Household Resilience Capacity and Food Security in Central Asia

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DEDICATION

This thesis is dedicated to the cherished memory of my father, **EGAMBERDIEV BAXODIR XUDAYBERDIEVICH**

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SUMMARY

Households in Central Asia often face the accumulated consequences of shocks and stresses. In the face of intensified shocks, they activate household coping mechanisms and resilience capacity so that adverse consequences of shocks should not have long-lasting effects on well-being or food security conditions. In socioeconomic science, *resilience* is defined as the ability or capacity of individuals, households or systems that can be activated to withstand shocks. In this case, the prominence of resilience has become a cornerstone in maintaining livelihoods when households cope with shocks and stresses. However, weak adaptability and resilience capacity are typical of Central Asian households when shocks or stresses intensify. National development strategies and international development agency recommendations in Central Asia have the implementation impetus of resilience enhancement in the region. As the most climate change shock-prone region, Central Asian countries still need further investigations and context-based resilience-enhancing programs. Therefore, further empirical analysis with robust results should corroborate policy recommendations and intervention programs to enhance household resilience in Central Asia.

This doctoral thesis aims to study household-level resilience capacity in selected Central Asian countries. It includes three published manuscripts that provide quantitative measures of household resilience capacity and analyse how resilience capacity affects food security outcomes in Kyrgyzstan and Tajikistan. The data used in the manuscripts include country representative and panel surveys: Life in Kyrgyzstan (LiK), Tajikistan Living Standards Survey (TLSS) and Tajikistan Household Panel Survey (THPS). The thesis chapters are based on the FAO's Resilience Index Measurement and Analysis (RIMA) framework to measure household Resilience Capacity Index (RCI) through different pillars (determinants).

One of the main objectives of the thesis is to examine how household resilience capacity affects food security outcomes. By applying the RIMA approach to data from Kyrgyzstan and Tajikistan, the second and fourth chapters explain the relationships between resilience capacity and food security by including clustered shocks and coping strategies, respectively. Both chapters apply novel econometric techniques with the Instrumental Variable (IV) approach to solve endogeneity problems and the Latent Class (LC) approach to control unobserved heterogeneity. The fourth chapter also employs a

Multiple Indicators Multiple Causes (MIMIC) model to build the relationship between resilience capacity, pillars, and food security outcomes.

Since theoretical and operational explanations of resilience confirm that a food security condition of the household should be resilient in the presence of shocks, the second chapter of the thesis classifies endogenous and exogenous shocks through the LC approach. Another unique contribution of the chapter is to obtain causal claims by including the dynamic nature of food security outcomes. A conceptual framework for food insecurity resilience draws a causal pathway, including coping mechanism attributes. Accordingly, the fourth chapter clusters households with the LC approach based on coping mechanisms, allowing us to explain the effect of resilience capacity and coping strategies on food security outcomes. In addition, empirical lacunae are apparent in the mediating or moderating role of household resilience capacity on food security outcomes; therefore, both chapters aim to understand how resilience capacity or RCI can mitigate the effects of shocks on food security. The analysis also covers the loss in food security obtained from the difference in food security outcomes between the two waves. The results suggest that higher resilience capacity (RCI) guarantees a mediating role when shocks intensify. In addition, resilience capacity or RCI has positive effects on food security outcomes. More comprehensive robustness checking also confirmed that higher RCI is likely to decrease the loss in food security outcomes.

The evaluation in conceptualization and measurement of resilience in food security analysis shows that measurement methodologies still have a blurred understanding of simultaneously using tangible and intangible assets. Therefore, the third chapter, using the LiK dataset for the 2013 and 2016 waves, analyses the relationship between social capital and food insecurity resilience in Kyrgyzstan. The objective is to measure (i) household resilience pillars and capacity (RCI) and (ii) social capital indicators through constructed trust and group membership variables. In addition, this part establishes causal inferences to conclude the effect of trust and group membership on resilience pillars or resilience itself. Considering a cumulative exposure over several years, the estimation strategy includes trust and group membership constructed variables from the 2013 wave and resilience estimations (pillars and RCI) from the 2016 wave. Due to the endogeneity problem for trust and group membership constructed variables, a unique approach of the chapter is about using IV with Structural Equation Model (SEM) or the IV-SEM framework for multiple endogenous covariates. Findings from this chapter confirm a significant relationship between social capital and household resilience capacity. In particular, trust and group membership have positive effects on pillars, except the pillar explaining access to basic services. The results also confirm that social capital positively and significantly affects overall resilience capacity (RCI), confirming the need to integrate social capital into food insecurity resilience conceptualisation.

The thesis makes different conclusions, including policy recommendations and methodological comments. Policy implications of the findings confirm that regional interventions should support a resilience-enhancement policy, particularly in rural areas. In addition, the cumulative effects of resilience pillars were found to be important for articulating dynamic relationships in the long term. Another important message is to support social capital, particularly unofficial networking channels, which may strengthen resilience-building mechanisms. The dynamic nature of food security indicators also confirmed the positive effects of household resilience capacity, which are important for long-term policy recommendations. As for the recommendation of methodological approaches, a resilience measurement as household capacity should further integrate other cultural, geographical and multidimensional aspects. Finally, the ubiquity of resilience should be accepted not as an end but as an instrument to achieve better livelihood and food security.

ZUSAMMENFASSUNG

Haushalte in Zentralasien sind oft mit den kumulierten Folgen von Schocks und Belastungen konfrontiert. Angesichts zunehmender Schocks aktivieren sie die Bewältigungsmechanismen und die Widerstandsfähigkeit, sodass die negativen Folgen von Schocks keine langfristigen Auswirkungen auf das Wohlergehen oder die Ernährungssicherheit haben sollten. In den Sozialwissenschaften wird die Resilienz als die Fähigkeit oder Kapazität von Einzelpersonen, Haushalten oder Systemen definiert, die aktiviert werden kann, um Schocks zu widerstehen. In diesem Fall ist die Bedeutung der Resilienz zu einem Eckpfeiler für die Aufrechterhaltung der Lebensgrundlagen geworden, wenn Haushalte mit Schocks und Belastungen fertig werden müssen. Eine schwache Anpassungsfähigkeit und Resilienzkapazität sind jedoch typisch für zentralasiatische Haushalte, wenn Schocks oder Belastungen zunehmen. Die nationalen Entwicklungsstrategien und die Empfehlungen internationaler Entwicklungsagenturen in Zentralasien haben den Impuls zur Umsetzung der Resilienzsteigerung in der Region gegeben. Da die zentralasiatischen Länder mit am stärksten von den Folgen des Klimawandels betroffen sind, sind weitere Untersuchungen und kontextbasierte Programme zur Stärkung der Resilienz erforderlich. Daher sollten weitere empirische Analysen mit belastbaren Ergebnissen die politischen Empfehlungen und Interventionsprogramme zur Stärkung der Resilienz der Haushalte in Zentralasien untermauern.

Diese Doktorarbeit zielt darauf ab, die Resilienzkapazität auf Haushaltsebene in ausgewählten zentralasiatischen Ländern zu untersuchen. Sie umfasst drei veröffentlichte Manuskripte, die quantitative Messungen der Resilienzkapazität von Haushalten liefern und analysieren, wie sich die Resilienzkapazität auf die Ergebnisse der Ernährungssicherheit in Kirgisistan und Tadschikistan auswirkt. Die in den Manuskripten verwendeten Daten stammen aus repräsentativen Länder- und Panelbefragungen: „Life in Kyrgyzstan (LiK)", ‚Tajikistan Living Standards Survey (TLSS)' und ‚Tajikistan Household Panel Survey (THPS)'. Die Kapitel der Dissertation basieren auf der „Resilience Index Measurement and Analysis" (RIMA) der FAO, um den Resilienzkapazitätsindex (RCI) von Haushalten anhand verschiedener Säulen (Determinanten) zu messen.

Eines der Hauptziele der Arbeit besteht darin, zu untersuchen, wie sich die Resilienzkapazität der Haushalte auf die Ergebnisse der Ernährungssicherheit auswirkt. Durch die Anwendung des RIMA-Ansatzes auf Daten aus Kirgisistan und Tadschikistan werden im zweiten und vierten Kapitel die Beziehungen zwischen Resilienzkapazität und

Ernährungssicherheit unter Einbeziehung von gebündelten Schocks bzw. Bewältigungsstrategien erläutert. In beiden Kapiteln werden neuartige ökonometrische Techniken mit dem Instrumentvariablenansatz (IV) zur Lösung von Endogenitätsproblemen und dem Latent-Class-Ansatz (LC) zur Kontrolle unbeobachteter Heterogenität angewendet. Im vierten Kapitel wird außerdem ein MIMIC-Modell (Multiple Indicators Multiple Causes) verwendet, um die Beziehung zwischen Resilienzkapazität, Säulen und Ergebnissen der Ernährungssicherheit herzustellen.

Da theoretische und operative Erklärungen der Resilienz bestätigen, dass die Ernährungssicherheit eines Haushalts bei Schocks widerstandsfähig sein sollte, klassifiziert das zweite Kapitel der Arbeit endogene und exogene Schocks durch den LC-Ansatz. Ein weiterer einzigartiger Beitrag des Kapitels besteht darin, kausale Aussagen zu treffen, indem die dynamische Natur der Ergebnisse der Ernährungssicherheit einbezogen wird. Ein konzeptioneller Rahmen für die Resilienz gegenüber Ernährungsunsicherheit zeichnet einen Kausalpfad, der auch die Eigenschaften von Bewältigungsmechanismen einbezieht. Dementsprechend gruppiert das vierte Kapitel Haushalte mit dem LC-Ansatz auf der Grundlage von Bewältigungsmechanismen, was es uns ermöglicht, die Auswirkungen der Resilienzkapazität und der Bewältigungsstrategien auf die Ergebnisse der Ernährungssicherheit zu erklären. Darüber hinaus sind empirische Lücken in der vermittelnden oder moderierenden Rolle der Resilienzkapazität von Haushalten auf die Ergebnisse der Ernährungssicherheit offensichtlich; daher zielen beide Kapitel darauf ab, zu verstehen, wie die Resilienzkapazität oder RCI die Auswirkungen von Schocks auf die Ernährungssicherheit abschwächen kann. Die Analyse deckt auch den Verlust an Ernährungssicherheit ab, der sich aus den unterschiedlichen Ergebnissen der Ernährungssicherheit zwischen den beiden Wellen ergibt. Die Ergebnisse deuten darauf hin, dass eine höhere Resilienzkapazität (RCI) eine vermittelnde Rolle garantiert, wenn sich Schocks verstärken. Darüber hinaus hat die Resilienzkapazität oder RCI positive Auswirkungen auf die Ergebnisse der Ernährungssicherheit. Eine umfassendere Robustheitsprüfung bestätigte auch, dass eine höhere RCI den Verlust an Ergebnissen der Ernährungssicherheit wahrscheinlich verringern wird.

Die Bewertung der Konzeptualisierung und Messung von Resilienz in der Analyse der Ernährungssicherheit zeigt, dass die Messmethoden immer noch ein unscharfes Verständnis für die gleichzeitige Nutzung von materiellen und immateriellen Vermögenswerten haben. Daher analysiert das dritte Kapitel, unter Verwendung des LiK-Datensatzes für die Befragungszeiträume2013 und 2016, die Beziehung zwischen Sozialkapital und Resilienz gegenüber Ernährungsunsicherheit in Kirgisistan. Ziel ist es, (i) die Resilienzpfeiler und -kapazität der Haushalte (RCI) und (ii) die Sozialkapitalindikatoren durch konstruierte Vertrauens- und Gruppenmitgliedschaftsvariablen zu messen. Darüber hinaus werden in diesem Teil kausale Schlussfolgerungen gezogen, um die Auswirkungen von Vertrauen und Gruppenmitgliedschaft auf die Resilienzpfeiler oder die Resilienz selbst zu ermitteln. Unter Berücksichtigung einer kumulativen Exposition über mehrere Jahre umfasst die Schätzstrategie konstruierte Variablen für Vertrauen und Gruppenmitgliedschaft aus der Welle von 2013 und Resilienzschätzungen (Säulen und RCI) aus der Welle von 2016. Aufgrund des Endogenitätsproblems für konstruierte Variablen für Vertrauen und Gruppenmitgliedschaft befasst sich ein einzigartiger Ansatz des Kapitels mit der Verwendung von IV mit dem Strukturgleichungsmodell (SEM) oder dem IV-SEM-Rahmen für mehrere endogene Kovariaten. Die Ergebnisse dieses Kapitels bestätigen einen signifikanten Zusammenhang zwischen Sozialkapital und der Widerstandsfähigkeit von Haushalten. Insbesondere Vertrauen und Gruppenmitgliedschaft wirken sich positiv auf die Säulen aus, mit Ausnahme der Säule, die den Zugang zu grundlegenden Dienstleistungen erklärt. Die Ergebnisse bestätigen auch, dass Sozialkapital die allgemeine Widerstandsfähigkeit (RCI) positiv und signifikant beeinflusst, was die Notwendigkeit bestätigt, Sozialkapital in die Konzeptualisierung der Widerstandsfähigkeit gegen Ernährungsunsicherheit zu integrieren.

Diese Thesis kommt zu verschiedenen Schlussfolgerungen, darunter politische Empfehlungen und methodische Anmerkungen. Die politischen Implikationen der Ergebnisse bestätigen, dass regionale Interventionen Maßnahmen zur Stärkung der Resilienz unterstützen sollten, insbesondere in ländlichen Gebieten. Darüber hinaus wurde festgestellt, dass die kumulativen Effekte der Resilienzpfeiler wichtig sind, um dynamische Beziehungen langfristig zu artikulieren. Eine weitere wichtige Botschaft ist die Unterstützung des Sozialkapitals, insbesondere inoffizieller Netzwerkkanäle, die Mechanismen zur Stärkung der Resilienz stärken können. Die dynamische Natur der Indikatoren für die Ernährungssicherheit bestätigte auch die positiven Auswirkungen der Resilienzkapazität der Haushalte, die für langfristige politische Empfehlungen von Bedeutung sind. Was die Empfehlung methodischer Ansätze betrifft, so sollte eine Resilienzmessung als Haushaltskapazität weitere kulturelle, geografische und multidimensionale Aspekte berücksichtigen. Schließlich sollte die Allgegenwart der Resilienz nicht als Selbstzweck, sondern als Instrument zur Verbesserung der Lebensgrundlagen und der Ernährungssicherheit akzeptiert werden.

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1. General Introduction

1.1 Resilience in Food Security

Households in developing countries often experience the combined consequences of climate shock, political instability, and other socioeconomic crises across individual, household or system levels. In this case, potential detrimental impacts of shocks on agriculture and food security have already been well discussed (Al Dirani et al., 2021; Esham et al., 2018; Hatfield et al., 2020; Mirzabaev et al., 2023; Pickson et al., 2023). Shocks, threatening the food security dimensions, are one of the major drivers of food insecurity and malnutrition in Central Asia (Babadjanova et al., 2024; Kavallari et al., 2014; Svanidze et al., 2019). For example, the recent COVID-19 pandemic had negative consequences on socioeconomic lives, health conditions, and food security, deteriorating the overall livelihood of people in Central Asia (Egamberdiev, 2021). Households in shock-prone areas activate coping strategies to withstand shocks and stresses. However, households with limited capacity to involve short- and long-term coping mechanisms have difficulties continuing their livelihood functions by developing robustness against shocks. Therefore, resilience thinking has become a cornerstone for the decision-makers to ensure that the system continues functioning or shifts into an alternative regime with minimum loss (Connelly et al., 2017; Douxchamps et al., 2017). Analysing food security through the lens of resilience has already become a compelling application for both research scientists and policymakers. Moreover, there has been growing cognizance that attention to specific shocks by applying food security and agricultural development contexts is directly pertinent to understand the role of resilience. In this circumstance, using a variety of appropriate approaches to improve or build household resilience towards shocks is recognized as inevitable (Béné et al., 2014; Kabir et al., 2023).

In the presence of high shock exposure, many international development agencies and scientific audiences have adopted resilience-enhancement approaches as a potential instrument of dealing with the problem of food security and malnutrition (Béné, Headey, et al., 2016). In this sense, international development applications have already given prominence to the necessity of a resilience concept to define the most desired form of interventions, particularly bringing the concept to the forefront of food security targets. However, methodological approaches to conceptualize and measure resilience towards food security proliferate, making them practically challenging in different contexts (Constas et al., 2022). Narrowing down the resilience concept to food security further requires an investigation of robustness in the theoretical framework. In addition, operationalizing resilience from a household food security situation pervasively needs more studies differentiating household resilience and coping mechanisms to stabilize food security conditions when shocks become more extreme. Although it is not characterized by a difficulty in the conceptualization, the methods to detect a causal claim between resilience and food security are inextricably linked with empirical findings and conclusions.

1.2 Resilience Conceptualization and Measurement

Initially, the term resilience was recognized as the capacity of the system to maintain its functioning (Gunderson & Holling, 2002); therefore, it was easily integrated into the ecological system. Diverging from its original engineering and ecological applications, Frankenberger et al. (2012) introduced a methodology to operationalize resilience and food security by including the elements from the livelihood approach. Accordingly, resilience is applied to food security analyses by recognizing household resilience capacity as a process. The framework also integrates a number of level aggregations (individual, household, or community) to represent adaptive capacity. In the presence of shocks, capacity-related livelihood attributes characterize a resilience pathway to food security. However, more attention to agency and empowerment is needed to conceptualize the power of the household as a decision-maker. For this perspective, a recent line of research has focused on the agency and ability to make decisions for the development outcomes (Béné, Headey, et al., 2016), requiring the determinants or attributes of resilience to be distinct and focused in the food security analysis (Ansah et al., 2019). For example, representing resilience through absorptive, adaptive, and transformative capacity, named the 3D resilience framework, has become a dominant paradigm in the food insecurity resilience concept (Béné et al., 2012). With theory-based measures in hand, combining three capacities in the 3D framework represents the synergy to link resilience with food security outcomes. Later, the 3D framework was successfully integrated into the resilience capacity measurement technique for implementing different projects under the Technical Assistance to NGOs, International (TANGO) by the United States Agency for International Development (USAID) (Frankenberger & Smith, 2015; Smith, 2015).

