On an Unknown Path in an Era of Change: Economic insights from Kyrgyzstan

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"The Only Constant in Life Is Change."

Heraclitus

Abstract

This study rigorously examines three key aspects of agricultural and rural development in the complex context of post-communist landscapes facing myriad shocks. This multifaceted analysis unfolds in three published papers: "Dynamics of food demand during political instability: Evidence from Kyrgyzstan," "Policy analysis with Melitz-type gravity model: Evidence from Kyrgyzstan," and "Heterogeneous effects of weather extremes on different dimensions of poverty in Kyrgyzstan."

The first paper explores the impact of two revolutions—the Tulip Revolution in 2005 and the Melon Revolution in 2010—on household food demand in Kyrgyzstan. The study reveals fluctuating household food demand based on pre-conflict expectations employing a complete demand system and seemingly unrelated regressions with nationally representative panel data. Despite varying total food expenditure during the revolutions, expenditure shares for staples and luxuries follow divergent trajectories, indicating shifting food preferences.

The second paper navigates the intricate terrain of agricultural credit subsidies and applied tariffs on international trade in Kyrgyzstan. Employing a modified Melitz-type structural gravity model and leveraging the Poisson pseudo maximum likelihood estimator, the research elegantly illustrates the contrasting effects of credit subsidies, amplifying international trade flows, and applied tariffs, significantly dampening Kyrgyzstan's exports.

The third paper employs nationally representative quarterly household panel data and climate information to assess the impact of weather extremes on Kyrgyzstan's household poverty from 2013 to 2020. The study employs a linear quantile mixed model to link poverty dimensions with four prominent weather extremes: cold winters, hot summers, excessive rains, and dry spells to examine multiple dimensions of poverty, including nutrition, education, health, and living standards. The findings underscore the pervasive harm inflicted on household wealth by all weather extremes, with cold winters emerging as the most detrimental, disproportionately impacting poor households.

In response to the first paper's findings, effective post-communist governance requires swift conflict anticipation and communication, emphasizing the protection of critical structures, including grocery stores, based on past lessons. The second paper advocates redirecting financial resources to public goods such as infrastructure and farm extension programs, prioritizing them over conventional agricultural credit subsidies. The Kyrgyz government is urged to negotiate tariff reductions strategically with key partners. Guided by insights from the 2014 critical winter in northern Kyrgyzstan, the third paper emphasizes targeting vulnerable regions and prioritizing education and health infrastructure for disadvantaged households amid escalating climate change impacts.

Overall, this study reveals diverse household responses to post-communist and environmental shocks, highlighting the importance of context-specific nuances. The nuanced understanding deepens our insight into household dynamics and has substantial implications for guiding future data-driven research and analytics. The critical insight emphasizes the necessity of a nuanced and contextualized approach in studying societal responses to transitions and environmental challenges, urging more in-depth and focused research in future endeavors.

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To my family—Akyl, mom, sister, and brother—you are my unwavering support, my constant pillar, and an endless source of motivation. Your overwhelming love and support mean the world to me. Akyl, you are truly an amazing gift from God!

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List of Abbreviations

AIDS **A**lmost **I**deal **D**emand **S**ystem
CES **C**onstant **E**lasticity of **S**ubstitution
CIS **C**ommonwealth of **I**ndependent **S**tates
CMEA **C**ouncil for **M**utual **E**conomic **A**ssistance
FAO **F**ood and **A**griculture **O**rganization
FSU **F**ormer **S**oviet **U**nion
GDP **G**ross **D**omestic **P**roduct
GVA **G**ross **V**alue **A**dded
ITS **I**ndirect **T**ranslog **S**ystem
KGS **K**yrgyzstani **S**om
KIHS **K**yrgyz **I**ntegrated **H**ousehold **S**urvey
LES **L**inear **E**xpenditure **S**ystem
LQMM **L**inear **Q**uantile **M**ixed **M**odel
MFN **M**ost **F**avored **N**ations
MPI **M**ultidimensional **P**overty **I**ndex
MPI_{KGZ} **M**ultidimensional **P**overty **I**ndex for **K**yrgyzstan
NSC **N**ational **S**tatistical **C**omittee
NTM **N**on **T**ariff **M**easure
OLS **O**rdinary **L**east **S**quares
PPML **P**oisson **P**seudo **M**aximum **L**ikelihood
QUAIDS **Q**uadratic **A**lmost **I**deal **D**emand **S**ystem
RTA **R**egional **T**rade **A**greements
SPI **S**tandardized **P**recipitation **I**ndex
STI **S**tandardized **T**emperature **I**ndex
SUR **S**eemingly **U**nrelated **R**egressions
UNCTAD **U**nited **N**ations **C**onference on **T**rade and **D**evelopment
WDI **W**orld **D**evelopment **I**ndicators

To my son Akyl

Chapter 1

General Introduction

1.1 Problem statement

The late 1980s collapse of the Soviet system led to a severe economic downturn in the Soviet bloc (Shleifer and Vishny, 1991; Easterly and Fischer, 1995; Reynolds, 2000). The transition to a market economy for rapid growth faced challenges due to misaligned strategies, political decisions, and external factors like environmental change, casting doubts on expectations (Reynolds, 2000; Gregory and Stuart, 2002; Rozelle and Swinnen, 2004). This study delves into the impact of political instabilities, agricultural policies, and weather extremes on various economic aspects.

Policymakers in transitioning nations formulated macroeconomic stabilization strategies, microeconomic restructuring, and institutional/political reforms. The speed and specifics varied, prompting a debate on rapid versus gradual reform (Svejnar, 2002). Despite a preference for swift changes, Central and Eastern European countries opted for more rapid reform than former Soviet Union (FSU) nations, resulting in notable policy divergences (Campos and Coricelli, 2002). Success relied on efficient tax collection, privatization, corruption reduction, and minimizing rent-seeking, with few effectively executing these crucial policies (Kaufmann and Siegelbaum, 1997; Roland, 2001).

Central Europe and the Baltic region countries pursued swift economic reforms focusing on macro stabilization, price liberalization, and dismantling communist institutions (Svejnar, 2002). Their strategy involved fiscal and monetary restraint, wage controls, and a fixed exchange rate (Aslund, 1999). Embracing trade openness for efficient resource allocation, subsidy cuts for state-owned enterprise restructuring, and removing barriers to new firms led to significant labor reallocation and improved economic performance. However, these successful reforms faced challenges and were less effective in Russia, other Commonwealth of Independent States (CIS) nations, and the Balkans (Estrin et al., 2009; Gregory and Stuart, 1998).

Countries opting for gradual reform aimed at establishing laws, regulations, and institutions for a market-oriented economy, replacing authoritarianism with a capable state apparatus. Despite variations in privatization, banking, and legal system development, this approach faced critical vulnerabilities during the initial transition, resulting in substantial output decline, mass privatization issues, hyperinflation, current account deficits, and high external debt. Struggles in tax collection led to budget deficits, limiting public expenditures, while high unemployment and reduced real wages exacerbated income inequality (Ham, Svejnar, and Terrell, 1998; Garner and Terrell, 2007; Pomfret, 2019).

Post-communist outcomes exhibit three trajectories (Møller and Skaaning, 2009). Radical reformers in Central Europe established dynamic market economies (Aslund, 2002). Gradual reformers in Southeastern Europe and most former Soviet republics

faced challenges in achieving democracy (Havrylyshyn, Meng, and Tupy, 2016). Belarus, Turkmenistan, and Uzbekistan maintained old dictatorships (Szanton, 2004; Pomfret, 2019). These outcomes underscore diverse challenges in today's transition countries, encompassing political, economic, and external factors.

Political factors turned into riots and revolutions in Georgia, Ukraine, and Kyrgyzstan (Radnitz, 2010; Afzal, 2005). The absence of succession in regimes, a lack of gradual and orderly change in ruling elites, imbalances in power structures, ineffective opposition within a multiparty system, and the absence of a substantial middle class during the transition were key contributors to this instability. Although analytically distinct, these factors are interrelated, with instability in one area potentially affecting others (Apter, 1973). Achieving stability depends on political institutions responding effectively to citizens' needs (Tusalem, 2015; Collier, 2017; Ansell, Sørensen, and Torfing, 2023).

While the causes of political crises have been extensively studied, a notable gap exists in understanding their impact on essential needs like food (Kemmerling, Schetter, and Wirkus, 2022; Mehrabi et al., 2022; Béné, 1998). Despite the rise in wars, revolutions, and aggressive protests, the existing literature on conflicts and their influence on food demand is scarce (Brück and d'Errico, 2019; Martin-Shields and Stojetz, 2019). Insight into how people behave and their food demand is affected during such situations is virtually non-existent. Analyzing food demand during political instability can offer invaluable insights into household behavior, providing crucial information for governments to gauge the adverse consequences of policies that may escalate public dissatisfaction.

Trade, a key economic factor, was crucial in shaping governing institutions and future development strategies in FSU countries (Mazhikeyev and Edwards, 2021; Lankina, Libman, and Obydenkova, 2016). The dissolution of the Council for Mutual Economic Assistance (CMEA), governing the Soviet bloc's trading area, marked a significant transformation in these nations (Korbonski, 1990; Kramer, 2005). This transformation led to a swift embrace of international trade, promoting more efficient resource allocation aligned with the global market (Sachs et al., 1995; FAO, 2003). Countries also promptly reduced direct subsidies to trusts and state-owned enterprises, prompting their restructuring or dissolution (King, 2003; Black, Kraakman, and Tarassova, 2000).

The unique role of the agriculture sector in ensuring food security, political stability, and economic growth in the Global South faces challenges due to intense global competition affecting local farmers in open economies (Nybom et al., 2021). State support becomes a lifeline in such situations (Li et al., 2022; Kumbhakar, Li, and Lien, 2023; Springmann and Freund, 2022; Fu et al., 2023). Whether through subsidies to bolster domestic production or strategic imports to ensure food security, government intervention plays a pivotal role (Boratyńska and Huseynov, 2017). It is a delicate balancing act, navigating the challenges while safeguarding the interests of farmers and the nation's food supply (FAO, 2022).

Open economies supporting agriculture must adhere to World Trade Organization's (WTO) rules to avoid trade consequences (Ching and Khor, 2013; Orden, Kaukab, and Diaz-Bonilla, 2002). The absence of support exposes them to volatile world prices, jeopardizing their food security (Achille, Denis, and Gervasio, 2020; Clapp, 2017; Kalkuhl, Braun, and Torero, 2016). Major economies' substantial agricultural subsidies complicate the assessment of policy impact on agricultural trade (OECD, 2022; Murray, Mark, and Kimberly, 2020). In contrast, smaller countries

with limited support can scrutinize the effects of specific state support or agricultural policies on trade, a crucial analysis for food security. This is especially true for the small and open economies of the Global South and newly open FSU countries heavily reliant on agriculture, where diminished state support has made food security a central and urgent concern.

Political goals drive countries to enhance agricultural policies for export growth, yet their effectiveness is debated. The key is to examine the evidence – do policies promote measurable export growth? Trade agreements, subsidies, and market access shape this potential. Assessing policy outcomes against export targets reveals successes or shortcomings. Precise analysis – measures, export trends – clarifies the link between policies and perceived export growth. The lack of clear evidence raises doubts about policy efficacy in achieving objectives.

Challenges in FSU countries originated from internal structural changes and external factors like climate change, significantly affecting transitioning nations (Smith et al., 2001; ADB, 2017). The vulnerability of newly established independent countries to climate change is heightened due to their heavy dependence on natural resources (Eriksen et al., 2021; WB, 2021b). Social and economic inequalities are exacerbated, particularly for unprepared and marginalized rural communities (Rao et al., 2023; Tenzing and Conway, 2022). However, assessing the impact of climate change on household welfare in FSU countries remains elusive, influenced by factors such as the intensity of climate change, geographical conditions of the regions, and households' adaptive capacity.

Research suggests a more pronounced negative impact of climate change on income in the Global South compared to the Global North (Azzarri and Signorelli, 2020; Tol, 2009). Additionally, evidence indicates that climate change disproportionately affects impoverished individuals, with a slower recovery observed among disadvantaged populations, especially in disadvantaged regions (Hallegatte et al., 2020; Barbier and Hochard, 2018; Hallegatte and Rozenberg, 2017). However, there is a limited understanding of how climate change influences various dimensions of welfare and poverty, as well as the spatial variations of these impacts, particularly in FSU countries (Adenle et al., 2017).

Beyond income and consumption, poverty includes deficits in well-being, positive emotions, relationships, social freedoms, and opportunities for personal development (Adger et al., 2022). Effective poverty interventions require consideration of these dimensions and tailored strategies (Dika, Tolossa, and Eyana, 1998). Quantifying the impact of weather-related shocks on poverty demands a disaggregated perspective to address socioeconomic heterogeneity within countries and regions (Nguyen et al., 2020), particularly crucial for nations disproportionately affected by changing weather patterns.

Understanding the impact of climate change on multidimensional poverty in vulnerable households requires precise quantification of poverty dimensions, factoring in country-specific nuances. Subnational analysis, dependent on high-cost georeferenced household panel data, becomes crucial for overlaying meteorological information and controlling for individual and household characteristics. While costly, this approach is essential for developing targeted, place-based adaptation strategies to mitigate the adverse effects of climate change on household welfare.

1.2 Research objectives

The thesis aims to investigate three dimensions of agricultural and rural development in a post-communist environment facing various shocks. It specifically addresses the impact of political instabilities on household food demand, explores how specific agricultural policies influence agricultural trade, and examines the repercussions of weather extremes on various dimensions of poverty. The research questions for each chapter are:

1. What is the impact of political instability on household food demand?
2. How do specific agricultural and trade policies influence agricultural trade?
3. What is the impact of weather extremes on various dimensions of poverty?

Our research focuses on Kyrgyzstan, a pivotal representative of our objectives. This CIS member serves as an insightful case study marked by profound political instability leading to two revolutions. Noteworthy for its small and open economy with liberal trade policies, Kyrgyzstan, as a resource-deficient, middle-income nation exposed to high weather shock risks, has grappled with formidable challenges over three decades. Our aim is to dissect the nuanced dynamics within this context, unraveling the impact of political instabilities, agricultural policies, and weather extremes on rural and agricultural development. Through a focused analysis of Kyrgyzstan, we seek to contribute targeted insights to the broader discourse on sustainable development in comparable environments.

1.3 Study area

Following independence from the Soviet Union in 1991, Kyrgyzstan (Figure 1.1) swiftly implemented a microeconomic strategy supported by the World Bank and International Monetary Fund (IMF). This strategy involved a shift from central planning, price liberalization, the introduction of a national currency in 1993, privatization of land and state-owned enterprises, individualization of agriculture, policy liberalization, and accession to the World Trade Organization (WTO) in 1998 (Shambetova et al., 2023). Despite an initial post-independence recession, the economy grew 5.7% in 1996-1997 (UNECE, 2010). However, growth slowed in 1998 due to the Russian crisis, domestic banking failures, and weak agriculture (WB, 2001).

A decade later, rapid reforms led to increased inequality and widespread poverty, primarily due to the failure to establish a conducive market environment (ILO, 2008; IMF, 2000). Despite formal efforts to instill the rule of law, unfriendly market practices and corruption persisted (ICGWCW, 2008). Licensing requirements escalated business costs, and a fragile banking system eroded trust (ADB, 2013; UNDP, 2023).

The Kyrgyz government faced a dilemma, balancing adverse social effects and controlling hyperinflation (Abazov, 1998). In the early 1990s, the country experienced a significant drop in transfers from the Soviet Union and lacked domestic funding (Howell, 1998; Namazie, 2002). Large budget deficits led to a 90% drop in government spending from 1991 to 2000 (Pomfret, 2019). Aid, initially utilized to mitigate the consumption shock of transition, contributed to a high debt-to-GDP ratio (Mogilevsky and Omorova, 2011).

After the 1998-99 banking crisis, macroeconomic imbalances were addressed (IMF, 2005). The government reduced the deficit and initiated energy supply reforms. The

FIGURE 1.1: Administrative Map of Kyrgyz Republic

Source: https://www.nationsonline.org/oneworld/map/kyrgyzstan-administrative-map.htm

crisis led to currency depreciation, import reduction, fiscal adjustments, decreased borrowing, and a subsidy cut (ADB, 2012). Subsequently, with a more sustainable macroeconomic policy, reforms were resumed, particularly in deregulation and reducing bureaucratic red tape (Pomfret, 2019).

In the first decade of the transition, economic crises dominated the landscape. However, political and external crises, including the impact of climate change, played a more prominent role in shaping economic development in the following two decades (Agadjanian and Gorina, 2018; GFDRR, 2011). Kyrgyzstan stands out as the most liberal nation in Central Asia, marked by a high degree of societal openness (Pomfret, 2019). This openness has led to greater scrutiny and analysis of the country, but it has also come at a cost, including uprisings and loss of lives among Kyrgyz citizens (Agadjanian, 2020).

Post-2000, regional frustration brewed in a nation divided by its geography (OECD, 2002; Smith and Richardson, 2017). The economically disadvantaged South felt marginalized, leading to President Akayev's resignation in 2005, marking a peaceful transition (Olcott, 2005). Economic challenges triggered emigration, intensified by the 2009 Russian oil price drop, causing return migration and a food crisis. President Bakiyev's violent overthrow in 2010, marked by 68 protester deaths, led to the most violent ethnic conflict in Central Asia (Nichol, 2010; Esenaliev and Steiner, 2012). Interim President Otunbaeva dissolved parliament, addressed ethnic conflict, and committed to new elections, boosting parliamentary authority (OSCE, 2010; Engvall, 2022).

The Kyrgyz Republic today enjoys greater political freedom in Central Asia but

contends with persistent corruption and clientelism (Pomfret, 2019). Despite fundamental agricultural reforms (1992-2003) and improved business conditions, 21st-century economic performance is yet to match the optimism following rapid '90s reforms (Mogilevskii et al., 2017; Curtiss et al., 2006). Recent crises, including the COVID-19 pandemic and the Russia-Ukraine war, significantly impacted citizens' economic well-being due to tied connections with neighbors (Djanibekov and Herzfeld, 2021; CRS, 2023). While facing challenges in ties with larger neighbors, such as joining the Eurasian Economic Union, projects like China's infrastructure development offer growth potential in overlooked regions (Shakhanova and Garlick, 2020; Melnikovová, 2020).

1.4 Outline of the thesis

This study unfolds with a general introduction, followed by three chapters dedicated to individual published research papers, and concludes with a synthesis of findings.

Chapter 2 analyzes the impact of political instabilities on household food demand, emphasizing heightened concerns for food security in the Global South based on conflict types. The study elucidates unfolding dynamics within transitional periods, where external conflicts act as disruptive shocks, worsening food insecurity and reshaping demand patterns (Delgado, Murugani, and Tschunkert, 2021; Canfield, Anderson, and McMichael, 2021). The anticipation of conflict-induced uncertainty influences expenditures and preferences, particularly toward staple food consumption (Rockmore, 2020). However, dynamics in the absence of anticipated conflict remain unclear.

The first paper advocates for a comprehensive demand system analysis, utilizing the Quadratic Almost Ideal Demand System (QUAIDS) to thoroughly understand food demand across diverse groups. It further analyzes the impact of anticipated and unexpected revolutions on food demand using Seemingly Unrelated Regressions (SUR) with nationally representative household data. This methodological approach ensures a thorough exploration of the multifaceted aspects of household food demand, providing insights into the intricacies of transitional challenges.

Chapter 3 explores the impact of agricultural and trade policies on the international trade of food products in small, open, and middle-income countries like Kyrgyzstan. Weak agricultural support during the transition allows for a feasible impact evaluation of subsidies, a challenge in larger economies with comprehensive agricultural subsidies. Although expectations for a shift from subsistence to commercial farming after transition reforms, unresolved market failures and weak governance impede progress. Prohibitively high transaction costs in agricultural marketing, attributed to the "curse of smallness," hinder sector growth, leading to contraction, import dependence, and threatening the country's food security.

The second paper employs the gravity model, categorizing credit subsidies as non-trade and applied tariffs as trade policy to analyze multiple instruments at the macro level. Extending Demidova and Rodríguez-Clare, 2013 small and open economy model, it identifies the general equilibrium effects of bilateral trade and unilateral non-trade policies. Additionally, the paper conducts analyses using a Melitz-type structural gravity model with cross-country annual panel data, utilizing the Poisson Pseudo Maximum Likelihood (PPML) estimator for its advantages in structural gravity models.

Chapter 4 explores the impact of weather extremes on household welfare during the transition, highlighting the vulnerability of households heavily reliant on

natural resources and facing challenges posed by low income. People in transition experience marginalization not only in terms of income and consumption but also in deficits of well-being, positive emotions, social freedom, and opportunities for personal development (Adger et al., 2022). Additionally, impoverished individuals are more susceptible to weather shocks and recover more slowly than the affluent population segment. Spatially disaggregated analyses become especially critical for countries disproportionately affected by changing weather patterns.

The third paper assesses the influence of four significant weather extremes—cold winters, hot summers, excessive rains, and dry spells—on multidimensional poverty, measuring alterations in nutrition, education, health, and living standards. The study integrates nationally representative georeferenced panel data with climate data to evaluate the impact of weather extremes on household poverty in Kyrgyzstan from 2013 to 2020. The research establishes the relationship between poverty dimensions and the identified weather extremes by employing a Linear Quantile Mixed Model (LQMM).

The final chapter consolidates the primary findings, contextualizing them within a policy framework. It evaluates contributions to pertinent economic literature, delineates innovations and limitations, and concludes with recommendations for future research.

Chapter 2

Dynamics of food demand during political instability: Evidence from Kyrgyzstan

[1]

Abstract

This study assesses the impact of two revolutions—the Tulip Revolution in 2005 and the Melon Revolution in 2010—on household food demand in Kyrgyzstan. Different categories within food products witnessed distinct adjustments in consumer demand. Employing a complete demand system and seemingly unrelated regressions with nationally representative panel data, we find that household food demand fluctuates based on pre-conflict expectations. Despite declining total food expenditure during the first revolution and increasing in the second, the expenditure shares for staples and luxuries display heterogeneous trajectories. Food preferences shifted toward luxuries during the first revolution and staples during the second. Our findings underscore the necessity of a disaggregated perspective in understanding conflict-induced shocks on food demand.

Keywords: food demand, QUAIDS, revolution, Kyrgyzstan

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2.1 Introduction

Conflicts, encompassing wars and revolutions, lead to unpredictable situations, inflicting grave and enduring repercussions on human populations. A notable consequence is the exacerbation of food insecurity (Delgado, Murugani, and Tschunkert, 2021; Canfield, Anderson, and McMichael, 2021). Food insecurity is progressively concentrated in conflict-affected areas of developing nations, leading to a harmful cycle of violence and hunger (Brück and d'Errico, 2019; Martin-Shields and Stojetz, 2019). In 2020, an estimated 720 to 811 million people faced hunger, with over 99.1 million in 23 countries affected by conflict-driven food crises (Brück and d'Errico, 2019; Delgado, Murugani, and Tschunkert, 2021; FAO et al., 2021; FSIN and GNAFC, 2021; Martin-Shields and Stojetz, 2019; Canfield, Anderson, and McMichael, 2021).

