 million MT of wheat on average per year and account for less than 1 percent of world wheat imports in the period from 2004 to 2016.** In contrast to the SC region, wheat imports in the CA region significantly increased over the recent years (Figure 3.12). The CA countries import wheat from 12 different countries, but due to location and infrastructure, Kazakhstan is by far the most important origin of wheat imports. The average market share for Kazakhstan is close to 99 percent, leading to a clearly monopolistic market structure. Imports from Kazakhstan increased from 183 thousand to 3 million MT.

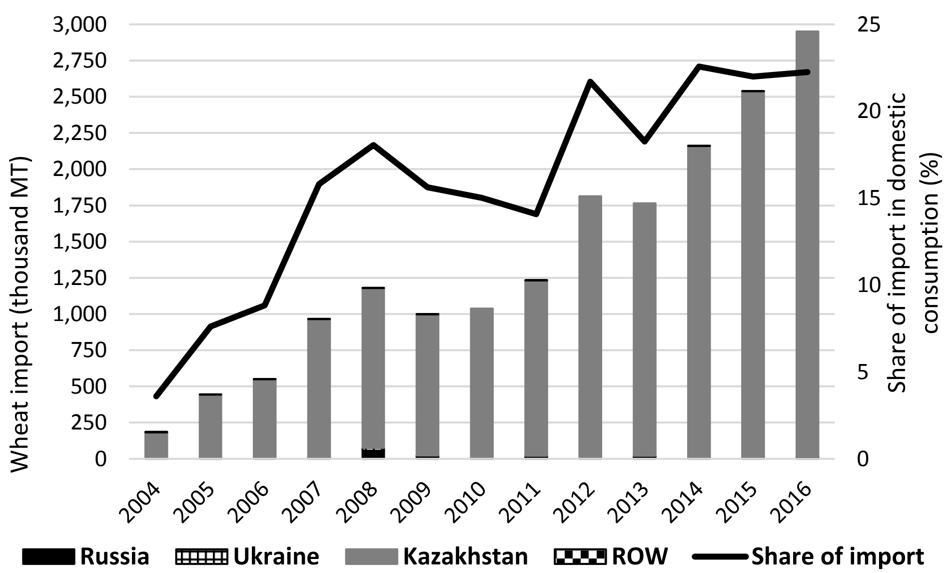
3.44. **Uzbekistan has a population of 32.4 million people and is the largest buyer of wheat in the CA region, importing 522 thousand MT per year (38 percent of total wheat import of**

**the CA region).** Second is Tajikistan with imports of 494 thousand MT, followed by Kyrgyz Republic with 301 thousand MT. Turkmenistan is the smallest buyer of wheat in the CA region and imports 53 thousand MT per year. Except for Kyrgyz Republic and Turkmenistan, Tajikistan and Uzbekistan significantly increased imports of wheat over the past five years, which is mainly due to the growing population and due to the substitution of flour by wheat imports.

3.45. **The share of imports in domestic consumption of wheat developed differently among importing countries.** This share steadily grew for Tajikistan and Uzbekistan from 8 to nearly 53 percent and from 0.3 to 17 percent. Kyrgyz Republic's share increased from 6 to 38 percent up to 2014 and decreased to 19 percent in 2016. Except for 2008, the share of imports in domestic consumption of wheat in Turkmenistan was the lowest among CA countries and accounted for less than 3.6 percent on average between 2004 and 2016. At the same time, the average share of imports in domestic consumption was more than 24 percent in Kyrgyz Republic, 32 percent in Tajikistan, and 7 percent in Uzbekistan, respectively.

3.46. **Between 2004 and 2016, the total wheat production of wheat importing countries in the CA region increased from 8 million MT to 10 million MT, showing considerable yearly variation (between 8 million MT in 2008 and 10 million MT in 2013)**. However, the total wheat consumption in the CA region increased even faster, from 10 million MT in 2005 to 14 million MT in 2016, leading to the observed increase of wheat imports.

*Figure 3.12: Wheat import markets, Central Asian, 2004-2016*




*Note: Share of imports in domestic consumption is shown as line referring to the secondary axis. Source: UN COMTRADE (2015) and USDA (2015).*

## 3.4. THE EFFECTS OF WHEAT EXPORT CONTROLS IN THE RUK

3.47. **This section summarizes the empirical findings on the effects of the governmental interventions implemented by RUK as a response to severe droughts and high food prices on**

**domestic and regional price developments along the food supply chain, on market stability, and on competition and trade.**

3.48. **A regime-switching price transmission model framework is utilized to investigate the effectiveness of wheat export controls to dampen agricultural and food prices in the RUK in the event of a drought-induced harvest shortfalls or dramatic world market price increases.** To identify the influence of export controls, we apply a spatial price transmission model20 capturing the price relationship between the domestic price and the relevant world market price for wheat. The influence of export controls on the flour and bread price is estimated with a model of vertical price transmission using wheat, flour and bread prices.

3.49. **The PTM and the RDE approaches are used to estimate and test for evidence price discriminatory behavior of RUK exporters.** To analyze the effect of the RUK export restrictions on trade patterns and trade relationships a gravity model is applied (Anderson and van Wincoop, 2003). Gravity models are standard econometric approaches to perform ex-post analysis in the trade literature. The basic idea of a gravity model is to explain export values via several factors, such as trade costs (e.g., distance or common borders), or measures of economic developments (e.g. gross domestic product).

### 3.4.1. Impact on domestic wheat markets in RUK

***Russia***[21]

3.50. **Wheat producer prices in the Southern Federal District of Russia, the primary wheat producing region, was decoupled from the world market prices by the export tax in 2007/08 by only 10 percent on average.** This means that the transmission of the high prices from the world market to the domestic market in Russia was reduced by 10 percent in the restricted regime compared to the free trade regime. This implied that the difference between the world market price and the domestic price increased when an export tax was applied. Contrasting, significantly stronger domestic wheat price effects were observed during the export ban in Russia 2010/11. Our estimations suggest that the difference between the world market price and the price prevailing in the North Caucasus wheat market increased by 67 percent relatively to the world market price. Thus, the domestic price in the region of North Caucasus was dampened by the export ban in Russia 2010/11 by 67 percent relatively to the world market price (Götz et al., 2016b). Thus, the price effects induced by the wheat export ban in 2010/11 were much stronger compared to the export tax in 2007/8.

3.51. **The export ban in Russia 2010/11 caused a domestic price dampening effects for the five primary grain production regions varying between 55 percent and 35 percent.** Thus, the price dampening effects vary significantly between the regions and was highest in the primary grain producing region which is also the primary grain export region.

[20] To keep the model applicable to many empirical situations and to allow comparability, the model does not account for the price effect of the weather extreme/harvest shortfall (see e.g. Ubilava and Holt, 2012 and 2013).