Another methodological evolution to conceptualize resilience to food insecurity recognized food security as one of the determinants of resilience capacity. Later, this approach was formalized as the FAO's Resilience Index Measurement and Analysis (RIMA) framework (FAO, 2016).

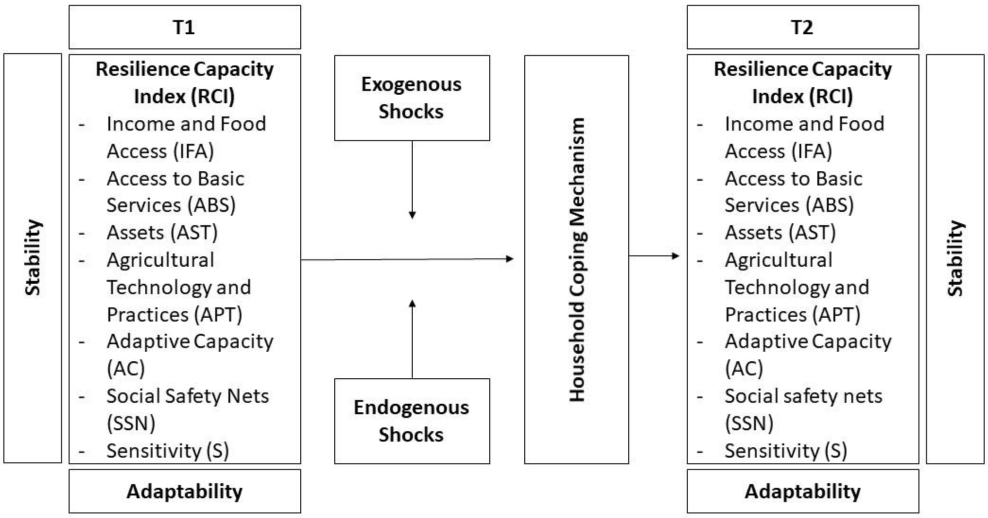

Figure 1.1 Resilience Index Measurement and Analysis (RIMA)

Source: Modified based on Alinovi et al. (2009)

According to the RIMA approach in Figure 1.1, pillars (available options) such as Income and Food Access (IFA), Access to Basic Services (ABS), Assets (AST), Agricultural Technology and Practices (APT), Adaptive Capacity (AC), Social Safety Nets (SSN), and Sensitivity (S) in the household at time T_1 are the preconditions in the household to activate a response mechanism to endogenous and exogenous shocks. If shocks occur between T_1 and T_2, the household as a unit of response activates its coping mechanisms, affecting stability and/or adaptability. In the framework, both stability and adaptability define household resilience capacity to food insecurity. To be more precise, stability implies the extent of variations in the available options of the household. Adaptability makes it possible to create proactive choices for alternative livelihood options depending on the extent of shocks. A higher level of household resilience stems from high stability and adaptability; therefore, the adverse consequences of shocks should not lead to a food insecurity regime.

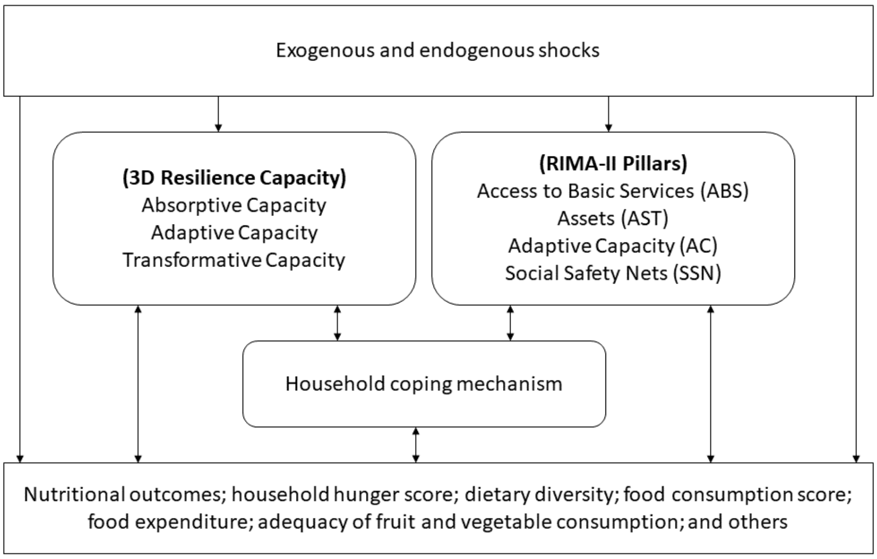

Figure 1.2 Resilience and Food Security Framework (TANGO and RIMA approaches)

Source: Modified based on Ansah et al. (2019)

According to the methodology by FAO (2016), the RIMA-II approach validates the resilience determinants into the following pillars:

- Access to Basic Services (ABS): ABS is a good proxy for access to services and infrastructure. The quality of institutional and public services is also particularly important to measure ABS.
- Assets (AST): AST, representing productive and non-productive resources, is a direct measure of household living standards. In general terms, the pillar may indicate income-earning opportunities from productive assets. At the same time, it may include non-productive assets that can be used as a coping mechanism to decrease the adverse consequences of shocks.
- Social Safety Nets (SSN): The pillar, including formal and informal networking sources, captures household safety nets that can be activated in the presence of shocks.
- Adaptive Capacity (AC): This pillar denotes household ability or adaptability to the changing environment, especially when shocks intensify.

The RIMA approach initially included Income and Food Access (IFA), Agricultural Technology and Practices (APT), and Sensitivity (S) (Ansah et al., 2019).

- Income and Food Access (IFA): The pillar includes the proxy variables representing income or income-generating activities and food security indicators.
- Agricultural Technology and Practices (APT): The APT pillar is an indicator based on the activities or technologies that belongs to agriculture or horticulture.
- Sensitivity (S): The pillar measures the exposure to risk or shock. At the same time, it may include the variables showing household resistance to shocks.

Later, RIMA-II was formalized by excluding the IFA pillar to understand the association between resilience capacity and food security outcomes (Ansah et al., 2019). If we compare the TANGO and RIMA approaches in Figure 1.2, all pillars (ABS, AST, AC, and SSN) are directly related to the 3D (Absorptive, Adaptive, and Transformative Capacity) framework (d'Errico & Smith, 2019), making the concept measurement more consistent. According to the measurement principles in TANGO, 3D includes:

- Absorptive capacity: Absorptive capacity should minimize exposure to shocks or stresses. It may also indicate how the household or system is able to recover from the shock-effected condition.
- Adaptive capacity: It shows the ability to adapt based on a changing environment.
- Transformative capacity: It indicates how the system or household is able to change the basic configuration or livelihood.

However, there are certain differences between TANGO and RIMA. One difference is that the RIMA approach directly includes well-being outcomes, particularly food security, in its measurement (d'Errico & Smith, 2019). From a conceptual standpoint, the following definitions define the distinct meanings of household resilience towards shocks. The RIMA approach defines resilience as *"the capacity of a household to bounce back to a previous level of well-being after a shock"* (FAO, 2016). According to TANGO, resilience is *"the ability of people, households, communities, countries, and systems to mitigate, adapt to, and recover from shocks and stresses in a manner that reduces chronic vulnerability and facilitates inclusive growth"* (USAID, 2012). The definition indicates that the TANGO concept requires different level integrations (such as community, country, or household) to measure intrinsic capacity to withstand shocks. For this reason, the approaches may not be directly comparable since they include different determinants and targets.

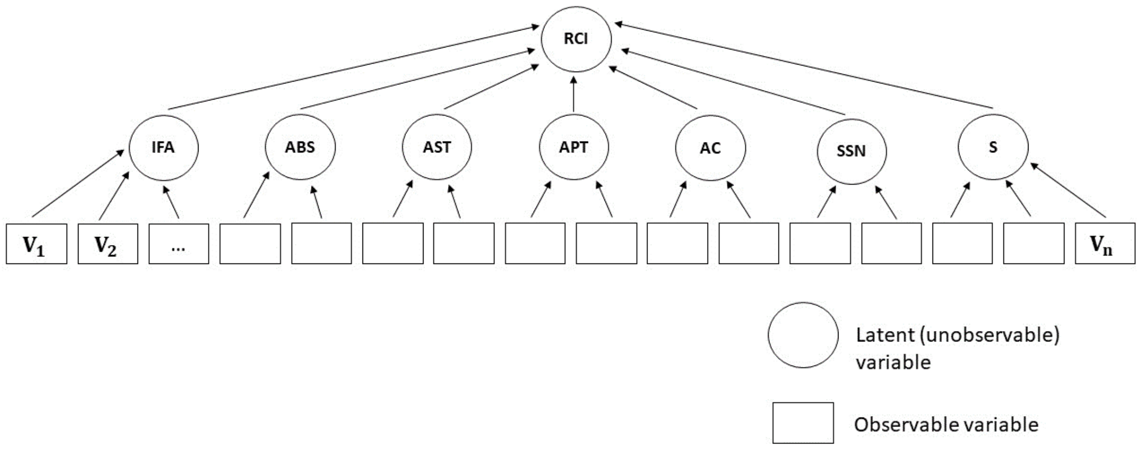

Figure 1.3 Resilience Capacity Index (RCI) measurement

Source: Modified based on Alinovi, d'errico, et al. (2010)

Generally, the TANGO and RIMA methods empirically construct Resilience Capacity Index (RCI) to represent a household ability to withstand shocks. Both methods aim to measure RCI through a latent variable approach, whereby multiple observed variables are used in the measurement. In the estimation of RCI, Structural Equation Modelling (SEM) and the multi-stage modelling methods are dominantly applied (Alinovi et al., 2009). An explanation behind using both methods is that there are latent or unobserved variables or determinants of resilience to be measured through the observed components in a complex dataset (Figure 1.3).

The SEM model combines the observable variables to measure the latent variables by taking their simultaneous relationships into account (Crockett, 2012). Although there are some difficulties in the computation of the SEM approach, d'Errico and Pietrelli (2017) could successfully apply SEM to measure RCI by considering the correlation of residual errors in the included latent variables (the pillars of RCI). In addition, SEM allows goodness of fit tests to understand how the model fits the data (Shi et al., 2018). Another alternative estimation strategy is related to the multi-stage modelling method, in which a factor or Principal Component Analysis (PCA) dominates. This method is used to reduce the number of observed variables by detecting the most unifying variables called factors. To be more precise, the multi-stage approach includes the measurement of latent variables (e.g., IFA, ABS, and others) through the observed components in the first stage. The circle in Figure 1.3 represents an unobserved latent variable or pillar measured in the first stage.

The second stage is used to measure RCI through the obtained pillars from the first stage. Mostly, PCA is used to reduce multidimensionality by drawing on item correlations to construct a small number of factors (Acock, 2013). In the calculations, the loadings are used to represent obtained common factors by predicting the factor correlation matrix. As for the score of pillars and RCI, either the regression or Bartlett's scoring method is used to obtain the scoring coefficients (d'Errico & Smith, 2019).

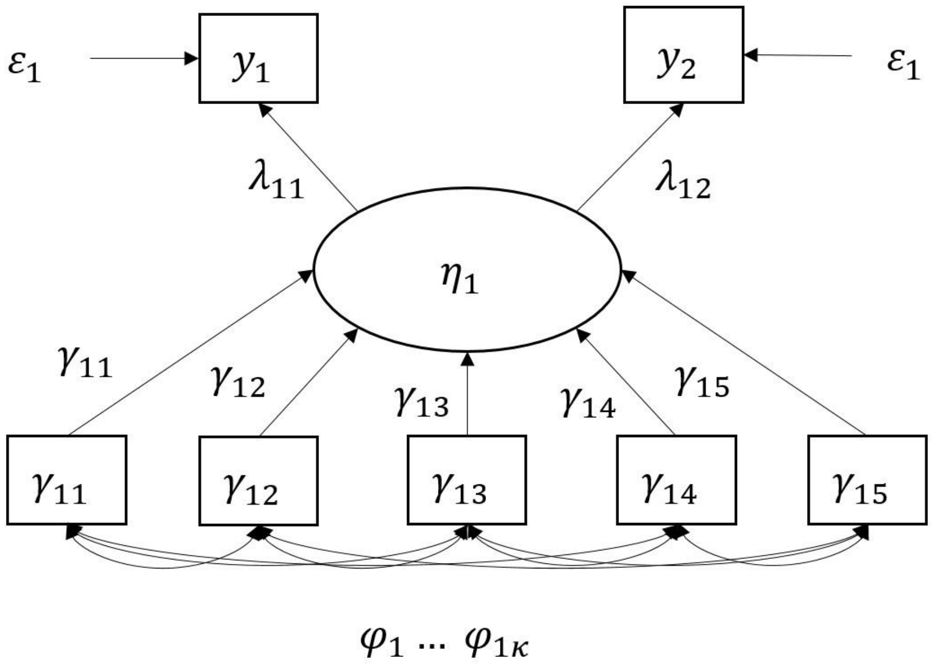

Figure 1.4 Multiple Indicator Multiple Causes (MIMIC)

Source: FAO (2016)

As for Figure 1.4, the RIMA-II approach proposes using a Multiple Indicator Multiple Causes (MIMIC) model with multiple indicators and multiple causes in the system of equation (d'Errico & Smith, 2019; FAO, 2016). The approach incorporates related food security outcomes into the measurement model. Figure 1.4 illustrates that MIMIC has formative and reflective models (Edwards & Bagozzi, 2000). In the cause structure of the figure, a latent variable represents the cause through the observable variables for the reflective model. In contrast, all included observed variables define a latent variable outcome for the formative model. In the RIMA approach, the pillars of resilience (ABS, AST, AC, SSN, and S) are observed as endogenous variables correlating with resilience or RCI. Therefore, food security is the outcome or achievement of RCI. The following equations represent MIMIC:

$$y = \lambda\eta + \epsilon \tag{1}$$

$$\eta = \gamma' x + \zeta \tag{2}$$

where $y_1, y_2, \dots, y_n$ are the determinants of latent indicator which is η. $x_1, x_2, \dots, x_n$ determine the latent η with the coefficient of γ.

1.3 Country Profile and Data

1.3.1 Food Security and Resilience Condition

Central Asia, including Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan, is located in a sub-region of Asia. The region, one of the largest arid zones in the world (Xu et al., 2015), is more vulnerable to climate change (Han et al., 2022; Qin et al., 2021; Reyer et al., 2017); therefore, it is projected to a *hot spot* of expected the most significant environmental migration in the world (Blondin, 2023). Although the consequences of climate change are noticeably severe in Central Asia, the research arena contributing to the dialog about the mechanism of climate change mitigation and resilience is minuscule (Vakulchuk et al., 2023). One of the less studied consequences as a potential risk for the region is food insecurity (Daloz, 2023), particularly due to decreasing agricultural productivity (Babadjanova et al., 2024; Sommer et al., 2013).

This thesis refers to the studies analysing household resilience to protect food security from shocks in Kyrgyzstan and Tajikistan. Kyrgyzstan, located in Central Asia, is a mountainous country; therefore, nearly two-thirds of the population are in rural areas. Prediction scenarios indicate that agricultural drought in Kyrgyzstan is becoming a severe problem (Park et al., 2022). Following this, there is a noticeable deterioration in water and agriculture, food security, energy systems, and health (Reyer et al., 2017; Yu et al., 2019). As a landlocked country with 33% of the population living below the poverty line (WB, 2023), Kyrgyzstan is still facing a challenge in achieving Sustainable Development Goal (SDG) 2 on Zero Hunger (UNDP, 2021; WFP, 2023). With 6.6 million population, more than 15% of them are acutely food insecure while 12% of them suffer from inadequate diet (WFP, 2022b). In this circumstance, the Kyrgyz government established the *"National Development Strategy for the Kyrgyz Republic 2018-2040"* (FAO, 2023c), the Decree on the *"Food Security and Nutrition Program in the Kyrgyz Republic for 2019-2023"* (FAO, 2023b), and *"Kyrgyz Republic Country Strategic Plan for 2023-2027"* by the World Food Program (WFP) (WFP, 2022a); however, there is still an urgent need for nutrition-sensitive (WFP, 2023) and resilience-building actions (FAO, 2024a).

Tajikistan is also experiencing unpredictable climate change with negative consequences (Closset et al., 2015; Haag et al., 2021). For example, the high frequency and intensity of dust storms negatively affect the agricultural sector (Abdullaev & Sokolik, 2020). The country has been suffering from a climate crisis because of its weak adaptability or resilience (Aalto et al., 2017). Moreover, a comparative study of Central Asia confirms it is highly vulnerable country to the food insecurity deterioration due to environmental problems (Su et al., 2024). For example, malnutrition and vitamin deficiency are still the highest in Central Asia (WFP, 2024a). Therefore, more than 30% of the population are food insecure (USAID, 2023). Due to the importance of nutrition-sensitive and shock-responsive actions, the government of Tajikistan initiated supporting programs in partnership with different international organizations: *"Strategic Programme for Climate Resilience"* together with the World Bank, the Asian Development Bank, and the European Bank for Reconstruction and Development (FAO, 2023a), *"Tajikistan Country Strategic Plan 2023-2026"* by WFP (WFP, 2024b), and the Decree on the *"Programme of Food Security in the republic of Tajikistan 2019-2023"* (FAO, 2024b). Despite efforts to mainstream food security, Tajikistan still needs resilience-enhancing interventions to progress toward SGD goals (UN, 2022a).