Empirical studies on the impact of conflict on food security often adopt a reduced-form single equation model to measure total food expenses and aggregated consumption (A.Adong et al., 2021; Akresh, Verwimp, and Bundervoet, 2011; Dabalen and Paul, 2014; D'Souza and Jolliffe, 2013; Ihle and Rubin, 2013; Koren, 2018; George, Adelaja, and Weatherspoon, 2019; Serneels and Verpoorten, 2015; Verwimp and Muñoz-Mora, 2018). However, this approach tends to overlook the possible substitution between different types of food. While some studies delve into the nutritional dimensions of food insecurity (Akbulut-Yuksel, 2014; Akresh et al., 2012; Bundervoet, Verwimp, and Akresh, 2009; Gordon and Halileh, 2012; Kumar and Quisumbing, 2013; Minoiu and Shemyakina, 2014), a comprehensive theoretical framework for effectively assessing trade-offs among various food groups at the time of conflicts warrants further exploration.

Conflict-induced uncertainty alters household expenditures and preferences toward staple food consumption (Rockmore, 2020). Categorizing food as a staple or luxury necessitates analyzing subcategories (Hussein, Law, and Fraser, 2021; Roosen, Staudigel, and Rahbauer, 2022). A complete demand system analysis is the sole approach to examining food demand coherently across different groups (Hoang, 2018; Korir, Rizov, and Ruto, 2020; Law, Fraser, and Piracha, 2019). This method effectively segregates total demand changes into income-induced shifts and preference-related changes (Hoang, 2018; Korir, Rizov, and Ruto, 2020; Law, Fraser, and Piracha, 2019).

This study presents a unique contribution to the literature by employing a comprehensive demand system analysis to assess the impact of conflict on food demand. More specifically, the effect of two short violent conflicts in the Kyrgyz Republic on the expenditures and demand functions' slope of different food groups will be quantified in a systematically sound manner. The analysis uses quarterly household data from the Kyrgyz Integrated Household Survey (KIHS) spanning 2005 to 2019, covering around 5000 households per wave and 337 food items. The case of Kyrgyzstan is particularly compelling, given two revolutions that led to 300 deaths and the displacement of 400,000 individuals (Solvang and Neistat, 2010).

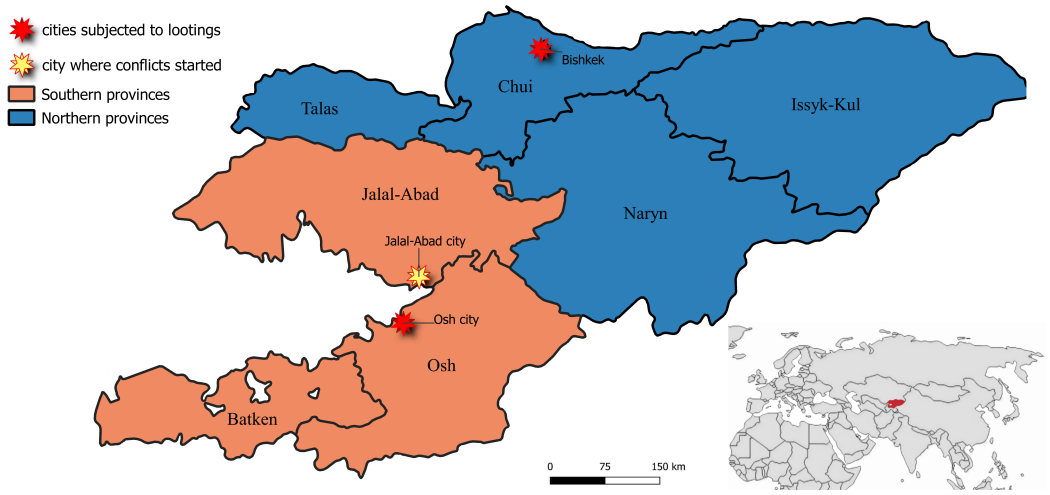
2.2 Context, data, food consumption, and theory

2.2.1 Context

Kyrgyzstan is one of the few transition economies rebounding from the dual political revolutions in 2005 and 2010. These events led to leadership changes and subsequent inter-ethnic clashes between Uzbeks and Kyrgyz in the South. In June 2010, these

clashes caused 300 deaths and displaced 400,000 people from their homes (Solvang and Neistat, 2010; Kubicek, 2011). The impact of these revolutions on national food demand remains uncertain, as the upheavals primarily affected the two largest cities, Bishkek and Osh (Figure 2.1).

FIGURE 2.1: Conflicts and looting in Kyrgyzstan.



Source: Author's figure.

Following its independence in 1991, Kyrgyzstan initially embarked on political and economic reforms during President Akayev's initial term (Anderson, 2013). However, Akayev consolidated power within his family during his second term, establishing a patronage system that marginalized Southern politicians. Subsequently, politicians from Southern voting districts obtained only 6 out of 75 parliamentary seats, while the population share accounts for 52% (Radnitz, 2012). This led to large-scale protests organized by the United Opposition in the South, which spread to the capital and culminated in the storming of the White House, prompting the president's departure from the country on March 24, 2005 (Kroeger and Anderson, 2014).

Under the leadership of Kurmanbek Bakiyev, the opposition assumed power, dubbing the movement that ousted Akayev the "tulip revolution." For many residents of Bishkek and Osh, however, those days are remembered for mass pogroms and looting, which targeted major shops and retail outlets.[2] These disturbances resulted in food scarcity and essential shortages for approximately two weeks until the restoration of shops and supplies. While citizens sought governmental change to enhance living conditions, they confronted short-term food deficits in Bishkek and Osh. Furthermore, the newly appointed president, Bakiyev, continued to uphold the core tenets of "patronal presidentialism," akin to Akayev's approach (Hale, 2006).

Amid accusations of corruption and overseeing economic stagnation, the Bakiyev regime faced widespread citizen protests. In the spring of 2010, demonstrators occupied government buildings nationwide, culminating in the overthrow of the Bakiyev government on April 7, 2010, despite violent resistance by government security forces (Eschment and Alff, 2010). The subsequent phase of conflict commenced when pro-Bakiyev forces seized control of public buildings in Jalal-Abad

[2] https://www.dw.com/ru/a-4121676

province. However, armed Uzbek-Kyrgyzstanis, aligned with the Interim Government, reclaimed these structures. This political struggle transformed into a deadly inter-ethnic conflict between Uzbeks and Kyrgyz in the southwest from June 7th to 25th, 2010 (Akiner, 2016; Steiner and Esenaliev, 2011).

TABLE 2.1: Timeline of events.

Date	Events
27.02.2005	Widespread violations of electoral legislation in the parliamentary elections
04.03.2005	A crowd gathered in Jalal-Abad's central square, with protesters criticizing authorities
21.03.2005	Osh oblast residents seized regional administration, declaring "people's" power
24.03.2005	Protesters stormed the capital's White House, overthrowing President Akayev
24.03.2005	In Bishkek and Osh, looting erupted as unidentified individuals set fire to and ransacked stores
06.04.2010	Security forces apprehended the majority of opposition leaders in Bishkek
07.04.2010	Protesters stormed the White House despite sniper fire; Bakiyev was overthrown
07.04.2010	Extensive looting swept through Bishkek city
13.05.2010	Bakiyev supporters seized South's regional buildings, aiming to topple the provisional government
14.05.2010	Provisional Government backers regained Jalalabad's administrative building
10.06.2010	A clash occurred between Kyrgyz and ethnic Uzbeks
12.06.2010	Arson and looting began in Osh city
14.06.2010	Osh stabilized, but sporadic violence, including looting, persisted in the days that followed

Following the initial phase of the second conflict in Bishkek, citizens avoided deprivation by pre-stocking essential items and food due to the vivid memory of the "tulip revolution" events in 2005.[3] In June 2010, Osh experienced looting and deadly violence, causing people to stay home out of fear. In retrospect, the anticipated nature of the June 2010 conflict prompted proactive measures, contrasting the situation in 2005. Notably, the second conflict disproportionately affected Osh over Bishkek, a shift from the more balanced regional impact of the initial conflict. The timeline of conflicts and related events is summarized in Table 2.1.[4]

[3]Source: https://www.rbc.ru/society/08/04/2010/5703d9339a79470ab501f5894

[4]Events assembled from local news https://kg.akipress.org/news:632188

2.2.2 Data and sample descriptives

We use data from the KIHS, conducted quarterly by the National Statistical Committee (NSC) of the Kyrgyz Republic from 2005 to 2019. This rotating panel offers a nationally representative sample, encompassing around 5000 households per wave since 2003. Notably, the exclusion of 2003 and 2004 is motivated by dissimilar questionnaire structures and the absence of suitably matched questions with other waves. Additionally, the KIHS sample underwent complete renewal in 2013, with only one-third of households replaced between 2013 and 2019 (see Table A1). The KIHS sample is selected using two-stage stratified random sampling based on

TABLE 2.2: Summary statistics for household demographics.

	All	**Urban**	**Rural**
Total biweekly expenditure on food* (1,000 KGS)	2.64	2.83	2.36
Monthly total household income (1,000 KGS)	13.35	14.19	12.12
Household size (count)	4.06	3.63	4.70
Gender of household head (1 = male)	.64	.58	.71
Age of household head (years)	52.71	52.40	53.17
Household heads with only basic education (=1 if yes)	.12	.10	.15
Household heads with secondary education (=1 if yes)	.42	.36	.51
Household heads with higher education (=1 if yes)	.38	.46	.26
Dependency ratio (from 0 to 1)	.35	.34	.36
Share of agricultural income	.02	.00	.05
Share of weekly worked hours in public sector	.33	.38	.25
Number of surveyed households	16,486	10,399	6,087
Number of observations	2,694,367	1,759,155	1,205,212

Note: The national currency devalued from 41.01 KGS/USD in 2005Q1 to 69.82 KGS/USD in 2019Q4 (IFS, 2023). Monthly income rose from 151 USD in 2005Q1 to 340 USD in 2019Q4.
* Total food expenditure spent at home and outside the home.

the 1999 population census. The country's 15 strata encompass urban and rural areas across seven provinces and the capital. Each cross-section maintains national, urban/rural, and provincial representation. The survey comprehensively examines consumption and expenditure, analyzing poverty and living standards. The utilized data encompass household expenditure, income, employment, and demographics, averaging 163.4 quarters per household. Summary statistics for the full sample, categorized by household type, are displayed in Table 2.2.

2.2.3 Food consumption in Kyrgyzstan

Food consumption and expenditure data encompass purchased, home-produced, gifted, and in-kind contributed food items, along with items obtained from hunting, covering 337 items.[5] The purchased and consumed amount of food is recorded separately based on recall over the last 14 days. For purchased goods, we use reported

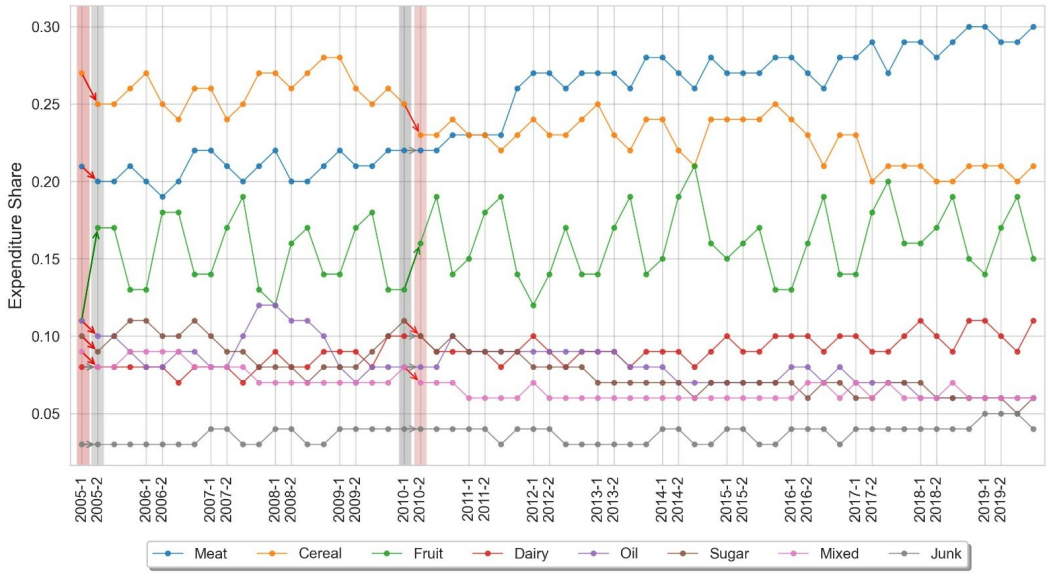
[5]Hunting products constitute .01% of total food consumption. Tobacco expenditures are excluded from the food basket. Aggregated food groups are classified by similarity.

expenditures. Only quantities are recorded for home-produced consumption, necessitating the use of the appropriate median unit value in the respective locality for valuation (Attanasio et al., 2013).

For demand elasticity estimation, we conducted several data transformations. Initially, we converted food item quantities into kilogram equivalents using conversion factors. Next, we derived unit prices by dividing reported expenditures by corresponding quantities of food items. To address missing unit prices due to zero purchases or omissions, we imputed them using median market prices by district, accounting for quality effects and measurement errors as addressed by Deaton, 1988 and Crawford, Laisney, and Preston, 2003. To mitigate these issues, we employed the communal mean price method introduced by Cox and Wohlgenant, 1986.[6] This method regresses mean-deviated unit values on household characteristics, removing quality effects to obtain adjusted prices. Additionally, we tackled price changes due to inflation using the FAO Monthly Consumer Price Index for food, converting monetary variables to real values.

Lastly, we aggregate all food items into eight groups: meat & fish, cereals & flour products, fruits & vegetables, dairy products, edible oils, sugar & sweets, mixed products, and junk (processed) products. This grouping aligns with the state classifier of the Kyrgyz Republic. Subsequently, we calculate both quantities consumed and expenditures for each group. The distribution of expenditure shares by food group for every quarter is depicted in Figure 2.2).

FIGURE 2.2: Expenditure shares by food groups.



Source: Author's figure.

2.2.4 Theory

Changes in demand are driven by an item's prices, complementary goods' prices, buyer's income, consumer preferences, and expectations, while the interplay of supply and demand determines market prices (Mas-Colell, Whinston, Green, et al.,

[6]For detailed quality-adjusted price procedures, refer to appendix A of Hoang, 2018. Quality-adjusted prices are presented in figure 7 in the Appendix.

1995). Political crises as external shocks lead to shifts in food demand (Holland, 2012). Disruptions in supply chains and income shocks primarily trigger these shifts (Mas-Colell, Whinston, Green, et al., 1995). However, if a crisis is anticipated, households might smooth their consumption strategically to alleviate its repercussions (Dutt and Padmanabhan, 2011).

Thus, it is likely that food demand will be differently affected by a short-term market disruption conditional upon the good's characteristics. A crisis diminishes demand for luxury items during and after the crisis while strengthening demand for staple goods (Pangarkar and Shukla, 2023). If consumers anticipate a crisis, the demand for staples might rise (Henchion et al., 2017). We can rely on the expenditure elasticity derived from the data to distinguish both broad categories. Staples exhibit an expenditure elasticity between zero and one, while luxury items show an expenditure elasticity exceeding one (Brauw and Herskowitz, 2021). This transition in a consumer's preference from luxury to staples is expected to result in a shift in own-price elasticities. Subsequently, the own-price elasticity of a staple good should increase, that is, the demand function becomes less elastic.

The unexpected upheaval of 2005 within Bishkek and Osh resulted in unrest and widespread looting that destroyed all shops, causing a temporary closure. During this period, the supply chain halted, eliminating the market dynamics, supply-demand interactions, and prices. Upon store restoration, supply disruptions ceased, but demand overshot. As explained above, the 2010 upheaval followed a comparable scenario, but it was anticipated to enable households to plan their food consumption strategically. Unfortunately, we lack data on income changes and supply chains during the short conflict period, and the survey does not provide exact interview dates within each quarter.[7] In light of this, we suggest the following hypotheses:

1. aggregate food demand decreases during the initial revolution (2005Q1) due to an income shock;

2. aggregate food demand rises before the second revolution (2010Q1) due to the anticipated revolution;

3. demand for staples rises and demand for luxuries reduces during the revolutions due to constrained budgets.

2.3 Methods

Demand analysis examines how consumers react to changes in price, willingness to pay, and income. Two primary approaches, rooted in neoclassical consumer theory, are employed. In the initial standard method, income elasticity is deduced by studying the link between consumption and income for a specific good or bundle of goods (Ogundari and Abdulai, 2013). However, this approach lacks adequate consideration of interdependencies among commodities due to budget constraints and relative prices (Sadoulet, Janvry, and Wehrheim, 1996).

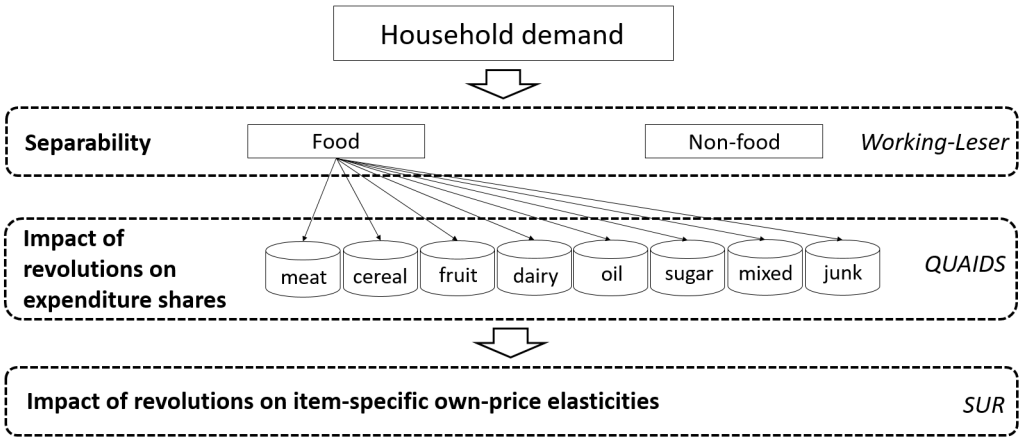
The second approach involves a two-stage process. In the first stage, households decide how to distribute total expenditures between food and non-food items. In

[7] As pointed out by one reviewer, the shift in elasticities could also be caused by a supply shift. However, there is no evidence that the revolutions affected agricultural production. Thus, we assume supply shocks remain limited to the short-term closure of shops.

the second stage, the allocation of total food expenditure among different commodity groups occurs. This method efficiently addresses interdependencies and substitution effects among food items and price changes. It achieves this by estimating fully defined demand systems, such as the linear expenditure system (LES) (Stone, 1954), the Rotterdam model (Barten, 1969), the indirect translog system (ITS) (Christensen, Jorgenson, and Lau, 1975), the almost ideal demand system (AIDS) (Deaton and Muellbauer, 1980), and the quadratic almost ideal demand system (QUAIDS) (Banks, Blundell, and Lewbel, 1997).

We investigate the impact of revolutions on food demand using a series of multi-stage estimations, as illustrated in Figure 2.3).

FIGURE 2.3: Conceptual framework.



Source: Author's figure.

2.3.1 Estimating the demand system

Estimating a complete demand system requires weak separability between food and non-food expenditures (Deaton and Muellbauer, 1980). This leads to a two-stage budgeting approach where households allocate income between food and non-food items using the Working-Leser model in the first stage. To handle non- linear Engel curves often seen in separable food demand systems, the QUAIDS model's flexibility is ideal. Thus, in the second stage, we use QUAIDS to assess household expenditure distribution across eight food groups.

Working-Leser model

Following Chern et al., 2002 and, more recently, Hoang, 2018, we employ the standard budget share model borrowed from Working, 1943 and Leser, 1963 as follows[8]

$$\ln \omega_t = \alpha_0 + \alpha_1 \ln M_t + \alpha_2 \ln \mathbf{P_t} + \sum_n \beta_n z_{nt} + \epsilon_t \tag{2.1}$$

where ω_t is the share of food in total expenditure in period t and M_t is total income per capita, which is the income a household receives from all sources such as self-employed business, remittances, salary, public transfers, and agriculture. $\mathbf{P_t}$ is a

[8]Regression results are reported in Table A.2.

Laspeyres price index, defined as:

$$\ln \mathbf{P_t} = \sum_i \overline{w_i} \ln \mathbf{p_{it}} \tag{2.2}$$

where $\overline{w_i}$ is the mean budget share and $\mathbf{p_i}$ is the price of the good i. Household characteristics z_{nt} include household size, province of residence, a dummy variable for urban residence, age, gender, and education of the household head. ϵ_t is an error term.

QUAIDS

We use Poi, 2012 quaids command implemented in Stata to model food demand with household demographics. This command incorporates demographics using the scaling technique introduced by Ray, 1983 and computes the uncompensated price elasticities for individual observations in the data. Assuming a utility-maximizing household with s demographic characteristics represented by vector $\mathbf{z}$ is scaled by the following function:

$$m_0(\mathbf{p}, \mathbf{z}, u) = \overline{m_0}(\mathbf{z})\phi(\mathbf{p}, \mathbf{z}, u) \tag{2.3}$$

where $\overline{m_0}(\mathbf{z})$ measures the increase in a household's expenditures in terms of demographic characteristics holding consumption patterns constant. The second term, $\phi(\mathbf{p},\mathbf{z}, u)$, controls for differences in relative prices and actual goods consumed. The budget share equation of Banks, Blundell, and Lewbel, 1997 derived from maximizing the indirect utility function and augmented with a vector of demographic variables $\mathbf{z}$ becomes:

$$\begin{aligned} w_{it} = \alpha_i + \sum_j \gamma_{ij} \ln p_{jt} + (\beta_i + \mathbf{j}_i'\mathbf{z}) \ln \left[\frac{m_t}{\overline{m_0}(\mathbf{z_t})a(\mathbf{p_t})} \right] \\ + \frac{\lambda_i}{b(\mathbf{p_t})c(\mathbf{p_t}, \mathbf{z_t})} \left\{ \ln \left[\frac{m_t}{\overline{m_0}(\mathbf{z_t})a(\mathbf{p_t})} \right] \right\}^2 + \epsilon_{it} \end{aligned} \tag{2.4}$$

where w_{it} is the expenditure share of food group i in period t, p_{jt} is the price of good j, m_t is a household's total food expenditure, $a(\mathbf{p_t})$, $b(\mathbf{p_t})$, $c(\mathbf{p_t}, \mathbf{z_t})$ are the price indices, $\mathbf{p_t}$ is the vector of prices, α_i, β_i, γ_{ij}, λ_i, η_i are parameters to be estimated, and ϵ_{it} denotes the error term.

Price indices are defined as:

$$\ln a(\mathbf{p_t}) = \alpha_0 + \sum_i \alpha_i \ln p_{it} + \frac{1}{2} \sum_i \sum_j \gamma_{ij} \ln p_{it} \ln p_{jt}. \tag{2.5}$$

$$b(\mathbf{p_t}) = \prod_i {p_{it}}^{\beta_i} \tag{2.6}$$

$$c(\mathbf{p_t}, \mathbf{z_t}) = \prod_j p_{jt}^{\eta_i' z} \tag{2.7}$$

where $\sum_j \eta_{sj} = 0 \; \forall s$ and η_i' represent jth column of parameter matrix η.