[21] A main characteristic of the Russian grain market is the large distance between the main grain production and consumption regions. An analysis ignoring this characteristic and using average national price data may produce misleading results. We rather use regional level wheat prices from the primary wheat producing region (i.e. Southern Federal District), which is also the primary export region with direct access to international markets.

3.52. **Export controls may also impact price relationships, between the grain producing regions within a country due to the increase or decrease in trade between those regions, respectively.** We therefore investigate grain price relationships between the major 6 grain producing regions of Russia during the export ban (2010/11) and compare it to the marketing year 2009/10, when international trade was unrestricted. We choose a threshold vector error correction model framework to capture the influence of distance (Svanidze and Götz, 2017). Results suggest that the integration of the regional wheat markets increased during 2010/11, which can be explained by the increase in interregional grain trade to balance the harvest shortfall in the most affected regions. The rise in inter-regional grain trade was reinforced by the implementation of the export ban forcing grain traders in North Caucasus to engage in inter-regional grain trade within Russia.

3.53. **The empirical work further suggests that transaction costs of interregional trade have increased during the export ban, which forced exporters to change export destinations and involve new trade partners.** In general, the business risk is particularly high in Russia due to a high degree of fraud and the difficulties to enforce contracts. Obviously, the transport subsidy was too low to balance this increase in transaction costs.

***Ukraine***

3.54. **Export controls led to price dampening effects varying between 10 percent and 26 percent across regions, suggesting an average price dampening effect of 19 percent for wheat export controls in Ukraine** (Table 3.5)**.** Thus, the Ukrainian market shows a much lower price dampening effect than the Russian market. This might be explained by that exports in the Ukraine remained possible up to certain degree compared to the strict export ban in 2010/11 in Russia.

*Table 3.5: Estimates of price insulating and price dampening effects of export quotas, Ukraine*

| | **RS-long-run price equilibrium model** *(Götz et al., 2016b)* | | | | **STC** *(Götz et al., 2016a)* | **Average** |
|---|---|---|---|---|---|---|
| Period of export control | 2006/07 | 2007/08 | 2010/11 | 2011 (tax) | 2006-2011 | |
| Price dampening effect (%) | 12 | 23 | 26 | 10 | 26 | 19 |

*Source: Own illustration.*

***Kazakhstan***

3.55. **For Kazakhstan it was not possible to conduct a quantitative price transmission analysis because data were not available.** The following findings are based on a qualitative analysis from expert interviews.

3.56. **When the wheat export ban in Kazakhstan was implemented in 2008, the domestic wheat price further increased even beyond** the world market price, even though the world wheat market price was already decreasing. Several factors led to the continuous increase in wheat prices in Kazakhstan even after the introduction of wheat export bans. Firstly, the size of the 2007 grain harvest was overestimated, which led to marked price increases as soon as the corrected estimation of grain production was published by the statistical office in early 2008. Also, when wheat exports were banned, Kazakh traders started to export wheat flour instead. Following, the wheat export restrictions implemented in Kazakhstan in 2008 have not unfolded any price dampening effects.

***Box 3.1: Export Controls***

Wheat export controls have not always proved as a successful policy to significantly dampen domestic wheat prices. Their effectiveness depends on the restrictiveness of the export controls and additional factors, such as their sequencing and the initial level of domestic supply deficit. Also, the strengthening of market integration between regions can lead to improved stability on the domestic market. If the price signals are faster transmitted from deficit to surplus regions and the transaction costs of trade are decreased, incentives for inter-regional trade from surplus to the deficit regions can be strengthened and can contribute to dampen the price effect of production shortfalls. This will reduce incentives for governments to implement export controls.

### 3.4.2. Price effects on the wheat-to-bread supply chain in the RUK

3.57. **In Russia, wheat, flour, and bread prices increased significantly during the period of the export tax in 2008.** During the 2010 export ban, bread prices rose even though wheat and flour prices remained almost constant. Moderate price increases along the wheat-to-bread supply chain are recorded in Ukraine during the periods of governmental intervention. In contrast to Russia and Ukraine, wheat and bread prices in Kazakhstan did not change during the period of the wheat export ban in 2008; however, flour prices increased substantially.

3.58. **The findings indicate that, in some cases, actors along the wheat-to-bread supply chain did not pass on price-dampening effects, but raised prices further.** This was particularly the case in Russia, where large industrial mills were able to increase their profits by raising flour prices. In contrast to mills, the baking industry in RUK was not able to benefit from dampened wheat prices, despite the fact that bread prices raised relatively to the flour price. The main reason is that the baking industry faced substantial increases in production costs such as energy and labor.

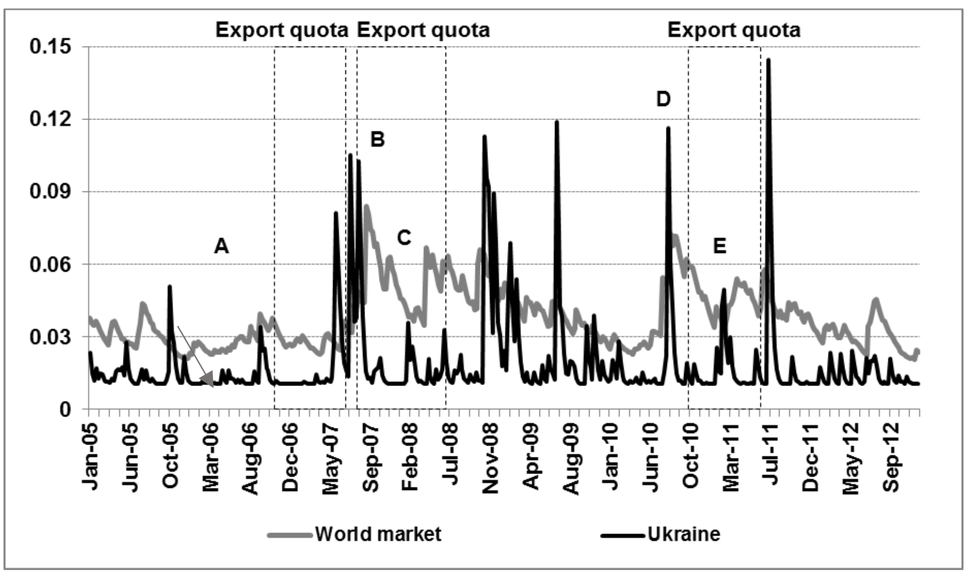
### 3.4.3. Effects on price volatility in the RUK

3.59. **The implementation of export controls may drastically increase market uncertainty**. Particularly in the case of Ukraine, export quotas were implemented on short notice. The size of the quota was changed and prolonged several times, and the quota licenses were not distributed in a transparent manner. Thus, export restrictions made market conditions unreliable and difficult to predict. Furthermore, market risks increased and lead to additional price volatility.