Methodological approaches should adapt resilience enhancement programs to the Central Asian context to make the interventions viable and approachable. In this case, many scholars have already accentuated the importance of resilience to improve household or system capacity to climatic warming and degradation in the region (Amirova et al., 2022; Bobojonov et al., 2023; Bossuyt, 2023; Ginatullina et al., 2017; Liao & Fei, 2016; Mustaeva & Kartayeva, 2019); however, little is known about resilience, coping mechanism, and mitigating roles of households.

1.3.2 Data

All used data, including the agricultural practices, socioeconomic conditions of households, and the environmental situations in Central Asia, are regionally representative. Precisely, two manuscripts use the Life in Kyrgyzstan Study (LiK) data, primarily from individual, household, and community levels. The survey, hosted by the German Institute for Economic Research (DIW Berlin), the Stockholm International Peace Research Institute (SIPRI), and the Leibniz Institute of Vegetable and Ornamental Crops (IGZ), uses the same 8,000 individual respondents from 3,000 households collected from seven regions and two administrative cities for 2011-2016 years (IZA, 2022). The data are nationally representative, covering rural and urban areas from the selected regions.

The sampling method of LiK is based on the stratified two-stage random sampling, in which strata belong to Bishkek City, Osh City, and seven other regions (Issyk-Kul, Jalal-Abad, Naryn, Batkent, Talas, Chui, and Osh province) for rural and urban areas. Overall, 16 strata in the data are left, including different points, community units, and quarters in rural and urban areas. Due to its multi-topic character, the data have been actively used to analyse women's empowerment and gender roles (Anderson & Esenaliev, 2019; Arabsheibani et al., 2021; Bazarkulova & Compton, 2021; Kolpashnikova & Kan, 2020; Kosec et al., 2022), risk management practices (Kuhn & Bobojonov, 2021; Liu et al., 2023), food security and nutritional outcomes (Freudenreich et al., 2022), inequality (Hennicke & Brück, 2022), poverty and vulnerability (Esenaliev, 2023; Gassmann et al., 2022; Karymshakov et al., 2023), environmental issues (Azhgaliyeva et al., 2021; Kapsalyamova et al., 2021), and other social issues (Chakraborty et al., 2015; Guirkinger et al., 2022; Paulone & Ivlevs, 2019).

The third manuscript uses the Tajikistan Living Standard Survey (TLSS) with 1,503 households in 2007 and 2009 years (WB, 2020b). The sample, including five regions (oblasts) under the urban/rural structure, is regionally representative. TLSS is collected through a stratified two-stage random sampling method. Therefore, 270 clusters were available in urban and rural regions of Tajikistan. Another included survey in the third manuscript is the Tajikistan Household Panel Survey (THPS) study in 2011 from the Institute for East and Southeast European Studies in Regensburg, Germany. The survey includes the same TLSS households, re-interviewed in 2011 to explain the effect of migration, remittance, and labour outcomes (Danzer et al., 2013b). The questions, available within eleven modules in TLSS and THPS, allowed us to analyse resilience and food security conditions since similar modules had been previously used in the famous Living Standards Measurement Study (LSMS) by the World Bank. Additional questions were added in 2011 to analyse the migration and remittance in Tajikistan. With its multi-topic modules, the data have been used to study health issues (Fan & Habibov, 2009; Kamiya, 2011), poverty and vulnerability (Falkingham, 2004; Gang et al., 2018; Jha et al., 2010; Murakami, 2017), migration (Danzer et al., 2013a), and other related topics (Gatskova et al., 2017, 2019; Kan & Aytimur, 2019; Meurs & Slavchevska, 2014).

1.4 Problem Statement and Research Objectives

The overarching objective of this study is to analyse the relationship between resilience, shocks, coping strategies, social capital, and food security outcomes. Meanwhile, the manuscript has three contributions, in which each is investigated as a separate chapter with a published journal article.

1.4.1 Research Objective-1: Mitigating and Dynamic Role of Resilience

Since one of the measurement principles of food insecurity resilience requires shock and stressor specificity, measuring shocks should be central to the analyses (Constas, Frankenberger, & Hoddinott, 2014). Nevertheless, the limitations of the combined effects of household and community shocks are increasingly apparent. In addition, few attempts have been made to explain how household resilience explains dynamic changes in food security outcomes. Previous studies have also been restricted to analysing the mediating effect of resilience to ensure that food security outcomes are not severely affected when shocks intensify.[1] Therefore, using resilience for the "bouncing back" effect, particularly after the shock, is at the forefront of resilience conceptualization (Béné, Headey, et al., 2016). Considering the above mentioned research gap, the manuscript has the following twofold objectives:

- To analyse the effect of resilience capacity (RCI) on the static and dynamic nature of food security outcomes with exogenous and endogenous shock systems.
- To analyse the mitigation effect of resilience capacity (RCI) on food security outcomes.

The manuscript measures resilience as household capacity to prevent from falling into a food insecurity regime. It methodologically proposes how to address the issue of heterogeneity in both exogenous and endogenous shocks. Therefore, it empirically divides heterogeneous shocks into homogenous clusters with Latent Class Analysis (LCA) and integrates the shock classes as one of the covariate variables through a three-step approach (Collier & Leite, 2017; Collins & Lanza, 2009). The manuscript also aims to detect a causal claim between resilience capacity and food security. As for the claims, the study contributes to the dynamic nature of resilience by analysing the effect of RCI

[1] Detailed discussions on dynamic changes in food security and mitigating effects of resilience are available in Section 2.2.

on food security at t_1 and on the loss of food security between t_0 and t_1 (dynamic nature of food security). Two models are applied within the instrumental variable (IV) approach: a two-stage least squares (2SLS) regression analysis and a Probit model with continuous endogenous regressors (IV Probit). In addition, the estimations include the lagged effects of dependent variables (food security indicators) to make the analysis dynamic from the food security perspective.

The last empirical part examines how RCI mitigates the impact of endogenous and exogenous shocks on food security. The interaction terms between *RCI*Exogenous Shock* and *RCI*Endogenous Shock* are included. Since RCI is a fully endogenous variable in the estimation, the interaction terms are also likely to suffer from the same problem. Therefore, we included another instrumental approach by multiplying the existing instrument with each exogenous shock latent variable in the first stage of 2SLS.

1.4.2 Research Objective-2: Social Capital and Food Insecurity Resilience

Although resilience applications have already been integrated into food security literature, operationalizing resilience has different methodological challenges. For example, the complexity of measurement requires a solid explanation of the relationship between nonmaterial determinants and resilience, requiring agency, power, and resilience integration. This existing challenge still impedes the measurement of resilience towards food insecurity. Practically, social capital in resilience operationalization is often veiled due to its cumbersome nature. Because the types of social capital are likely to give plausible explanations for resilience (Anuradha et al., 2019; De Luca & Verpoorten, 2015), the role of social capital in development studies has important implications for policy recommendations (Fafchamps, 2006). Since many low-income countries have been encouraging community-driven development programs, the interconnection between social capital and resilience structure might be compelling evidence for the context of Kyrgyzstan.[2] In this case, adding social capital elements to resilience thinking is particularly important because people experiencing poverty in Kyrgyzstan strongly depend on the social capital attributes.

The measurement technique is required to work on the premise that measuring resilience capacity should be based on accumulating physical and social capital. Although asset accumulation and capital formation are well integrated, social aspects of the household are not fully captured in the RIMA methodology. Therefore, the manuscript draws parallel attention between Income and Food Access (IFA), Access to Basic Services (ABS), Agricultural Practices and Technologies (APT), and Adaptive Capacity (AC) by Alinovi et al. (2008) together with social capital components such as Group Membership and Trust.

Although a higher level of group membership and trust can translate into improved resilience, some findings show a negative association between social capital and resilience. This "dark side" of social capital requires expanding resilience analysis beyond descriptive into more causal claims. Moreover, previous studies within the RIMA approach have disregarded the role of social capital without explaining the level of

[2] Detailed discussions on the relationship between social capital and resilience are available Section 3.2.2.

relationship between social capital and resilience determinants. Therefore, the manuscript aims to fill this void by analysing the effect of social capital through trust/group membership variables on food insecurity resilience (household resilience capacity and determinants of resilience). Generally, the manuscript has the following two objectives:

- To analyse the effect of Group Membership and Trust on resilience pillars (IFA, ABS, APT, and AC)
- To analyse the effect of Group Membership and Trust on resilience capacity (RCI)

In the estimation strategy, the manuscript proposes to estimate the effect of social capital elements or Group Membership and Trust in time t on pillars or resilience in time $t+1$. This corresponding strategy explains a dynamic nature of social capital and household resilience by considering a cumulative exposure over the years. The manuscript, applying 2SLS and IV Structured Equation Model (IV-SEM) to detect the causal effects, adopts the IV approach in the presence of multiple endogenous (Group Membership and Trust) variables in the estimation.

1.4.3 Research Objective-3: Role of Resilience and Coping Strategies

The conceptualization of resilience, particularly in the RIMA approach, confirms a relationship between coping strategy and resilience capacity. However, more attempts are needed to overview how household resilience and coping mechanisms simultaneously behave when shocks intensify. In this case, relatively little is known about the effect of resilience together with coping mechanisms on food security outcomes.[3] The premise of the manuscript is to analyse a causal relationship between resilience and food security when households activate coping strategies. The study includes the following objectives:

- To analyse the effect of resilience capacity (RCI) on the static and dynamic nature of food security outcomes in the presence of a short-term household coping mechanism.
- To analyse how household resilience (RCI) mitigates the negative effects of shocks on food security in the presence of a short-term household coping mechanism.
- To analyse how a short-term coping mechanism is associated with food security.

The manuscript constructs RCI using ABS, AST, SSN, AC, and S pillars (Alinovi, d'errico, et al., 2010; Alinovi et al., 2008). Since many recent studies do not include the S pillar, we still believe there is a strong relationship between household sensitivity and other resilience determinants. SEM is applied in addition to Principal Component Analysis (PCA) for robustness in the construction. One of the main reasons for applying the SEM approach is to evaluate the relationship between the pillars, including the measurement error components in the model. In addition, the manuscript includes factorability and best-fit estimations. It also investigates the validity through convergent, discriminant, and external validity indicators that have not been applied in the RIMA approach.

The manuscript, using the MIMIC model, includes a two-stage procedure for the relationship between RCI and food security (FAO, 2016). In other words, the study tries to build path arrows showing the relationship between RCI and food security (food expenditure, adequacy of fruits and vegetables, and household food expenditure share). Since MIMIC does not claim any causal relationships, the 2SLS model for the static

[3]Detailed discussions on the relationship between resilience and food security in the presence of coping mechanism are available Section 4.

nature of food security outcomes and the IV Probit model for dynamic changes in food security are used. The interaction term between RCI and shock (Standardized Precipitation Index) or *RCI* Shock* is used to analyse how resilience effectively mediates the shock. The interaction term is also instrumented to control the endogeneity issue. Homogenous households using coping strategies are determined by applying the multivariate clustering solutions with LCA. From another perspective, this novel framework for analysing the household heterogeneity of coping strategies could profoundly address the response of household resilience and coping mechanisms to the shocks.

1.5 Structure of the thesis

The thesis, representing three peer-reviewed and published articles, contains five chapters (Table 1.1). In addition to the introduction in the first chapter, the second chapter recognizes resilience as household capacity. The manuscript in this chapter empirically analyses the extent of the effect of household resilience on food security in Kyrgyzstan. The third chapter empirically analyses the effect of social capital on food insecurity resilience in Kyrgyz households. At the end of the spectrum, specific attention is given to the RIMA-I approach, in which food security is not the outcome of resilience because it is located in one of the pillars of the resilience index. The fourth chapter applies the RIMA-II approach to the context of Tajikistan, focusing on the effects of household resilience on food security outcomes in the presence of homogenous coping strategies as a response to climate change. The last chapter is devoted to concluding remarks with methodological remarks and policy perspectives. Moreover, it introduces related limitations that further research should take into account.

The main difference between the second and fourth chapters is that the fourth chapter manuscript investigates the relationship between resilience and food security analysis by creating homogenous coping mechanism profiles. In addition, the manuscript includes a Household Food Expenditure Share (HFES) indicator as one of the dependent variables to obtain more robust results. As for the construction of RCI, the measurement includes the Sensitivity (S) pillar, in which the observed variables show subjective resilience through the life and financial satisfaction levels. For the construction of RCI, the index measured through PCA and SEM was reasonably robust to food security outcomes.

Table 1.1 Thesis Structure

Manuscript	Approach	Methodology and estimation strategy	Country	Dependent variables	Main independent variables	Primary and secondary objectives
(Egamberdiev et al., 2023)	RIMA – II	Principal Component Analysis (PCA); Structural Equation Modelling (SEM); Latent Class Analysis (LCA); Three-step approach; and Instrumental Variable (IV) Approach.	Kyrgyzstan	Dietary diversity (DD); Food Expenditure (FE; Adequacy of Fruits and Vegetables (AFV); Loss in DD; Loss in FE; and Loss in AFV.	Resilience Capacity Index (RCI); Interaction term between RCI and Endogenous Shock profiles; and Interaction term between RCI and Exogenous Shock profiles.	To construct resilience capacity. To cluster households in exogenous and endogenous shock profiles. To analyse the effect of resilience on food security. To analyse the mediating role of resilience on food security.
(Egamberdiev, 2024)	RIMA	Principal Component Analysis (PCA); Instrumental Variable (IV) Approach; and Instrumental Variable (IV) Approach with Structural Equation Modelling (SEM) or IV-SEM.	Kyrgyzstan	Income and Food Access (IFA); Access to Basic Services (ABS); Agricultural Practices and Technologies (APT); Adaptive Capacity (AC); and Resilience Capacity Index (RCI).	Trust; and Group Membership.	To construct resilience pillars and capacity index. To measure social capital. To analyse the effect of social capital on resilience pillars and resilience capacity.

(Egamberdiev et al., 2024)	RIMA – II	Principal Component Analysis (PCA); Structural Equation Modelling (SEM); Latent Class Analysis (LCA); Three-step approach; Multiple Indicator Multiple Causes (MIMIC); and Instrumental Variable (IV) Approach.	Tajikistan	Food Expenditure (FE); Adequacy of Fruits and Vegetables (AFV); and Household Food Expenditure Share (HFES); Loss in FE; Loss in AFV; and Loss in HFES.	Resilience Capacity Index (RCI); Interaction term between RCI and Precipitation Index; and Coping strategy profiles.	To construct resilience capacity. To cluster households in short-term coping strategies. To analyse the effect of resilience on food security. To analyse the mediating role of resilience on food security. To analyse the relationship between coping strategy and food security.

2. Household Resilience Capacity and Food Security: Evidence from Kyrgyzstan

Abstract: Commonly, resilience against external shocks is treated as a household or community capacity. Resiliency against food insecurity is of particular importance for rural household under the impression of recent price surges and supply chain disruptions. The aim of this paper is to analyze the effect of household resilience capacity on food security outcomes in Kyrgyzstan, using individual, household and community datasets of the "Life in Kyrgyzstan" panel survey for several waves from 2011 to 2016. Firstly, a resilience capacity index to food insecurity was estimated through key determinants or pillars under the Resilience Index Measurement and Analysis (RIMA) II methodology, while latent analysis was used to classify shocks. The effect of resilience capacity on food security outcomes was estimated along an instrumental variable approach. Our results suggest that resilience capacity serves to improve food security status and decrease the proneness of households to suffering from food insecurity in the presence of shocks. Furthermore, the interaction between resilience capacity and shocks was included to explain whether the negative effect of the shocks is weakened by resilience. The findings confirm that resilience capacity is able to mitigate the adverse effects of shocks on food security outcomes; moreover, it is sufficient to resist a decline in food security. Following the large contributions of social safety nets and adaptive capacity to the resilience capacity index, policy efforts should be focused on increasing income generating capacity, networking, migration, and education level of households to strengthen resilience to food insecurity.[4]

[4] This chapter is based on article: Egamberdiev, B., Bobojonov, I., Kuhn, L., and Glauben, T. (2023). Household resilience capacity and food security: evidence from Kyrgyzstan. Food Sec. 15, 967–988. https://doi.org/10.1007/s12571-023-01369-1

2.1 Introduction

Political conflict, global climate change and socio-economic shocks confronted 155 million people worldwide with acute food insecurity in 2020 (UN, 2021). In light of the increasing frequency of climate-related shocks, but also systemic events like the recent COVID epidemic and related economic and political upheavals, the ability to absorb and compensate for shocks has become of the utmost importance for maintaining a sustainable food system. Food systems exhibit various potential and interlinked vulnerabilities to climate shocks in particular, including food insecurity and social welfare loss among consumers, environmental degradation and disruptions of food system activities (Ericksen, 2008). In order to decrease food system vulnerabilities, various programs are aimed at introducing more consistent response mechanisms, including the FAO's Food and Nutrition Security Resilience Program (FAO, 2020a), Country Strategic Plans or Food Assistance for Assets of the World Food Program (WFP, 2021a, 2021b), the UNDP's Global Commission for Adaptation (UNDP, 2020) and the Food System Resilience Program (WB, 2021).

Response mechanisms to shocks are commonly summarized under the term resilience. Within the United Nations' Sustainable Development Goals (SDGs), resilience is defined as, *"the ability to prevent disasters and crises as well as to anticipate, absorb, accommodate or recover from them in a timely, efficient and sustainable manner"* (FAO, 2021). Socioeconomic research has long established a strong connection between resilience and long-term economic development (Beauchamp et al., 2021; Fan et al., 2014), supporting the understanding of resilience as a development goal (Barrett & Constas, 2014). More recent work defines resilience as the capacity to deal with ongoing exposure to risks (Constas, Frankenberger, & Hoddinott, 2014). Correspondingly, development studies explain resilience as the capacity of economic agents to cope with different types of shocks (Alfani et al., 2015; Béné et al., 2015). As a strategy, Pasteur (2011) has advanced the definition of resilience to, *"the ability to absorb, cope with and recover from the effects of hazards and to adapt to longer term changes in a timely and efficient manner without undermining food security or wellbeing"*.