Deriving demand elasticities

Using the procedure given in Banks, Blundell, and Lewbel, 1997, we derive demand elasticities for aggregated food groups by partially differentiating equation (2.4) with

respect to $\ln m_t$ and $\ln p_{jt}$ such that:

$$\mu_{it} \equiv \frac{\partial w_{it}}{\partial \ln m_t} = \beta_i + \eta_i' \mathbf{z} + \frac{2\lambda_i}{b(\mathbf{p_t})c(\mathbf{p_t}, z)} \ln \left[\frac{m_t}{\overline{m_0}(\mathbf{z})a(\mathbf{p_t})} \right] \text{ and} \tag{2.8}$$

$$\mu_{ijt} \equiv \frac{\partial w_{it}}{\partial \ln p_{jt}} = \gamma_{ij} - \mu_{it} \left(\alpha_j + \sum_k \gamma_{jk} \ln P_{kt} \right) - \frac{\lambda_i(\beta_i + \eta_i' \mathbf{z})}{b(\mathbf{p_t})c(\mathbf{p_t}, \mathbf{z})} \left\{ \ln \left[\frac{m_t}{\overline{m_0}(\mathbf{z})a(\mathbf{p_t})} \right] \right\}^2 \tag{2.9}$$

where P_{kt} is a price index calculated as the arithmetic mean of prices for all k food groups.

Then the expenditure and the uncompensated price elasticities are respectively computed as

$$\varepsilon_{it} = \mu_{it}/w_{it} + 1 \tag{2.10}$$

and

$$\varepsilon_{ijt}^u = \mu_{ijt}/w_{it} - \delta_{ijt} \tag{2.11}$$

where δ_{ijt} represents Kronecker delta taking value 1 if $i = j$ and 0 otherwise. Using the Slutsky equation, we can finally compute the compensated price elasticities as

$$\varepsilon_{ijt}^c = \varepsilon_{ijt}^u + \varepsilon_{it} w_{jt}. \tag{2.12}$$

2.3.2 Seemingly unrelated regressions

We analyze the impact of revolutions on item-specific uncompensated price elasticities using seemingly unrelated regressions (SUR) initially developed by Zellner, 1962. SUR enables more efficient estimation by consolidating data from different food groups and imposing parameter constraints across various equations. The SUR model for uncompensated price elasticities of eight food groups is outlined as follows:

$$\begin{aligned} \hat{\varepsilon}_{it} = \beta_i + \beta_{i1} R_{1t} + \beta_{i2} R_{1t+1} + \beta_{i3} R_{2t} + \beta_{i4} R_{2t-1} + \beta_{i5} R_{1t} \\ \times B + \beta_{i6} R_{1t} \times O + \beta_{i7} R_{2t} \times B + \beta_{i8} R_{2t} \times O + \epsilon_{it}, \end{aligned} \tag{2.13}$$

where $\hat{\varepsilon}_{it}$ represents the uncompensated price elasticity for the food group i in period t, obtained from the QUAIDS model. R_{1t} and R_{2t} are dummy variables signifying revolutions in 2005 and 2010. Meanwhile, R_{1t+1} and R_{2t-1} denote post-revolution I and pre-revolution II quarters, respectively. B and O serve as dummy variables indicating cities (Bishkek and Osh) subjected to looting. ϵ_{it} represents the error term.

2.4 Results

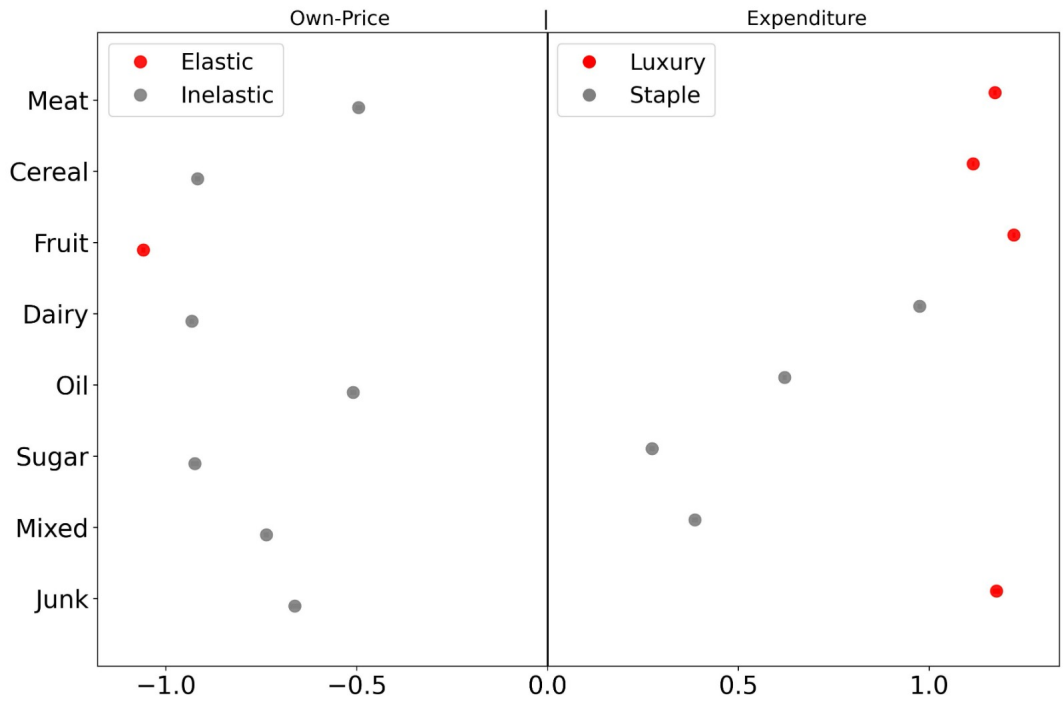
2.4.1 Demand elasticities

Figure 2.4 reports expenditure and uncompensated own-price elasticities.[9] These elasticities are evaluated at the sample mean for the entire sample and across regions. The expenditure elasticities range from .39 to 1.22, all displaying positive values, indicating that all goods are normal. Based on the estimated expenditure elasticities, meat & fish (1.17), cereals & flour (1.12), fruits & vegetables (1.22) and junk products (1.18) fall into the luxury category. The majority of these categories also account for

[9] Values of expenditure, own- and cross-price elasticities are available in Table A.3.

the highest expenditure shares. Medium- and low-consumption goods such as dairy, edible oils, sugar, and mixed products are relatively income-inelastic and considered staples in the following.

FIGURE 2.4: Demand elasticities.



Note: The graph shows the average elasticities for the full sample and the corresponding standard deviation.

The uncompensated own-price elasticities, as expected, exhibit negative values, ranging from -1.06 to -.5. With the exception of fruits & vegetables (-1.06), demand for all food groups is classifies as own-price inelastic, signifying quantities that respond to price changes by less than one. Sugar and flour products, being imported with volatile prices, heighten households' price sensitivity. The relatively lower own-price elasticity for more expensive items like meat & fish (-.5) can be attributed to meat's significant role in the Kyrgyz diet, where its expenditure share exceeds .25 in most quarters.

2.4.2 Food consumption and revolutions

Table 2.3 presents the outcomes derived from fixed-effects and QUAIDS estimations. These analyses aim to explore the relationship between households' overall food expenditure (depicted in column 1), the allocation of expenditures across eight specific commodity categories (columns 2–9), and explanatory variables encompassing binary indicators signifying revolutions and supplementary sociodemographic factors.

TABLE 2.3: Effect of revolutions on food expenditure shares.

	FE	QUAIDS							
Variables	**food**	**meat**	**cereal**	**fruit**	**dairy**	**oil**	**sugar**	**mixed**	**junk**
Revolution I	-542 (5.648)	.007 (.003)	.044 (.002)	-.037 (.001)	-.032 (.001)	.027 (.001)	.007 (.001)	-4e-4 (.001)	-.015 (.001)
Post_Revolution I	-541 (5.162)	-.021 (.002)	.003 (.002)	.015 (.001)	-.017 (.001)	.014 (.001)	.006 (.001)	.009 (.001)	-.009 (.001)
Revolution II	84 (5.461)	-.004 (.003)	-.021 (.002)	-.003 (.001)	.001 (.001)	.005 (.001)	.019 (.001)	.009 (.001)	-.006 (.001)
Pre_Revolution II	49 (4.973)	.008 (.002)	-2e-4 (.002)	-.026 (.001)	.010 (.001)	-.003 (.001)	.016 (.001)	.001 (.001)	-.006 (.001)
Revolution I×Bishkek	-68 (10.043)	-.026 (.006)	-.030 (.004)	-4e-4 (.003)	.071 (.003)	-.040 (.002)	-.021 (.002)	-.007 (.002)	.053 (.002)
Revolution I×Osh	-53 (10.722)	.030 (.007)	.005 (.005)	-.020 (.004)	.012 (.003)	-.016 (.002)	-.003 (.003)	-.006 (.002)	-.003 (.002)
Revolution II×Bishkek	49 (10.142)	-.049 (.006)	-.003 (.004)	.011 (.004)	.056 (.003)	-.015 (.002)	-.011 (.002)	.002 (.002)	.010 (.002)
Revolution II×Osh	37 (10.592)	-.002 (.007)	-.001 (.005)	.028 (.004)	-.001 (.003)	.015 (.002)	-.015 (.003)	-.009 (.003)	-.015 (.002)
Rural		4e-5 (.001)	.023 (4e-4)	-.024 (3e-4)	-.041 (3e-4)	.024 (2e-4)	.018 (2e-4)	.010 (2e-4)	-.10 (2e-4)
Age	3.419 (.128)	.001 (2e-5)	-3e-4 (1e-5)	-9e-5 (1e-5)	3e-4 (7e-6)	-2e-4 (8e-6)	-3e-4 (8e-6)	-2e-4 (8e-6)	-7e-5 (8e-6)
Gender	351 (2.826)	.009 (.001)	-.013 (4e-4)	-.009 (3e-4)	-.012 (3e-4)	.008 (2e-4)	.012 (3e-4)	.011 (2e-4)	-.006 (2e-4)
Basic education	-231 (5.502)	-.012 (.001)	.018 (.001)	.008 (.001)	-.018 (.001)	.010 (4e-4)	.002 (.001)	-1e-4 (.001)	-.008 (.001)
Secondary education	-142 (4.382)	-4e-4 (.001)	.001 (.001)	.008 (.001)	-.009 (.001)	.006 (4e-4)	.001 (4e-4)	-.002 (4e-4)	-.005 (4e-4)
High education	137 (3.581)	-.005 (.001)	-.004 (.001)	.002 (.001)	.002 (.001)	2e-4 (4e-4)	.005 (4e-4)	.002 (4e-4)	-.002 (4e-4)
Dependency ratio	218 (3.890)	-.029 (.001)	.003 (.001)	-.012 (.001)	.022 (4e-4)	.006 (4e-4)	.012 (4e-4)	.001 (4e-4)	-.004 (4e-4)
Share of farm income	79 (4.207)	-.024 (.002)	-.005 (.002)	-.002 (.001)	-.006 (.001)	.005 (.001)	.019 (.001)	.014 (.001)	-.002 (.001)
Share of public employment	52 (2.023)	.006 (.001)	-.008 (4e-4)	-1e-4 (3e-4)	-.002 (3e-4)	-.005 (2e-4)	.002 (2e-4)	.001 (2e-4)	.004 (2e-4)
Constant	2414 (8.443)	.395 (.008)	.617 (.006)	.411 (.005)	-.002 (.004)	-.114 (.003)	-.229 (.003)	-.231 (.003)	.154 (.003)
R^2	.479	.079	.075	.184	.147	.212	.153	.092	.070

Note: Robust standard errors are indicated in parentheses. Fixed-effects analysis involves 295,539 observations, and QUAIDS analysis uses 300,000 observations.

In the first quarter of the initial revolution, average food spending dropped by 542 KGS, followed by a decline of 541 KGS in the subsequent quarter. Unlike the previous trend, households increased food spending before and during the second revolution, with rises of 85 KGS and 49 KGS, respectively. During the first revolution, cities affected by looting (Bishkek and Osh) experienced more significant food expenditure reductions: 610 KGS and 595 KGS, respectively. In the second revolution, households in these cities increased their food expenditure by 134 KGS and 86 KGS. The percentage of mean expenditure before the second revolution increased by 12% in Bishkek and 7% in Osh.

QUAIDS estimates reveal that the initial revolution is associated with reduced expenditures on fruits & vegetables (4%), dairy products (3%), and junk items (2%), where fruits & vegetables and junk food are luxuries. In the subsequent quarter, there was a decrease in expenditure on meat (2%), which is also a luxury along with other products. Bishkek residents reduced their consumption of meat (2%), fruits & vegetables (4%), oil (1%), and sugar (1%). On the other hand, Osh citizens decreased spending on fruits & vegetables (6%), mixed products (1%), and junk items (2%).

During the second revolution, food consumption patterns diverged from the initial revolution nationwide, while both cities faced looting incidents. Across the country, there was a decline in expenditure shares for all luxury categories, including meat & fish, cereals, fruits & vegetables, and junk items, while spending on all staple items increased. In Bishkek, expenditure shares for luxury items like meat & fish, fruits & vegetables, and staples such as edible oils and sugar decreased. Similarly, residents of Osh exhibited heterogeneous consumption patterns for various food items.

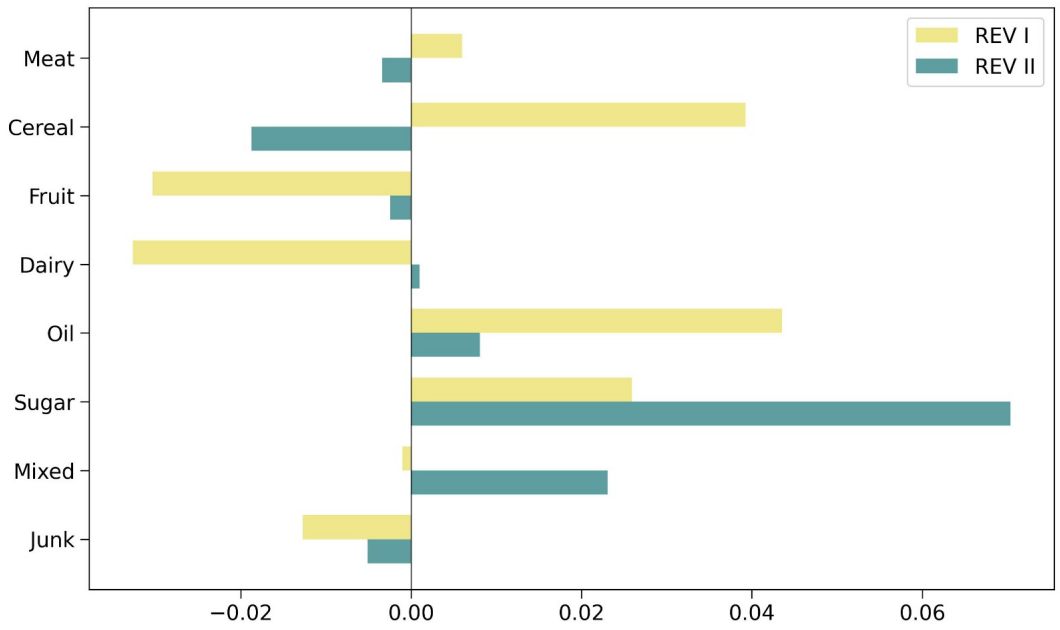
Considering the effect of sociodemographic variables on food expenditure shares, the age of the household head has no economically relevant impact on any food category. Different levels of education of household heads are associated with heterogeneous food consumption. Surprisingly, farmers spent less on the most often consumed items such as meat & fish, cereals, and fruits & vegetables than non-farmers. Households with more children and elderly members spent more on the relatively cheap categories such as cereals, sugar, edible oils, dairy, and mixed products.

In Figure 2.5, we normalize the predicted expenditure shares by the expenditure elasticities to accentuate the relative shifts in expenditure shares compared to their elasticities, both by product and between the two revolutions. Figure 2.5 reveals significant increases in expenditure shares for cereals, edible oils, sugar, and meat & fish, accompanied by declines in dairy, fruits & vegetables, junk, and mixed products during the first revolution. In the second revolution, expenditure shares for luxury foods decreased while those for staples increased.

2.4.3 Food preferences and revolutions

Table 2.4 displays the outcomes of the SUR estimates. These estimates were conducted to investigate the connection between households' uncompensated own-price elasticities and binary variables representing revolutions, along with their interaction with cities subjected to looting. It is worth noting that in equation (2.11), the presence of w_{it} in the denominator can lead to missing observations when a household does not consume a specific item (w_{it}=0). Additionally, when w_{it} is close to 0, the estimated uncompensated price elasticity can be high in absolute terms. Consequently, we limited the sample to household-level elasticities ranging from (-2) to (+2) to mitigate extreme values. This adjustment explains the lower number

FIGURE 2.5: Effect of revolutions on food expenditure shares.



of observations in the SUR estimation due to missing and extreme values. Across the country, there was a significant rise in preferences for key staples such as dairy, sugar, mixed products, and frequently consumed luxury items like meat & fish, and cereals during the initial revolution. With elasticities for dairy (–.93) and sugar (–.92) over the sample average (see Table A.3), consumer demand in Bishkek is predicted to be less elastic by .25 and .24 percentage points, respectively. In Osh, preferences decreased for almost all products but remained inelastic, except for fruits & vegetables.

During the second revolution and pre-revolution quarters, the absolute impact of the second revolution on food preferences decreased for all commodities. We observe the most significant reduction in sugar and meat nationwide. Food choices varied between the two cities, reflecting distinct household responses. In Osh, preferences predominantly rose for luxury items like meat & fish, fruits & vegetables, and junk food. Conversely, in Bishkek, preferences increased for almost all items except cereals, dairy, and junk food.

Figure 2.6 illustrates the impact of revolutions on food choices relative to their actual own-price elasticities. We divide the nationwide own-price elasticities acquired during the periods of conflict by the actual price elasticities calculated over 15 years. The figure reveals that in the first revolution, a price escalation would result in a more pronounced decline in demand for commodities such as meat & fish, dairy, sugar, and mixed food products, similar to patterns seen in non-conflict periods. Conversely, all products displayed heightened elasticity during the second revolution, indicating increased sensitivity to price changes.

Comparing Figures 2.5 and 2.6, it is evident that the changes in price elasticities show a significantly larger scale than alterations in expenditure shares. The impact of conflicts on food demand is more pronounced through price shifts than income changes. Additionally, the effect of revolutions on food expenditure shares is heterogeneous. During the first revolution, food preferences shifted towards luxury items

TABLE 2.4: Food preferences and revolutions.

Variables	meat	cereal	fruit	dairy	oil	sugar	mixed	junk
Revolution I	.164	.006	-.125	.147	-.134	.140	.041	-.074
	(.017)	(.004)	(.003)	(.006)	(.018)	(.018)	(.011)	(.023)
Post_Revolution I	.187	-.019	.027	.010	-.083	-.107	.005	-.168
	(.011)	(.003)	(.002)	(.004)	(.013)	(.013)	(.008)	(.016)
Revolution II	-.161	-.009	-.024	-.096	-.178	-.346	-.130	-.104
	(.011)	(.003)	(.002)	(.004)	(.012)	(.012)	(.007)	(.015)
Pre_Revolution II	-.270	-.014	-.069	-.152	-.139	-.483	-.189	-.162
	(.009)	(.002)	(.002)	(.003)	(.010)	(.010)	(.006)	(.012)
Revolution I×	.129	-.034	.037	-.245	.036	-.239	-.063	-.279
Bishkek	(.024)	(.006)	(.004)	(.008)	(.026)	(.026)	(.016)	(.034)
Revolution I×	-.037	-.030	-.020	-.132	-.161	-.171	-.025	.179
Osh	(.036)	(.009)	(.007)	(.013)	(.039)	(.039)	(.024)	(.051)
Revolution II×	.467	-.040	.032	-.045	.451	.203	.146	-.039
Bishkek	(.021)	(.005)	(.004)	(.007)	(.022)	(.022)	(.014)	(.029)
Revolution II×	.091	-.029	.033	-.004	-.124	-.085	.097	.262
Osh	(.031)	(.008)	(.006)	(.011)	(.033)	(.034)	(.020)	(.043)
R^2	.017	.002	.037	.035	.007	.029	.011	.004

Note: Robust standard errors are given in parentheses. The number of observations is 128,492.

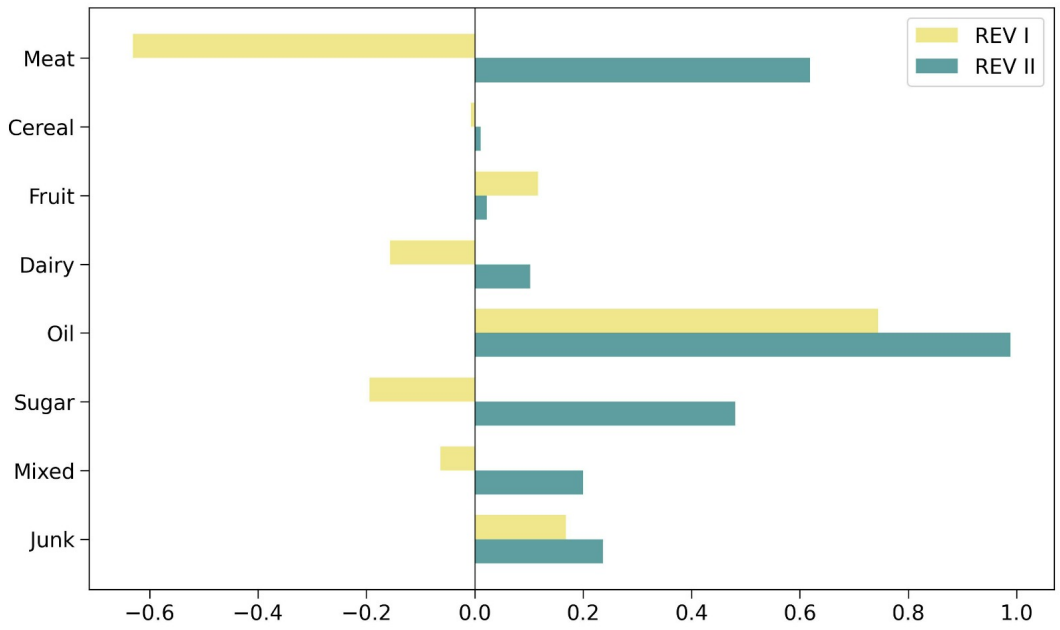
like fruits & vegetables and junk food. In contrast, the shift was more pronounced during the second revolution toward staples such as edible oils, sugar, and mixed food.

2.5 Discussion

Our analysis offers a comprehensive understanding of the impact of political conflicts on different food groups' demands in Kyrgyzstan. Our study uncovered diverse household behavior in food demand during conflicts and examined the effects of anticipated and unanticipated conflicts on food demand.