3.60. **Contrasting to the (French) world market price, price volatility on the wheat market in Ukraine exhibits high susceptibility for external shocks and low impact of own variance and thus low persistence (Götz et al. 2013b).** This leads to a couple of short periods of time in which excessive volatility prevails. Furthermore, the findings indicate that the Ukrainian wheat market did not follow volatility developments on the world market in 2007/08 and 2010/11, which suggests domestic factors to be of greater importance for the observed volatility.

3.61. **Analysis of the policy environment provides strong evidence for a correlation of phases of high volatility with the occurrence of rumors and the announcement of changes in wheat market trade policy by the Ukrainian government, especially concerning the implementation and extension of the temporary export restrictions.** Figure 3.13 shows that volatility spike A coincides with the announcement of an export-quota system by the Ukrainian government. The point of time of spike B matches with the temporary lift of export quotas and their unexpected reintroduction. High volatility phase C coincides with the quota increase that was announced but not realized. It also coincides with the commission meetings concerning the distribution of the export licenses. Spike D occurred when an export ban was introduced in Russia, which induced extensive discussions in the Ukrainian media about whether export controls would also be introduced in Ukraine. Spike E occurred when an extension of the export quota in Ukraine was announced and implemented. These results confirm that export restrictions increase price volatility temporarily that is caused by increased market uncertainty.

*Figure 3.13: Development of price volatility in the Ukrainian wheat market*



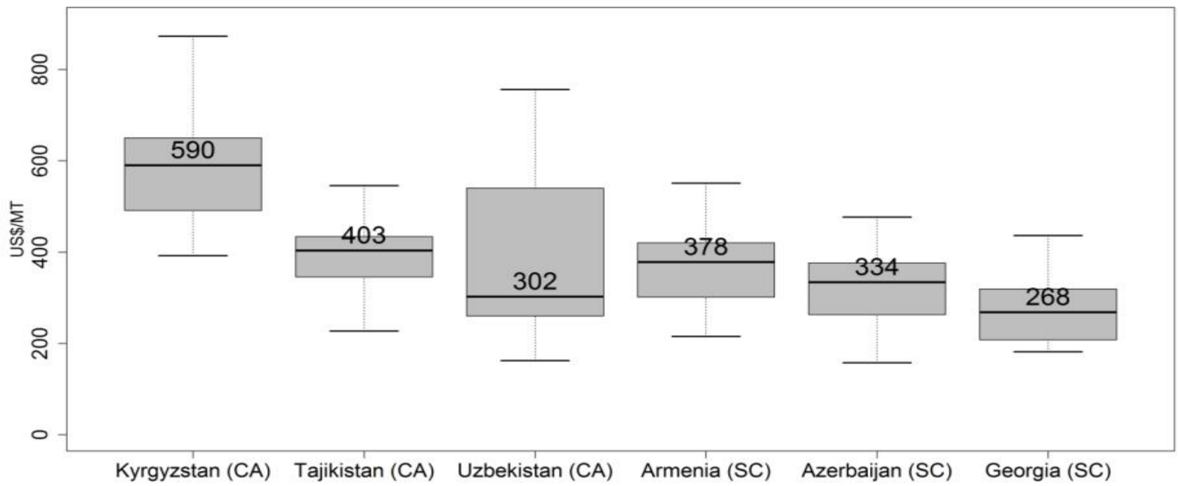

*Source: Götz et al. (2015).*

3.62. **In Ukraine in particular, export controls have not significantly reduced price volatility on the domestic wheat market.** On the contrary, our findings suggest that the multiple and unpredictable interference of the Ukrainian government in the wheat export market substantially increased market uncertainty, which in turn led to pronounced additional price volatility.

### 3.4.4. Price effects on import-depending countries in CA and SC

3.63. **The comparison of domestic wheat price developments (Figure 3.14) indicates that wheat prices in CA are overall higher than the wheat prices in SC.** Relatively high price levels are typical for domestic markets in landlocked countries. In addition, the distributional characteristics of the wheat prices might be influenced by quality. For instance, the relatively low median of domestic wheat price in **Tajikistan,** compared to Kyrgyz Republic, may be due to the generally lower quality of domestically grown wheat as a result of unfavorable climate conditions and lacking irrigation systems. Wheat of relatively higher quality is produced in **Kyrgyz Republic**, which also reflects in the high median price.

*Figure 3.14: Boxplot of domestic wheat prices in CA and SC, 2006-2014*




*Source: Svanidze et al. (2016).*

3.64. **Co-movement of domestic prices with export prices in the RUK region and world markets is stronger in SC than in CA.** Price changes in the regional RUK markets are on average by 16 percent more directly transmitted to the SC domestic wheat prices (67 percent of RUK price changes are transmitted to SC on average) compared to CA (47 percent on average). These results are partially explained by transportation costs, which are significantly higher in CA than in SC. It is striking that the size of official transportation costs does not vary strongly across regions. Major source of large differences in "real" total transportation costs between CA and SC result from unofficial payments in CA, which are mostly charged by customs and traffic police. Pomfret (2016) estimated that these unofficial payments might be three to four times higher than the official transportation costs. He argues that not only transportation costs are high in CA, but that also inadequate facilitation of regional trade results in long delays at the borders all over the CA region.

3.65. **The price transmission results for the SC indicate that prices in the wheat market of Georgia are strongly tied to the export prices of the major grain exporting countries (i.e. RUK, France, and USA).** The main reason might be that Georgia has access to own grain-handling terminals at the Black Sea and thus is able to directly import wheat from Russia and Ukraine. Compared to Georgia, Armenia is moderately integrated with the world markets. Armenia is a landlocked country and, thus, has to rely on Georgian ports and railroads to import wheat from Russia or Ukraine. Wheat markets in Azerbaijan are the least integrated. Wheat price changes in Kazakhstan are minor linked to the wheat markets in Armenia and Georgia as compared to Russia and Ukraine, which is in line with the high transportation costs.

3.66. **Azerbaijani wheat prices co-move stronger with prices in Kazakhstan, probably due to strong business relationships between Kazakhstan and Azerbaijan.** In addition, Azerbaijani importers prefer Kazakh wheat with high protein contents over Russian wheat. As a reaction of increasing wheat prices in RUK export markets, wheat prices also increased in all countries in SC. However, the most significant price spikes were observed in Azerbaijan in 2007/08 and in Armenia in 2010/11. Consequently, the SC region featured a lower escalation of domestic wheat prices following to the rise of export prices in 2012/13.