Resilience capacity from the perspective of farm households touches three vulnerability dimensions of the farm system at the same time, namely food insecurity, food system activities, and social welfare among producers. By building resilience capacity, farm households may endure shocks and stresses without suffering from a long-lasting deterioration of their production and livelihoods, thus maintaining their food system activities and securing regional food security. We therefore argue that the ability to maintain a sufficient food supply under severe shock events is both a strong indicator of a proactive response of farm households to shock events as well as a decisive factor in the prevention of ripple-down effects from the micro-perspective of producers into food systems at the macro level. In order to explore the relationship between resilience and food security, this paper broadens one of the existing food insecurity resilience conceptualizations, taking the case of Kyrgyzstan. With a population of 6.7 million people, Kyrgyzstan is located in the north-east of Central Asia (NSC, 2022). Kyrgyzstan is one of the few Low-Income Food-Deficit (LIFD) and Landlocked Developing countries (LLDc) where more than 60% of the population live in rural areas (FAO, 2018, 2022b; UN, 2022b). Furthermore, Kyrgyz regions are characterized by the hazard of the country's geographical isolation and climate vulnerability in Central Asia, showing the significance of studying resilience in the country (Xenarios et al., 2019). While Kyrgyzstan has introduced various action plans (Burkitbayeva et al., 2020) and investment programs (Bhutta et al., 2020) for food security and nutritional development, a large part of the population is still on the brink of food insecurity and malnutrition (WFP, 2020). This problem is compounded by poor adaptive capacity, inadequate transport infrastructure, limited access to basic health or sanitary facilities and low social protections (FAO, 2019b). Therefore, designing food security and nutritional interventions or policies may not be enough unless there are extra commitments to build or strengthen household and community resilience to shocks. This further requires an understanding of the structural dimensions of resilience and their dynamics towards food insecurity. In this respect, it is of interest for us to analyze the relationship between household resilience and food security by adopting a multidimensional approach that contributes more effectively to resilience policy programs in Kyrgyzstan.

In order to analyze the connection between resilience and food security, we utilize a longitudinal multi-topic survey with 3,000 households in the Kyrgyz countryside from the “Life in Kyrgyzstan” (LiK) study. The LiK includes detailed information on individual, household and community levels, covering topics on household demographics, assets, expenditure, migration, agriculture, shocks, networking, well-being and others (Research Data Center of IZA, 2016). Supplying multi-dimensional and high-frequency panel data, the LiK study enables us to analyze resilience trajectories and food security dynamics by integrating individual, household and community modules over several waves from 2011, 2012, 2013 and 2016.

In order operationalize resilience capacity as a latent intermediate outcome of different capacity building dimensions in the household, we require a multi-stage approach (Alinovi, Mane, et al., 2010). For this paper, we chose the Resilience Index Measurement Analysis II (RIMA-II) to measure resilience capacity to food insecurity in the presence of shocks (Ansah et al., 2019; FAO, 2016). In contrast to its predecessor RIMA-I, RIMA-II treats resilience as household capacity (Ansah et al., 2019). According to this methodology, food security is the result of activating resilience in the face of shocks.

Overall, this paper provides several contributions to the exiting literature. Firstly, a growing body of literature looking into the relationship between resilience and food security points out the necessities to differentiate between endogenous and exogenous shocks (Brück et al., 2019; d'Errico et al., 2018; Lascano Galarza, 2020; Murendo et al., 2020). We follow this suggestion by conceptually analyzing the relationship between resilience capacity and food security in the presence of shock clusters that are categorized by Latent Class Analysis (LCA) under distinct characteristics of observable variables (Collier & Leite, 2017). A second contribution of this paper is related to the analysis of resilience along a dynamic perspective, as recommended by the FAO (2016). Since very few studies have applied resilience in a dynamic context, the applicability of resilience as measured by the RIMA approach remains unconfirmed (d’Errico & Di Giuseppe, 2016; d’Errico et al., 2021).

In this paper, household resilience estimated at time t_0 is regressed on food security outcomes t_1. In order to capture resilience to food insecurity, we include the following food security outcomes: (a) static food security outcomes at t_1 and (b) food security loss between t_0 and t_1. Furthermore, some interaction terms between the RCI and shock variables are introduced in order to understand the shock-mediating role of resilience. In this regard, we expect that the resilience capacity of the household acts as a mediator, ensuring food security outcomes are not adversely affected. In order to deal with the problem of endogeneity regarding the link between the RCI and food security outcomes, we apply an Instrumental Variable (IV) approach to estimate the causal effects of household resilience on food security.

The remaining part of the paper is structured as follows: Section 2 provides a literature review on resilience and its relationship with food security outcomes; Section 3 includes a data description, measurements and the model; Section 4 presents empirical findings on the relationship between resilience and food security outcomes, and Section 5 contains concluding remarks.

2.2 Literature Review

Resilience as a concept was earlier described in ecological literature. Some scholars successfully defined resilience as a system persistence that has the ability to absorb changes without shifting into an alternate regime (Holling, 1973; Tilman & Downing, 1994), particularly in the case of decreasing variability (Pimm, 1984; Schulze, 1996). Indeed, a resilient system is expected to absorb disturbances in which there should not be any change in maintaining the functions of the system. However, not shifting into alternative states is a misnomer in complex social-ecological systems; therefore, other scholars have proposed resilience as both adaptation and transformation (Folke, 2006; Walker et al., 2006; Walker et al., 2004). In this case, adaptability refers to the extent of managing the system, while transformability is the ability to create a new system. In environmental and socio-economic systems, the nature of resilience has been explained by stimulus and responses to shocks (Levin et al., 1998), and later characterized by absorption, adaption and transformation dimensions (Béné, 2013; Béné et al., 2012; Nelson et al., 2007; Walker et al., 2004). Such a dimensional approach allows for the integration of capacities such as the ability of households or communities to deal with shocks, making resilience an intermediate outcome for socio-economic studies.

In recent years, various papers have undertaken an application of the concept of resilience to a development context, for instance with respect to rural development (Salvia & Quaranta, 2017; Schouten et al., 2012; Scott, 2013), sustainable livelihoods (Quandt, 2018; Sok & Yu, 2015; Thulstrup, 2015), wellbeing (Beauchamp et al., 2021; Walsh & Hallegatte, 2020) and food security (Fan et al., 2014; FAO, 2021). One of the first contributions applying the resilience concept to food insecurity assumed that households not merely absorb shocks but react by using available response mechanisms and capacities (Alinovi, Mane, et al., 2010). In food security analysis, resilience is commonly understood as an unobservable or latent household capacity explaining how to withstand different types of socio-economic, climatic and other types of shocks (d'Errico et al., 2018).

The quantification of resilience entails several conceptual and operational challenges (Béné, Al-Hassan, et al., 2016; Béné, Headey, et al., 2016). Conceptually, the estimation of resilience should be based on principles proposing resilience as a latent and multidimensional capacity index (d'Errico et al., 2016). In theory, resilience *capacity* is described as a shock mediator that helps to put the household in a better position to improve food security or recover from any food security loss (Constas, Frankenberger, & Hoddinott, 2014). In this case, shocks can be typified as both widely experienced (i.e. exogenous) or suffered from by an individual (i.e. endogenous) (Choularton et al., 2015). This condition is one of the fundamental precursors to operationalize resilience as a capacity (d'Errico et al., 2016). Empirically, the resilience index is constructed as a *latent* variable, since it is not observable per se (Alinovi, d'errico, et al., 2010). Although there is no congruent structure of resilience capacities, it should represent different aspects of household livelihoods (Crookston et al., 2018). Therefore, another important foundation of measurement is related to its *multidimensionality* (FAO, 2016).

As a composite index, the resilience index of households includes stability, social safety nets, access to public services, assets, income and food access and also an adaptive capacity (Alinovi, Mane, et al., 2010). This conceptual framework treats resilience as latent and multidimensional, showing the ability of households to maintain their wellbeing in the face of shocks. This methodology was later operationalized into the so-called RIMA-I model. However, the RIMA-I framework has two shortages in its modelling, by not treating resilience as a capacity index and food security as one of the indicators of resilience (Ansah et al., 2019). Later, RIMA-II was developed, treating resilience as capacity and food security as outcome variables. One of the most promising proposals to measure the Resilience Capacity Index (RCI) integrates four pillars: Access to Basic Services (ABS), Assets (AST), Social Safety Nets (SSN) and Adaptive Capacity (AC) (FAO, 2016). According to RIMA-II, the framework assumes that a change in Y outcome between t_0 and t_1 (e.g. food security) can be observed due to the occurrence of different types of shocks.

The relationship between resilience and food security outcomes is most studied in the RIMA-II framework (Brück et al., 2019; Chiwaula et al., 2022; Ciani & Romano, 2014; Haile et al., 2022; Otchere & Handa, 2022), particularly where dynamic (d'Errico & Di Giuseppe, 2016) and cross-country analysis (d'Errico et al., 2018; d'Errico et al., 2021; Sibrian et al., 2021) have provided promising results. By considering a fundamental problem in causal relationships between resilience and food security or nutritional outcomes, d'Errico and Pietrelli (2017) used the IV approach in their identification strategies. Their findings confirmed a causal relationship indicating a negative effect of the RCI on the probability of having malnourished children and the number of malnourished children in the household. Moreover, some authors conceptualized the relationship between resilience and food security in the presence of dynamic changes of food security (d'Errico et al., 2018; Haile et al., 2022). More precisely, the RCI is modelled in the outcomes of both food security loss and food security recovery. This gives a clear understanding of how resilient households are able to bounce back to a previous food security condition. Another paper by Murendo et al. (2020) has added a contribution to the RIMA-II approach in which authors conceptualized the association between the RCI and pillars with diet diversity and a food consumption score. In the estimation strategy, a lagged RCI variable is taken into the model to deal with reverse causality. By providing extra evidence to explain a mediating role of resilience, the framework is further formalized through the interactions between the RCI and different types of shocks. Acknowledging its mediating role, findings have confirmed the effectiveness of the RCI in dealing with shocks on food security outcomes (d'Errico et al., 2018; Haile et al., 2022; Murendo et al., 2020; Ouoba & Sawadogo, 2022; Sunday et al., 2022). Generally, the empirical analyses mostly confirm a positive relationship between resilience and food security. However, there are still avenues for empirical investigations providing further robust scientific evidence.

2.3. Methodology and Data

2.3.1. Data

The LIK is a multi-topic longitudinal survey collected from both households and individuals in Kyrgyzstan. The survey was conducted as part of the research project "Economic Transformation, Household Behavior and Well-Being in Central Asia: The case of Kyrgyzstan", which was undertaken by the German Institute for Economic Research (DIW Berlin) in collaboration with the Humboldt-University of Berlin, the Center for Social and Economic Research (CASE-Kyrgyzstan) and the American University of Central Asia (Brück et al., 2014). Being nationally and regionally representative, the survey includes five waves (2010, 2011, 2012, 2013 and 2016) from seven Kyrgyz regions (oblasts) as well as the cities of Bishkek and Osh, with the same 3,000 households with 8,000 individuals being tracked over the waves (Research Data Center of IZA, 2016). To be consistent in the selection of variables in the construction of the RCI, the initial waves are excluded from the analysis. We construct variables for the four resilience pillars (ABS, AST, AC and SSN) for 2013 and, for food security outcomes, we mostly use the 2016 wave to make further inferential analysis between the RCI in t_0 and food security outcomes in t_1.

After dropping observations with insufficient information to generate the RCI and outcome variables, we ended up with a final sample of 2,530 households (Table A1.1). In most cases, the household heads were male, although more than 25% of the families were headed by females, most likely due to high occurrences of (seasonal) labor migration among the rural male population. The average age of household heads was 54 years, and more than 60% of the household heads were married. The average household size was 5 family members. More than 60% of households were located in rural areas. Since there is a noticeable heterogeneity of resilience levels among regions of Kyrgyzstan (FAO, 2019b), we grouped 9 oblasts (provinces) into 3 main regions: Bishkek and the Northwest, Issyk-Kul and the Tian-Shan, and Fergana Valley. The analysis of microdata confirmed that the accessibility indicators generally coincide with the three mentioned regional differences (Blankespoor, 2013). Correspondingly, more than 40% of communities in the sample belonged to Fergana Valley, while around 34% and 12% of communities represented Bishkek and the Northwest as well as Issyk-Kul and the Tian-Shan regions, respectively.

2.3.2. Measures

2.3.2.1. Resilience Capacity – RIMA-II

Methodologically, RIMA-II is based on a two-stage measurement analysis including Factor Analysis (FA) and Multiple Indicators and Multiple Causes (MIMIC) (FAO, 2016). Four resilience pillars, namely ABS, AST, SSN and AC, are constructed by factor analysis (Alinovi, d'errico, et al., 2010) (Alinovi, Mane, et al., 2010).

For the construction of the RCI along the RIMA-II methodology, we followed the existing literature and applied Principal Component Analysis (PCA) (Ado et al., 2019; Atara et al., 2020; Gambo Boukary et al., 2016; Lascano Galarza, 2020). By defining the principal components, which are linear combinations of variables explaining a large proportion of variance in the dataset, this method allows for the number of variables to be reduced (Rabe-Hesketh & Everitt, 2003). For a list of underlying variables used to construct the four pillars, we refer to Table A1.2 in the Appendix. To compute factor scores, we used the weighted sum method proposed by Bartlett (Bartlett, 1937). By avoiding the risks of multicollinearity, the Bartlett method produces relatively unbiased estimations of true factor scores (Hershberger, 2005). In the final step, the four pillars were turned into a composite index representing the resilience capacity index (RCI) of a household:

$$RCI = f\,(ABS, AST, SSN, AC) \qquad (1)$$

Here, the RCI of a household is a function of the four pillars ABS, AST, SSN and AC. To generate a standardized index, the Min-Max scaling transformation was applied. A similar scaling technique was used to obtain standardized RCI indexes (d'Errico et al., 2018; Lascano Galarza, 2020).

$$RCI^{*} = (RCI - RCI_{min}) \,/\, (RCI_{max} - RCI_{min}) \times 100 \qquad (2)$$

Before constructing pillar indices and the RCI, we applied the *Bartlett Test of Sphericity* to detect factorability, which tests for whether the variables are orthogonal (Tobias & Carlson, 1969). For measuring sampling adequacy, the *KMO (Kaiser-Meyer-Olkin)* statistic was used (Kaiser, 1974). In our study, we used a *KMO* value of 0.5 or above as a model selection criterion (Field, 2013). To check for multicollinearity, we applied a *Determinant of R-Matrix* or correlation coefficient matrix in the model, which should be greater than 0.00001 (Field, 2013). By applying a latent root criterion for component extraction in the factor analysis, we only considered factors with an eigenvalue bigger than 1.0 or the *Kaiser criterion* (Acock, 2013; Kaiser, 1960). In order to maximize the dispersion of factor loadings within each extracted factor, we applied a *Varimax Rotation* method (Kaiser, 1958).

Our choice of resilience capacity pillars is based on a literature review, household characteristics, data availability and statistical analysis (Table A1.3). In the following section, we introduce our four dimensions, or pillars, of resilience capacity, with the first being ABS, which describes the ability of households to activate resilience strategies based on access to basic services (FAO, 2016). In this paper, we included household characteristics that represent the quality of the conditions of the shared dwellings, along with distances to certain destinations. Moreover, this entails access to health and the household Infrastructure Index. The second pillar is AST, which is an important prerequisite for shock response (Alinovi, d'errico, et al., 2010). The effects of shock depend on the types of productive and non-productive assets as preferable proxies for income during and post shock-recovering phases. In this context, it is explicable on the basis that included variables to construct AST pillar represent both productive and non-productive of assets per capita. AC refers to the extent of household capacity to cope with and/or adapt to a new situation in which households are able to perform usual activities without long-lasting disturbances (Alinovi, d'errico, et al., 2010; FAO, 2016). An explanation may be that relatively more adaptive households are more capable at dealing with new environments without deteriorating the quality of usual performances (Gallopín, 2006; Lascano Galarza, 2020). Our paper includes diverse socio-economic contexts of adaptive capacity believed to make households reconfigure without significant deterioration in their functioning. Because many households are located in rural areas, we included an Informal Networking Index and migration-related variables to characterize social capital and extra flexibility of the households in dealing with shocks. Finally, the pillar SSN represents a household's ability to access both formal and informal assistance from relatives and friends, international agencies, charities, non-governmental organizations and others (Alinovi, d'errico, et al., 2010). In this paper, we included cash or in-kind sources covering migration remittances, aids and allowances.

2.3.2.2. Food Security

As food security indicators we used three variables, namely a household dietary diversity index, weekly food expenditures and the adequacy of fruit and vegetable consumption. In capturing both monetary and diet diversity aspects of food security, we are in line with previous approaches (Brück et al., 2019; d'Errico et al., 2018; FAO, 2016; Lascano Galarza, 2020). Household dietary diversity is frequently used in food security analysis (Hoddinott & Yohannes, 2002) for its ability to assess nutritional adequacy over a reference period (Smith & Subandoro, 2007). Household dietary diversity in this paper is measured by the Simpson Index (Simpson, 1949), which was initially developed for assessing biodiversity, although recently it has also found application in assessing nutritional diversity (Krivonos & Kuhn, 2019). The measure of food expenditure (Moltedo et al., 2014) is weekly food expenditures spent on food items by the household, expressed in Kyrgyzstani Som (KGS). In order to analyze the nutritional aspects of food security, it is recommended to consider fruits and vegetables, which can provide an overview about vitamins and minerals for nutrient and density supply of calories (Moltedo et al., 2014). Since the daily intake of fruits and vegetables in developing countries is relatively below the recommended level (Rekhy & McConchie, 2014), we used the adequacy of fruit and vegetable consumption in the household, which should be a minimum of 400 grams/capita/day (INDDEX, 2018).