Our study reveals that when conflicts arise unexpectedly, total food demand decreases. This discovery aligns with empirical evidence indicating that violent conflicts directly impair food systems, negatively impacting food security (Delgado, Murugani, and Tschunkert, 2021). The deliberate use of food as a weapon of war and the intentional destruction of food systems by conflict actors contribute to a lasting legacy of food insecurity resulting from the war (Keen and Lee, 2007). Our findings indicate that government adoption of radical laws can swiftly escalate public dissatisfaction, potentially triggering a coup that initiates a chain of adverse consequences, beginning with compromised food security.

FIGURE 2.6: Effect of revolutions on price elasticities.



Our findings also reveal that households strategically plan their food consumption when conflicts are anticipated, increasing total food expenditure before the conflict's commencement. This observation adds to the literature on household coping strategies adopted before and during crises (Barrett, Reardon, and Webb, 2001). However, the mechanisms and processes underlying these strategies still need to be more adequately understood in the development literature, where limited attention has been given to analyzing the variations in coping strategies employed by households in peaceful versus conflict-affected settings.

Our hypothesis of heightened demand for staples was partly affirmed in the initial revolution and fully validated in the second, while preferences for luxury items decreased in the second revolution and increased in the first. This finding underscores the crucial role of event predictability in shaping rational human behavior (Zhang et al., 2021). Furthermore, our findings emphasize that preferences more prominently drive the effects of conflicts on food demand than changes in income, underscoring the significance of market conditions in shaping food choices over budget constraints (Heffetz and Shayo, 2009).

Finally, it is crucial to acknowledge the potential limitations of this study. One significant factor is the possibility of underestimating demand due to potential disruptions in the supply chain for stores that continued operating during conflicts. Furthermore, accurately capturing the timing of conflicts could be challenging due to the difficulty distinguishing between households directly impacted by conflicts and those unaffected due to data limitations. Lastly, the study emphasizes the dominance of long-term conflict impacts on food demand over short-term effects, where short-term impacts may not be readily apparent (refer to Figure 2.2).

2.6 Conclusion and Policy implications

Amidst escalating armed conflicts and widespread unrest, this article delves into the impact of political conflicts on food demand through complete demand system analyses. To comprehend the ramifications of conflicts, we formulate three hypotheses elucidating consumer behavior before, during, and after conflicts, along with their preferences across various food group categories. Drawing from our findings, we propose that governments, mass media, and other institutions responsible for disseminating information should promptly convey signals of anticipated conflicts if they become unavoidable.

Our findings emphasize that solely analyzing the impact of conflict on total food expenditure overlooks potential shifts within food categories. Adopting a disaggregated perspective becomes imperative for researchers focusing on the interplay of conflicts with food and nutrition security. Likewise, the results reveal a regional disparity, with households in the most affected regions—Bishkek and Osh—experiencing more substantial impacts on food expenditure than other areas. Furthermore, predicting conflicts' effects on individual food categories is challenging. Additional analyses are essential to determine suitable strategies for averting shortages of specific foods, which is especially crucial for ensuring healthy nutrition during tumultuous periods.

Chapter 3

Policy analysis with Melitz-type gravity model: Evidence from Kyrgyzstan

[1]

Abstract

Several governments worldwide aim at fostering agricultural productivity growth by providing investment support. However, the policy's effect on trade for middle- and low-income countries has not been analyzed so far. This paper analyzes the impact of agricultural policies (credit subsidies and tariffs) on agricultural trade flows by modifying a Melitz-type structural gravity model for a small and open economy. According to the theory, trade flows are expected to increase with credit subsidies and decrease with partners' applied tariff rates. We analyze bilateral agricultural trade flows between Kyrgyzstan and its 69 trading partners from 2007 to 2018 to test our theoretical findings. Applying the Poisson pseudo maximum likelihood estimator, we find that credit subsidies effectively increase international trade flows while applied tariffs imposed on agricultural products reduce Kyrgyzstan's export substantially. These results can be applied to similar economies with publicly available data where small budgetary efforts drive trade expansion.

Keywords: gravity model, general equilibrium effects, tariffs, subsidies

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3.1 Introduction

Previous analyzes of the impact of agricultural input subsidies covered a broad range of outcome indicators (Hemming et al., 2018). Many of them are of a microeconometric nature comparing beneficiaries with non-beneficiaries. However, the availability of farm- or household-level data, ideally covering several years, is often a challenge. Furthermore, a focus on household-level effects might fail to consider indirect effects at the level of consumers or international trade, which might be substantial as illustrated by Tong, Pham, and Ulubaşoğlu, 2019 in the case of aggregated US farm subsidies. However, the effect of a single input policy instrument cannot be disentangled. Therefore, this study offers an alternative approach to disentangle the economic impact of an input subsidy. More specifically, this study is the first to examine the effect of credit subsidies for agricultural producers on agricultural trade. Agriculture differs from other export-oriented sectors in many aspects, particularly in countries dominated by a scattered farming sector such as Kyrgyzstan. First, products have to be pooled by some middlemen in order to reach viable quantities providing a disincentive to quality-enhancing investments at the producer level. Second, many transition economies are still characterized by a processing and wholesale sector fitting the large-scale agricultural structures of the past instead.

Existing international trade literature mainly evaluates trade policy instruments such as trade liberalization, regional trade agreements (RTAs), tariffs, quotas, and export subsidies, including credit subsidies (Carmichael, 1987; Chang, Chen, and Saito, 2021; Kuenzel and Sharma, 2021; Mah, 2006; Rees and Tyers, 2004). Studies on the efficacy of input support policies on trade at the macro level are scarce due to the complexities in calculating the indirect effects of subsidizing inputs (Defever, Imbruno, and Kneller, 2020; Fu, Zhang, and Li, 2021). The impact evaluation analysis is almost impossible for large economies such as the European Union, which provides comprehensive agricultural input subsidies through many instruments. However, the analysis becomes feasible for small countries with few government support policies in the raw commodity sector, such as agriculture in Kyrgyzstan.

Agricultural support policies are still among the most debated issues in developing countries (Jayne et al., 2018). Evidence from North America, Europe, Asia shows that the governmental support for intensifying agriculture mechanization, technology, irrigation, and use of improved fertilizer led to increased farm productivity and agricultural growth (Fuglie et al., 2019; Wang, Deng, and Deng, 2020). However, large fertilizer subsidy programs in Africa have resulted in several unintended negative impacts (Holden, 2019; Theriault and Smale, 2021). In this regard, the impact evaluation of Kyrgyzstan's farm supporting project, whose primary goal is to increase the export of agricultural goods, is essential.

We employ gravity model treating credit subsidies as non-trade and applied tariffs as trade policy to analyze multiple instruments at the macro level simultaneously. Gravity model, acquiring a range of micro-founded macro theoretical bases, is the most frequently used framework in applied international trade literature (Agnosteva, Anderson, and Yotov, 2014; Bergstrand, Larch, and Yotov, 2015; Dai, Yotov, and Zylkin, 2014; Fally, 2015; Jarreau, 2015; Wilson, Mann, and Otsuki, 2003). The policy studies focused on international trade use of Anderson and Wincoop, 2003 model of perfect competition with homogeneous goods or an Eaton and Kortum, 2002 model with sectoral heterogeneity. Both models assume that each firm's productivity is identical before entering the international market. However, Bernard et

al., 2007 provided an overview of empirical patterns about firms engaged in international trade and found considerable heterogeneity in a firm's exporting behavior. Before entering the international market, exporting firms tend to be larger, more productive, more skilled, and capital-intensive than non-exporting ones.

A Melitz, 2003 model of monopolistic competition with heterogeneous firms captures many empirical facts mentioned by Bernard et al., 2007 and the potential source for gains from trade (Arkolakis, Costinot, and Rodríguez-Clare, 2012). Although the Melitz, 2003 model provides the backbone for many trade papers written in the past decade, a few studies used this framework theoretically (Eaton, Kortum, and Kramarz, 2011; Helpman, Itskhoki, and Redding, 2010) and empirically (Bas and Bombarda, 2013; Chevassus-Lozza and Latouche, 2012; Eaton, Kortum, and Sotelo, 2012; Helpman, Melitz, and Rubinstein, 2008). To our best knowledge, no paper addresses the Melitz, 2003 model's gravity framework in the context of the agricultural sector of a small economy.

Farm products are consistent with the assumptions of the Melitz framework. Farmers differ in productivity due to their heterogeneity in production technologies resulting in differentiated agricultural commodities. In addition, we assume that the distribution of productivity is Pareto since productivity is related to agricultural land, which is usually Pareto distributed (Akhundjanov and Chamberlain, 2019). Hence, the present study derives a Melitz-type sectoral gravity equation for a small economy and examines theoretical findings with Poisson pseudo maximum likelihood (PPML) estimator (Silva and Tenreyro, 2006) using data from Kyrgyzstan.

Kyrgyzstan is a small, open, and developing economy with negative growth rates of foreign trade. Foreign trade turnover in 2013–2019 decreased by 12.7% – from USD 7.993 billion to USD 6.975 billion. Exports in 2019 amounted to USD 1.986 billion and decreased by 1% compared to 2013, while imports amounted to USD 4.989 billion and decreased by 16.7%. The export potential of the agricultural sector in total export volume is approximate 10% (about USD 190 million per year on average over the past five years). At the same time, crop production plays a leading role (more than two-thirds of total agricultural output).[1]

In 2013, the Kyrgyz government launched the "Financing of Agriculture" project to reduce the country's import dependence on farm products by enhancing farmers' productivity. In particular, it has provided subsidized interest rates on farmers' loans under a series of government programs. Although the government adjusts the credit subsidies annually, no impact evaluation study has been conducted. This study aims to assess the effect of credit subsidies and applied tariff rates on trade flows of aggregated farm goods and suggest policy implications for the Kyrgyz government.

The contribution of our work to the existing literature is twofold. First, given the characteristics of the country and the relevance of a Melitz, 2003 model, we extend a small and open economy model of Demidova and Rodríguez-Clare, 2013 to identify the general equilibrium effects of bilateral trade and unilateral non-trade policies. Second, we illustrate a macro-level impact analysis of agricultural subsidies. Such an approach might be particularly useful in contexts with a rather heterogeneous agricultural sector and a lack of representative farm-level data.

The analyses are provided examining a Melitz-type structural gravity model using the PPML estimator due to its numerous advantages over other estimators in structural gravity models (Silva and Tenreyro, 2006). We use cross-country annual panel data to evaluate the impact of agricultural support policies (credit subsidies

[1]Source: WTO, "Trade policy review WT/TPR/G/411," 2021.

and applied tariffs) on bilateral trade flows from and to Kyrgyzstan. Empirical results show that credit subsidy policy does not significantly influence trade flows while applied tariffs substantially decrease the export of farm products, which is in line with theory.

The remainder of the paper is structured as follows. The next section provides the necessary background on agricultural trade in Kyrgyzstan and a summary of agrarian policy regimes. In the third section, we present our theoretical findings. The fourth section presents the empirical analysis with the results. The last section concludes the study.

3.2 Agricultural trade in Kyrgyzstan

Kyrgyzstan was an agricultural country during the Soviet period. The population was primarily rural-based on cotton in the south, grain farming in the north, and livestock. Agriculture in Kyrgyzstan is still the primary sector but it is no longer "a driver" of economic growth as it was in the second half of the 1990s (Light, 2007). About a quarter of the economically active population in Kyrgyzstan is engaged in agriculture, while half of the total population depends on the sector for their livelihood (World Bank, 2020). The share of agriculture in GDP has dropped from 46% in the first decade of transition to about 12% in 2018 (World Bank, 2020). As of January 1, 2020, more than 453 thousand operating economic entities are operating in agriculture, forestry, and fishing. Among them, 341.1 thousand, or 75.5% of the total number of such entities, fell on peasant farms, 110.1 thousand entities, or 24.3% on individual entrepreneurs engaged in agricultural production.[3]

Kyrgyzstan is neighboring Kazakhstan, Uzbekistan, Tajikistan, and China. Although it is landlocked, it is geographically and economically well-positioned for international trade in large markets located nearby. Additionally, Kyrgyzstan was one of the most quickly reforming countries among the former Soviet republics and became the first, apart from the Baltic states, to accede to the World Trade Organization (WTO) in 1998 (Pomfret, 2019). Despite substantial trade policy liberalization at the beginning of the transition phase, its export performance was disappointing. On the one hand, increased demand for high value-added products driven by lifestyle habits and dietary structure increased the imports of processed food products since 2001. On the other hand, the low competitiveness of the agro-processing sector in terms of technology, product variety, and quality led to a sharp decline in the agro-processing industry's output. In addition, a significant deficit in agricultural machinery hinders sector productivity resulting in Kyrgyzstan's trade balance being negative since 2001 (Figure 3.1).[4]

To further evaluate the international trade trend, we look at the net trade of primary five agricultural commodities during 2000–2018. This group of main items includes grains (wheat, maize, barley, rice), raw cotton, unmanufactured tobacco, fruits and vegetables (potatoes, tomatoes, cucumbers, apricots, onions, cabbages, carrots, grapes, apples, pears, cherries, peaches), and animal products (beef, pork, mutton, horse meat, poultry, milk, eggs, wool, and honey). As shown in Figure 3.2, the composition of exports and imports of all agricultural commodities has changed structurally in the last two decades. Kyrgyzstan has been the fastest-growing net importer in grains and animal products and net exporter in fruits and vegetables

[3]Source: NSC KR "Agriculture of Kyrgyz Republic," 2020.

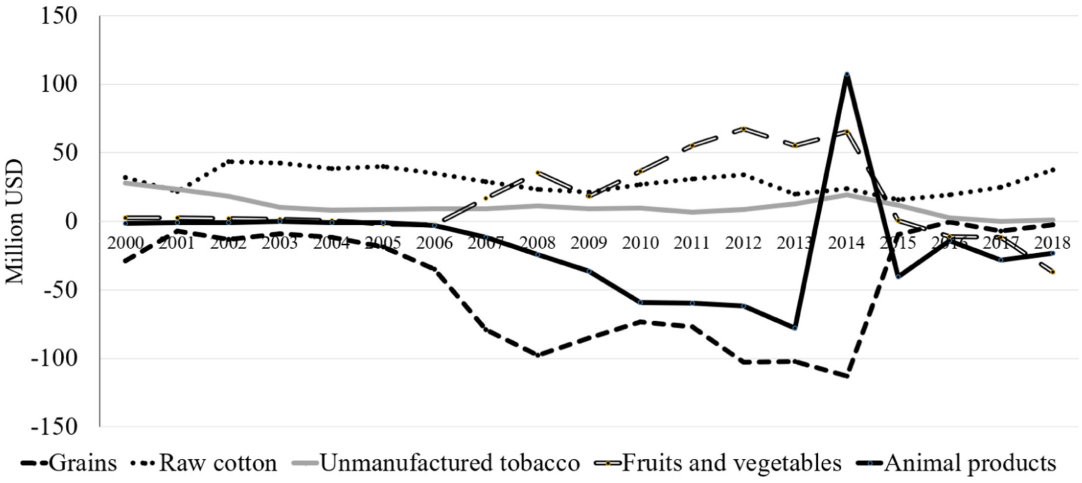
[4]Source: FAO, "The Kyrgyz Republic Farm mechanization and agricultural productivity," 2009.

FIGURE 3.1: Evolution of trade in agricultural goods, 2000–2018.

With regards to discussions related to trade, all individual products belonging to product groups with 2-digit HTS codes between 01 and 24 are accepted as agricultural goods.
Source: UN COMTRADE 2020, authors' calculations.

during 2000–2014.[5] As of 2014, the trend for all commodities has changed to the opposite. The country started to export more raw materials and import high-value-added products such as fruits and vegetables. A one-year flash in animal products' structure occurred due to a large amount of exported beef to Kazakhstan in 2014.

FIGURE 3.2: Evolution of net trade in agricultural commodities, 2000–2018.



Source: UN COMTRADE 2020, authors' calculations.

After the collapse of the Soviet Union, the Kyrgyz government implemented a series of fundamental changes in the agricultural sector, such as the dismantlement of state farms, the abolition of direct support, agricultural price liberalization, and privatization of land. Among all the reforms, scholars assess two as particularly successful in increasing farmers' productivity: private ownership and land redistribution. Other reforms did not increase the farmers' productivity due to weak institutions and poor infrastructure in the agricultural sector. Furthermore, newly

[5]Source: Authors' calculations using UN COMTRADE data.

created smallholder farms needed support and required farm services' adjustments (Lerman and Zedik, 2009).

On the other hand, implemented reforms and the substantial decline in transfers from Moscow led to a massive budget deficit (about 17% of GDP). The Kyrgyz government tried to cushion the impact of withdrawing direct support from the USSR through indirect subsidies: tax exemptions from value-added tax, price support for irrigation services, price discount for electricity usage, and vaccinations usually provided by the finance obtained from international aid organizations. Moreover, only in 2013 did the government implement the project called "Financing of Agriculture–I-IV," which was extended for additional five years in 2016.

The project aims at providing subsidized interest rates on loans obtained from the government's partner banks. The government compensates banks by paying the difference between the subsidized credit interest rate and the average market interest rate on loans. The target sectors within the project are animal husbandry, crop production, and processing of agricultural products. Favorable interest rates fluctuate from 6% to 10% (market interest rates fluctuate from 22% to 30%), and crediting period up to 60 months, based on the target industry. The government has introduced additional preferred requirements related to farmers' occupation and productivity because the total amount of support is restricted due to the limited state budget. One of the preferred requirements is being an exporter of agricultural products, which restricts small-scale farmers' access to subsidized loans as they are oriented towards the domestic market.

3.3 Theoretical framework

To analyze the effect of credit subsidies and tariff rates on trade in a small and open economy, first, we modify a Demidova and Rodríguez-Clare, 2013 model. Specifically, the government levies labor taxes and imposes tariffs on imported agricultural products to provide credit subsidies to farmers in our model. Second, we derive general equilibrium effects and the Melitz-type structural gravity equation. Then, we provide a comparative statics analysis according to our focus variables.

3.3.1 Demand

We consider the origin country as i and the destination country as j where i can be treated as a small economy. Countries are populated by identical households where each inelastically supplies one labor unit and earns wage w. Consumers spend their income on domestic and imported varieties of differentiated goods. Additionally, consumers are assumed to have CES-type utility functions over a continuum of goods indexed by $\omega \in \Omega$ with an elasticity of substitution $\sigma > 1$.

Optimal demand in country j for domestic variety is

$$q_{ij}(\omega) = p_{ij}(\omega)^{-\sigma} Y_j P_j^{\sigma-1} \tag{3.1}$$

where $p_{ij}(\omega)$ denotes the the price of the good produced in i and sold in j. Y_j indicates the aggregate expenditure of country j. $P_j \equiv \left(\sum_i \int_{\omega \in \Omega_i} p_{ij}(\omega)^{1-\sigma} d\omega\right)^{\frac{1}{1-\sigma}}$ stands for the price index in country j. In line with a small and open economy assumption, demand for foreign variety is given by $q_{ji}(\omega) = A p_{ji}(\omega)^{-\sigma}$ where A includes both national income and the price index in the origin country.

3.3.2 Supply

In each country, a differentiated variety is produced by a different producer where M_i denotes the mass of the monopolistically competitive firms in the origin country. Labor is the only factor of production. Firms pay a fixed cost $w_i f_i^e$ to enter the market; after that, they draw their random productivity φ which is sampled from a Pareto distribution with a cumulative distribution function[6] given by $G_i(\varphi)$. Knowing φ, the domestic market-oriented producer in country i faces variable costs $\frac{w_i}{\varphi}$ while the export-oriented producer must additionally pay tariffs $(1+\kappa_{ij})$ imposed on imported goods by the destination country j and fixed market access cost $w_i f_{ij}$. Moreover, producers in the small country face liquidity constraints in financing their production costs. More precisely, firms borrow their production cost in advance at a market interest rate $r_i \in (0,1)$ which is exogenously given[7]. However, they receive a credit subsidy $s_i \in [0, r_i]$ on the market interest rate r_i. Accordingly, the net interest rate $(r_i - s_i)$ should matter for producers. Credit subsidies are provided on funds collected from labor taxes at a constant rate $\gamma_i \in (0,1)$ by the government. As usual, we assume that there are iceberg transport costs $\tau_{ij} = \tau_{ji} \geq 1$, where $\tau_{ii} = 1$.

Given demand (Eq.3.1), tax, interest and subsidy rates the price charged by the firm from i conditional on selling to destination j is

$$p_{ij}(\varphi) = \frac{\sigma}{\sigma - 1} \frac{w_i}{\varphi} (1+\kappa_{ij}) \tau_{ij} \, (1 + r_i - s_i). \tag{3.2}$$

3.3.3 Government

The government taxes labor income on a lump-sum basis and imposes tariff rates on imported goods to subsidize loans to producers. The planner's budget is balanced in every period. Then, the government budget constraint is given by

$$S_i \equiv \frac{M_i s_i q_{ij}(\varphi)}{\varphi} = w_i L_i \gamma_i + M_j q_{ji}(\varphi) \kappa_i, \tag{3.3}$$

where $\frac{M_i s_i q_{ij}(\varphi)}{\varphi}$ is the amount of the total loans subsidized by the government and it is the only source of the government spending S_i. The total income of the government i consists of labor taxes $w_i L_i \gamma_i$ and income from imposed tariffs $M_j q_{ji}(\varphi) \kappa_i$.

3.3.4 Equilibrium

General equilibrium for this model is defined as follows.

Definition 1 *An equilibrium of this economy is a set of quantities* $\{q_{ij}^*(\varphi)\}$, *prices* $\{p_{ij}^*(\varphi), w^*\}$, *and exogenous government policies* $\{s_i^*, \gamma_i^*, r_i^*, \kappa_i^*\}$, *such that*

1. *given* $\{p_{ij}^*(\varphi), w^*, \gamma_i^*, r_i^*\}$, *the representative consumer chooses the optimal quantities to maximize the consumer's utility in a budget-constrained environment;*

[6] Our parametrization of the productivity function based on Chaney, 2008. According to his assumption, productivity φ is distributed Pareto with lower bound $\varphi_{\min} = 1$ and shape parameter $\theta_i > \sigma - 1$. The cumulative distribution function is $G_i(\varphi) = 1 - \varphi^{-\theta_i}$ and the probability density function is given by $g_i(\varphi) = \theta_i \varphi^{-\theta_i - 1}$.

[7] Foreign lenders do not affect the welfare of the origin country. Consequently, we assume that interest rates are not affected by firms in the model.

2. *given* $\{s_i^*, w^*, r_i^*, \kappa_i^*\}$*, the representative producer chooses the optimal prices to maximize the producer's profit at the optimal demand;*

and the following conditions hold:

- *zero cutoff profit condition;*
- *free entry condition;*
- *labor market clearing condition;*
- *trade balance condition;*
- *income spending equality condition.*

The *zero cutoff profit condition (ZCP)* requires the firm to earn non-negative profits and engage in export if and only if $\Pi_{ij}(\varphi) \geq 0$. Among the producers in country i, only the most productive ones with $\varphi_{ij} \geq \varphi_{ij}^*$ sell in the market j.

The *free entry condition (FE)* for firms in country i equalizes the expected profit on market entry with the entry cost, $E_\varphi \left[\sum_j \max\left\{\Pi_{ij}(\varphi), 0\right\}\right] = w_i f_i^e$.