3.67. **Within CA region, price changes at regional and world wheat export markets are not transmitted to the domestic wheat prices in Uzbekistan.** This may be explained by the fact that the Uzbek wheat market is one of the most comprehensively regulated markets in CA, e.g. by governmental input cost subsidies, wheat price controls and state purchase programs. Additionally, we observe that free market prices of wheat in Uzbekistan significantly increased in 2007, leading to a widening of the price gap between domestic and regional export prices by more than 100 percent. Among CA countries, Kyrgyz Republic is most strongly integrated with Kazakhstan, followed by Tajikistan. Kazakh wheat is exported to Kyrgyz Republic by a direct railway line through a common border, whereas Tajikistan imports Kazakh wheat mainly through Uzbekistan, which results in additional costs of transportation. Increase in RUK export prices is particularly strongly passed through domestic wheat prices in Kyrgyz Republic and Tajikistan in 2007/08, whereas next waves of increasing world prices in 2010/11 and 2012/13 was less strongly felt by domestic markets in these countries.

3.68. **The price transmission analysis along the wheat-to-bread supply chains in SC indicate moderate increase in retail flour and bread prices during the observed periods of the RUK wheat export restrictions.** There was an increase in the flour and bread prices in **Armenia** in 2007/08, however, these prices responded moderately to the large increase in domestic wheat prices in 2010/11. There was no momentous change in price margins (i.e. price difference) between both bread and wheat, and flour and wheat prices. Moreover, small margin increase in 2010/11 returned to the previous level in 2012.

3.69. **In Azerbaijan, all prices along the wheat-to-bread supply chain show significant changes in 2007/08. During 2010/11only flour prices increased significantly, compared to wheat and bread prices.** As compared to other countries in the SC, the Azerbaijani government is relatively active in administrating wheat and bread prices on its domestic markets. Consequently, transmission of wheat price changes to retail bread price in Azerbaijan is lowest in the region (Table 3.6). There was no significant widening of bread and flour price margins over time in Azerbaijan. Further, the percentage margin was lowest in 2007/08, indicating that retailers reduced price margins, probably supported by governmental subsidies, to counteract the negative impact of increasing food prices on consumers. All price series in **Georgia** along the wheat-to-bread supply chain demonstrate the similar pattern of responses to the increasing commodities prices. Additionally, there is no significant difference in margin development neither for retail flour nor bread prices, only in 2007/08 and 2010/11 flour price margins slightly increased returning to its previous levels in the next years.

*Table 3.6: Price transmission (elasticities) along the wheat-to-bread supply chain in selected SC and CA countries.*

| | South Caucasus | | | Central Asia | |
|---|---|---|---|---|---|
| | **Armenia** | **Azerbaijan** | **Georgia** | **Kyrgyz Republic** | **Tajikistan** |
| $P^b - P^w$ | 0.44 | 0.38 | 0.47 | 0.60 | 0.44 |
| $P^f - P^w$ | 0.53 | 0.65 | 0.47 | 0.65 | 0.83 |

*Note: $P^b$ – bread price; $P^w$ – wheat price; and $P^f$ – flour price.*
*Source: Authors' calculation.*

3.70. **For the selected CA countries, there was a significant increase in bread prices since 2007/08, whereas flour prices peaked in both periods of RUK market interventions**. In general, retail flour prices in CA compared to bread prices are more responsive to the upstream price changes: about 65 and 83 percent of wheat price changes in Kyrgyz Republic and Tajikistan are transmitted to retail flour prices, respectively. In contrast, 60 and 44 percent of wheat price changes are transmitted to the bread prices in respective countries (Table 3.6).

3.71. **In contrast to the SC countries, there was a proportional widening of margins between bread and wheat prices in Kyrgyz Republic since 2007/08**. This is partially explained by increasing labor costs (wages) and the general performance of the economy (GDP growth). Especially wages in the services sector have increased in all CA countries during recent years. Although there are no new employment opportunities in Tajikistan and Kyrgyz Republic, wages may be kept up by job offers from Russia.

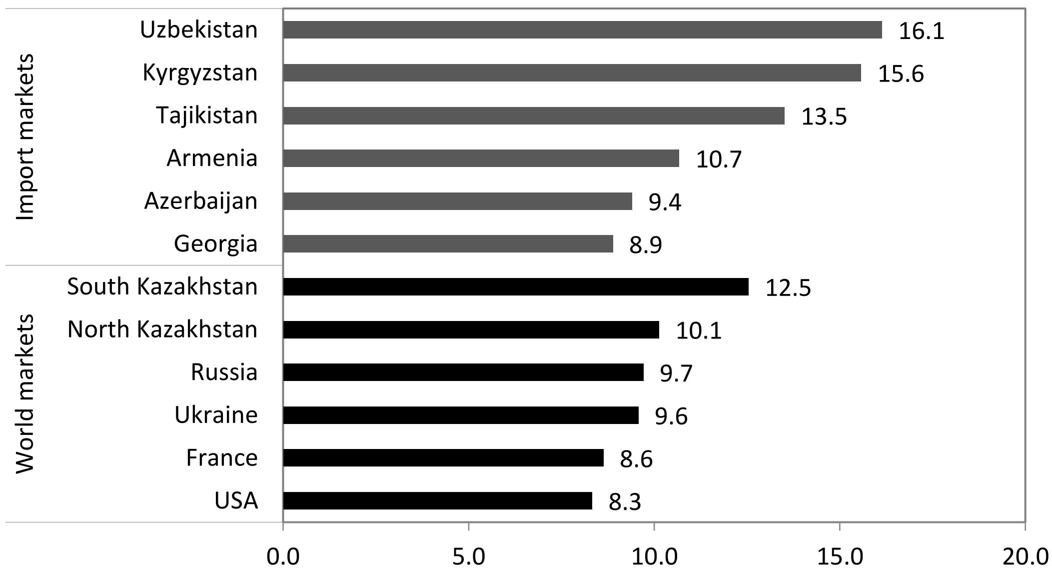
3.72. **The transmission of price changes from upstream to downstream prices along the supply chain in CA is higher than in SC, where the price transmission elasticities mainly reflect cost shares of the major inputs (wheat) in the final products (bread and flour).** This implies that the consumer price of bread in CA compared to SC tends to more strongly react to the commodity price increases (recently observed in 2007/08, 2010/11 and 2012/13); expert interviews also confirm that traders, millers and bakers in CA were not affected by increases in wheat prices. Nonetheless, traders, millers and bakers increased their price margins, which led to end consumer price increases and counteracted the government policy intentions.

3.73. **Overall, the findings above suggest that domestic price depend on intermediate actors of the supply chain, especially during crisis periods, where they could use the argument of significant increase in prices of raw materials (i.e. wheat) to justify increasing the price of their products (i.e. flour or bread).** As pointed out, disproportional increases of consumer prices can have an additional negative effect on domestic food security, and thus represent a great challenge, especially for SC and CA countries.