As was proposed by the RIMA-II approach, food security outcomes should reflect both static and dynamic perspectives, where we draw our conclusions on changes in food security outcomes between t_0 and t_1. Therefore, to capture changes, we included (a) food security outcomes and (b) loss in food security outcomes (Table A1.1). In 2016, the average dietary diversity (Simpson) score was 0.87. However, more than 66% of households suffered from a reduction in dietary diversity between the years 2013-2016. As for food expenditure, the average weekly amount was KGS 2035 in 2016, representing 28% of affected households in the last 3 years. The adequacy of fruit and vegetable consumption was 391 grams/capita/day, which was lower than the recommended level of 400 grams/capita/day. The level of decrease of this adequacy over the last 3 years was more than 62%. Approaching resilience thinking in both static and dynamic nature of food security allows us to further explore the long-term effects of household resilience on food security outcomes.

2.3.2.3. Shocks

In this paper, another task is to identify and accurately enumerate homogenous shock classes. When it comes to household systems, there are generally two types of shocks, namely endogenous shocks that affect individuals or households, and exogenous shocks that affect groups of households or communities. To classify shocks, we applied LCA to generate categorical latent variables (Hagenaars & McCutcheon, 2002) through observed variables for detecting population heterogeneity (Lanza & Cooper, 2016). This allowed us to obtain similar groups representing homogenous households in terms of experienced shocks. In the dataset, shocks were measured by dummy variables indicating whether the household had faced a specific type of shock within the last twelve months. In this respect, we included five types of exogenous shocks and eight types of endogenous shocks for creating latent classes from the 2016 wave (Table A1.4). In order to model identified latent classes as covariates in the relationship between the RCI and food security outcomes, we applied a three-step approach (Collier & Leite, 2017; Vermunt, 2010; Vermunt & Magidson, 2021). First, we built a latent class model for a set of response items. Second, we assigned subjects to the classes based on posterior class membership probabilities. Third, we analyzed the association between class membership and external variables. The last step allowed us to use a regression analysis by taking the latent class variable in the regression analysis.

Since the latent class prevalence is the probability of class membership, we measured an individual's posterior class-membership probabilities (Collins & Lanza, 2009; Hagenaars & McCutcheon, 2002):

$$P(Y=y)=\sum_{c=1}^{C}\gamma_c\prod_{j=1}^{J}\prod_{r_j=1}^{R_j}\rho_{j,r_j|c}^{I(y_j=r_j)} \tag{3}$$

where y_j represents element j of y response pattern. When the response to variable $j = r_j$, the indicator function $I\,(y_j=r_j)$ is equal to 1 and otherwise 0. Therefore, the probability of a vector response is regarded as the function of the probabilities of membership in each latent class and the probabilities of each response conditional on class membership represented by $\gamma's$ and $\rho's$, respectively. The vector of item-response probabilities of the variable for a particular latent class is always equal to 1 (Collins & Lanza, 2009):

$$\sum_{r_j=1}^{R_j} \rho_{j,r_j|c} = 1 \tag{4}$$

Taking into account the assumption of *"local independence"* or *"conditional independence"* of LCA, equation (4) indicates that the probability of a response *(ρ)* to each variable is conditioned on class membership only. Therefore, LCA is recognized as a probabilistic approach in which each observed respondent belongs to only one class that is defined as mutually exclusive (Collins & Lanza, 2009). In order to assess the fit of the LC models, we applied Akaike's Information Criterion (AIC) (Akaike, 1987b), the Bayesian Information Criterion (BIC) (Schwarz, 1978), and entropy based criteria (Larose et al., 2016), since they are widely applied for comparing models by considering their balance between fit and parsimony (Collins & Lanza, 2009; Tein et al., 2013).

2.3.3 Estimation Model

The problem of endogeneity between the RCI and food security outcomes has already been mentioned in previous publications (Ansah et al., 2019; Murendo et al., 2020). We addressed this issue by using the IV approach. In order to incorporate community-related variables, we used the LIK community dataset from the 2011 wave. Taking country contexts and the available literature into account, we used *the distance to the nearest country border from the community* as a valid instrument. The distance variable is re-scaled with the Min-Max technique, in which the value of 100 indicates the maximum distance in km. Discussions on the RCI and food security outcomes include the improvement of cross-border coordination, collaboration and information sharing to increase household resilience capacity for those who depend on seasonal migration in search of alternative income sources (FAO, 2019c). Accordingly, the level of the RCI is highly varied depending on the location, explained by certain characteristics such as conflict, economic prosperity, trade activities and education levels. Moreover, recent literature findings cogently explain the roles of trade facilitation across borders (Bonuedi et al., 2020), which certainly makes inroads into strengthening the resilience to withstand different types of shocks (Şlusarciuc, 2017). For example, a border trade based on transit bazaars between Kyrgyzstan and other countries plays an important role (Steenberg, 2016), and a bazaar-centered informal economy manifests its significance in Kyrgyz economy (Karrar, 2019). Taking into account that countries undergoing development are often prone to external shocks (Ryan, 2012), Kyrgyzstan highly depends on border relationships, strongly reflected on natural resources (Toktomushev, 2017). This is particularly important for countries depending on agriculture, since a close border relationship is one of the key positions in strengthening household resilience (Ambrosino et al., 2018). In this respect, a *regional cross-border approach* by analyzing cross-border livelihoods illuminates the ways to measure the resilience in food security perspectives (FAO, 2018).

As we propose, the RCI should have a positive relationship with food security outcomes. At the same time, it should protect from the negative impacts of shocks on food security. Accordingly, we used the RCI in 2013 to analyze its relationship with the static nature of food security outcomes in 2016 and food security loss from 2013 to 2016 for dynamic changes. In order to understand whether the RCI mediates the relationship between shocks and food security outcomes, we separately looked at the relationship between RCI*Shock and food security outcomes in further models.

As has been mentioned, both food security outcomes and loss were measured by dietary diversity, weekly food expenditures and the adequacy of fruit and vegetable consumption. We also included a corresponding lagged dependent variable calculated from the 2012 and 2013 waves to capture the effects of its past status (Vaitla et al., 2020; Wilkins, 2018). Therefore, our models indicate that both static and dynamic outcomes are the function of past food security levels. Since we have both continuous and binary outcomes, the relationship using IV is estimated through two-stage least squares (2SLS) and a Probit model with continuous endogenous regressors (IV Probit). The model can be written in reduced form:

$$y_h^* = \mathbf{y}_h \beta_1 + x_{1h} \beta_2 + u_h \qquad (5)$$

$$\mathbf{y}_h = x_{1h} \boldsymbol{\Pi}_1 + x_{2h} \boldsymbol{\Pi}_2 + \boldsymbol{v}_h \qquad (6)$$

where $h=1,\ldots,N$, y_h^* is the dependent and $\mathbf{y}_h$ is the endogenous variable for *h*th observation. Both x_{1h} and x_{2h} collectively represent the instruments while x_{2h} is the excluded exogenous regressor (instrument). For binary outcomes, we observe:

$$y_h = \begin{cases} 0 & y_h^* \leq 0 \\ 1 & y_h^* > 0 \end{cases} \quad (7)$$

by assumption, $(u_h, v_h) \sim N(\boldsymbol{O}, \boldsymbol{\Sigma})$, implying joint normal distribution.

To check for endogeneity, we applied a *Wald test of exogeneity* (Wooldridge, 2010), indicating RCI or RCI*Shock is fully exogenous. Since the RCI is still endogenous, the interaction variable representing the RCI and shocks may provide inconsistent results in the presence of endogeneity. To obtain consistent estimators of interaction terms in this situation, we incorporated additional instrumental variables by interacting the existing instrument, which is *the distance to the nearest country border*, with exogenous shock variables (Aghion et al., 2005; Ebbes et al., 2022; Kim et al., 2011; Nizalova & Murtazashvili, 2016). In order to include a valid instrument representing excluded exogenous variables in the model, there should be a statistically significant correlation with the endogenous regressor but not with the error term (Cameron & Trivedi, 2009). Therefore, we implemented the first-stage regression to analyze whether the instrumental variable is a predictor of RCI or RCI*Shock interactions. The results suggest a negative and statistically significant association between the border distance and RCI or RCI*Shock terms. Moreover, we implemented *Anderson-Rubin (AR)* (Finlay & Magnusson, 2009) and *Cragg-Donald statistics* (Cragg & Donald, 1993) to check the strength of our instruments; the test results show that the selected instruments are strong enough (Table A1.5 and Table A1.6). After obtaining fitted values of the RCI by using selected instrumental variable and covariates from the 2013 wave in the first stage, we also used them as exogenous variables for robustness checking together with covariates from 2016 in the second-stage regression. The standard errors of fitted values of the RCI are obtained via bootstrapping (Table A1.7-Table A1.9). In this way, it is still possible to obtain unbiased estimates of both intercepts and slopes (Grace, 2021), particularly with bootstrapping the standard errors (Cameron & Trivedi, 2009).

2.4. Results

2.4.1. Latent Class Analysis

Until the best model was achieved in Table 2.1, we selected a two-class solution for exogenous shocks. Due to non-convergence in the third class for endogenous shocks, we were still able to distinguish between homogenous shock classes depending on a two-class model.

Overall statistics of exogenous shock indicate that flood, cold weather and drought were the major shock events experienced by households in 2016. As for latent classes of exogenous shock, the existence of all types of shocks is significantly low in the first class (Figure A1.1). In other words, there is a low conditional probability of shocks happening. Therefore, we labeled the first class *"Low Shock"* latent class. As for the predicted probability of class memberships, the *"Low Shock"* class represents about 78%. Correspondingly, we named the second class *"High Shock"*, because the above-mentioned three corresponding shock events are very much above the mean in the predicted scale. This class represents the remaining 22% of the sample.

Table 2.1 Model fit statistics

	Model	N	LL (model)	df	AIC	BIC	Entropy
Exogenous Shock	Class-1	2518	-4811.967	5	9633.935	9663.091	
	Class-2	2518	-4223.693	11	8469.387	8533.53	0.522
	Class-3	2518	-4128.983	17	8291.966	8391.096	0.278
Endogenous Shock	Class-1	2518	-4179.886	8	8375.772	8422.422	
	Class-2	2518	-3899.158	17	7832.317	7931.447	0.487

Source: compiled by the authors

With respect to endogenous shocks in Class-1, disease in crops and livestock as well as water insufficiency were commonly experienced shock events in 2016. Looking at the latent class analysis, the probabilities of almost all types of shocks in Class-1 are below the median (Figure A1.2). Therefore, we labeled Class-1 *"Low Shock"* and Class-2 *"High Shock"* latent classes. Class memberships represent around 19% and 81% for *"Low Shock"* and *"High Shock"* classes, respectively.

2.4.2. SEM Analysis

In order to understand the explanatory power of the pillars and their correlations to resilience, we used Structural Equation Modelling (SEM) for a descriptive purpose only. One advantage of this method is that the latent variable (RCI in our case) is linearly correlated with underlying factors (the pillars in our case) (Acock, 2013). Our findings, both the unstandardized with reference to AC and the standardized without any reference group, indicate that all pillars except ABS are positively correlated with the RCI (Table A1.10). As it is recommended, the highest value of the coefficient of AC was taken as a reference group (Acock, 2013). The findings indicate that SSN and AC are the most contributing pillars for building stronger food security resilience. The PCA results are also very consistent with our SEM findings, where one can observe higher explanatory weights of both AC and SSN in Factor-1 (Figure A1.3).

Figure 2.1 illustrates that the AC pillar is one of the most significantly contributing factors, which is in line with other findings (Ado et al., 2019; Brück et al., 2019; d'Errico & Pietrelli, 2017; d'Errico et al., 2018). The finding of the Factor-1 of the AC, the RCI is inextricably intertwined with migration (Figure A1.4). For example, both variables representing migration share for the last 12 months and the consecutive five years manifest alternative income sources. In practice, migration and alternative income sources contribute significantly to the resilience of households in Central Asian countries (Marat, 2009). In many cases, unrecorded channels in rural areas, which may determine informal social networks, are not easily integrated into the construction of the RCI (FAO, 2016). In this case, we tried to capture unofficial social networks in AC by recognizing the possibility of different forms of networking by constructing the Informal Networking Index. This index indicates household abilities to respond to shocks with financial and non-financial aids through informal networking possibilities. Correspondingly, it elicits information about generating additional income through informal channels, which indicates that the AC of resilience strongly depends on the existence of informal networks.

As SSN is the second most relevant pillar for the RCI, the importance of it in resilience capacity has been acknowledged in particular for poor population strata (Alinovi, d'errico, et al., 2010). For example, SSN was found to be the second most contributing factor of the RCI for Tanzania and Uganda (d’Errico et al., 2018). For the measurement, SSN represents different types of safety nets (Alinovi, Mane, et al., 2010), where support from friends or relatives (Ado et al., 2019), cash assistance (Brück et al., 2019) and state support (Lascano Galarza, 2020) can be precursors of the household resilience capacity in the struggle with the adverse effects of shocks. Looking at the factor loadings for SSN, money transfers from abroad and the number of times where money from migrants working abroad is received have relatively higher loadings in Factor-1, indicating the significance of migration for resilience (Figure A1.5). Accordingly, both Factor-2 and Factor-3 represent mostly money aid obtained from other forms, pensions, and allowances in Kyrgyzstan.

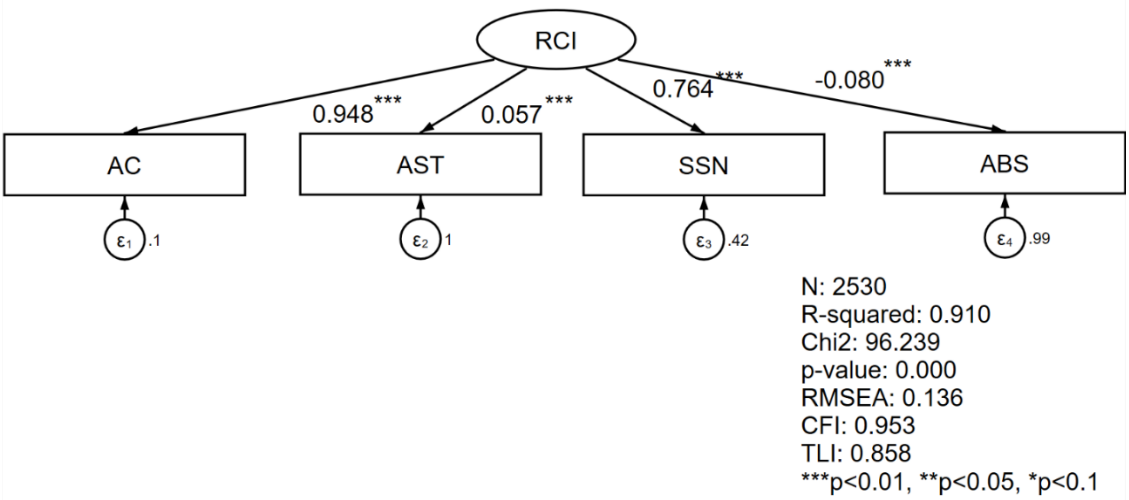

Figure 2.1 SEM of RCI

Source: compiled by the authors

AST, where productive assets are mainly in Factor-1 and non-productive assets in Factor-2 (Figure A1.6), represents the significance of building or strengthening resilience. Similar to our findings, other authors have also found that AST is the most relevant pillar for the RCI, as in the case of Malian households (d'Errico & Pietrelli, 2017; Lascano Galarza, 2020).

Since capacity dimensions or pillars may behave differently depending on the situation (Constas, Frankenberger, & Hoddinott, 2014), a negative relationship between ABS and the RCI might be expected. In our context, households living far from main facilities or lower ABS may experience higher levels of migration, informal networking, or others indicated in AC. This observation about synergies between pillars or capacities of resilience is consistent with discussions stating that improving one capacity may shape the level of another capacity of resilience (Béné et al., 2012). Since the obtained factors in ABS (Figure A1.7) represent the access to infrastructure, basic services and health, ABS still can be regarded as a good proxy for the quality of the RCI.

2.4.3. Household Resilience Capacity and Food Security

A positive relationship between the RCI in 2013 and food security outcomes in 2016 (Table 2.2) indicates that a higher RCI is meant to increase outcomes by 0.004 on average in dietary diversity (Column-2), KGS 68.242 in food expenditure (Column-4) and 11.368 grams/capita/day in the adequacy of fruit and vegetable consumption (Column-6). The relationship between shocks and food security outcomes is rather complex. By taking *"Low Shock"* as the base, the *"High Shock"* latent class for exogenous shock is negative with the outcome of food expenditure (Column-4) while the endogenous *"High Shock"* class is significantly positive with both dietary diversity and adequacy outcomes. This result seems to be consistent with previous studies, finding a positive relationship between certain types of shocks and food security outcomes (Brück et al., 2019; d'Errico et al., 2018), which might be due to activating food coping strategies in the short period of time (Lascano Galarza, 2020; Murendo et al., 2021). In the current context, strong family attachments in Kyrgyz households can, not surprisingly, enable them to use unofficial networking channels when faced with endogenous shocks. A study by Wossen et al. (2016) confirmed that households are able to smooth consumption by activating informal networks of social capital. A significant and positive coefficient of the lagged dependent variable in Column-4 indicates that food expenditure is a function of its past level. Ansah et al. (2019) have indicated that more food-secured households might be expected to adopt strategies or institutional mechanisms easily in achieving better food security outcomes. A negative and significant relationship of rural households with dietary diversity (Column-2) and food expenditure (Column-4) was detected. As expected, the size of a household is positively associated with food expenditure in Column-4, compared to negative outcomes of the adequacy rate in Column-6. Households with a married head are likely to have better outcomes in dietary diversity and food expenditure, as presented in Column-2 and Column-4, respectively. There is a negative relationship between the age of the household head and food expenditure outcome. The direction of this relationship changes in the squared coefficient, indicating a nonlinear effect of age.