The *labor market clearing condition (LMC)* equalizes total labor demand to labor supply in the country i which is given as

$$M_i^e w_i f_i^e + M_i \int_{\varphi_{ij}^*}^{\infty} \left(q_{ij}(\varphi)\tau_{ij} \frac{(1 + r_i - s_i)(1 + \kappa_{ij})}{\varphi} + w_i f_{ij} \right) \frac{dG_i(\varphi)}{1 - dG_i(\varphi_{ij}^*)} = L_i(1 - \gamma_i) \tag{3.4}$$

where M_i^e and L_i denote the mass of entrants and the number of identical households in the origin country, respectively.

The *trade balance condition (TB)* requires the origin country's aggregate imports from the destination country to be equal to its aggregate exports to the destination country, $X_{ij} = X_{ji}$.

The final equilibrium condition, stating that the total income should be equal to the total spending of the country i automatically holds by Walras' Law.

To summarize[8], equilibrium consists of four ZCPs, two FEs, and two LMCs, making up a system of eight equations in eight unknown endogenous variables: $\varphi_{ii}^*, \varphi_{jj}^*, \varphi_{ij}^*, \varphi_{ji}^*, M_i, M_j, w_i, w_j$.

3.3.5 Bilateral Trade

To generate a gravity equation, we need to aggregate total trade flows across all firms in the origin country which requires aggregate variables of prices and productivity. Hence, average price charged by all firms in i selling to j is $\int_{\Omega_i} p_{ij}(\varphi)^{1-\sigma} d\varphi = \int_0^\infty M_{ij} p_{ij}(\varphi)^{1-\sigma} \mu_{ij}(\varphi) d\varphi$ where M_{ij} is the mass of firms exporting from i to j and $\mu_{ij}(\varphi)$ is the probability density function of firms' productivities from country i that sell to country j. Average productivity of exporters can be defined as $\tilde{\varphi}_{ij} \equiv (\int_0^\infty \varphi^{\sigma-1} \mu_{ij}(\varphi) d\varphi)^{\frac{1}{\sigma-1}}$.

These considerations allow us to write the gravity equation implicitly as

[8] Detailed derivation of every condition can be presented upon request.

$$X_{ij} = \left(\frac{\frac{\sigma}{\sigma-1} w_i (1 + r_i - s_i) \tau_{ij} (1 + \kappa_{ij})}{\tilde{\varphi}_{ij} P_j} \right)^{1-\sigma} M_{ij} Y_j \tag{3.5}$$

where

$$\tilde{\varphi}_{ij} = \left(\frac{M_i}{M_{ij}} \frac{\theta_i}{1-\sigma+\theta_i} \left(\frac{\sigma}{\sigma-1} \frac{(1+\kappa_{ij})\tau_{ij}(1+r_i-s_i)w_i}{P_j} \right)^{\sigma-1-\theta_i} \left(\frac{\sigma f_{ij}}{Y_j} \right)^{\frac{\sigma-1-\theta_i}{\sigma-1}} \right)^{\frac{1}{\sigma-1}}.$$

Eq.3.5 provides the same sectoral gravity equation due to the separability of the structural gravity theory demonstrated by Anderson and Wincoop, 2003. Explicit derivation of the sectoral gravity equation (Eq.3.5) yields

$$X_{ij} = \frac{Y_i^{\frac{\theta_i}{\sigma-1}} Y_j^{\frac{\theta_i}{\sigma-1}}}{\sum_j Y_j^{\frac{\theta_i}{\sigma-1}}} \left(\frac{\tau_{ij}(1+\kappa_{ij})}{P_j \Pi_i} \right)^{-\theta_i} f_{ij}^{\frac{\sigma-1-\theta_i}{\sigma-1}}. \tag{3.6}$$

The terms $P_j = \sum_i \left(\frac{\tau_{ij}(1+\kappa_{ij})}{\Pi_i} \right)^{-\theta_i} \frac{Y_i^{\frac{\theta_i}{\sigma-1}}}{\sum_j Y_j^{\frac{\theta_i}{\sigma-1}}} f_{ij}^{\frac{\sigma-1-\theta_i}{\sigma-1}}$ and $\Pi_i \equiv \sum_j \left(\frac{\tau_{ij}(1+\kappa_{ij})}{P_j} \right)^{-\theta_i} \frac{Y_j^{\frac{\theta_i}{\sigma-1}}}{\sum_j Y_j^{\frac{\theta_i}{\sigma-1}}} f_{ij}^{\frac{\sigma-1-\theta_i}{\sigma-1}}$ are respectively called inward and outward multilateral resistance terms that account for third-country effect in determining bilateral trade flows (Anderson and Wincoop, 2003).

We take the first-order derivatives of X_{ij} with respect to s_i and κ_{ij} to find the relationship between agricultural policies and trade flows of agricultural goods:

$$\frac{\partial X_{ij}}{\partial s_i} = C \frac{\theta_i}{(1 + r_i - s_i)^{1+\theta_i}} (1 + \kappa_{ij})^{-\theta_i} > 0, \tag{3.7}$$

$$\frac{\partial X_{ij}}{\partial \kappa_{ij}} = -C \frac{\theta_i}{(1 + \kappa_{ij})^{1+\theta_i}} (1 + r_i - s_i)^{-\theta_i} < 0, \tag{3.8}$$

where $C \equiv \sigma^{\frac{\sigma-1-\theta_i}{\sigma-1}} \left(\frac{\sigma-1}{\sigma} \right)^{\theta_i} \left(\frac{\theta_i}{1-\sigma+\theta_i} \right) \left(\frac{P_j}{\tau_{ij} w_i} \right)^{\theta_i} Y_j^{\frac{\theta_i}{\sigma-1}} M_i f_{ij}^{\frac{\sigma-1-\theta_i}{\sigma-1}}$.

Two hypotheses are proposed for bilateral trade and unilateral non-trade agricultural policies based on the comparative statics analysis in Eq.3.7 and Eq.3.8:

Hypothesis 1 *Trade flows increase as the amount of credit subsidies increases (based on Eq.3.7).*

Hypothesis 2 *Trade flows decrease as the applied tariff rates increase (based on Eq.3.8).*

Credit subsidies as a cost reducer influence demand through prices, which directly increase exporters' productivity and the product's trade flow. On the contrary, trade barriers such as applied tariff rates increase the cost of the product resulting in reduced trade. Besides trade policies affecting trade costs, domestic policies such as regional trade agreements (RTAs) and currency regimes are crucial in driving trade and external competitiveness by changing relative prices, which is not derived explicitly in our theoretical framework (Aman, Mallick, and Nemlioglu, 2022; Mallick and Marques, 2016; Yang and Mallick, 2014).

Melitz, 2003 heterogeneous firm model is more sensitive to changes in trade costs than Krugman, 1980 model of homogeneous firms due to the $\theta_i > \sigma - 1$ assumption.

Furthermore, it predicts a larger change in trade flows by considering intensive (exporting firms export more) and extensive (smaller firms start to export) margins, while Krugman, 1980 model lacks the second effect. To capture all effects (multilateral resistances, intensive and extensive margins), we estimate Eq.3.5 (Melitz-type gravity equation) applying to Kyrgyzstan's agricultural sector. Although no data exist about the number of exporting farmers (which clearly shows the extensive margin of trade policies) we provide a descriptive analysis of new destinations of trade flows.

3.4 Empirical evidence

We aim to analyze Kyrgyzstan's international trade flows (export and import) in all agri-food products for its 69 trading partners using the structural gravity model in a more specific way. We provide an econometric panel data estimation of the earlier derived theoretical concept (Eq.3.5) defining Kyrgyzstan as a single-origin country.

3.4.1 Specification

We follow Yotov, Piermartini, Larch, et al., 2016 guide for estimation purposes. They propose a comprehensive and theoretically-consistent gravity specification that identifies bilateral and unilateral non-discriminatory trade policy effects. Despite the lack of data on fixed costs and the number of exporters, we include all other Melitz framework's variables such as productivity and consumer price indices. We do not include the RTA dummy because applied tariff rates are calculated, including trade agreements; therefore, putting the RTA dummy into the regression would perfectly collinear with tariffs. With the reduction of import tariffs on agricultural and food products worldwide, the spread of non-tariff measures (NTMs) becomes vital for policymakers (Cusolito and Hollweg, 2013). Hence, our empirical analysis consists of the estimation of the following gravity equation with the inclusion of NTM:

$$X_{ij,t} = \exp\big[\beta_1 \ln S_{i,t} + \beta_2 I_{ij,t} \times \ln S_{i,t} + \beta_3 \ln S_{i,t-2} + \beta_4 \ln T_{ij,t} + \beta_5 \ln N_{ij,t} + \beta_6 \ln V_{ij,t} + \beta_7 \ln Y_{j,t} + \beta_8 \ln D_{ij,t} + \beta_9 P_{j,t} + \pi_{i,t} + \chi_{j,t} + \lambda_{i,j}\big]\, \varepsilon_{ij,t}. \quad (3.9)$$

Eq.3.9 describes the relation between nominal trade flows ($X_{ij,t}$) at time t and the following explanatory variables where $S_{i,t}$ refers to the total amount of credit subsidies provided by the Kyrgyz government. $I_{ij,t}$ is a dummy variable which takes a value of 1 if Kyrgyzstan is an importer; 0 otherwise. We put an interaction term in our specification to separate credit subsidies' effect on imports because the import substitution effect can stimulate expansion in production. Also, we include two years lagged subsidies $S_{i,t-2}$ to evaluate the phasing-in effects of implemented policy (i.e. agricultural production responding to investments]. $T_{ij,t} = (1 + \kappa_{ij,t})$ denotes applied agricultural bilateral tariff rates where we use applied most-favored-nations (MFN) tariffs for those countries Kyrgyzstan does not have any trade agreement and $N_{ij,t}$ is NTMs on imported goods. $V_{ij,t}$ represents the average productivity of farmers while $Y_{j,t}$ indicates the production of agricultural goods of destination country. D_{ij} shows the weighted distance between Kyrgyzstan and its trading partners (proxy for transportation costs) and $P_{j,t}$ represents an import price index. $\pi_{i,t}$, $\chi_{j,t}$ and $\lambda_{i,j}$ indicate the time-varying exporter-importer fixed effects and pair fixed effects, respectively. $\varepsilon_{ij,t}$ is the multiplicative error term. Our focus is on the sign of the estimated coefficients of $S_{i,t}$ and $T_{ij,t}$ in this specification. According to our theoretical analysis,

we expect the sign of credit subsidies to be positive since a larger amount of subsidies implemented by Kyrgyzstan accelerates the productivity of farmers which in turn affects trade flows positively (Vatn, 2002). In contrast, an increase in tariff rates imposed by importers is associated with a small amount of trade flows for Kyrgyzstan and vice-versa. Hence, we expect the sign of tariffs to be negative.

3.4.2 Data

Our dataset is a balanced annual cross-country data for Kyrgyzstan and its 69 trading partners[9], consisting of exports and imports during 2007-2018 with 1,656 observations. Agricultural trade encompasses the categories 01 to 24 of the eight-digit Harmonized System 2007 nomenclatura. We used the United Nations COMTRADE database for data on international trade flows. The data on agricultural credit subsidies,[10] as exporter's non-trade policy data, collected from the Ministry of Finance database of the Kyrgyz Republic. The data on weighted tariffs, as importer's non-discriminatory trade policy data, was calculated according to WTO's manual by Bachetta et al., 2012 using trade and tariff rates from WTO's annual publications called "World Tariff Profiles." We prefer import-weighted tariffs over simple averages because simple averages give the same weight to products that are not imported and those imported in large amounts, causing biasedness[11]. The data on NTMs collected from UNCTAD's TRAINS database. The database covers import (technical and non-technical measures) and export measures as well as information on "procedural obstacles" (e.g. administrative burdens, transparency issues or infrastructural challenges). We also used other sources for standard gravity variables like the United Nations Statistics Divisions database for data on gross value added (GVA), the International Monetary Fund database for consumer price indices, and the GeoDist database on CEPII measured by Mayer and Zignago, 2011 for weighted international bilateral distances. We calculate the average productivity data[12] using GVA and employment in agricultural sector. The data on total labor force in the agricultural sector are sourced from the World Bank's World Development Indicators (WDI).

Table 3.1 provides descriptive statistics of all variables used in the empirical analysis.

3.4.3 Methodology

We follow Silva and Tenreyro, 2006 to estimate our theoretical model with the PPML estimator[13] since our gravity model is in multiplicative form and it has a number

[9]Trade partners include Afghanistan, Albania, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahrain, Belarus, Belgium, Bosnia Herzegovina, Bulgaria, Canada, China, Hong Kong, Croatia, Czechia, Denmark, Egypt, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan, Jordan, Kazakhstan, South Korea, Kuwait, Latvia, Lebanon, Lithuania, Malaysia, Mexico, Moldova, Mongolia, Montenegro, Netherlands, Macedonia, Norway, Oman, Pakistan, Philippines, Poland, Qatar, Romania, Russia, Saudi Arabia, Serbia, Singapore, Slovenia, Spain, Switzerland, Tajikistan, Thailand, Turkey, Ukraine, United Arab Emirates, United Kingdom, United States of America, Uzbekistan, Viet Nam.

[10]Credits are provided by the following interest rates: livestock - 10%, crop - 10%, processing - 8%.

[11]Source: WTO, "A Practical Guide to Trade Policy Analysis," 2012

[12]Average productivity of farmers is calculated as follows: Prod=GVA/labor force in the agricultural sector.

[13]Stata contains a built-in *ppml* command developed by Silva and Tenreyro, 2006 that can easily be applied to the gravity model.

TABLE 3.1: Complete dataset summary statistics.

	Mean	**Std. Dev.**	**Min.**	**Max.**
Trade (million USD)	6.02	25.70	0	262.00
Subsidy (million USD)	2.34	4.25	0	13.70
Weighted tariff (%)	9.14	30.98	0	844.50
NTMs (number of measures)	8.17	54.60	0	699.00
Productivity (thousand USD)	17.35	108.90	.55	2976.43
Nominal GVA (billion USD)	16.70	74.50	.06	1020.00
Weighted distance (thousand km)	4.51	2.56	.54	15.96
CPI (%)	116.94	32.83	63.01	508.02

of advantages over other estimators such as Tobit and OLS. First, it accounts for heteroscedasticity. Second, the PPML estimator can use information containing zeros in trade flows while other log-linear estimators exclude them or treating them with small values may bias the estimation results (Linders and Groot, 2006). Third, it is consistent in the presence of fixed effects as in simple OLS. Fourth, the PPML can also be used to calculate theory-consistent general equilibrium effects of trade policies (Larch and Yotov, 2016). Finally, the interpretation of the PPML estimator's coefficients is straightforward and follows the same pattern as in OLS. However, we also display estimates using the OLS estimator to show the robustness of our analysis.

We provide five different estimations to see the effects of gravity variables and multilateral resistance terms on trade flows by applying other methods. Loglinearizing our econometric model, first, we perform pooled OLS and fixed effects OLS estimation techniques. However, these estimators do not control for heteroscedasticity, where our data exhibits a large degree of heteroscedasticity. Furthermore, fixed effects OLS only partially controls the multilateral resistances while pooled OLS does not.

Second, we provide the PPML estimator with exporter and importer time fixed effects without counting potential endogeneity issues of focus variables. The fourth regression includes directional country-pair fixed effects to the PPML estimator to obtain consistent gravity estimates. We further modified the fourth regression in Column 4, including two years lagged subsidy variable, to capture the impact of subsidy policy changed over time. Even more important, there might be a time lag between the uptake of the credit subsidy by a farmer and the resulting (expected) increase in production. Therefore, we focus on the last estimator, where we consider all before mentioned econometric issues except serial correlation and cross-sectional interdependence. Our data do not suffer from serial correlation. In contrast, we faced cross-sectional interdependence, which may cause bias in the nonzero correlation between factors and regressors (Kapetanios et al., 2017). Such multi-dimensional models call for new econometric methods to deal with this issue which is not readily developed.

3.4.4 Results and discussion

We present the parameter estimation results for our gravity model's determinants in Table 3.2. Econometric specifications deliver relatively low fit with an R-square ranging from 21% to 33%. However, a high R-square does not necessarily indicate the models' goodness of fit because adding a predictor to a model increases R-square. Overall, the estimates for the gravity equation's "conventional" variables align with previous studies in the literature establishing the sample's representativeness. By comparing different specifications, our results remain stable and the coefficients do not differ markedly in terms of magnitude, which shows the robustness of our analysis[14].

The empirical results summarized in Table 3.2 show that the Kyrgyz government's credit subsidies as a unilateral non-trade policy fail to support our theory as we cannot reject the Null hypothesis. Possible reasons for this outcome could be the following. First, the amount of subsidies is too small compared to agriculture's GVA. For instance, the share of credit subsidies increased from .93% of GVA in 2013 to 1.17% in 2018.

Second, this policy could affect farmers' total productivity but not their export performance. Farmers could produce commodities that are mainly sold in the domestic market. A rise in the supply of agricultural products reduces farm products' import substitution due to the country's fixed demand for agricultural goods. However, the share of the labor force in agriculture to the total labor force in Kyrgyzstan decreased from 53.08% to 26.52% in the last two decades. Hence, subsidies could increase domestic farmers' productivity, but the demand for imported agricultural products could also increase due to the supply shortage of farm goods in the domestic market.

Farmers could switch producing one type of agricultural commodity to another (see Figure 3.2). To examine the impact of credit subsidies on the international trade of exporters and importers separately and whether the structural break in 2014 is related to any farm support policy or other external factors, we need disaggregated data on the production, labor, and production costs of exporters and importers, which could be the subject of future research. However, this break does not affect our results in the study because we take it into account and minimize it with exporter and importer time fixed effects.

Last but not least, these subsidies can be used for purposes other than intended ones. Banks need to provide more loans than to monitor their efficiency. Farmers could use this opportunity for other consumption purposes like festive events characteristic for the Central Asian people (Aldashev, 2019). Over the years, their popularity has grown, increasing their expenses, thus forcing people to spend credit subsidies for other purposes. Which of these effects could serve as explanation requires more data, including micro-level observations from beneficiaries.

We find a statistically insignificant relation between interaction term and import which confirms that the impact of a supply shortage of agricultural goods dominates the indirect effect of credit subsidies on importers. Furthermore, the shift of domestic production from high-value-added crops to raw materials in 2014 could also enhance the demand for imported high-value-added crops. Consequently, this policy does not influence importers' trade decisions due to Kyrgyzstan's increasing demand for imported goods.

[14]The total number of observations is 1656. Some of the observations are omitted due to perfect colinearity with time and pair fixed effects in the PPML estimations.

TABLE 3.2: On the impact of subsidies and tariffs on international trade.

	OLS	**OLS**	**PPML**	**PPML**	**PPML**
Log credit subsidy	-.016	-.101	.008	.013	-.006
	(.010)	(.061)	(.027)	(.027)	(.026)
Importer × log credit subsidy	.042	.083	.104	.066	.077
	(.029)	(.108)	(.074)	(.076)	(.088)
Lagged log credit subsidy (t-2)					-.028
					(.024)
Log weighted tariffs	-.414***	-.578***	-.716***	-.978***	-1.045***
	(.081)	(.135)	(.109)	(.103)	(.108)
NTM	.004**	.633***	.002**	-.001	-.001
	(.001)	(.159)	(.001)	(.001)	(.001)
Log average productivity	.420***	.245**	.273***	.016	.020
	(.078)	(.077)	(.056)	(.046)	(.050)
Log gross value added	.528***	.478***	.570***	..457***	.466***
	(.058)	(.051)	(.049)	(.046)	(.050)
Log distance	-1.821***	-.814***	-.880***		
	(.142)	(.201)	(.114)		
Consumer price index	.002	.004	0	0	0
	(.002)	(.003)	(.001)	(.001)	(.001)
Constant	13.310***	2.232	2.547	.806	.440
	(1.468)	(2.333)	(1.386)	(1.261)	(1.312)
R-squared	.242	.224	.210	.303	.327
Observations	1322	1322	1308	1308	1116
Exporter-time fixed effects	No	Yes	Yes	Yes	Yes
Importer-time fixed effects	No	Yes	Yes	Yes	Yes
Country-pair fixed effects	No	No	No	Yes	Yes

Notes: Column (1) applies pooled OLS estimator and column (2) uses the OLS fixed effects estimator. Therefore, dependent variables for these estimators have logged variables of bilateral trade flows. Column (3), (4), and (5) employ the PPML estimator. Column (4) adds directional country-pair fixed effects and column (5) introduces two years of lagged credit subsidy to the previous column. The estimates for the fixed effects and the pair fixed effects are omitted for brevity. Standard errors are robust and are reported in parentheses. *, **, *** denote 1, 5 and 10% confidence levels, respectively.

Any investment needs time to result in a higher output. However, the two-year-long lagged subsidy variable's estimated coefficient points to strong but statistically insignificant phasing-in effects. In particular, the relatively small average effect of credit subsidies over the first two years after its implementation decreases more than five times. The four-year lagged subsidy variable shows an insignificant but positive coefficient suggesting a non-monotonic relationship between trade flows and

credit subsidies. That being said, the effects of subsidies remain insignificant even four years after their implementation.

The applied tariff rates as a bilateral trade policy implemented by the importers show statistically significant negative estimates consistent with theory and confirm the existing literature on the importance of international trade tariffs (Emlinger, Jacquet, and Lozza, 2008; Heid, Larch, and Yotov, 2021). Moreover, the coefficients are lower for those estimates where we control the multilateral resistances with directional (exporter and importer) fixed effects. In our theoretical framework, the beta coefficient of applied tariffs is equal to $\beta_4 = -\theta_i$ where the estimates of trade elasticity of substitution (σ) vary between 2 and 12 in the existing literature.[15] Hence, our beta coefficients obtained from all specifications are within these boundaries except PPML estimation with pair-fixed effects. The beta coefficient of tariffs in PPMLE with pair-fixed effects can be slightly lower when σ takes a lower bound value, $\sigma = 2$.

As traditional trade barriers such as tariffs have been declining over time, there has been a concurrent upward trend in adopting various food safety standards such as NTMs. NTMs are driven by human health and environmental concerns which can be critical for farmers in achieving better product quality. However, the overall effect of NTMs on trade can be either positive or negative, depending on whether the trade-cost effect dominates or falls short of the demand-enhancing effect. Our results show that international trade in agricultural products has increased due to NTMs, as Kyrgyzstan has already complied with NTMs of major partners such as Russia and other Central Asian countries.

The estimates in Column 5 of Table 3.2 indicate that 10% increase in foreign partner's GVA enhances Kyrgyzstan's trade flows by 4.67%. Since 1996, Kyrgyzstan's agricultural sector has reduced while trade flows, particularly, net imports have increased. Thus, our results confirm that Kyrgyzstan has substituted a domestic shortage of farm products with imports.

Distance as a proxy for transportation cost is a significant impediment to bilateral trade. A ten percent increase in length restricts international trade between trading partners by 8.63% on average (Column 3). According to Head and Mayer, 2014 the estimated coefficient of distance is virtually close to the benchmark (–1). Interestingly, while the estimated coefficients of distance obtained from estimators with directional fixed effects (Column 2 and Column 3) are close to (–1), it significantly differs for pooled OLS (Column 1), confirming existing literature on inconsistent results without proper control on multilateral resistance terms.