3.74. **Price volatility on domestic wheat markets in SC is significantly lower compared to the CA countries during the observed period from 2006 to 2014 (Figure 3.15).** This result may be explained by relatively inelastic wheat supply (almost 99 percent import from Kazakhstan), which is characteristic for the markets in the landlocked CA import countries. An additional argument is the fact that grain storage facilities and international grain supply in these countries are very limited (World Bank, 2010), thus leading to high transaction costs compared to the SC countries. Furthermore, unofficial payments involved in CA wheat trade with Kazakhstan could easily double transportation costs from official 30 to 100 US$ to the total of 80 to 180 US$ per MT (Svanidze et al, 2016).

3.75. **In 2007/08, wheat price volatility is highest in Azerbaijan among the SC countries.** However, in 2010/11, when Russia introduced the export ban, the highest wheat price volatility was observed in Armenia**,** followed by Georgia, both countries that largely depend on wheat imports from Russia. During the 2012/13 drought, wheat price volatility was modest in all SC countries. In contrast, increased wheat price volatility is observed in all CA countries during all episodes of high wheat export prices in RUK. In addition, the magnitude of price variation is larger in CA than SC.

*Figure 3.15: Wheat price volatility of domestic prices in selected ECA and world markets, 2006-2014*




*Note: Historical price volatility; Only for Uzbekistan calculation period covers 2006-2009.*
*Source: Svanidze et al. (2016).*

## 3.5. EFFECTS ON COMPETITION AND TRADE

### 3.5.1. The effects on market competition

3.76. **The PTM estimates provide evidence of price-discriminating behavior of Russian exporters against several import destination countries**. Russian exporters exercised market power particularly in the aftermath of the Russian export controls in 2007. In nine out of twenty-four destinations, including two out of three SC countries such as Armenia and Georgia**,** price discrimination could be observed (Pall et al., 2013). In addition, the results of a PTM approach indicate the existence of imperfectly competitive market and the exercise of price discrimination by Russian exporters in Uzbekistan and in Georgia (Uhl et al., 2016).

3.77. **Further analysis also indicates that Russian wheat exporters exercise market power in two out of three countries of the SC region (Armenia and Azerbaijan) and in one out of four wheat importing countries of CA countries (Turkmenistan)**. However, there is no evidence of market power exercised by Russian wheat exporters in Georgia, Kyrgyz Republic, Tajikistan, and Uzbekistan. In contrast to Russia and Ukraine, Kazakhstan has the highest market share in CA markets. Specifically, the Kazakh market share is above 75 percent in these markets. PTM results though, show that Kazakh wheat exporters are not able to price discriminate in all three SC countries and in two out of four CA countries, i.e. Kyrgyz Republic and Turkmenistan. On the other hand, there is some evidence of imperfect competition in Tajikistan and Uzbekistan (Gafarova et al., 2015).

***Box 3.2: RDE Results***

The results from the RDE analysis corroborates the findings from the PRM approach and indicate that Russian wheat exporters as price takers on the Egyptian wheat market due to high competition between wheat exporting countries created by the tender system and the free access to the world markets. In contrast, there is evidence that that Russia has dominant position in some SC countries wheat markets. The SA countries do not use the tender system that may stimulate competition between wheat traders. Also, the wheat markets in these countries are not much diversified as there are only one or two big wheat suppliers with large market shares.

The RDE analysis also indicates two potential factors that constraint the exercise of market power by large grain exporters: First, a tender system open to range of different exporters may foster competition in the destination markets. Second, improving access to world markets and lowering transaction cost for land-locked destinations can limit the potential to exert market power.

3.78. **In six selected drought years, there was no remarkable differences in the pricing behavior when compared to the "ordinary" years and/or the whole period.** Nevertheless, there is no evidence for PTM behavior in Armenia, Azerbaijan and Turkmenistan in the drought periods in contrast to the results of the whole sample.

3.79. **Overall, RUK countries are able to price discriminate in some of the SC, CA countries (and some EU and MENA countries).** There are some differences between exporting countries (RUK), both in the pricing strategies of exporters across destinations, and their broad geographical market predominance. Moreover, there is first evidence that there is no relationship between extreme whether events (droughts) and pricing-to-market behavior of Russian exporters in most of the investigated countries.

### 3.5.2. Effects on regional trade

3.80. **Three key results emerge from the gravity model estimates**: First, variable trade costs, measured by the distance variable, are significantly larger for SC and CA than for other countries. This might be explained by the fact that neither SC nor CA have a direct access to a large seaport, which is why wheat can only be exported by train to these regions. Railroad transport, however, is usually more expensive than the transportation by ship. Second, the parameter estimates for the production variable, which can be interpreted as elasticities, are about one in both models. This indicates that a one percent increase in wheat production in RUK leads to a one percent increase in RUK wheat exports. Third, the elasticity estimates for the consumption variable are below one when all countries are considered, and they are above one when only SC and CA are considered. This indicates that the SC and CA are more dependent on RUK wheat imports than countries in North Africa and the Middle East. The latter countries seem to have more opportunities to diversify their wheat imports, which is important particularly in cases of an increasing import demand.

3.81. **The gravity model estimates also indicate that the export restrictions had an impact on the trade structures of the RUK wheat exports, and also that the timing of the export controls seems to affect the strength of this impact on the market.** The estimates for Ukraine indicate that whenever Ukraine introduced export restrictions, its wheat exports decreased in the corresponding crop year. On the contrary, for Kazakhstan the policy dummy indicates an increase in wheat exports in 2007/08. The latter might be explained by the fact that Kazakhstan introduced its export restrictions at the end of the crop year in April, whereas Ukraine always introduced its export restrictions relatively early in the crop year and over longer time periods. It appears that the Ukrainian export restriction were more restrictive than the Kazakh interventions. For Russia, there was an increase in wheat exports in 2007/08, which contrasts to a decline in wheat exports in 2010/11. This suggests that in 2010/11, Russia probably intervened too early in the market.

# 4. Agricultural Stress due to Climatic Variations and Poverty

4.1. **If the policy response (e.g. export controls) to reduced grain production due to droughts was effective, little or no impact on welfare and poverty would be observed during periods in which agricultural stress increases and grain yield decreases due to adverse climatic conditions.** However, the empirical work presented in the previous section provides robust evidence that export restrictions, -- which is often used as a tool to mitigate the effects of drought induced production shortfalls -- often have limited price-dampening effects and cause significant by-product distortions, which may amplify the welfare impacts of droughts, particularly on the most vulnerable populations.

4.2. **Individuals in both rural and urban areas are exposed to the environmental and economic effects of climate variability associated with droughts and the respective loss of income and increased food prices**. Droughts impact crop production, reduce income for those who depend on agriculture, increase food insecurity, and may lead to food price inflation, affecting rural and urban populations. Vulnerable and poor people are usually hit hardest by the unmitigated effects of climate variability.