Table 2.2 OLS and 2SLS models of food security outcomes

	Dietary Diversity (DD)		**Food Expenditure (FE)**		**Adeq.Fruits and Vegetables (AFV)**	
	(1) **OLS**	**(2)** **2SLS**	**(3)** **OLS**	**(4)** **2SLS**	**(5)** **OLS**	**(6)** **2SLS**
RCI	0.000	0.004***	-0.337	68.242***	0.290	11.368**
	(0.000)	(0.001)	(1.413)	(22.683)	(0.378)	(5.007)
DD_2013	-0.014	0.013				
	(0.034)	(0.048)				
FE_2013			0.343***	0.267***		
			(0.030)	(0.050)		
AFV_2013					0.018	0.021
					(0.022)	(0.027)
Age HH head	0.001**	-0.002	10.541	-48.490**	12.491***	1.971
	(0.000)	(0.001)	(10.482)	(24.628)	(2.813)	(5.786)
Sq. Age HH head	-0.000**	0.000	-0.054	0.431**	-0.100***	-0.013
	(0.000)	(0.000)	(0.092)	(0.208)	(0.024)	(0.048)
Female head	0.007	0.010	-25.729	-20.304	11.048	18.962
	(0.004)	(0.006)	(70.406)	(101.533)	(19.180)	(22.935)
Head married	0.011**	0.020***	108.203	225.795**	9.973	34.348
	(0.004)	(0.007)	(71.882)	(110.648)	(19.525)	(25.542)
HH size	0.003**	-0.000	168.594***	121.314***	-114.486***	-125.726***

	(0.001)	(0.002)	(28.933)	(44.531)	(7.586)	(10.291)
Sq. HH size	-0.000*	-0.000	-9.377***	-7.720**	4.930***	5.347***
	(0.000)	(0.000)	(2.032)	(2.980)	(0.543)	(0.668)
Rural	-0.008***	-0.013***	-404.628***	-521.139***	-5.178	-19.480
	(0.002)	(0.004)	(46.415)	(77.150)	(12.146)	(15.726)
Exogenous	0.005*	-0.001	-31.801	-162.149*	25.258*	3.821
shock	(0.003)	(0.005)	(51.848)	(86.213)	(13.929)	(19.076)
Endogenous	0.013***	0.010*	181.261***	146.133	56.983***	50.471***
shock	(0.004)	(0.005)	(61.571)	(89.530)	(16.591)	(19.816)
Issyk-Kul and	-0.026***	-0.018***	-435.411***	-329.166***	-53.163***	-32.772
the Tian-Shan	(0.004)	(0.006)	(65.263)	(100.403)	(17.573)	(22.698)
Fergana	-0.008**	-0.035***	-53.515	-519.856***	68.696***	-5.516
Valley	(0.004)	(0.010)	(49.785)	(169.563)	(13.417)	(36.983)
Constant	0.836***	0.878***	782.656***	1818.541***	392.649***	572.031***
	(0.036)	(0.052)	(295.893)	(546.322)	(80.344)	(124.622)
Observations	2138	2138	2169	2169	2169	2129
R-squared	0.041		0.192		0.235	
Cragg-Donald Statistics		16.781		17.536		17.021

****ρ<0.01, **ρ<0.05, *ρ<0.1. A base class for both exogenous and endogenous shocks is "Low Shock" class. Standard errors in parentheses. The excluded regional dummy is Bishkek and the Northwest.*

Source: compiled by the authors

Moreover, a more comprehensive estimation is included, where each shock class was interacted with the RCI for each outcome model (Table 2.3). Accordingly, the relationship between RCI*Exogenous or RCI*Endogenous shocks and food security outcomes provides robust results. More precisely, the sign and magnitude of effects are similar to those models with the absence of interaction terms, indicating the role of resilience in smoothing shocks. In this case, the findings are consistent with other conclusions confirming a weakened effect of the shocks by the RCI (d'Errico et al., 2018; Haile et al., 2022; Murendo et al., 2020; Ouoba & Sawadogo, 2022; Smith & Frankenberger, 2018). Moreover, it can be observed that shocks are negatively associated, with a majority of relationships being statistically significant.

Table 2.3 2SLS model of food security outcomes (mitigating effect of RCI)

	Dietary Diversity (DD)		**Food Expenditure (FE)**		**Adeq.Fruits and Vegetables (AFV)**	
RCI*Exog. Shock	0.002***		44.208***		8.435**	
	(0.000)		(15.395)		(3.577)	
RCI*Endog. Shock		0.003***		47.487***		8.929**
		(0.001)		(15.421)		(3.601)
DD_2013	-0.012	0.006				
	(0.045)	(0.047)				
FE_2013			0.280***	0.277***		
			(0.047)	(0.046)		
AFV_2013					0.021	0.025
					(0.027)	(0.027)
Age HH head	-0.001	-0.001	-36.633*	-36.385*	2.941	3.025
	(0.001)	(0.001)	(21.660)	(20.656)	(5.334)	(5.119)
Sq. Age HH head	0.000	0.000	0.333*	0.330*	-0.021	-0.022
	(0.000)	(0.000)	(0.778)	(0.175)	(0.045)	(0.043)
Female head	0.009	0.010*	-23.484	-14.802	16.772	20.772
	(0.006)	(0.006)	(96.259)	(95.057)	(23.031)	(22.912)
Head married	0.016**	0.018***	172.008*	190.527*	25.277	30.507
	(0.006)	(0.006)	(100.656)	(100.498)	(24.248)	(24.484)
HH size	0.001	0.001	148.905***	151.869***	-121.097***	-120.491***
	(0.002)	(0.002)	(40.110)	(39.380)	(9.507)	(9.267)
Sq. HH size	-0.000	-0.000	-9.166***	-9.325***	5.081***	5.061***
	(0.000)	(0.000)	(2.778)	(2.741)	(0.651)	(0.641)
Rural	-0.010***	-0.013***	-457.673***	-509.058***	-10.827	-20.125
	(0.003)	(0.004)	(65.954)	(71.055)	(14.710)	(15.556)
Exogenous shock	-0.054**	-0.001	-1027.163***	-148.463*	-165.668**	2.354
	(0.022)	(0.005)	(353.573)	(79.373)	(82.890)	(18.902)
Endogenous shock	0.009	-0.050**	124.817	-806.323**	43.853**	-130.179*
	(0.005)	(0.021)	(86.423)	(331.255)	(20.591)	(78.040)
Issyk-Kul and the Tian-Shan	-0.016**	-0.019***	-283.656***	-354.404***	-21.764	-34.868
	(0.006)	(0.006)	(103.568)	(91.806)	(24.955)	(22.007)
Fergana Valley	-0.027***	-0.030***	-400.148***	-425.999***	6.626	2.928
	(0.008)	(0.008)	(137.258)	(137.101)	(31.376)	(31.403)

Constant	0.892***	0.877***	1710.613***	1681.491***	574.214***	563.713***
	(0.052)	(0.050)	(515.834)	(492.737)	(124.039)	(117.926)
Observations	2138	2138	2169	2169	2129	2129
Cragg-Donald Statistics	17.275	19.951	17.347	20.418	17.232	20.108

****ρ<0.01, **ρ<0.05, *ρ<0.1. A base class for both exogenous and endogenous shocks is "Low Shock" class. Standard errors in parentheses. The excluded regional dummy is Bishkek and the Northwest.*

Source: compiled by the authors

Looking at the relationship between the RCI and food security loss outcomes in Table 2.4 a higher RCI is likely to decrease the probability of food security loss. In Column-2, a one-point higher change in the RCI shows a decreased probability of diet diversity by an average of 0.060. As for the relationship between the RCI and loss in food expenditure, we observe a similar relationship, with a lower magnitude of effect. More precisely, a point increase in the RCI decreases the probability of loss by an average of 0.034 in Column-4. The sign of the relationship between the RCI and loss in adequacy of fruits and vegetables does not change, but the marginal effect is not statistically significant (Column-6). Households experiencing at loss in the past are likely to recover it in the future, since the coefficients of all lagged dependent variables are negative. This might be due to activating resilience (d'Errico et al., 2018; Haile et al., 2022) or non-food coping strategies in the past (Lascano Galarza, 2020). A positive relationship between rural communities and loss in food security outcomes is also confirmed, out of which the coefficient of food expenditure loss is statistically significant. As for other controlling variables, both the age of the household head and the size of household increase the probability of loss in major cases. To some extent, the direction of this relationship changes in the squared measures of age, indicating potentially nonlinear effects of age. A household with a married head is also stable at decreasing the loss in dietary diversity (Column-2) and food expenditure (Column-4).

Table 2.4 Marginal effects of Probit and IV Probit models of food security loss

	Dietary Diversity (DD)		Food Expenditure (FE)		Adeq.Fruits and Vegetables (AFV)	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	Probit	**IV Probit**	**Probit**	**IV Probit**	**Probit**	**IV Probit**
RCI	-0.000	-0.060*	0.000	-0.034***	-0.000	-0.010
	(0.000)	(0.032)	(0.000)	(0.011)	(0.000)	(0.009)
DD_2013 loss	-0.272***	-0.209***				
	(0.019)	(0.058)				
FE_2013 loss			-0.208***	-0.231***		
			(0.020)	(0.031)		
AFV_2013					-0.248***	-0.251***
loss					(0.020)	(0.022)
Age HH head	0.002	0.060*	0.003	0.037***	-0.008	0.001
	(0.005)	(0.033)	(0.005)	(0.013)	(0.005)	(0.010)
Sq.Age HH	-0.000	-0.000*	-0.000	-0.000***	0.000	-0.000
head	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female head	-0.037	-0.087	-0.023	-0.052	-0.019	-0.027
	(0.034)	(0.079)	(0.033)	(0.051)	(0.035)	(0.037)
Head married	-0.045	-0.178*	-0.039	-0.119**	-0.027	-0.049
	(0.035)	(0.104)	(0.034)	(0.058)	(0.035)	(0.042)
HH size	-0.023*	0.042	0.023***	0.058**	0.049***	0.059***
	(0.013)	(0.045)	(0.013)	(0.023)	(0.013)	(0.017)
Sq. HH size	0.001	-0.001	-0.000	-0.001	-0.000	-0.001
	(0.000)	(0.002)	(0.000)	(0.001)	(0.001)	(0.001)
Rural	0.013***	0.114	0.031	0.079**	0.082***	0.096***
	(0.022)	(0.073)	(0.021)	(0.036)	(0.022)	(0.027)
Exogenous	-0.038	0.076	-0.081**	0.018	-0.060**	-0.041
shock	(0.025)	(0.075)	(0.022)	(0.042)	(0.026)	(0.032)
Endogenous	-0.118***	-0.061	-0.021	0.003	-0.019	-0.011
shock	(0.031)	(0.074)	(0.028)	(0.045)	(0.030)	(0.032)
Issyk-Kul and	0.019	-0.088	0.107***	0.040	0.040	0.021
the Tian-Shan	(0.032)	(0.089)	(0.029)	(0.050)	(0.033)	(0.039)
Fergana	-0.098***	0.303	0.007	0.239***	-0.148***	-0.083
Valley	(0.023)	(0.221)	(0.023)	(0.084)	(0.024)	(0.067)
Observations	2086	2086	2086	2086	2077	2077

Pseudo R-squared	0.093		0.029		0.095	
Cragg-Donald Statistics		16.497		17.731		17.297
Wald-test of exogeneity		11.65		19.70		1.19
p-value		0.000		0.000		0.274
AR		4.48		18.16		1.34
p-value		0.034		0.000		0.247

****ρ<0.01, **ρ<0.05, *ρ<0.1. A base class for both exogenous and endogenous shocks is "Low Shock" class. Standard errors in parentheses. The excluded regional dummy is Bishkek and the Northwest.*

Source: compiled by the authors

Moreover, it is expected that the interaction terms between the RCI and shocks should have a negative relationship with loss. Although findings in the probability of fruit and vegetable consumption adequacy loss are not statistically significant, the interaction terms have negative effects on the loss probability of dietary diversity and food expenditure (Table 2.5). As for the shocks, the "*High Shock"* latent class for both exogenous and endogenous shocks is significantly positive with dietary diversity and food expenditure outcomes. This could indicate that household resilience has a protective effect on loss as exogenous shocks intensify.

Table 2.5 Marginal effects of IV Probit model of food security loss (mitigating effect of RCI)

	Dietary Diversity (DD)		Food Expenditure (FE)		Adeq.Fruits and Vegetables (AFV)	
RCI*Exog. Shock	-0.048* (0.267)		-0.019*** (0.006)		-0.011 (0.007)	-0.010 (0.007)
RCI*Endog. Shock		-0.049* (0.027)		-0.021*** (0.007)		
DD_2013 loss	-0.216*** (0.061)	-0.225*** (0.056)				
FE_2013 loss			-0.232*** (0.028)	-0.233*** (0.028)		
AFV_2013 loss					-0.248*** (0.023)	-0.247*** (0.022)
Age HH head	0.060* (0.034)	0.057* (0.033)	0.027** (0.010)	0.027*** (0.010)	0.004 (0.011)	0.002 (0.010)
Sq. Age HH head	-0.000* (0.000)	-0.000* (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000 (0.000)	-0.000 (0.000)
Female head	-0.080 (0.086)	-0.098 (0.085)	-0.041 (0.045)	-0.050 (0.046)	-0.028 (0.039)	-0.032 (0.039)
Head married	-0.135 (0.098)	-0.164 (0.103)	-0.080* (0.048)	-0.095* (0.049)	-0.046 (0.042)	-0.051 (0.043)
HH size	0.019 (0.040)	0.017 (0.038)	0.038** (0.018)	0.038** (0.018)	0.057*** (0.016)	0.056*** (0.016)
Sq. HH size	0.000 (0.002)	0.000 (0.002)	-0.000 (0.001)	-0.000 (0.001)	-0.001 (0.001)	-0.001 (0.001)
Rural	0.071 (0.063)	0.118 (0.078)	0.048* (0.029)	0.071** (0.031)	0.090*** (0.026)	0.100*** (0.028)
Exogenous shock	0.372*** (0.010)	0.087 (0.082)	0.362*** (0.137)	-0.029 (0.036)	0.172 (0.142)	-0.0333 (0.034)
Endogenous shock	-0.014 (0.091)	0.336*** (0.014)	0.012 (0.042)	0.445*** (0.128)	0.001 (0.036)	0.185 (0.039)
Issyk-Kul and the Tian-Shan	-0.167 (0.128)	-0.085 (0.093)	0.028 (0.048)	0.057 (0.043)	-0.001 (0.047)	0.018 (0.039)
Fergana Valley	0.271	0.280	0.159***	0.175***	-0.069	-0.072

	(0.212)	(0.222)	(0.061)	(0.063)	(0.065)	(0.066)
Observations	2086	2086	2086	2086	2077	2077
Cragg-Donald Statistics	16.893	19.962	17.992	21.264	17.531	20.463
Wald-test of exogeneity	12.39	10.87	14.99	15.99	2.29	1.93
p-value	0.000	0.001	0.000	0.000	0.130	0.165
AR	4.13	3.72	14.87	15.28	2.22	1.98
p-value	0.042	0.053	0.000	0.000	0.136	0.159

****ρ<0.01, **ρ<0.05, *ρ<0.1. A base class for both exogenous and endogenous shocks is "Low Shock" class. Standard errors in parentheses. The excluded regional dummy is Bishkek and the Northwest.*

Source: compiled by the authors

2.5. Discussion and Conclusion

In this paper, we analyzed the effect of resilience capacity on food security status and its loss under exogenous and endogenous shock events along a dataset of LIK for Kyrgyz smallholders. In the first step, we constructed the RCI through ABS, AST, AC and SSN pillars. The results call for interventions and policies to encourage especially SSN and AC in order to enhance the RCI. Access to transfers from migrants in Kyrgyz households represents one of the major contributors of SSN and AC pillars. In practice, migration and remittance are paramount for economic growth in Kyrgyzstan (Murzakulova, 2020); therefore, programs and institutional mechanisms to support efficient coordination of remittance income at the household level likely unlock the potentials of strengthening resilience to food insecurity. Households also become more adapted towards increasing resilience when they have opportunities to build informal networks, which is in accord with studies confirming a positive relationship between social capital and resilience (Anuradha et al., 2019; Béné, Al-Hassan, et al., 2016; Rayamajhee & Bohara, 2019; Wang et al., 2021). This implies that policies strengthening resilience should appreciate the functions of networking, since social capital is likely to serve as a substitute for physical assets. Related tangible factors such as allowances and savings are also particularly important to strengthen SSN and AC, respectively. Therefore, resilience interventions should consider existing and potential social assistance programs and financial systems in Kyrgyzstan. Similar to findings by d'Errico and Pietrelli (2017), education is found to be one of primary contributing factors to increase AC. It is expected that higher level of education significantly contributes to stabilize resilience in the presence of shocks, particularly under limited availability of safety nets. From another perspective, a potential synergy between productive and non-productive assets in AST is also essential for increasing resilience. A negative relationship between ABS and RCI implies that there should be more pertinent approaches by focusing on factors having relatively obvious and direct relationships with resilience.