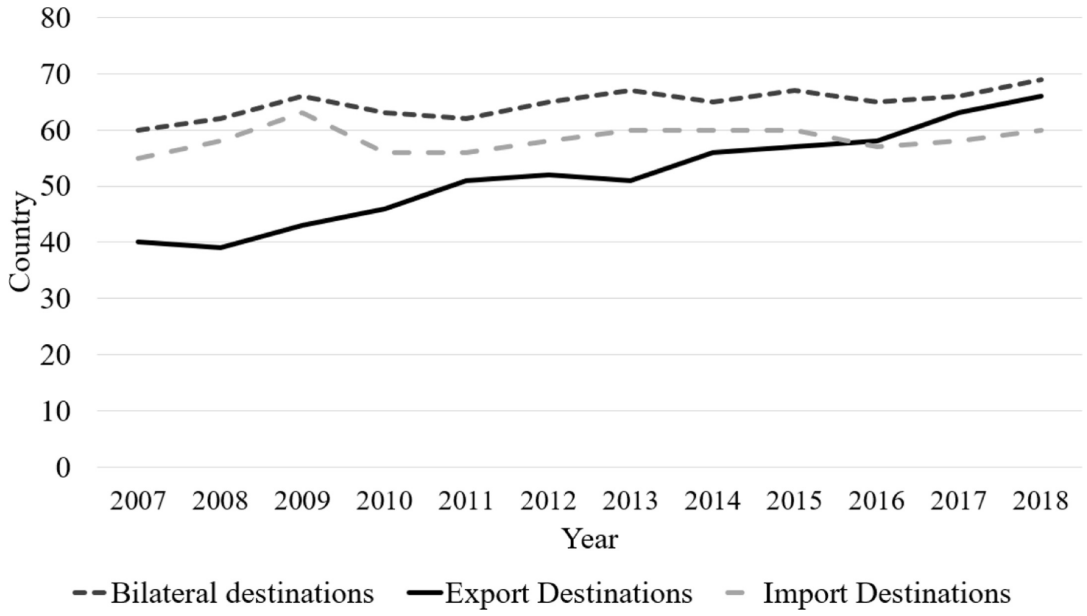
Firms vary in productivity and export choices in the Melitz, 2003 framework. Moreover, the rise in firms' productivity increases trade flows due to intensive and extensive margins. Our empirical results also show that the rise in farmers' average productivity increases trade flows between Kyrgyzstan and its trading partners (Columns 1, 2, 3), reflecting the Melitz, 2003 model's predictions by the extensive margin. However, its significance dropped with excluding the time-invariant distance variable since the variability in productivity is small, and its effect is absorbed by other variables such as tariffs and GVA.

We compare Kyrgyzstan's trade destinations in 2007–2018 to predict the Melitz, 2003 framework's intensive margin effect (Figure 3.3). As shown in Figure 3.3, trade destinations in all directions (export and import) increased. In particular, the most significant change is observed in the export destination compared to import and

[15] The average estimate of σ is equal to 6.13 in the analysis of Head and Mayer, 2014.

bilateral destinations. Hence, our empirical results confirm all the theoretical framework predictions related to multilateral resistances' extensive and intensive margins.

FIGURE 3.3: Evolution of agricultural trade destinations of Kyrgyzstan, 2000–2018.



Source: UN COMTRADE 2020, authors' calculations.

To summarize, our empirical analysis shows that the implementation of non-trade policies does not affect trade flows. In contrast, tariff rates and NTMs as a bilateral trade policy are essential in bilateral trade flows. We can also conclude that the benchmark regression results are robust to various sensitivity analyses.

3.5 Conclusions and policy implications

Existing literature on structural gravity models is mainly based on the theoretical foundations of Anderson and Wincoop, 2003 and Eaton and Kortum, 2002. This study contributes to the existing literature by its novelty of theoretical upgrades such as modification and derivation of a Melitz-type structural gravity equation for small scale economies. Moreover, we show the importance of bilateral trade and unilateral non-trade policies in increasing international trade for emerging economies because the effect of implemented policies could vary with the country's size and development.

This paper examines the impact of trade and non-trade policies using a newly derived Melitz-type structural gravity model that incorporates all the gravity model's traditional and policy variables. According to our theoretical results, policy variables such as credit subsidies are trade-enhancing while trade barriers like applied tariffs are trade-reducing in small open economies. We test our theoretical results using cross-country panel data on agricultural products in Kyrgyzstan from 2007 to 2018. Empirical results lead to two main conclusions.

First, agricultural credit subsidies are not efficient in increasing international trade flows. In Kyrgyzstan, the agricultural sector continuously declined in the last

two and a half decades due to the government's insufficient support and the country's deteriorating infrastructure in the transition period. Moreover, farmers shifted from the unprofitable agricultural sector to profitable ones such as manufacturing and service or migrated abroad. As a result, the country became heavily dependent on imports of farm goods due to the decline in GVA and the total employment in agriculture. To reduce reliance on importers and enhance domestic production of agricultural goods, the Kyrgyz government began to provide credit subsidies to farmers in 2013. Our study shows that this policy is not statistically effective in increasing international trade, which is consistent with studies analyzing other small countries such as Lithuania (Namiotko et al., 2019). Hence, our results suggest that a different use of financial resources could be more effective. Investments into public goods and services such as infrastructure, collection centers, grading facilities or farm extension and training might generate broader effects than the support of individual farms.

Second, bilateral applied tariffs act as a trade barrier and significantly reduce the number of exports from Kyrgyzstan. The annual sum of weighted applied tariffs imposed on the Kyrgyz agricultural products abroad increased from 474.13 in 2007 to 581.59 in 2018. Similarly, the yearly sum of weighted applied tariffs imposed on foreign agricultural products in Kyrgyzstan rose from 612 in 2007 to 654.71 in 2018, showing the interconnectedness of these two phenomena. Turkey, South Korea, and India put the highest tariff rates on Kyrgyz agricultural products, while Kyrgyzstan mostly restricts agricultural products from Mexico, Georgia, and Ireland. Even though these countries (Turkey, South Korea, and India) put high tariff rates on Kyrgyz products, imports from these countries to Kyrgyzstan are quite important. Therefore, the Kyrgyz government should negotiate with these countries on a mutual reduction in applied tariff rates on agricultural products.

To summarize, the Kyrgyz government should invest more effort in bilateral trade deals, such as trade negotiations and agreements, than in its policy of subsidized loans for individual farmers. Moreover, our research shows that the cause of structural changes in international trade flows of agricultural commodities from 2014 was not implementing the subsidy policy. Further research with microdata is required to fully understand the nature of those structural changes, which is not the main focus of this study. Thus, our results may be relevant to other small countries that lack farm-level data or are characterized by a heterogeneous agricultural sector. Macroeconomic data are often easily accessible and can help in assessing policies' effects on trade.

Chapter 4

Heterogeneous effects of weather extremes on different dimensions of poverty in Kyrgyzstan

[1]

Abstract

Weather extremes become more frequent and intense with climate change, but how weather extremes impact household wealth in the Global South remains elusive in many regions. We combined nationally representative quarterly household panel data with climate data to evaluate the impact of weather extremes on household poverty in Kyrgyzstan between 2013 and 2020. We evaluated multiple dimensions of poverty by quantifying changes in nutrition, education, health, and living standards. We used a linear quantile mixed model to relate the poverty dimensions with four salient weather extremes: cold winters, hot summers, excessive rains, and dry spells. Our findings show that all weather extremes harmed household wealth but with substantial spatial variation. Cold winters were the most detrimental, with negative consequences that continued into the subsequent year. Poor households suffered disproportionally more from extremes than rich ones. Our results underscore the need to initiate place-based adaptation options to cushion the adverse effects of extreme weather events on household wealth.

Keywords: weather extremes, multidimensional poverty, vulnerability, Kyrgyzstan

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4.1 Introduction

With climate change, weather extremes become more frequent, which jeopardizes household livelihoods, particularly in the Global South (Soergel et al., 2021; Spilker et al., 2020). More frequent and intense extreme weather events, such as cold winters, hot summers, excessive rains, and dry spells, already substantially impact ecosystems and humans (Sandhu and Sandhu, 2014; Barrett, Travis, and Dasgupta, 2011). The suddenness and variability of weather extremes exacerbate social and economic inequalities, especially for unprepared and marginalized rural communities (Rao et al., 2023; Tenzing and Conway, 2022). Therefore, it is essential to understand the effects of weather extremes on household wealth, particularly for vulnerable households with limited resilience to external shocks.

Developing countries are particularly vulnerable to climate change due to their heavy dependence on natural resources and the challenges posed by low-income levels for timely adaptation (Salvucci and Santos, 2020; Arouri, Nguyen, and Youssef, 2015). Previous research has demonstrated that climate change has a greater negative impact on income in the Global South compared to the Global North (Azzarri and Signorelli, 2020; Tol, 2009). Furthermore, evidence suggests that climate change disproportionately affects impoverished individuals, particularly in disadvantaged regions (Hallegatte et al., 2020; Barbier and Hochard, 2018; Hallegatte and Rozenberg, 2017). However, how climate change, particularly weather extremes, impacts multiple dimensions of wealth and poverty and how these effects vary across space remains understudied in many regions (Adenle et al., 2017).

Poverty encompasses more than just income and consumption; it includes deficits in well-being, positive emotions, relationships, social freedoms, and opportunities for personal development (Adger et al., 2022). To effectively address poverty, interventions must consider these multiple dimensions and target them accordingly (Dika, Tolossa, and Eyana, 1998). Empirical evidence further suggests that the effects of climate change and adaptation options to these changes differ substantially between households and regions (Thornton and Herrero, 2014; Bryan et al., 2013; Carman and Zint, 2020).

The existing empirical literature focuses on analyzing the effect of weather extremes on poverty on the sample mean but often neglects within-sample heterogeneity. People living in poverty are more susceptible to weather shocks and recover more slowly than affluent population segments. Evidence testifies that poor households receive less support from friends, family, and social safety nets after a natural disaster than wealthier households (Hallegatte and Rozenberg, 2017). Quantifying the effects of weather-related shocks on poverty requires a disaggregated perspective to account for socioeconomic heterogeneity within countries and regions (Nguyen et al., 2020).

Spatial targeting and wealth mapping are critical to determine how the effects of climate change impact poverty by region and district (Marcinko et al., 2022). Spatially disaggregated analyses are, therefore, especially paramount for countries that suffer disproportionately from the effects of changing weather patterns. However, subnational analysis in developing countries remains limited due to high data requirements, such as georeferenced household panel data, which allow overlaying meteorological data and control for unobserved individual and household characteristics.

Central Asia is a blind spot in analyses of spatially disaggregated impacts of weather on the multiple dimensions of poverty. Recent research has elucidated the

adverse impacts of how extreme weather increases the probability of stunting of children and reduces birth outcomes in Kyrgyzstan, where extreme weather, such as droughts, floods, and cold spells, severely affect children under 20 months of age and rainfall damaged prenatal birth weights (Freudenreich, Aladysheva, and Brück, 2022; Nguyen and Le, 2023). Our analysis aims to evaluate the effects of weather extremes on poverty with nationally representative, location-matched, quarterly household panel data from Kyrgyz households. We use a linear quantile mixed model to quantify how four types of weather extremes (extreme winter cold, extreme summer heat, excessive rainfall, and drought) affect the different dimensions of poverty and how these effects are distributed throughout Kyrgyzstan.

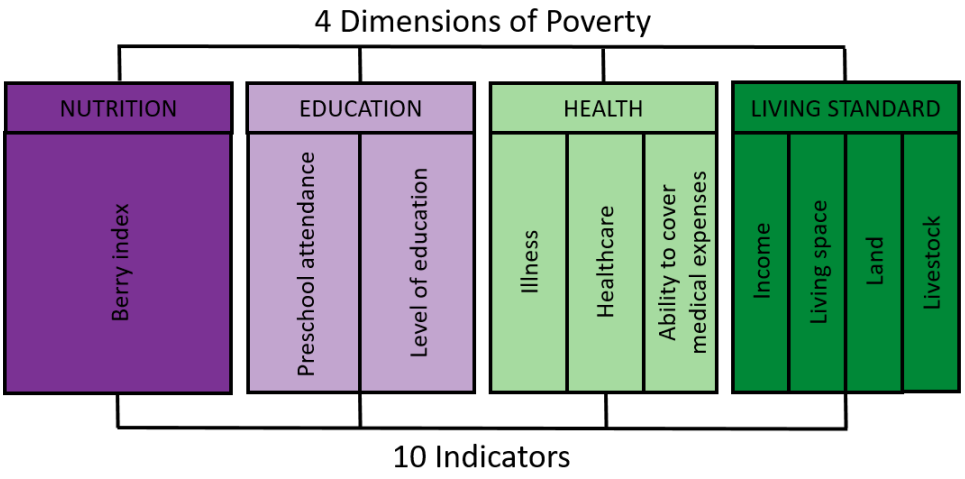
Kyrgyzstan is an interesting case because almost 70% of the population lives in rural areas, and nearly 25% was below the national poverty line in 2020 (Nguyen and Le, 2023). Additionally, the country suffers from frequent and variable extreme rainfall, heat waves, and harsh winters (WB, 2021a). Weather extremes and the lack of adaptive capacity to these extremes make Kyrgyzstan one of the most vulnerable countries in Central Asia (UNICEF, 2017).

4.2 Methods

4.2.1 Identifying poverty

Poverty measures such as the Human Development Index, the Human Poverty Index, and the Multidimensional Poverty Index (MPI) (Alkire and Santos, 2014) define poverty as a multidimensional phenomenon. Our MPI for Kyrgyzstan, MPI_{KGZ}, comprises ten indicators that proxy deprivation along four dimensions: *nutrition*, *education*, *health*, and *living standard* (see Figure 4.1 and Table B.1 for a detailed definition). Each dimension was linked to the Millennium Development Goals at the time and is equally weighted across dimensions (Alkire and Santos, 2014). The MPI_{KGZ} is continuous and ranges from 0 to 1, with higher values indicating a wealthier household status. However, the original MPI was designed for low-income contexts.

FIGURE 4.1: Multidimensional Poverty Index for Kyrgyzstan (Alkire and Santos, 2014).



Source: Authors' figure.

We adapt the original MPI to the conditions prevalent in Kyrgyzstan to account for the local specificities due to the Soviet past (see Table B.2 for a detailed description of the method). The original MPI includes nutrition and child mortality indicators as part of the health dimension. However, child mortality in Kyrgyzstan is very low, comparable to high-income countries, and does not show variation between regions. Consequently, we exclude *child mortality* from MPI_{KGZ} and isolate *nutrition* as a separate dimension.

The general energy intake of the Kyrgyz people is sufficient and there is no undernourishment in the country. However, the quality of the diets of low-income households suffers from a low variety (Rodríguez-Cruz, Álvarez-Berríos, and Niles, 2022). Consequently, we measure the dimension of *nutrition* by relying on the degree of diversification. We aggregated food expenditure shares into ten groups: cereals, flour products, edible oils, fruits & vegetables, processed food, meat & fish, dairy products, beverages, sugar, and miscellaneous items (Kimsanova, Sanaev, and Herzfeld, 2023). These groups form the Berry Index, which shows the degree of food diversification as

$$BI = 1 - \sum_{i=1}^{10} \omega_i^2, \tag{4.1}$$

where ω_i is the share of expenditures on food group i in the household's total consumption expenditure (Thiele and Weiss, 2003; Herzfeld, Huffman, and Rizov, 2014). The value of the Berry index is between 0 and 1, with higher values indicating a more varied diet.

The second dimension of the original MPI is *education*, with *years of schooling* and *school attendance* as indicators. The level of education in Kyrgyzstan is higher than in African countries due to nine years of compulsory schooling. Consequently, we replace the original indicators of *school attendance* and *years of schooling* with *preschool attendance* and *level of education*, where the latter includes household heads without 11 years of education.

We include health as a separate dimension with three indicators: *illness*, *healthcare*, and the *ability to cover medical expenses*. These focus on identifying the inability to receive medical assistance (Bambrick, Moncada, and Briguglio, 2015). Kyrgyz households can suffer from severe health problems due to the country's lack of health insurance (Moldoisaeva et al., 2022). In addition, medical treatment is expensive and unaffordable for poor households.

Finally, the living standard in the original MPI includes *cooking fuel*, *sanitation*, *drinking water*, *electricity*, *housing*, and *assets* as a wealth measure. However, these are basic needs and are satisfied by each Kyrgyz household, thus failing to distinguish the level of wealth. Therefore, our *living standard* measure consists of *income* and *living space* for urban and rural subsamples and *land* and *livestock* for rural households. *Income* and *living space* are normalized and standardized for urban and rural subsamples to avoid discrimination against rural households. We measure the existence of *livestock* and *agricultural land* only for rural households since these are not available to urban households.

4.2.2 Household Survey Data

We use data from the Kyrgyz Integrated Household Survey (KIHS), conducted quarterly each year by the Kyrgyz Republic's National Statistical Committee for 2013-2020. The KIHS is a rotating panel that forms a nationally representative sample of nearly 5,000 households each quarter since its inception in 2003. The sampling

procedure is stratified into urban and rural areas within the seven provinces and the capital city of Bishkek, resulting in sampling strata. In 2013, the sample was renewed with additional information on the location of households in 206 districts. Therefore, our analysis is based on households included in the survey in 2013, and our sample runs until 2020 (for more details of the panel characteristics, see Table B.3).

The survey provides information on a broad set of individual, household, and community characteristics, including demographics, education, health, employment, monthly expenditures, durable goods, land, livestock, housing conditions, income, and transfers. The means of indicators used in the MPI_{KGZ} assessment at the household level, separating the sample into three subsamples (terciles), are presented in Table 4.1. The sample is skewed to the right with a mean of .69 (minimum=.29, maximum=.93). All variables are linearly related across the terciles, except income, living space, and agricultural land. The distribution of households by poverty level is illustrated in Figure 4.2.

TABLE 4.1: Means of indicators used in MPI_{KGZ} computation.

		Poor	**Middle**	**Rich**
	MPI	.61	.71	.75
1	Berry Index	.75	.76	.81
2	Children not in preschool due to financial constraints (%)	9	3	0
	Household heads without secondary education (%)	33	0	0
3	People who cannot afford medical care (%)	22	6	2
	People who cannot afford hospital treatment (%)	19	7	1
	People who cannot cover medical expenses (%)	76	43	10
4	Monthly household income (1,000 KGS)	56.27	45.22	69.63
	Living space per person (m^2)	18.04	16.48	23.73
	Agricultural land (ha)	.83	.68	.70
	Livestock (LSU)	1.64	1.44	1.62
	Number of households	2,616	3,099	2,833
	Number of observations	32,010	32,010	33,980

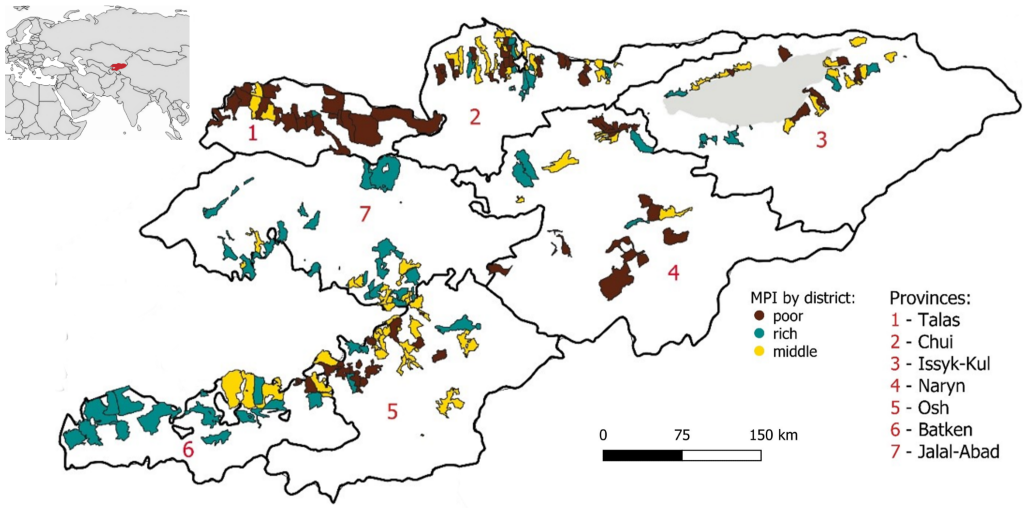
Note: poor=lowest tercile, middle=second tercile, rich=highest tercile.

4.2.3 Identifying weather extremes

We selected three types of weather extremes that were indicated as extreme weather events by Kyrgyz households in the national household survey 'Life in Kyrgyzstan' (LiK, 2010-19). These are cold winters (reported by 25% of the households interviewed), excessive rainfall (33%), and dry spells (16%). We also include hot summer waves, which pose an additional challenge for Kyrgyzstan (IFRC, 2021).

To define dry spells, we use the standardized precipitation index (SPI), a commonly used index to estimate deviations of recorded precipitation from long-term average levels (WMO, 2012). The SPI ranges from -3 to +3 and is calculated by normalizing the precipitation at a predefined time scale after fitting it to its long-term probability density function (McKee, N. J, Kleist, et al., 1993).

FIGURE 4.2: Distribution of households by tercile/wealth status for all surveyed districts.



Note: Tercile I is represented in brown, tercile II in yellow, and tercile III in blue (Table B.4 presents the MPI by province).

In Kyrgyzstan, water availability during the summer largely depends on rainfall that accumulates as snow during winter in the upstream parts of river basins (Apel et al., 2018; Cowherd, Leung, and Girotto, 2023). We determined dry spell events by calculating the 12-month SPI at the provincial level for a hydrological year that starts in October of the previous year and ends in September. We classified an annual SPI value of less than -1 as a dry spell event corresponding to moderate to severe dry conditions (McKee, N. J, Kleist, et al., 1993). We also calculated a 1-month SPI time series for each district to determine extreme rain events and classified values above +2 during the spring months as excessive rainfall.

We used the standardized temperature index (STI) to capture the effect of temperature extremes. We calculated a time series of 1-month district-level STIs and classified cold winter when the observed STI was less than -2 (severely cold) in January, February, or March. We used these three months to describe winter conditions because, in addition to being cold, long periods of cold and snow in early spring can increase mortality and reduce the productivity of livestock (Kaziev, 2021). Hot summers are events in which monthly STI values surpass +2 in July or August. Table 4.2 summarizes the resulting extreme weather events considered in the following analysis.