4.3. **Poverty rates are declining both on national and regional levels in the RUK region, but variations in agricultural activity associated with climatic-induced agricultural stress affect the dynamics of poverty, particularly in regions that are large grain producer.** For instance, there is a strong association between changes in rural[22] poverty rates and the changes in the ASI in northern oblasts of Kazakhstan (Kustanayskaya, Severo-kazachstanskaya and Akmolinskaya), which are responsible for over two thirds of all grain production in the country and subject to significant impacts El-Niño /El Niña climatic variations (see Figure 4.1).

4.4. **This section explores the relationship between poverty rates and agricultural stress caused by droughts and finds evidence that El-Niño and El Niña-induced climate variations impact poverty rates in the RUK region.** A dynamic panel data model that follows Tebaldi and Beaudin's (2016) methodology is used to examine the impact of the agricultural stress index on rural and urban poverty.[23] The empirical work is conducted separately for Kazakhstan, Russia, and Ukraine using 2003 – 2013 Oblast level data from the Household Budget Survey (BHS) and ASI data from the FAO.

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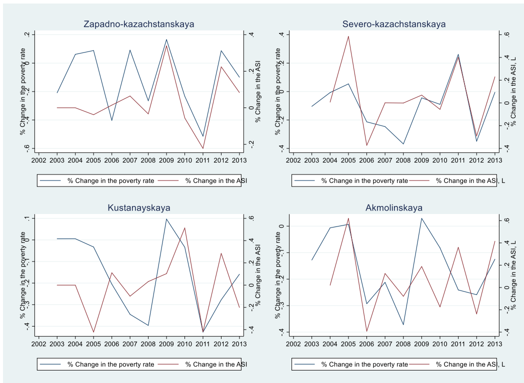
[22] The same pattern is observed for changes in urban poverty and changes in the ASI in the RUK region.

[23] Consider the equation: $\Delta y_{i,t} = \delta \Delta y_{i,t-1} + \beta_1 ASI_t + \beta_2 ASI_{t-1} + \alpha_i + a_t + \varepsilon_{i,t}$,
where $\Delta y_{i,t}$ represents the poverty rate of region (oblast) $i$ in year $t$, $ASI_{i,t}$ represents the Agricultural Stress Index, $\alpha_i$ denotes region fixed effects, $a_t$ is a time trend, and $\varepsilon$ is an error term. The model also includes the lagged ASI to allow time for poverty rates to respond to climatic events and the lag of the poverty rate to account for initial condition or economic dynamics. The presence of the lagged poverty rate on the right-side of the model creates a potential bias (*Nickell bias*) due to the correlation between the error term and the lagged dependent variable. To address this issue, all models are estimated using the approach suggested by Anderson and Hsiao (1981). As a robustness check, models using the rate of change in poverty rates against the rate of change of the ASI were also estimated. The results of these models are qualitatively and quantitatively similar.

*Figure 4.1: The agricultural stress index (ASI) is correlated with rural poverty, Kazakhstan, 2003-2013*




*Source: World Bank staff.*

4.5. **The empirical work suggests that El-Niño and La Niña-induced agricultural stress increases poverty in both rural and urban areas and the effects on poverty goes beyond the regions that are large grain producers.** The effect of the agricultural stress on poverty is more pronounced in rural than in urban areas. The impact on poverty rates is larger in Kazakhstan than in Russia and Ukraine.

## 4.1. KAZAKHSTAN

4.6. **In Kazakhstan, the effect of climate-induced agricultural stress on rural poverty rates is dynamically distributed over time, thus rural poverty rates respond either with a lag or gradually to changes in the ASI** (Table 4.1 ). This suggests that the effect of unfavorable weather conditions has long-lasting impacts on the livelihoods of people who live in rural areas of Kazakhstan. This could be linked to the significant reduction in agricultural yield (grain production) during severe droughts, which reduces income and jobs in rural areas and cause food price inflation; all factors linked to poverty.

4.7. **Unfavorable weather conditions impact urban poverty, but the effect on poverty is significantly smaller than that observed in rural areas of Kazakhstan** (Table 4.1). The income of households who live in urban areas are usually delinked from agricultural activities/yield, thus this finding suggests that any effect from the ASI on urban poverty might be through food price inflation.

*Table 4.1: Agricultural stress is linked to rural and urban poverty in Kazakhstan*

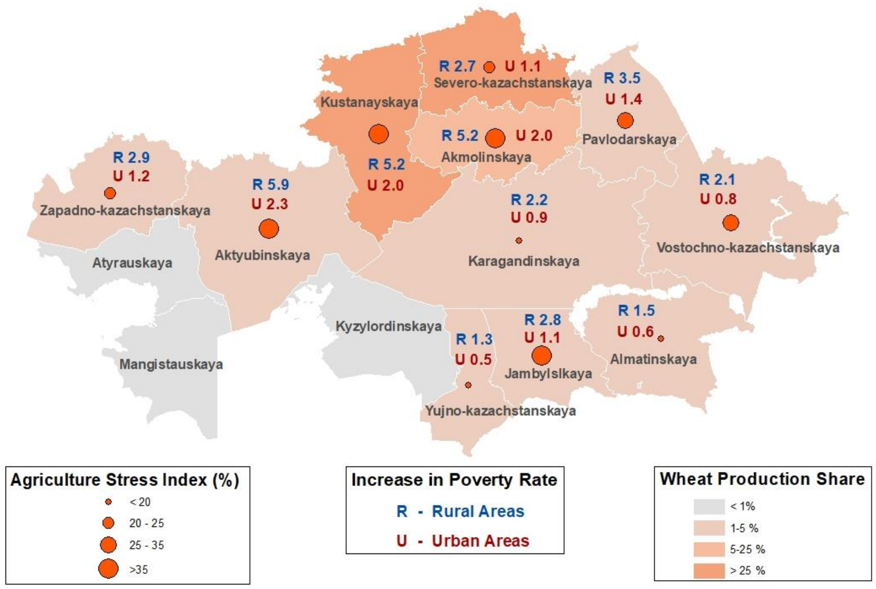
| Variables | Rural poverty rate | | | Urban poverty rate | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Lag of poverty rate | 0.917*** | 0.339*** | 0.269*** | 0.852*** | 0.562*** | 0.451*** |
| | [0.0128] | [0.0803] | [0.0787] | [0.0194] | [0.0661] | [0.0614] |
| Agricultural Stress Index – ASI | | | | | | |
| t | 0.0565* | 0.0354 | 0.0293 | 0.0460* | 0.0426* | 0.0361** |
| | [0.0305] | [0.0403] | [0.0327] | [0.0253] | [0.0198] | [0.0133] |
| t -1 | 0.0813 | 0.109*** | 0.123*** | 0.0440 | 0.0649 | 0.0728* |
| | [0.0517] | [0.0297] | [0.0286] | [0.0484] | [0.0369] | [0.0332] |
| Time trend | | -4.267*** | -4.025*** | | -1.747*** | -1.237*** |
| | | [0.5395] | [0.5890] | | [0.3108] | [0.3577] |
| % Tertiary education | | | -126.6*** | | | -28.72* |
| | | | [31.8988] | | | [13.6404] |
| % Unemployed | | | 27.97 | | | 192.9*** |
| | | | [70.9238] | | | [44.7883] |
| Constant | -4.210** | 80.13*** | 88.71*** | -1.865 | 29.99*** | 23.75*** |
| | [1.3610] | [11.0469] | [11.1188] | [1.2826] | [6.0246] | [5.8774] |
| Observations | 121 | 121 | 121 | 121 | 121 | 121 |
| R-Squared | | | | | | |
| Overall | 0.847 | 0.876 | 0.875 | 0.856 | 0.866 | 0.862 |
| Within | 0.842 | 0.889 | 0.901 | 0.841 | 0.863 | 0.885 |
| Between | 0.969 | 0.917 | 0.298 | 0.989 | 0.991 | 0.741 |