In the second step, we applied LCA to identify unobserved homogeneous groups based on different types of shocks experienced by households over the twelve months of 2016. We found that the latent class representing *"High Shock"* for endogenous shocks is positively associated with food security outcomes, while the reverse is true for the case of exogenous shocks in connection with food expenditure. This finding might be explained by two arguments: Firstly, shocks are based on very subjective perspectives of the respondents, which have shown to be strongly influenced by individual risk attitudes and other personal characteristics. One of the cases reported by d'Errico et al. (2018) also concluded over-/under-estimation of self-reported shock perceptions for analyzing household resilience to food insecurity. Secondly, it is quite possible that households experiencing endogenous shocks might be able to activate short-term risk-coping strategies. This finding further supports the idea that resilient households are likely to use coping strategies (Crookston et al., 2018) characterized by a set of capacities such as absorbing, adapting and transforming in the face of shocks and stressors (Constas, Frankenberger, & Hoddinott, 2014). Exogenous shocks, in contrast, make risk coping a more difficult task, as they are likely to exhaust the financial resources of the whole social network and government resources alike. Such unpredictable exogenous shocks make coping mechanisms less effective in low-income transition economies (Kuhn & Bobojonov, 2021), especially for food insecurity (Alinovi, d'errico, et al., 2010). Moreover, findings from applying interaction-terms confirm that both shocks frequently deteriorate food security conditions. They also increase the loss of dietary diversity and food expenditure. Correspondingly, interventions primarily should consider how different types of shocks affect the condition of food security for designing a resilience approach. Such recognition certainly improves the effectiveness of resilience based interventions to development outcomes (Choularton et al., 2015).

In the last stage, we established a causal relationship between the RCI and food security outcomes. To control for potential endogeneity, we employed the IV approach, instrumenting the distance to the nearest country border from the community for the RCI. Our results suggest that the household resilience capacity serves to increase household dietary diversity, food expenditure and the adequacy of fruit and vegetable consumption or to decrease losses in dietary diversity and food expenditure. This message is consistent with conclusions indicating a positive relationship between the RCI and food security outcomes (d'Errico & Pietrelli, 2017; Murendo et al., 2020) and a negative relationship between the RCI and loss in dietary diversity and food expenditure (d'Errico et al., 2018; Haile et al., 2022). Policy and program interventions aiming to strengthen household resilience are likely to make some significant inroads into ensuring long-term food security in poor or developing countries. We further integrated our multiplicative effect models by including the interaction terms between the RCI and latent shock classes. In order to obtain consistent estimates for the interaction terms, we treated them as separate endogenous regressors with their own instrumental variables. The interaction terms between the RCI and shocks are consistent with our initial models built without the moderating role of resilience. Findings imply that the RCI is able to mediate the impact of shocks on food security outcomes, which is in line with other studies (Haile et al., 2022; Murendo et al., 2020; Ouoba & Sawadogo, 2022; Sunday et al., 2022). Particularly, the results reveal that resilience has a role in mitigating the negative effects of both exogenous and endogenous shocks on all static food security outcomes. The results in dynamic findings also confirm the mitigating role of resilience on the impact of both types of shocks on the loss of dietary diversity and food expenditure. This supplementary finding reinforces our conclusion of the positive effect of the RCI on static food security conditions or its negative effect on losses of food security in the presence of shocks. By addressing shocks with resilience to food insecurity, households are able to achieve better outcomes by decreasing losses in food security, which is important for developing resilience-based policies.

Looking at other variables in the models, previous or lagged values of food security indicators are likely to predict future values, particularly when it comes to loss. A negative relationship between a previous and future probability of loss is probably due to activated coping strategies or household resilience. The age of the household head and the size of the household have a positive and significant relationship with suffering from food insecurity, which has similarly been found in other studies (d'Errico & Pietrelli, 2017; d'Errico et al., 2018). Concurrently, a further policy recommendation is related to strengthening the role of younger farmers or decision-makers in the household to contribute to the improvement of food security, for instance by strengthening agricultural education and providing targeted trainings. Since rural areas are subject to relatively higher vulnerability to food insecurity, policies building or strengthening food insecurity resilience should focus on targeting rural populations. The low resilience of rural populations can be explained by pronounced rural-urban gaps in income or public services, but also by the systemic character of production shocks in agricultural, usually affecting not a single household but the whole regions and communities. Concrete measures could be the formation of larger social networks and institution based on collective actions in the more remote areas. By considering the remittance as one of the most consistent parts of income in Kyrgyzstan (FAO, 2019b), improving remittance channels by creating safe and accessible links to transfer in highly migrating rural areas is of particular significance in increasing resilience.

We acknowledge some limitations of this study. First of all, resilience research still lacks some concrete cutoff points to define whether the status of a household is resilient or not (Atara et al., 2020). The categorization of resilience dimensions is one step towards the differentiation between vulnerable and resilient households in the context of food security outcomes (Nahid et al., 2021). Moreover, an understanding of the dynamic nature of resilience and its heterogeneity across different groups is important in order to differentiate livelihood strategies for household mechanisms (Alinovi, d'errico, et al., 2010; Atara et al., 2020). Finally, a measurement conceptualization for resilience is implemented through tangible indicators. In this paper, the majority of factors applied to construct the RCI is based on tangible assets. Further attempts to measure resilience capacity may consider intangible assets such as perception, trust, gender roles and others, which will probably improve the operationalization techniques (Ansah et al., 2019). In order to link household resilience and food security, the resilience of local food systems should be considered as one of the influencing factors (Béné, 2020). Correspondingly, the results will certainly complement and extend related conclusions towards the role of household resilience to improve food security outcomes.

3. Social Capital Effects on Resilience to Food Insecurity: Evidence from Kyrgyzstan

Abstract: This paper investigates the role of social capital in terms of trust and group membership in building household resilience to food insecurity. Using detailed 'Life in Kyrgyzstan' multi-topic panel data, the research estimates resilience to food insecurity through the Resilience Index Measurement and Analysis (RIMA) approach, including different pillars and a resilience capacity index. The impact of social capital on resilience pillars and capacity is estimated using IV models for multiple endogenous variables. The results suggest that both trust and group membership positively affect resilience pillars and capacity.[5]

[5] This chapter is based on article: Egamberdiev, B. (2024). Social capital effects on resilience to food insecurity: Evidence from Kyrgyzstan. Journal of International Development. 36(1), 435–450. https://doi.org/10.1002/jid.3826

3.1 Introduction

Due to its possibility of conceptualizing household capacity for coping with shocks, the concept of resilience has become a cornerstone of policy interventions. In this respect, resilience thinking has already been embedded in socio-economic and environmental aspects of livelihood. This suggests that the concept of resilience has the potential to explain the behavior of a system showing commensurate attention to social and economic changes. Practically, resilience describes the ability of socio-economic and ecological systems to transfer towards more sustainable states of development (Alexander, 2013). In developmental literature, the concept of resilience is largely discussed in the domains of food security (Ansah et al., 2019; Béné, 2020), agricultural sustainability (Shapiro-Garza et al., 2020), vulnerability (Miller et al., 2010; Sallu et al., 2010) and wellbeing (Beauchamp et al., 2021); however, there is limited research that considers social aspects in resilience discussions.

Perhaps not as often considered is how social aspects of the environment manifest themselves in resilience. Looking at behavioral characteristics might provide better explanations by focusing on the convergence of social capital (Carpiano, 2007). By assuming an emergent property of the system, resilience is explained as the self-organising behavior of the system (Gunderson, 2000). To function properly, the system should be able to absorb without any change or adapt to the new system. From this perspective, the concept characterises the combination of capacities (Béné, Headey, et al., 2016), in which its effectiveness as a response mechanism should incorporate the elements of social capital (Sadri et al., 2018). More precisely, successfully coping with the consequences of shocks, adjusting changes and even creating a new system largely depend on social capital, enhancing the social fabric towards building and strengthening resilience.

To the best of my knowledge, this paper presents for the first time the role of social aspects in strengthening food insecurity resilience in Kyrgyzstan. Kyrgyzstan, home to 6.5 million people, is a landlocked country in which headcount poverty still remains high (WB, 2020a). Among particularly susceptible households, vulnerability to poverty in the face of socio-economic and climatic shocks is particularly notable. Therefore, the country is still facing the menace of seasonal fluctuations in both poverty and vulnerability (Aidaraliev, 2017). Moreover, poor agricultural sector performance is common due to weak knowledge and limited access to resources, problems with markets or standards, and a high vulnerability to environmental issues (FAO, 2020b). As the food security condition in Kyrgyz households is still precarious and unstable (Babu & Akramov, 2020), the prevalence of undernourishment is 7.1% (FAO, 2019a). As for resilience, Kyrgyz households are less resilient due to low social protection, limited access to credit, and low productivity, making them highly vulnerable and exposed to shock events (FAO, 2019b). In view of the rising awareness of building or strengthening resilience, it is absolutely critical to determine factors that may contribute to the development agenda in Kyrgyzstan.

Although there is a strong consensus among academics regarding the role of social capital in resilience, some findings have confirmed that certain forms of social capital may have a negative or insignificant association with resilience, explicitly reflecting a non-adapting mode of resilience or long-term food insecurity (Béné, Headey, et al., 2016; Coulthard, 2011; Crookston et al., 2018). Therefore, the conceptualisation of resilience by integrating social capital should be extended, particularly in the context of developing countries. This study, analysing the relationship between social capital and resilience in Kyrgyzstan, a post-Soviet Central Asian country, may provide extra evidence for investigating the critical drivers of food insecurity resilience.

As for the measurement, there are two rival methods for operationalising resilience as household capacity to food insecurity: FAO's Resilience Index Measurement and Analysis (RIMA) and Technical Assistance to NGO's International (TANGO International) (Upton et al., 2022). The TANGO approach has integrated social capital into absorptive, adaptive and transformative capacities (d'Errico & Smith, 2019). Although the association between social capital and food insecurity resilience is empirically confirmed in the RIMA approach (Atara et al., 2020; d'Errico et al., 2018), the establishment of a causal relationship is rather limited. Therefore, there is another need to legitimately deduce a cause-and-effect relationship between these two phenomena. A further research gap is the limited focus on the practical insights in more rigorous analysis between social capital and resilience through its determinants. The mechanism explaining such a relationship is still limited for intervention policies that identify which dimension or determinant of resilience is likely to be influenced by social capital.

By taking the abovementioned gap into account, the paper contributes to the literature on food insecurity resilience from different perspectives. First of all, it uses nationally representative "Life in Kyrgyzstan" (LiK) panel data, including the 2013 and 2016 waves, for the largely understudied Kyrgyzstan. Correspondingly, the LiK data includes individual, household, agriculture and community surveys over the waves, allowing for quantitative measurement of both social capital and resilience. By acknowledging one of the main dimensions of social capital, the composite score of both trust and group membership is obtained by using a data reduction technique of factor analysis. As for the dependent variable, the Resilience Capacity Index (RCI) towards food insecurity is measured by different determinants/pillars under the RIMA approach. Accordingly, the RCI is constructed by factor analysis through the following pillars: income and food access (IFA), access to basic services (ABS), agricultural practices and technologies (APT) and adaptive capacity (AC) (Alinovi et al., 2008). As a latent variable, each pillar itself is also obtained by factor analysis. In order to identify the mechanism explaining how social capital affects resilience and its pillars, each pillar is included as a dependent variable.

The estimation strategy between social capital and resilience does not assume that there is an instantaneous effect in which the RCI or a pillar is time- and event-dependent. Therefore, this paper proposes an empirical strategy to analyse the effect of social capital in time t on resilience or pillar outcomes in time $t + 1$. Due to a theoretical foundation and data availability, it was possible to adopt an instrumental variable (IV) approach for detecting the causal effects of social capital on RCI and related pillars IFA, ABS and APT, as well as AC. In order to identify the IV approach, IVs such as existence of mosques/churches in the community and the number of groups in the community are used for endogenous trust and group membership variables, respectively. An empirical strategy is based on two-stage least squares (2SLS) and the IV structural equation model (IV-SEM) to explore the causal effects in the presence of multiple endogenous variables. The findings generally confirm that both trust and group membership positively affect IFA, APT, AC, and the RCI itself.

3.2 Review of Relevant Literature

3.2.1 Social Capital

The discussions surrounding social capital and its role in development studies have already reached exponential growth in research. Like physical and human capital, the arguments about the socio-cultural roles of both individuals and society in the last decade have given a stronger impetus to also include the role of social capital. Social capital, which is relatively less tangible or absolutely intangible, represents the relationships among people in society. The term social capital refers to general or specific characteristics of society representing trust, norms and networking under facilitated and coordinated accomplishments (Putnam et al., 1994). Generally, social capital refers to social trust, willingness to cooperate, group membership and participation (Macinko & Starfield, 2001). Considering a multivariate model in analysing neighbourhood characteristics, social capital is divided into different dimensions comprising collective efficacy, local networking, organisation involvement and conducting norms (Sampson & Graif, 2009). For example, Carpiano and Hystad (2011) have used membership and participation in different groups, while Cramm et al. (2012) have focused on neighbourhood group membership to represent social capital. Musalia (2016) has used a challenging and invigorating methodology by using trust in the community to represent cognitive social capital. Trust in social capital is strongly accentuated since it also shows linking as a third topology of social capital, in which people are likely to interact across explicit, formal or institutionalised power or authority in society (Moore & Kawachi, 2017).

3.2.2 Social Capital and Resilience

The concept of resilience was discussed by Holling (1973), who proposed the persistence of relationships within a system. Accordingly, a system is recognised as persistent or resilient when it is able to absorb changes. Moreover, resilience is recognized as the flexibility and ability of the system to adapt to regular disturbances (Nelson et al., 2007); therefore, it is theoretically discussed as a way of "bouncing back" from endogenous and exogenous shocks (Skerratt, 2013). Another important element of resilience was added by Walker et al. (2004), proposing a transformation in resilience. Transformability enables a social, economic, ecological or political environment to create the system when the existing condition does not function. In socio-ecological systems, resilience has a buffering capacity to withstand shocks so that households are able to properly maintain their functioning (Folke, 2006). In this perspective, resilience should provide the ability to self-organise, explained by the magnitude of tolerance to disturbances (Carpenter et al., 2001).

Although the relationship between social capital and resilience is not unidirectional, the establishment of resilience capacity strongly depends on human empowerment by collective actions or social dynamisms (Fischer & McKee, 2017; Hayward, 2013). In resilience thinking, social capital therefore manifests itself as a plausible factor to strengthen resilience (Aldrich & Meyer, 2014). More precisely, Wang et al. (2021) have confirmed a positive relationship between social networks and livelihood resilience. In this respect, building inter-community relationships in rural areas leads to stronger resilience. In the presence of shocks, the level of social networking is linked with a transformation capacity when farmers face a system of change (Sinclair et al., 2014). As a long-term response to socio-economic or environmental changes, building trust and cooperation is reflected in strengthening the AC (Folke et al., 2005). Respectively, strong ties characterise the ability of farmers to respond to changing conditions by activating and exchanging strategies within networks (Castaing, 2021). In Kyrgyzstan, as a transition country, social capital plays a crucial role in building resilience. Social capital components such as trust and networking may not have the same direction because building them depends on the level of state control over society (Radnitz et al., 2009). Therefore, similar situations have created an adaptive mechanism through building networks that ameliorate socio-economic adversity (Schwanbeck, 2020). As for rural areas in Kyrgyzstan, strengthening the AC to climate change through social capital has already proven to provide successful results (Ashley et al., 2016). Since remittance is one of the most effective ways to reduce the risk of exposure to shocks (Roberts & Moshes, 2016), social remittances entailing the transmission of social capital to the sending-country community are also particularly important (Ivlevs et al., 2019). In addition to this, strengthening social capital through an additional migrant network may stimulate food insecurity resilience (Fan et al., 2014). Therefore, paying particular attention to the local forms of social capital is critical in order to build or strengthen the resilience of Kyrgyz households.

Looking at the sources of resilience within a system, social capital makes substantial inroads into the conceptualisation of household resilience to food security outcomes (Alinovi, d'errico, et al., 2010; Alinovi et al., 2008; Atara et al., 2020; Egamberdiev et al., 2023). Following this, Constas et al. (2020) have provided harmonised metrics under the core indicators for resilience analysis approach, in which social capital gained prominence as an enabling capacity to minimise the effect of shocks. Furthermore, and pertinent to this approach, the development of the resilience causal framework by the resilience measurement technical working group (RM TWG) integrates social capital as one of the most important components of resilience since it articulates the relationship or interaction in the process of recovering from a shock (Mock et al., 2015). Within the same conceptual approach, d'Errico et al. (2018) have advanced the relationship between social capital, constructed through the perception of social inclusion in the decision-making process and local services provision and resilience. Accordingly, empirical findings have confirmed a positive effect of social capital on resilience capacity and food security. Another seminal contribution uses the bonding, bridging and linking dimensions of social capital to construct a resilience index towards food insecurity (Smith & Frankenberger, 2018). Therefore, the association between social capital and food insecurity resilience, particularly in the RIMA approach, is a promising line of research. Since the majority of discussions are based on the relationship between social capital and food insecurity resilience through a factor score or weighted sum of the items, empirical estimations for causal relationships are still needed.

3.3 Data and Methodology

3.3.1 Data

"Life in Kyrgyzstan" (LiK) is a longitudinal survey of households and individuals that includes 3000 households and 8000 individuals over time in seven regions (oblasts) and two cities (North/South, rural/urban) of Kyrgyzstan. The survey was established as a part of the 'Economic Transformation, Household Behavior and Well-Being in Central Asia: The Case of Kyrgyzstan' project, a collaboration of DIW Berlin, Humboldt-University of Berlin, the Center for Social and Economic Research (CASE-Kyrgyzstan) and the American University of Central Asia. Representative at national and regional levels, the survey covers different topics related to household demographics, well-being, health, migration, agriculture, shocks and many others (Brück et al., 2014). The survey, consisting of six waves, was conducted for the period from 2010 to 2016, tracking the same individuals and households over the waves. The most agricultural-specific section of LiK was additionally included in the wave of 2016, providing a unique opportunity to study agriculture at a household level. Correspondingly, the paper uses both the 2013 and 2016 waves due to their relevance to the scope of study.

3.3.2 Estimating Resilience and Social Capital

One comprehensive approach to constructing the index is based on the components of resilience. This method was later formalised as RIMA for food security outcomes (FAO, 2016). The estimation framework for constructing resilience should consider following these analytical principles: (i) resilience has a nature of multidimensionality; (ii) resilience is a latent or unobserved variable; and (iii) resilience is a constructed index (d'Errico et al., 2016).