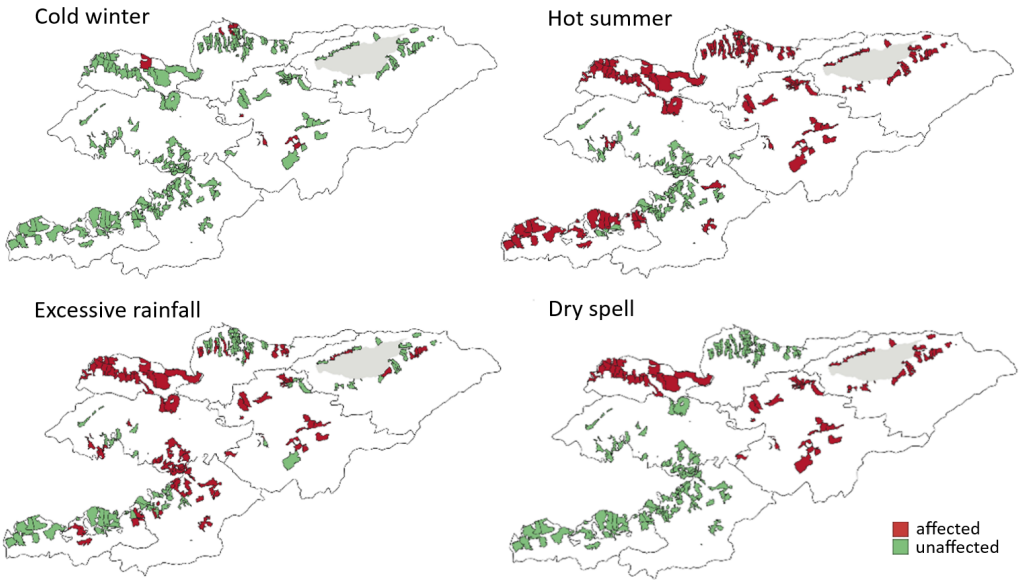
TABLE 4.2: Derivation of weather extremes.

Variables	**Explanation**	**Space resolution**
Dry spell (DS)	SPI< -1 for the hydrological year	province
Excessive rain (ER)	Monthly SPI in spring > 2	district
Cold winter (CW)	Monthly STI for January, February, March < -2	district
Hot summer (HS)	Monthly STI for July, and August > 2	district

4.2.4 Climate data

We calculated all SPI and STI indices using precipitation and temperature data from the ERA5-Land global reanalysis dataset (Muñoz-Sabater et al., 2021), available at a resolution of approximately 9 km. We used the entire 1950-2020 ERA5 Land period to establish long-term climatological averages and calculate the time series of the SPI and STI indices for the boundaries of each district of Kyrgyzstan derived from OCHA, 2021. Figure 4.3 depicts the distribution of districts where we detected at least one instance of a weather extreme.

FIGURE 4.3: Districts where weather extremes occurred at least once during 2014-2020.



Note: Figure B.1 displays the frequency of weather extremes across the country.

4.2.5 Specification of the econometric model

The effects of weather extremes on a household's wealth can be heterogeneous in space and time. We are particularly interested in understanding whether weather extremes affect the poorest households more than more affluent ones. Therefore, we need an estimator that divides our sample into three subsamples, representing the three terciles of the MPI distribution. Additionally, household wealth and weather shocks are clustered in districts that are likely to correlate with unobserved location characteristics, which we account for in the estimations.

We use the linear quantile mixed model (LQMM) of Geraci and Bottai, 2014. The LQMM allows us to model the relationship between independent and dependent variables for each subsample. Furthermore, the model accounts for the potential correlation of household wealth within districts. We use the *lqmm* package of R to analyze the model specified as

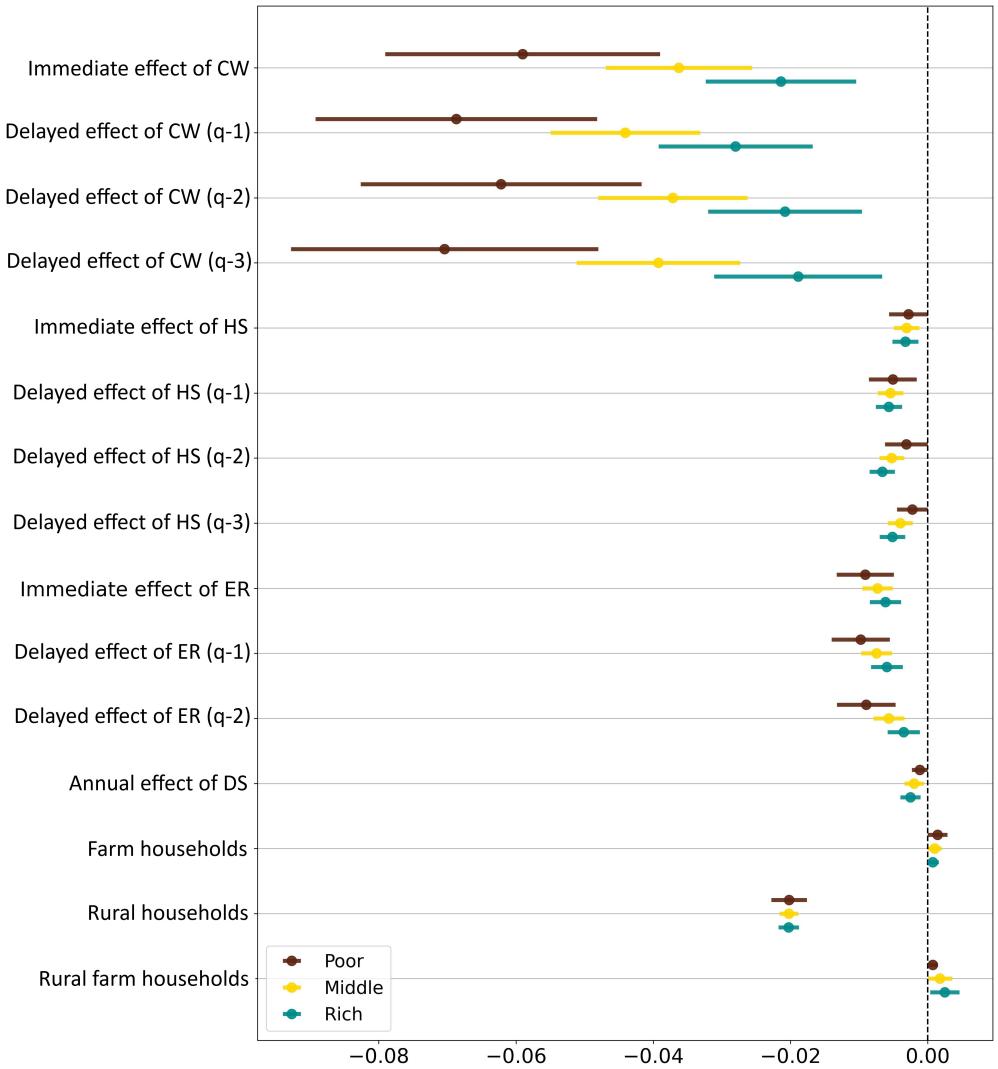
$$MPI_{ij}^{KGZ} = \alpha^{\tau} + \gamma_i^{\tau} + (\beta^{\tau} + \lambda_i^{\tau}) \times \left(\sum_{n=-3}^{0} CW_{ij}^{n} + \sum_{n=-3}^{0} HS_{ij}^{n} + \sum_{n=-2}^{0} ER_{ij}^{n} + DS_{ij} + A_{ij} + R_{ij} + AR_{ij} \right) + \varepsilon_{ij}^{\tau}, \tag{4.2}$$

where MPI_{ij}^{KGZ} is an MPI_{KGZ} of the household i in the district j. CW_{ij}^{n}, HS_{ij}^{n}, ER_{ij}^{n}, and DS_{ij} are the climate variables where n represents lagging values. A_{ij}, R_{ij}, and AR_{ij} signal if a household is farm, rural, or both, as farming infers MPI. α^{τ} and β^{τ} are the fixed intercept and slope of the τ^{th} quantile level of interest, respectively. γ_{i}^{τ} and λ_{i}^{τ} are the random intercept and slope for the i_{th} household, respectively. ε_{ij}^{τ} is an unexpected error associated with MPI_{ij}^{KGZ}.

4.3 Results

Weather extremes harm household wealth, with cold winters being the most destructive (Figure 4.4). Poor households are particularly vulnerable to cold winters and excessive rainfall. The delayed effects of weather shocks over a quarter-year period vary between different types of shocks and poverty classes.

FIGURE 4.4: The average partial effects of weather extremes on MPI.



Note: The length of the lines shows the 95% confidence intervals. Immediate and delayed effects of weather extremes on MPI are displayed for up to 3 subsequent quarters (q) and the respective control variables.

The average partial effect estimates of -.06 for the lowest tercile, -.04 for the second tercile, and -.02 for the highest tercile imply that an immediate cold winter was associated with a 6 percentage points reduction of the MPI for the poor, 4 for the middle, and 2 for the rich. The delayed effects of cold winters in spring and fall further exacerbate poverty, especially for the poor, with a 7 percentage point increase. Overall, the delayed effects of cold winters are greater for the poor and middle classes.

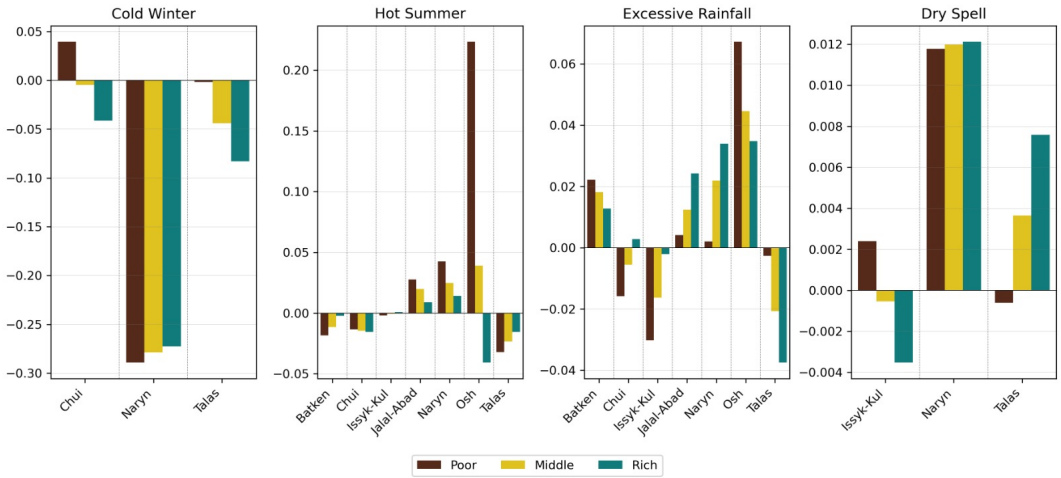
Hot summers, excessive rainfall, and dry spells have comparatively less detrimental effects throughout the year. The immediate effect of hot summers was similar for all households and below 1%, while the delayed effects of hot summers were more harmful to wealthy households. The immediate and delayed effects of excessive rainfall are the same for all households. The annual effect of a dry spell is negligible.

Rural households consistently exhibit lower MPI than urban households in all subsamples. Farm households, in general, are, on average, slightly wealthier than non-farm households, with rural farm households notably surpassing their urban counterparts in wealth.

4.3.1 Large regional differences in the impact of weather extremes

We calculate the marginal and gross effects of weather shocks by summing the immediate and delayed effects of each weather event by province over the year (Figure 4.5). Compared to the main specification (Figure 4.4), the results show larger effects due to the increased focus on specific provinces and the higher proportion of affected households within those provinces.

FIGURE 4.5: Marginal changes in MPI by province and population segment.



Weather shocks demonstrated varying impacts on specific population segments across different provinces. Notably, hot summers and excessive rainfall showed various consequences, albeit of lesser magnitude compared to cold winters and dry spells. Cold winters had an overall detrimental effect on individuals throughout all provinces, reducing up to .3 points in their MPI. Conversely, dry spells tended to yield favorable outcomes.

Naryn (see districts locations in Figure 4.2), a poverty-stricken province with harsh winters, experienced a significant .3-point decline in its MPI due to cold weather,

affecting all components of the MPI (Figure 4.5). Most households in Naryn depended on the rearing of livestock and were forced to sell or slaughter their livestock, resulting in substantial losses. Tragically, some livestock perished due to extreme cold. This finding aligns with the research by Sultakeev and Petrick, 2021, highlighting the crucial role of livestock as the primary asset for Naryn pastoralists in breaking the cycle of poverty.

The favorable impact of dry spells on the well-being of the Naryn and Talas families is linked to the distinctive geographical and agricultural characteristics of these provinces. Their elevated terrain and reliance on upstream river basins indicate a lower vulnerability to droughts than regions heavily dependent on irrigated agriculture. Additionally, these provinces focus predominantly on livestock farming rather than irrigated crop cultivation, contributing to their resilience to dry spells. Although dry spells adversely affect irrigated crop production, their impact on other agricultural activities in these areas is less pronounced.

Naryn households benefit from hot summer events, taking advantage of their high elevation and generally colder setting. The occasional warmth contrasts with their typical cooler climate, providing residents with a temporary reprieve from chilly conditions and potentially improving overall well-being during the summer months.

Unlike mountainous regions, Osh, Jalal-Abad, and Batken provinces in low-elevation valleys possess different climates and susceptibilities to weather-related risks. Their hot and arid climate provides advantages over their mountain counterparts, particularly in managing hydroclimatic extremes. This climatic distinction reduces vulnerability to excessive rainfall episodes, a significant benefit in rugged terrain.

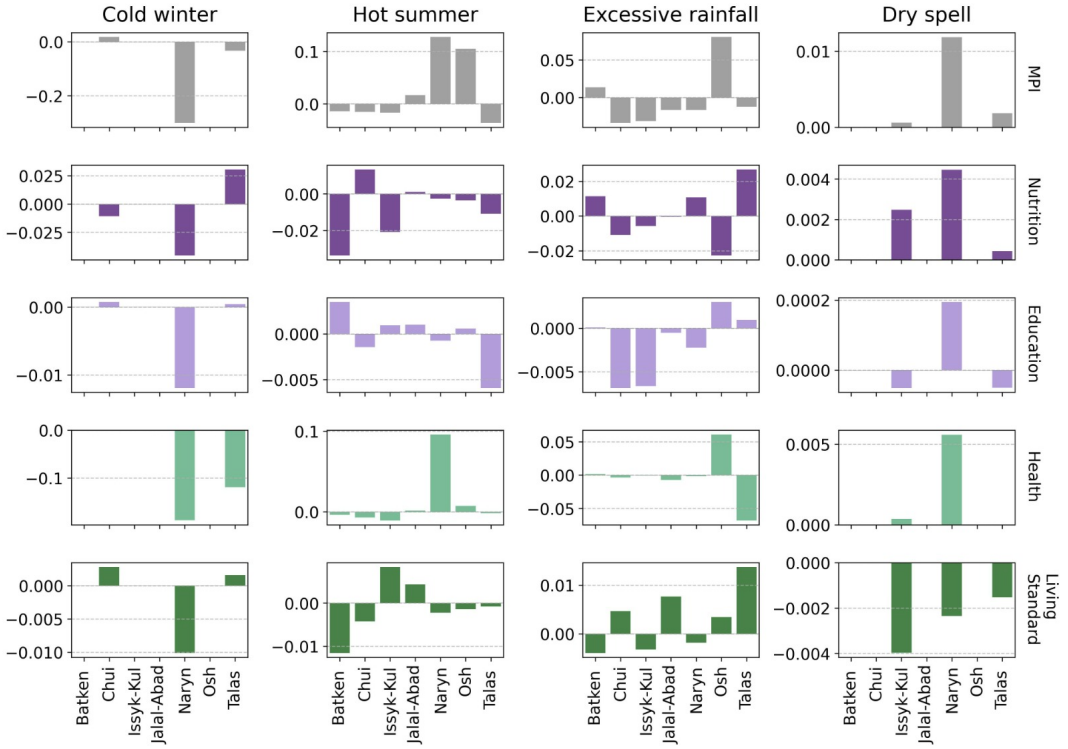
4.3.2 Heterogeneous effects of weather extremes on the different dimensions of poverty

We estimated four separate regressions to analyze the effects of the province and MPI dimensions on the sample mean (Figure 4.6). The results reveal slight differences from the pooled sample, as different subsamples have different distributions. In particular, households in provinces with an average MPI closer to the national average exhibit results similar to those of the pooled sample.

Weather events had varying impacts on MPI components, with education, health, and nutrition accounting for 95% of MPI (see Figure B.2). The findings reveal a positive correlation between MPI and hot summers in Naryn, driven by health improvements. In Osh, a noticeable positive impact of around .1 points is observed on overall MPI during hot summers, with negligible effects on individual dimensions. This underscores the nuanced disparities within subsample distributions and accentuates the intricate interplay between climatic variables and poverty dimensions.

The positive impact of excessive rains on MPI in Osh is related to improvements in education, health, and living standards. Presumably, households in Osh favor more rainfall due to the severe aridity in the region. Similarly, the positive impact of dry spells on MPI in Naryn and Talas is associated with improvements in nutrition, education, and health, possibly influenced by warm weather. A comprehensive exploration is warranted to discern the causal mechanisms, particularly given the long-term nature of these dimensions.

FIGURE 4.6: Marginal changes in MPI and its dimensions by province.



4.4 Discussion

Our analysis offers a comprehensive understanding of the impact of increasingly frequent weather extremes on the various dimensions of poverty in Kyrgyzstan. We revealed the regional specifics of the weather extremes on the poverty dimensions and explored the varied impacts of the extremes on different wealth segments.

We show how the poorer population segments suffer disproportionally more from weather extremes than the richer segments. This finding corroborates empirical evidence that weather extremes predominantly jeopardize the livelihoods of the poor and thus tend to increase inequality (Diffenbaugh and Burke, 2019; Cappelli, Costantini, and Consoli, 2021). The delayed impact of weather extremes appeared to aggravate poverty by compounding the extent and probability of increased economic inequality arising from climate change (Schewe et al., 2019). Our results suggest that existing adaptation measures, though partially effective, do not fully alleviate the regressive impact of weather extremes on economic inequality in Kyrgyzstan. Similar worrying developments have also been found in other countries, particularly in the Global South, such as the Caribbean island (Friedman, 2023) and the Philippines (See and Wilmsen, 2020).

We also reveal that the impacts of extreme weather on the local population exhibit considerable geographic variability, highlighting the importance of spatially explicit analysis. It also underscores that climate adaptation efforts must respond to this spatial variation and encompass locally adapted strategies, which fall within the

responsibility of local governments and communities (Mathew, Trück, and Henderson-Sellers, 2012). However, weak government institutions, limited research and development capacity, and fragile state bureaucracies often impede effective climate adaptation actions and fail to reach some population groups, especially marginal ones (Garschagen and Doshi, 2022).

Approximately 1.2 billion people worldwide live in acute poverty, as measured by the MPI (UNDP, 2022). The United Nations uses MPI to monitor progress toward Sustainable Development Goal 2 of reducing global poverty by half, covering all dimensions of poverty (UN, 2022). Our econometric findings underscore the importance of tailored policies that consider regional disparities and that account for the various dimensions of poverty between households. These go beyond monetary measures, such as income, and include education, health, and nutrition as critical indicators. Our comprehensive approach effectively addresses how weather shocks affect these multiple dimensions, which is critical to achieving the desired reduction in poverty in the face of ongoing climate change.

Empirical impact functions, as used here, are based on historical data. While providing important lessons from historical developments, we know that such approaches are only of limited use to accurately predict long-term impacts and adaptations in the face of increasing climate variability (Lee et al., 2023). Our analysis can also not fully account for additional multifaceted inequalities such as gender, race, and the large variation in the adaptive capacities of households. Moreover, we caution readers to generalize our results to different climatic conditions and other socioeconomic contexts.

4.5 Conclusion and policy implications

Previous studies have documented an increase in the frequency, duration, and severity of droughts, floods, heatwaves, mudslides, and wildfires globally and in Central Asia. This trend is projected to continue due to accelerating climate change and is likely to jeopardize the well-being of households, particularly in the global South. In Kyrgyzstan, the results of our analysis underline that weather extremes have a heterogeneous effect on various dimensions of poverty.

The cold winter in the northern part of the country in 2014 was particularly critical to poor households, mainly by reducing education levels and health conditions. If these extremes persist, households in these regions will be in danger of a downward spiral of reducing levels of education and health. Policymakers should particularly target these vulnerable people and risk areas by supporting education and health infrastructure.

With climate change, heat waves are intensifying and rainfall events become more extreme in Central Asia. It is crucial for the Kyrgyz government to implement effective measures to mitigate the adverse consequences, particularly in regions where these shocks have severe impacts. Priority should be given to disadvantaged and impoverished households, as they bear a disproportionate burden of these effects.

Chapter 5

Discussion and conclusion

5.1 Introduction

The post-Soviet era brought about diverse trajectories for the economies of the FSU, each nation carving its unique path toward economic independence. Yet, the ties of culture, history, and geography continue to bind them. Despite a shift from centralized decision-making to decentralized models, there persists a preference for top-down solutions on overarching issues like natural resource management, trade connectivity, and border control.

Kyrgyzstan, serving as a microcosm, grapples not only with government policies but a myriad of macroeconomic challenges. Political instability casts a shadow, coupled with extreme weather events, disrupted supply chains, and evolving borders with neighboring nations. The repercussions of rapid liberalization policies reverberate, affecting infrastructure, income distribution, and poverty exacerbation. The mass exodus of labor abroad further complicates the economic landscape, creating a complex web of interconnected issues for Kyrgyzstan and its FSU counterparts to navigate.

This study delves deeply into three pivotal challenges—political instability, agricultural policies, and environmental changes—within the specific context of Kyrgyzstan. We employ a comprehensive analysis to reveal their extensive impact on critical domains, including food demand, agricultural trade, and rural development. The resulting insights offer a nuanced and comprehensive understanding of the intricate interconnections among these issues. With lasting relevance, our findings are poised to guide the formulation of compelling economic, agricultural, and rural policies for the persistent challenges faced by FSU economies and other developing countries with similar economic and environmental characteristics.

In this chapter, the study succinctly outlines its three independent papers. Section 5.2 concisely summarizes the main findings, while Section 5.3 offers specific conclusions for each paper and an overarching conclusion. Section 5.5 shifts focus to practical implications for policymaking, providing a bridge between theory and actionable strategies. The chapter concludes in Section 5.6 with a reflective panorama, acknowledging limitations and suggesting avenues for future research.

5.2 Key findings

5.2.1 Expected conflicts boost food demand, favoring staple consumption

The study reveals that unexpected political conflicts lead to a decrease in total food demand, marked by households making chaotic purchases across all food categories without distinguishing between luxuries and staples. On the contrary, anticipated

conflicts drive households to strategically plan their food consumption, resulting in an increase in total food expenditure before the conflict. Moreover, the anticipation of conflict heightens demand for staple foods while decreasing it for luxury items.

5.2.2 Agricultural credit subsidies fail for trade, bilateral tariffs hinder

Our theoretical findings suggest that policy variables like credit subsidies enhance trade, while trade barriers such as applied tariffs diminish trade in small and open economies. Testing these theories with cross-country panel data on Kyrgyzstan's agricultural products from 2007 to 2018 yields two primary conclusions. Firstly, agricultural credit subsidies prove inefficient in augmenting international trade flows in Kyrgyzstan. Secondly, bilateral applied tariffs function as a trade barrier, substantially decreasing Kyrgyzstan's export volume.