*Source: World Bank Staff.*
*Note: Robust standard errors in brackets, * p < 0.10, ** p < 0.05, *** p < 0.01. Coefficient estimates are from fixed effects models using 2003 – 2013 Oblast level data from the Household Budget Survey (BHS) and ASI data from the FAO.*

4.8. **The estimated effects of El-Niño -induced agricultural stress on poverty is much stronger in northern areas of Kazakhstan (Kustanayskaya, Severo-kazachstanskaya and Akmolinskaya), which are large grain producers, as well as in neighboring regions of Aktyubinskaya and Zapadno-kazachstanskaya** (Figure 4.2). The estimates indicate that average impact of the last four severe droughts lead to an increase in poverty rates of about 5 percent points in rural areas and approximately 2 percentage points in urban areas of the northern regions of Kazakhstan.[24] Other regions of the country were also impacted by the effects of increased agricultural stress due to climatic variability, but the increases in poverty rates were much smaller, particularly in urban areas.

[24] These estimates are obtained using the average ASI during the droughts of 1998, 2008, 2010, and 2012 and estimated coefficients from column 2 of Table 4.1.

*Figure 4.2: Estimated impact of the ASI on rural and urban poverty rates is stronger in Oblasts in northern Kazakhstan*




*Source: World Bank staff.*
*Note: These estimates were obtained using the average ASI during the droughts of 1998, 2008, 2010 and 2012 and coefficient estimates reported in Table 4.1).*

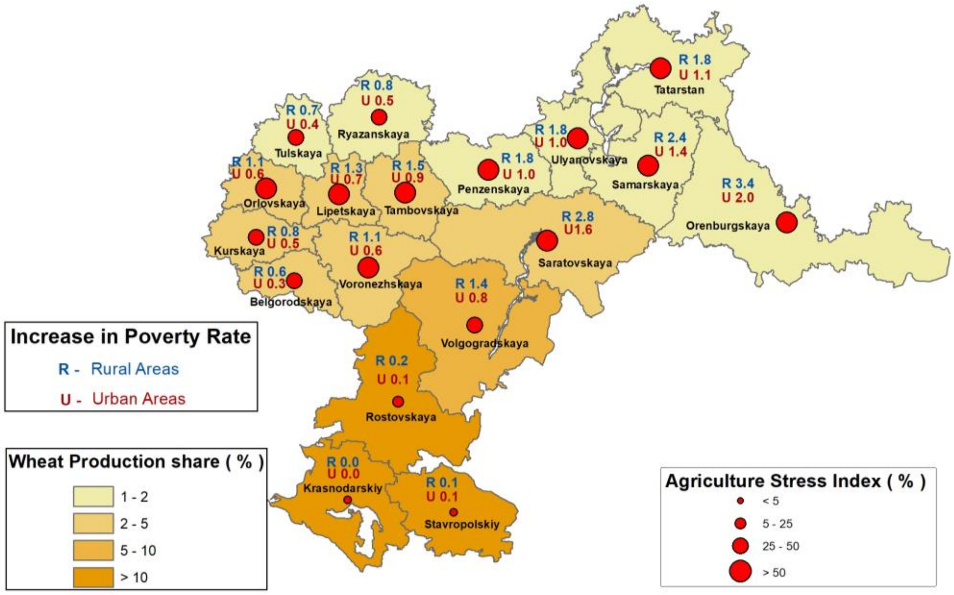
## 4.2. RUSSIA

4.9. **In Russia, poverty rates also respond to changes in the ASI either with a lag or gradually and the impact of unfavorable weather conditions on poverty is much larger in rural than in urban areas**.[25] These findings are similar to those of Kazakhstan and indicate that severe droughts reduce income in rural areas and is associated with food price inflation, which increases poverty rates in both rural and urban areas in Russia.

4.10. **The estimated effect of El-Niño -induced agricultural stress on poverty is small or not significant in southern regions (Krasnodarskiy, Stavropolskiy, Rostovskaya, and Volgogradskaya) of Russia, which are large grain producers.** However, regions that are more sensitive to droughts are estimated to have experienced increases in poverty rates during the 2010 severe drought event **(**Figure 4.3**).** For instance, the estimates indicate that climatic conditions similar to that of 2010 would be associated with an increase in poverty rates of approximately 3 percent in rural areas and 2 percent in urban areas of Saratovskaya and Orenburgskaya (the most affected regions), compared to less than one percent across the western regions.[26]

[25] To save space, the regression results for Russia are not reported here. The model specification is identical to that of Kazakhstan reported in Table 4.1, but the coefficients on the ASI variables are smaller.
[26] These estimates are obtained using the average ASI during the droughts of 1998 and 2010 and regression estimates (not reported).

*Figure 4.3: Agricultural stress is associated with increased rural and urban poverty rates in Russia*




*Source: World Bank staff.*
*Note: These estimates were obtained using the average ASI during the 2010 drought and regression coefficient estimates (not reported).*

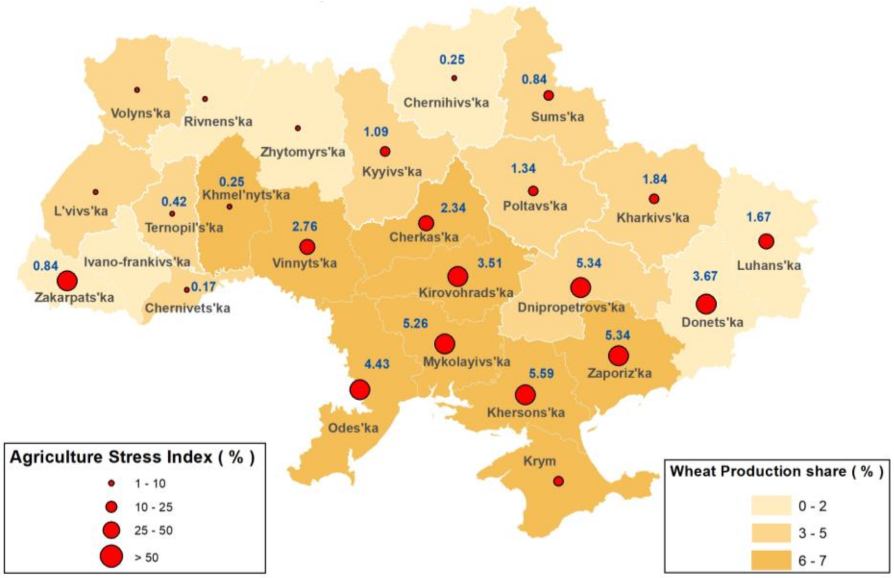
## 4.3. UKRAINE

4.11. **In Ukraine, agricultural stress caused by drought events impact rural poverty rates, but has no effects on poverty in urban areas.**[27] The strong impact of the ASI on poverty in rural areas is likely associated with low rates of crop area that were covered against climatic risks during the 2007 and 2012 droughts, which exposes producers to significant economic losses due to low yield, reduces job opportunities and income for workers in rural areas and, thus, affect the livelihoods of people living in rural areas of Ukraine.

4.12. **Poverty in rural areas of southern-center oblasts of Ukraine is much more sensitive to the effects of El-Niño -induced agricultural stress than in northern regions.** The estimates indicate that average climatic conditions similar to that of 2007 and 2012 would be associated with an increase in poverty rates of approximately 5 percent in rural areas of Dnipropetrovs'ka, Khersons'ka, Zaporiz'ka, and Mykolayivs'ka, compared to no increase in rural poverty in the northwestern regions.[28]

[27] To save space, the regression results for Russia are not reported here. The model specification is identical to that of Kazakhstan reported in Table 4.1, but the coefficients on the ASI variables are smaller.
[28] These estimates are obtained using the average ASI during the droughts of 2007 and 2012 and regression estimates (not reported).

*Figure 4.4: Agricultural stress is associated with increased rural poverty rates in Ukraine*




*Source: World Bank staff.*
*Note: These estimates were obtained using the average ASI during the droughts of 2007 and 2012 and regression coefficient estimates (not reported).*

# 5. Conclusion

5.1. **Droughts and climate change are significant threats to grain production in the RUK region and for global food security.** Repeatedly severe droughts significantly affect wheat production in RUK and climate change may cause these events to occur more often and in more severe forms in the future. In addition, in the KUR region agricultural stress due to El Niño and La Niña phenomena is associated with increased poverty in both rural and urban areas and the effects on poverty goes beyond the regions that are large grain producers. The effect of the agricultural stress on poverty is more pronounced in rural than in urban areas. The impact on poverty rates is larger in Kazakhstan than in Russia and Ukraine.

5.2. **In the RUK region, export controls implemented as a response to increasing grain prices due to drought-induced production shortfalls had limited price-dampening effects, but caused significant by-product distortions including market uncertainty and price volatility.** In addition, export controls induce welfare losses for producers and traders by not profiting from the high global market prices. They can increase uncertainty and impact famers' production plans in the future. Ad hoc policy changes significantly increase market risk for domestic producers, processors and traders, which ultimately decreases domestic production and exports to the world market.

5.3. **Export restrictions were not effective to protect consumers and vulnerable individuals during climate-induced periods of reduced grain production.** Besides the well-known static welfare effects of export restrictions and their negative consequences for importing countries, this report shows that policy and market risks increase and affect the allocation on the domestic market. Export controls also failed to mitigate the impacts of droughts on poverty, particularly in rural areas of the RUK region and affected trade partners, which experienced higher grain price volatility during the periods of droughts and wheat export restrictions in the RUK region.

5.4. **The results from the analysis support the following recommendations for grain producers:**

i. **The RUK region's response to climatic events including droughts must change from reactive to preventive and predictive.** Predicting the life cycle and strength of the El Niño and La Niña events is critical to develop effective strategies to cope with and mitigate theirs effects on grain production, on agriculture in general, and on food security. To tap into this potential, significant investments and concerted efforts among governments, agricultural input and service providers, advisory service networks, and farmers would be required to develop and implement a national strategy focused on resilience and preparedness to face the odds of increased climatic volatility and drought events.

ii. **Emerging digital technologies offer unique predictive and diagnostic capabilities that can be coupled with climate-smart agriculture to improve resilience to El Niño and La Niña events.** Digital technologies and climate-smart agriculture can enable and potentialize the benefits of tools and farming practices developed to mitigate the impacts of climatic variability (e.g. droughts) including water-saving technologies, heat and drought-resistant seeds, as well as improve monitoring and response to weather variations and soil degradation. A public-private interface could be utilized to develop or enhance existing agricultural information systems and create a market to develop and deploy digital agricultural technologies that could improve resilience to climate variability, reduce transaction costs, and increase productivity.

iii. **Consider a broad range of interventions to manage risk.** A developed insurance market is important to assist producers to cope with drought risks, but the current model where RUK governments have purred the development of insurance markets through significant subsidies is inefficient and not sustainable. Alternative options to mitigate risks in agriculture must be considered including (a) functioning futures markets, (c) diversification of production, (c) training of farmers, traders, consultants and (d) provision of quality extension services.

5.5. **The findings of the report also suggest that import-depending countries need to re-examine their trade diversification strategy.** Import-depending countries that diversify imports (e.g. Georgia) face lower domestic price increases during periods of grain production crises in the RUK region. Import diversification does not only increase the number of alternative suppliers, but also strengthens competition between exporters. For countries in which trade diversification comes at high costs, governments may develop strategies on how to increase domestic production and/or increase domestic grain stocks.

5.6. **Overall, both RUK and regional trade partners would have to leverage private and public investments in infrastructure to reduce transportation costs, increase trade, and strengthen market integration.** Substantial investment deficits in roads, rails, harbors, and storage capacity strongly affect the integration of domestic markets within and across international markets. Market integration fosters competition and leads to more fair, transparent and predictable prices for producers, trader, processors, and consumers.

5.7. **In conclusion, this report makes a case that severe droughts and climate variability are a threat to grain production in RUK and, thus, to regional and global food security because the region accounts for one third of global wheat exports.** The region's response to the potentially damaging impacts of droughts and climate variability must include predictive and preventive interventions instead of relying on reactive distortionary policies including export controls.

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