5.2.3 Weather extremes disproportionately harm the poor, highlighting regional disparities

We illustrate the disproportionate impact of weather extremes on the poorer population, notably during the critical cold winter of 2014 in the northern part of the country, adversely affecting education and health conditions. The delayed effects of cold winters in spring and fall worsen poverty, particularly for the poor and the middle classes. Varying impacts across provinces underscore nuanced disparities within subsample distributions, emphasizing the intricate interplay between climatic variables and poverty dimensions.

5.3 Conclusion

Theoretical advancement in Chapter 2 indicates that conflicts negatively impact food demand, leading households to shift towards consuming staple foods. However, the nuances of these effects are pronounced, contingent on the nature of the conflict. Anticipated conflicts trigger strategic behavior, with Kyrgyz households intentionally increasing demand, particularly for staples. Conversely, unforeseen conflicts lead to indiscriminate purchases across all food categories, resulting in an overall decrease in total food demand. This intricate interplay highlights the nuanced and context-dependent dynamics in the relationship between conflicts and food consumption patterns in Kyrgyzstan.

The theoretical framework established in Chapter 3 posits that policies play a pivotal role in either amplifying or curtailing trade within small and open economies. It specifically contends that well-designed policies can serve as catalysts for trade, whereas trade barriers, exemplified by tariffs, may act as hindrances. However, the empirical analysis centered on Kyrgyzstan diverges from this theoretical expectation. The findings reveal that despite their theoretical potential to enhance trade, agricultural policies do not effectively increase international trade for Kyrgyzstan. In contrast, applied tariffs emerge as a substantial factor, notably diminishing the volume of exports from the country. This disjunction between theory and empirical evidence prompts critical inquiries into the efficacy of current agricultural policies and underscores the significant impact of applied tariffs on Kyrgyzstan's trade dynamics.

Chapter 4 introduces a novel multidimensional poverty index for Kyrgyzstan, aiming to assess the comprehensive impact of weather extremes on poverty holistically. Aggregated findings reveal universally detrimental effects of all weather extremes on poverty. However, upon spatial disaggregation and a nuanced examination of diverse poverty dimensions, a mosaic of heterogeneous effects surfaces. These effects vary by poverty level, regional differences, and specific dimensions of poverty, providing a multifaceted understanding of the complex relationship between weather extremes and different dimensions of poverty in Kyrgyzstan.

In conclusion, the theoretical framework falls short of encompassing the diverse spectrum of households' responses to post-communist and environmental shocks, underscoring the crucial significance of contextual nuances inherent in each specific shock. This acknowledgment not only enriches our understanding of household dynamics but also holds profound implications for the trajectory of future research endeavors and data-driven analytics. The imperative for a nuanced and context-specific approach in studying societal reactions to both transitions and environmental upheavals emerges as a pivotal insight from this theoretical exploration.

5.4 Policy implication

5.4.1 Conflict anticipation and management

In light of the insights gleaned from Chapter 2, the immediate and effective communication of signals for anticipated conflicts stands as a cornerstone of proactive governance. Governments, mass media, and information-disseminating institutions must swiftly convey these signals, acknowledging the inevitability of conflicts during post-communist transitions. The government is advised to fortify the protection of strategically vital structures such as grocery stores and hospitals, mitigating potential fallout from conflicts and minimizing societal disruption, building on lessons from past incidents.

5.4.2 Strategic financial resource allocation

Chapter 3 underscores the efficacy of redirecting financial resources towards avenues beyond conventional agricultural credit subsidies. The study suggests that investments in public goods and services—from infrastructure and collection centers to grading facilities and farm extension programs—yield broader and more sustainable impacts than individual farm support. Moreover, recognizing the economic dynamics, the Kyrgyz government is urged to negotiate strategically with countries like Turkey, South Korea, and India to reduce applied tariff rates on agricultural products mutually. This shift towards bilateral trade deals is positioned as a more effective strategy than the prevailing policy of subsidized loans for individual farmers.

5.4.3 Climate resilience and social support

The study's examination of the critical winter of 2014 in northern Kyrgyzstan informs the third policy recommendation. Acknowledging the potential long-term consequences on poor households, specifically in terms of reduced education levels and compromised health conditions, policymakers are advised to target vulnerable regions. The Kyrgyz government is called upon to implement effective measures

in the face of intensifying heat waves and excessive rainfall due to climate change. The focus should be on mitigating adverse consequences in regions severely impacted by these shocks, prioritizing disadvantaged and impoverished households that bear a disproportionate burden of these effects. Education and health infrastructure support become paramount in preventing a detrimental downward spiral in these vulnerable communities.

In summary, these three interlinked policy recommendations form a comprehensive strategy to fortify Kyrgyzstan's resilience to post-communist shocks, with broader implications for similar economies facing analogous challenges.

5.5 Limitations and future research

In Chapter 2, potential limitations arise from the study's reliance on data, particularly in underestimating demand due to disruptions in the supply chain for stores operating during conflicts. The accurate timing of conflicts poses a challenge, given the difficulty distinguishing households impacted from unaffected ones due to data constraints. Additionally, the study underscores the dominance of long-term conflict impacts on food demand, cautioning that short-term effects may take time.

Chapter 3 confronts limitations as the use of aggregated macrodata restricts a comprehensive understanding of crucial dynamics, such as the structural changes in the trade of agricultural commodities in 2014. The research suggests that the cause of these changes differed from the subsidy policy's implementation, necessitating further exploration with microdata to unravel the nature of these shifts fully.

In Chapter 4, the employment of empirical impact functions based on historical data introduces limitations, acknowledging their constrained ability to predict long-term impacts and adaptations amidst escalating climate variability. The analysis falls short of fully accounting for multifaceted inequalities, including gender, race, and the varied adaptive capacities of households. Furthermore, a cautionary note is sounded against generalizing results to different climatic conditions and diverse socioeconomic contexts.

Future research for the first paper could enhance insights by incorporating qualitative data, delving deeper into consumers' behavior during revolutions and synthesizing it with the current study's quantitative results. This approach would provide a more holistic understanding of the multifaceted dynamics shaping consumer choices amid societal upheavals.

In the second paper, addressing the identified limitations calls for a future focus on collecting microdata. Specifically, research should hone in on detailed information regarding farm production decisions and trading activities, with a particular emphasis on exporting capabilities. This microdata-driven approach would offer a more nuanced and comprehensive exploration of the intricacies of agricultural trade dynamics.

For the third paper, future research avenues can explore the natural characteristics of regions where weather extremes positively influence household welfare. Delving deeper into these environmental nuances could provide a more robust explanation of the intricate relationship between climatic variations and their impact on the well-being of households in specific regions.

Appendix A

TABLE A1: Panel structure of KIHS, 2005-2019.

		in % from						
Years	Households	2005	2006	2007	2008	2009	2010	2011
2005	4,771							
2006	4,863	91						
2007	4,803	71	79					
2008	4,995	65	71	91				
2009	4,984	59	65	82	91			
2010	4,979	56	61	75	83	91		
2011	5,010	52	57	70	75	83	91	
2012	5,006	48	53	65	69	76	83	90
		in % from						
Years	Households	2013	2014	2015	2016	2017	2018	
2013	5,013							
2014	5,006	91						
2015	5,016	83	90					
2016	5,006	78	85	93				
2017	5,016	72	78	85	91			
2018	5,015	69	75	82	87	95		
2019	5,016	66	72	78	83	90	95	

FIGURE A.1: Quality-adjusted prices for food groups.

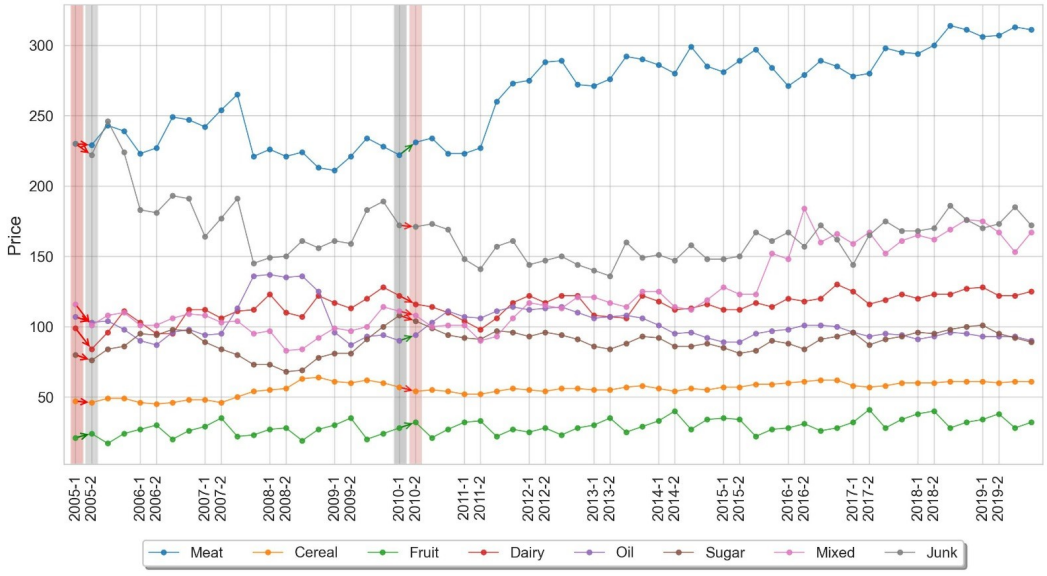


TABLE A.2: Estimates of the Working-Leser model.

Log total food expenditure	
Log total income	.012 (8e-5)
Laspeyres food price index	.408 (.007)
Household head's age	-3e-4 (2e-5)
Household head's gender	.107 (.001)
Household size	.101 (1e-4)
Education	
Household heads with only basic education	-.090 (.001)
Household heads with secondary education	-.042 (.001)
Household heads with high education	.061 (.001)
Provinces	
Issyk-Kul	-.143 (.001)
Jalal-Abad	-.046 (.001)
Naryn	-.494 (.001)
Osh	-.068 (.001)
Talas	-.027 (.001)
Chui	.199 (.001)
Bishkek	.159 (.001)
Batken	base outcome
Urban	.226 (.001)
Rural	base outcome
Constant	4.976 (.033)
Number of observations	2,371,168
Adjusted R-squared	.321

Note: Robust standard errors are given in parentheses.

TABLE A.3: Demand elasticities (2005-2019).

Variables	**meat**	**cereal**	**fruit**	**dairy**	**oil**	**sugar**	**mixed**	**junk**
Expenditure	1.172	1.115	1.222	.975	.621	.274	.386	1.176
	(.004)	(.003)	(.004)	(.006)	(.005)	(.007)	(.008)	(.010)
Uncompensated price								
meat	-.495	-.401	.155	.032	-.060	-.169	-.029	-.205
	(.009)	(.008)	(.005)	(.004)	(.007)	(.007)	(.004)	(.005)
cereal	-.410	-.917	.173	-.186	.163	.072	-.029	.019
	(.007)	(.007)	(.004)	(.003)	(.005)	(.005)	(.003)	(.004)
fruit	.229	.230	-1.059	-.210	-.182	-.064	-.209	.043
	(.009)	(.008)	(.005)	(.004)	(.006)	(.007)	(.004)	(.005)
dairy	.144	-.474	-.348	-.932	.072	.228	.280	.054
	(.013)	(.012)	(.007)	(.006)	(.010)	(.010)	(.006)	(.007)
oil	-.064	.650	-.300	.118	-.509	-.156	-.221	-.138
	(.011)	(.010)	(.006)	(.005)	(.008)	(.008)	(.005)	(.006)
sugar	-.414	.467	.001	.365	-.147	-.924	.138	.241
	(.013)	(.013)	(.008)	(.006)	(.010)	(.010)	(.006)	(.008)
mixed	.076	.059	-.445	.475	-.262	.149	-.737	.299
	(.015)	(.014)	(.009)	(.006)	(.011)	(.012)	(.007)	(.009)
junk	-1.382	.103	.192	.108	-.313	.363	.415	-.662
	(.022)	(.021)	(.013)	(.010)	(.017)	(.017)	(.009)	(.013)

Note: Robust standard errors are given in parentheses.

Appendix B

TABLE B.1: Dimensions and subdimensions comprising MPI for Kyrgyzstan.

Dimension	Subdimension	Explanation of subdimensions	Survey question	Weights
Nutrition	Berry Index	Food diversity is measured by Berry Index as follows: $$BI = 1 - \sum_{i=1}^{10} \omega_i^2, \qquad \text{(B.1)}$$ where ω_i is the share of expenditures on food group i in the household's total consumption expenditure.	What kind of food products were consumed by members of your household during the surveyed 14 days?	Berry Index/4
Health	Illness	Identify the need for medical assistance and determine the reason for refusing medical services. We considered it poor if a family could not pay for medical care or buy medicine due to a lack of money.	Have you needed medical assistance in the past year? If yes, were there any cases during the year when you could not use medical services? If yes for what reason did you not use medical services during the year?	Illness/12
Health	Healthcare	Identification of the need for inpatient treatment and determination of the reasons for refusal of inpatient treatment. We considered it poor if a family could not pay for hospital treatment due to a lack of money.	Have you been referred to a hospital or needed hospital treatment but did not go to the hospital in the past year? If, Yes, I was referred but did not go to the hospital, or/and Yes, I needed hospital treatment but didn't go to the hospital. Reasons why you did not go to the hospital.	Healthcare/12

Health	Ability to cover medical expenses	Identification of financial difficulties in covering medical expenses.	What did you have to do to use medical services over the past year?	Ability to cover medical expenses /12
Education	Preschool attendance	Identification of children who do not attend preschool and whether this is due to financial difficulties.	Does (NAME) attend preschool? If no, what is the reason (NAME) is not attending preschool?	Preschool attendance/8
Education	Level of education	Identification of the household head's level of education and consider uneducated if the household head does not have 11 years of primary education.	What is the highest level of education you have received?	Level of education/8
Living Standard	Income	The total household income (urban and rural) is calculated as the sum of recorded and deflated individual earnings that are aggregated into three main groups: wages, social transfers, and remittances. Values are standardized and normalized.	What income did you receive over the past month and the amount of this income?	Income/16
Living Standard	Living space	The living space available to each household member is calculated as the ratio of the living space to the number of household members. The obtained values are also standardized and normalized.	What is your family's living space (sq. m.)?	Living space/16

Living Standard	Rural land	Amount of land owned by rural households, which is also standardized and normalized.	Do you have any land in use? If yes, what is the plots' total area (with the house) (sq. m.)?	Land/16
Living Standard	Rural livestock	Livestock from various species is unified by the Livestock unit https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Livestock_unit_(LSU) and multiplied by the amount of livestock, then normalized and standardized.	What livestock, poultry, or other animals do you have?	Livestock/16

TABLE B.2: Description of MPI modification.

The MPI's mathematical structure corresponds to one member of a family of multidimensional poverty measures proposed by Alkire and Foster Alkire and Foster, 2011. Constructing this measure entails the following steps in our study:
Identification of deprivations: Define and identify the key dimensions of poverty, such as nutrition, education, health, and living standards.
Selection of indicators: Choose specific indicators within each dimension that accurately capture the extent of deprivation (Berry Index, preschool attendance, level of education, illness, healthcare, ability to cover medical expenses, income, living space, land, and livestock).
Threshold determination: Set appropriate thresholds for each selected indicator to distinguish between the deprived and non-deprived population. In establishing deprivation thresholds, our study employs specific criteria across dimensions. Within the food diversification dimension (Berry Index), ranging from 0 to 1, higher values indicate a more diverse diet, designating households with higher values as non-deprived. The education dimension considers preschool attendance and level of education, categorizing households with children unable to attend preschool due to financial constraints or with uneducated heads as deprived (assigned 0), while others are non-deprived (assigned 1). In the healthcare dimension, binary variables (illness, healthcare, and ability to cover medical expenses) dictate that households unable to pay for medical care, hospital treatment, or cover medical expenses are classified as deprived (assigned 0). The living standard dimension, comprising continuous variables (income, living space, land, and livestock), undergoes standardization and normalization between 0 and 1 for a precise distinction between deprived and non-deprived categories.
Selection of weights: We focus on selecting relative weights for each indicator such that they sum to one as $\frac{Nutrition}{4} = \frac{BerryIndex}{4}, \frac{Education}{4} = \frac{Preschooleducation}{8} + \frac{Levelofeducation}{8}, \frac{Health}{4} = \frac{Illness}{12} + \frac{Healthcare}{12} + \frac{Abilitytocovermedicalexpenses}{12}, \frac{Livingstandard}{4} = \frac{Income}{16} + \frac{Livingspace}{16} + \frac{Land}{16} + \frac{Livestock}{16}$.
Calculation of deprivation score: In calculating the deprivation score, we compute the weighted proportion of deprivation for each household.
Poverty classification: A household is categorized as multidimensionally poor if deprivation score falls within the first tercile, identified as middle if in the second tercile, and classified as rich if situated in the third tercile. This approach succinctly stratifies households based on their level of multidimensional deprivation.
By following these steps, the constructed measure captures the nuanced aspects of multidimensional poverty and provides a comprehensive assessment of well-being beyond a unidimensional approach.

TABLE B.3: The panel structure of KIHS (%), 2013-2020.

	2013	2014	2015	2016	2017	2018	2019
2013							
2014	91						
2015	83	90					
2016	78	85	93				
2017	72	78	85	91			
2018	69	75	82	87	95		
2019	66	72	78	83	90	95	
2020	63	68	74	79	86	90	95

TABLE B.4: MPI by province.

	Poor	Middle	Rich
MPI by province:	.61	.71	.75
Talas	.66	.71	.83
Chui	.69	.73	.84
Issyk-Kul	.70	.73	.87
Naryn	.63	.71	.83
Osh	.65	.72	.85
Batken	.71	.73	.86
Jalal-Abad	.72	.74	.93

FIGURE B.1: Frequency of weather extremes across the country.

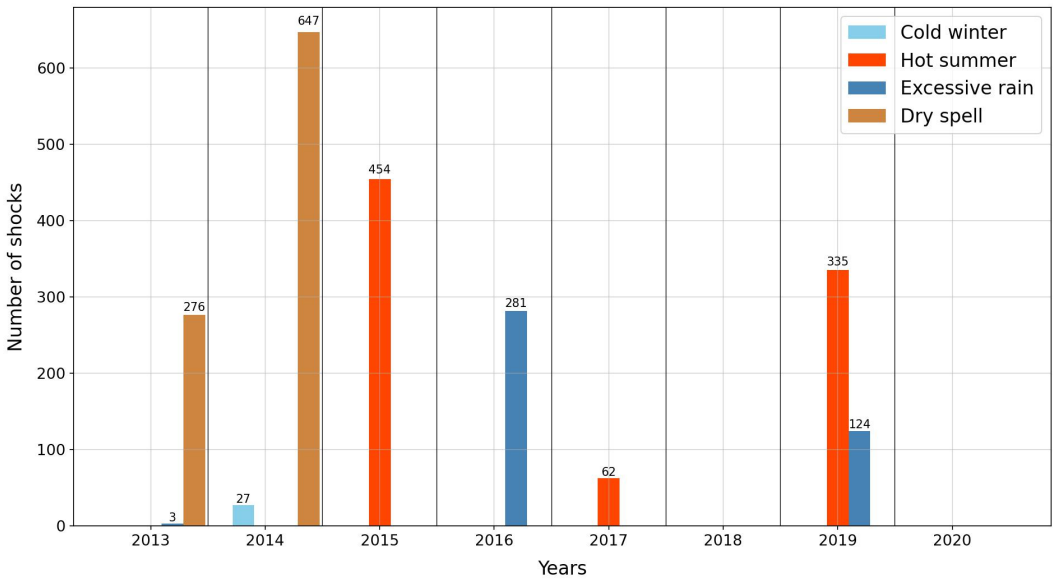
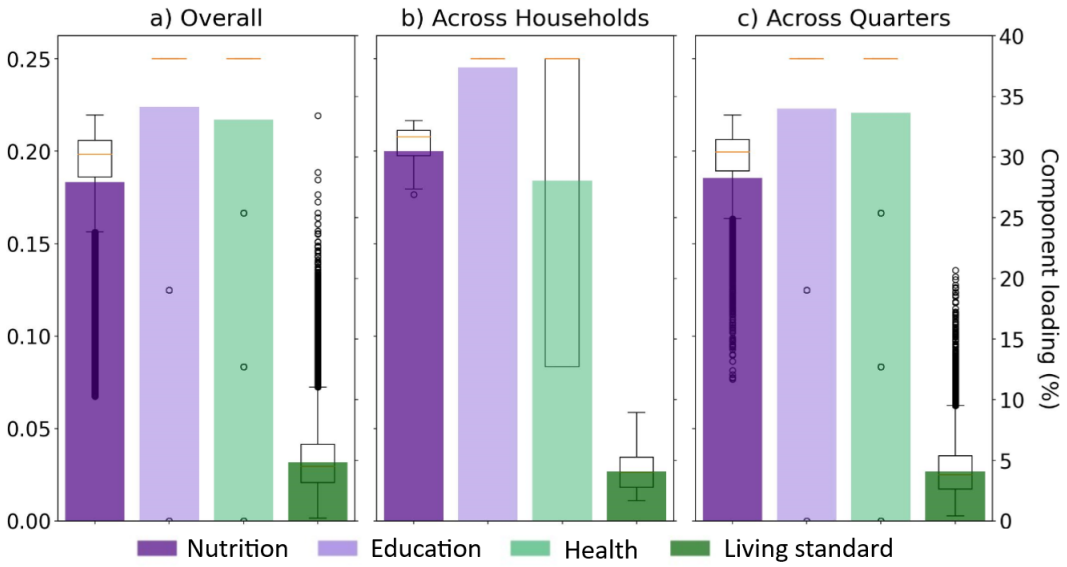


FIGURE B.2: Variation and component loadings of MPI.



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Declaration under Oath

Ich erkläre an Eides statt, dass ich die Arbeit selbstständig und ohne fremde Hilfe verfasst, keine anderen als die von mir angegebenen Quellen und Hilfsmittel benutzt und die den benutzten Werken wörtlich oder inhaltlich entnommenen Stellen als solche kenntlich gemacht habe.

I declare under penalty of perjury that this thesis is my own work entirely and has been written without any help from other people. I used only the sources mentioned and included all the citations correctly both in word or content.

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Curriculum Vitae

Barchynai Kimsanova demonstrated academic excellence by earning her B.Sc. degree in Economics with a scholarship from the International University of Kyrgyzstan in July 2007. Subsequently, in 2007, she received a fellowship from the Turkish Government for her M.Sc. studies. From 2007-2008, she immersed herself in the Turkish language center in Ankara as a prerequisite for her master's studies. She obtained her M.Sc. degree in Economics from the Middle East Technical University in 2011. Fueled by a Ph.D. scholarship, she commenced her Ph.D. studies in Economic Theory at Ankara University in 2011. She completed her Ph.D. in December 2016, focusing on "The Effects of Government Policies in Liquidity-Constrained Economies." Between 2017 and 2019, she was a lecturer at Kyrgyz-Turkish "Manas" University and the OSCE Academy in Bishkek. In June 2019, she embarked on her Ph.D. project as a junior researcher at the Leibniz Institute of Agricultural Development in Transition Economies (IAMO) while pursuing her doctorate at Martin-Luther Halle-Wittenberg University.