The choice of the variables adopted for constructing the IFA, ABS, APT and AC pillars together with the RCI is based on literature findings, country context and factorability statistics (see Table A2.1). The RIMA approach embodies the abovementioned principles by constructing a capacity index under multidimensional latent characteristics. In this paper, the RCI for household h is expressed by four pillars:

$$RCI_h = f(IFA_h, ABS_h, APT_h, AC_h) \tag{1}$$

As long as any of these variables is not directly observable, an appropriate method is to apply principal component analysis (PCA) in order to identify the structures within a set of possibly correlated observable variables in a smaller set of uncorrelated ones. Alinovi, d'errico, et al. (2010) have proposed a similar technique with a weighted scoring method for constructing pillars and the RCI itself. By using PCA, the paper uses the Bartlett weighting method (Bartlett, 1937) to produce a latent variable for pillars and RCI. In order to ease the interpretation of regression findings, a min-max rescaling approach was applied.

To define the number of factors to be retained with the eigenvalue, it is considered a value with a minimum of 1 (Kaiser's criterion). The value indicates how much of the total variance over the items can be explained by the factor (Acock, 2010). Accordingly, factors retained with Kaiser's criterion were further interpreted by the loadings of variables (association to the underlying factor), which should be more than a minimum of 0.30. The paper used the varimax rotation technique by maximising the dispersion of loading within the obtained factors (Field, 2013). In order to check correlations between the selected variables in the factor, a Kaiser-Meyer-Olkin (KMO) test was used, in which only items above the threshold level of 0.50 were considered (Kaiser, 1974). Bartlett's test of sphericity was also applied by checking whether a matrix was significantly different from an identity matrix (Field, 2013). Accordingly, a test of significance at 1% was applied, indicating that variables are suitable for factor analysis with enough covariance. Lastly, the multicollinearity was checked by the determinant of R-matrix*,* which should be higher than 0.00001 (Field, 2013). Table A2.2 presents factorability details on pillars and RCI.

Independent variables of trust and group membership were constructed by using relevant observed variables (Table A2.3). Each variable is based on the perception of respondents, who were asked to agree with statements representing the characteristics of the neighborhood. Since social capital is embedded in a multidimensional structure, its composite score in socio-economics has been found to be promising (Narayan & Cassidy, 2001). Therefore, both trust and group membership are obtained by PCA. Table A2.2 provides factorability details of both trust and membership. The order of the questions was reversed in order to maintain the same direction with the scales. In trust measurement, respondents were asked about their perception of the level of trust in the neighborhood based on a 4-point Likert scale (1: strongly disagree; 4: strongly agree). There are six item questions to represent the level of trust in the community. As for the construction of group membership, there are 12 item questions representing whether a respondent has belonged to the corresponding group during the last 12 months.

Resilience as capacity implies that pillars should support a positive shift in the likelihood function if shocks intensify; therefore, a measurement of resilience over the course of an actual period of shock exposure is required (d'Errico & Smith, 2019). Accordingly, the paper includes 25 types of multi-level shocks from the household dataset to provide an appropriate and independent metric towards food insecurity resilience. By covering socio-economic and environmental aspects, idiosyncratic (small-scale) and covariate (large-scale) shocks from both household and community surveys of LiK are included (Table A2.4). In the estimation, a household stability index and a community stability index were measured through PCA from rescaled shocks experienced over the last 12 months (assuming a value 0 for experiencing or 1 for not experiencing the shock to represent stability). In the construction of the RCI, the household stability index was included as one of the defining variables of AC (Alinovi, d'errico, et al., 2010; Alinovi et al., 2009; Alinovi, Mane, et al., 2010). Since the RCI is measured at household level, the Community Stability Index, representing 14 types of shocks from the community-level dataset, was included as a controlling variable in further regression models.

3.3.3 Instrumental Identification Strategy

In the epidemiological literature, a zero-time lag between exposure and outcome provides implausible explanations (Blakely & Woodward, 2000). Considering causal pathways, a cross-sectional design may not provide a true picture of neighborhood effects (Macintyre et al., 2002). Accordingly, any transformation in the social characteristics of the neighborhood does not reflect a change in human behavior or socio-economic life at the same time or within a short period of time. Instead, a change in household resilience is recognised as the result of cumulative exposure over several years. Therefore, there should be more fervent attempts to analyse how social capital in a time period t is associated with resilience outcomes in the future, or $t+1$ period. A similar approach was supported by authors' conceptualisation of the role of resilience for food security outcomes (d'Errico & Pietrelli, 2017; d'Errico et al., 2018; FAO, 2016).

To ensure a variation of social capital in resilience outcomes, the main objective is to understand how trust and group membership in 2013 are likely to influence both pillars and RCI in 2016. The conceptual framework for the relationship is:

$$Pillars/RCI_h = \beta_0 + \beta_1 Trust_h + \beta_2 Group\ Membership_h + \beta_3 X_h + u_h \quad (2)$$

in which h = household; $Trust$ and $Group\ Membership$ are constructed variables representing the social capitals of a neighbourhood; X describes household and community characteristics (Table A2.1). Most probably, trust and membership are endogenous and correlated with the error term. Therefore, OLS estimators are likely to be inconsistent due to the problem of endogeneity. One of the broad approaches to correcting endogeneity is applying the IV approach to the regression model (Wooldridge, 2010). Due to the existence of endogeneity in Equation (2), I instrumented it with related variables represented by the vector Z_h.

$$Trust_h = \gamma_0 + \gamma_1 Z_{1h} + \gamma_2 X_h + v_h \quad (3)$$

$$Group\ Membership_h = \eta_0 + \eta_1 Z_{2h} + \eta_2 X_h + \omega_h \quad (4)$$

In this case, I adopted IV by using the variables existence of mosques/churches in the community for trust and number of groups in the community for group membership. In terms of exclusion restriction, the relationship between existence of mosques/churches or the number of groups in the community and resilience is mostly realised through trust or group membership. Since social interaction within homogenous groups is inextricably linked with religious membership (Vikram, 2018), the presence of religious organisations is used to measure social capital (Harrison et al., 2019; Rupasingha & Goetz, 2008). Although the existence of a mosque or church does not represent a true congregation, it is an indirect way to understand religious attendance. Such prevalence of participation in a group increases the sense of belonging (Carpiano & Hystad, 2011); as a result, people are likely to provide financial, economic or social support to members of the groups in which they identify themselves as members (Wakefield et al., 2017). This is particularly important for post-Soviet Central Asian countries like Kyrgyzstan, since exchanging information or strengthening group identity is established in unofficial organisations located in 'mahalla' (Dadabaev, 2017). According to this, mahalla, referring to a community group, may provide mutual support termed 'khashar' in most Central Asian countries. In this respect, building social networks through available mosques/churches or community organisations is the first outcome. Consequently, it enables the creation of strong bonds and ties within the group that can bring additional social, economic or political resources to build or strengthen resilience. For example, findings have confirmed that the expansion of social support is strongly linked with the social ties available in congregational membership, in which members activate support mechanisms when dealing with shocks. (Idler et al., 2003).

In order to implement the IV approach, 2SLS estimation was used. This model estimation is practically useful when one or more of the regressors are found to be endogenous. The causal estimation is obtained in the second-stage regression in Equation (2), including predicted values of endogenous regressors through instruments in Equations (3) and (4). Table A2.5 provides the first-stage results of IV for both instruments. In highly complex relationships, simultaneous equation modelling also allows for implementing the IV approach (Wooldridge, 2010). Practically, it has been applied through a structural equation model (SEM), which can be another major application for implementing IVs in the presence of the problem of endogeneity (Bollen, 1996). In this case, a promising method is to use a maximum likelihood (ML) estimation for SEM to implement the IV approach (IV-SEM) by drawing causal inferences on the model (Grace, 2021). Accordingly, IV-SEM made it possible to use covariance procedures by modelling endogenous covariance directly (Figure A2.1). In this case, Maydeu-Olivares et al. (2019) have confirmed that both 2SLS and IV-SEM provide accurate coverage rates in the presence of endogeneity if the sample size is bigger than 500 observations. As long as 2SLS is practically susceptible under the weak instrument assumption, IV-SEM allowing nonlinear estimation is robust (Meyer et al., 2016). In addition to the 2SLS and IV-SEM models, a two-stage regression model was regressed manually with a bootstrapping method. It allows standard errors to be fixed by resampling from the sample in statistical inferences (Cameron & Trivedi, 2009). For assessing the goodness-of-fit in IV-SEM, decisions were generally based on extended statistical information. Fit statistics cover the likelihood ratio chi-square test, root mean squared error of approximation (RMSEA), standardised root mean squared residual (SRMR) and comparative fit index (CFI) for estimating the appropriateness of SEM (Acock, 2013). An identification assumption for one endogenous regressor depends on Cragg-Donald statistics (Cragg & Donald, 1993). Due to the existence of multiple endogenous covariates, the identification of weak instruments is notoriously challenging. Although there is no consensus for using any exact type of test for weak instrument identifications in the presence of multiple endogenous regressors, the decision is based on Sanderson-Windmeijer statistics (Sanderson & Windmeijer, 2016).

3.4 Results

Table 3.1 shows the relationship between trust and group membership, with IFA outcomes for all models. Table A2.6-Table A2.8 show the second-step results including the controlling variables. Although the magnitude of the impact of the group membership index is relatively high in the 2SLS model (column 3), findings generally confirm that an improvement in IFA is due to a point index rise in both social capital indexes.

Table 3.1 Impact of trust and group membership on IFA and ABS: IV-SEM and 2SLS second-stage results

	Income & Food Access (IFA)			Access to Basic Services (ABS)		
	(1)	(2)	(3)	(4)	(5)	(6)
	IV-SEM	2SLS Bootstrap.	2SLS	IV-SEM	2SLS Bootstrap.	2SLS
Trust	1.359**	1.198***	1.146**	0.541*	0.666***	0.423
	(0.532)	(0.282)	(0.474)	(0.029)	(0.188)	(0.377)
Group membership	1.525*	1.610**	3.436***	-4.491***	-4.626***	-3.724***
	(0.833)	(0.787)	(1.289)	(1.053)	(0.561)	(1.061)
Observations	1782	2218	1782	1814	2259	1814
R squared	0.301	0.213		0.223	0.077	
Chi-square	15.073			16.150		
p-value	0.002			0.001		
RMSEA	0.048			0.049		
CFI	0.982			0.971		
SRMR	0.009			0.010		

Note: Standard errors in parentheses. Household and community controls: head age, head female, head married, head education, household size and community stability index. Regional dummies: Issyk-Kul and the Tian Shan, Ferghana valley, and Bishkek and the Northwest. The excluded dummy is Bishkek and the Northwest.

*Abbreviations: 2SLS, two-stage least squares; CFI, comparative fit index; IV-SEM, instrumental variable structural equation model; RMSEA, root mean squared error of approximations; SRMR, standardized root mean squared residual. ***p<0.01, **p<0.05, *p<0.1.*

Source: compiled by the author

Since IFA is constructed through food security indicators, the findings are still relevant to the results explaining the relationship between social capital and food security outcomes. The effect of food security is mainly driven by Factor 1, where coefficients of variables are higher than 0.5 (Figure A2.2). Generally, social capital is inherently linked with defining food security (Dzanja et al., 2015; Leddy et al., 2020) or nutritional outcomes (Vikram, 2018), in which different aspects of social capital such as social support, social cohesion, social control and social participation are deeply connected with a positive status of food security (King, 2017). As for a dynamic change in food security outcomes, social capital did emerge as a potential factor to promote food security, where one can observe the transition from food insecurity to food secure status (Paul et al., 2019). Another remarkable finding for the relationship between social capital and IFA confirms the role of social capital for income from agriculture, benefits and remittance since they have noticeable contributions to building Factor 1 and Factor 3 (Figure A2.2). In this case, a potential explanation is that household members dependent on income from agriculture and social benefits are likely to migrate and activate additional sources for their livelihoods. It is noteworthy that the existing literature also shows strong ties between social capital and remittances (Eckstein, 2010), in which remittance-recipient countries noticeably benefit from remittances to build growth under strong social capital elements (Borja, 2014). Although there is a positive relationship between the trust index and ABS (columns 4 and 5), the relationship between group membership and ABS is negative in all outcomes. This may be the result of using certain variables to represent community characteristics. For example, the generated Factor 1 and Factor 3 generally characterise the distance from households to community destinations (Figure A2.3). In this respect, social capital does not always echo the condition of community infrastructure development (McShane, 2006), especially in the presence of long-lasting disturbances (Ledogar & Fleming, 2008). A positive relationship between the trust index and ABS is clearly detected in the IV-SEM and 2SLS models (columns 4 and 5).

Table 3.2 Impact of trust and group membership on APT and AC: IV-SEM and 2SLS second-stage results

	Agricultural Practices and Technologies (APT)			Adaptive Capacity (AC)		
	(1)	(2)	(3)	(4)	(5)	(6)
	IV-SEM	2SLS Bootstrap.	2SLS	IV-SEM	2SLS Bootstrap.	2SLS
Trust	1.222**	1.028***	1.038**	0.529***	0.475***	0.443**
	(0.486)	(0.310)	(0.466)	(0.198)	(0.105)	(0.187)
Group membership	2.362***	3.116***	4.196***	0.886***	0.898***	1.696***
	(0.904)	(0.832)	(1.344)	(0.319)	(0.294)	(0.530)
Observations	1821	2269	1821	1813	2257	1813
R squared	0.351	0.317		0.359	0.277	
Chi-square	16.579			16.094		
p-value	0.001			0.001		
RMSEA	0.050			0.049		
CFI	0.984			0.984		
SRMR	0.010			0.010		

Note: Standard errors in parentheses. Household and community controls: head age, head female, head married, head education, household size and community stability index. Regional dummies: Issyk-Kul and the Tian Shan, Ferghana valley, and Bishkek and the Northwest. The excluded dummy is Bishkek and the Northwest.

*Abbreviations: 2SLS, two-stage least squares; CFI, comparative fit index; IV-SEM, instrumental variable structural equation model; RMSEA, root mean squared error of approximations; SRMR, standardized root mean squared residual. ***p<0.01, **p<0.05, *p<0.1.*

Source: compiled by the author

As for the outcome of APT in Column 1 of Table 3.2, both social capital indicators positively affect APT. The magnitude of impact is higher in IV-SEM for trust (column 1) and in 2SLS for group membership (column 3). Current literature discussions are successfully showing the relationship between social capital and agricultural development (Munasib & Jordan, 2011; Rivera et al., 2019). Such a relationship is presumably driven by the addition of livestock and crop production in Factor 1 for strengthening APT (Figure A2.4). As expected, there are positive relationships between both social capital variables and AC. The improvement of AC in column 6 is relatively high for each index rise in group membership. The ability to engage in community organisations was found to be a potential precursor to building household resilience through strengthening AC (Bernier, 2014). In the presence of weak formal institutions in less developed economies, social capital plays a major role by promoting networks (Fafchamps, 2006). This situation is very much applicable in our findings, with the informal networking index as one of determining factors of AC (Figure A2.5). A plausible explanation is that trust or membership accommodates the peculiarities of unofficial networking for building AC. In this case, households are likely to adapt by activating informal networking channels to have access to transfers in the presence of higher social capital values (Paldam, 2000). Moreover, the presence of trust and membership is likely to strongly empower AC with weather information and extension services (Figure A2.5). Less progress in government policies may encourage farmers to strengthen their relationships (Pretty & Ward, 2001), which is particularly strongly reflected in the relationship with heterogeneous groups such as extension officers or advisors (Cofré-Bravo et al., 2019).

Table 3.3 shows the effect of trust and membership on RCI. There is a positive and significant effect under all types of models. As discussed above, the magnitude of relationship between group membership and RCI under the 2SLS model (column 3) is relatively high. Studies have confirmed a positive relationship between social capital and resilience (Aldrich & Meyer, 2014; Carrico et al., 2019), where social network and trust were found to be promising ways to influence resilience (Carmen et al., 2022). This relationship confirms that building household resilience towards food insecurity is a multifaceted social process.

Table 3.3 Impact of trust and group membership on RCI: IV-SEM and 2SLS second-stage results

	RCI		
	(1)	(2)	(3)
	IV-SEM	2SLS Bootstrap.	2SLS
Trust	1.026***	0.878***	0.862***
	(0.356)	(0.156)	(0.315)
Group membership	0.965**	1.157***	2.372***
	(0.459)	(0.389)	(0.841)
Observations	1777	2210	1777
R squared	0.397	0.352	
Chi-square	14.622		
p-value	0.002		
RMSEA	0.047		
CFI	0.988		
SRMR	0.009		

Note: Standard errors in parentheses. Household and community controls: head age, head female, head married, head education, household size and community stability index. Regional dummies: Issyk-Kul and the Tian Shan, Ferghana valley, and Bishkek and the Northwest. The excluded dummy is Bishkek and the Northwest.

Abbreviations: 2SLS, two-stage least squares; CFI, comparative fit index; IV-SEM, instrumental variable structural equation model; RMSEA, root mean squared error of approximations; SRMR, standardized root mean squared residual.

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

Source: compiled by the author

As for controlling variables provided from Table A2.6-Table A2.8 household head age, household size and stability in the community generally translate into improved pillars and RCI. However, a reverse relationship is true for head female households, where IFA, ABS and RCI outcomes are negative. This negative relationship might be due to gender roles in agriculture and food security (Malapit & Quisumbing, 2015; Sraboni et al., 2014). A negative relationship between head education and the pillars or RCI is not very conclusive since the outcome of ABS is positive. In this case, the potentially negative effects of education could be hidden by the fact that the experience in agriculture of the household head is not taken into account in the models.

3.5 Conclusion

It is possible to conclude that the heuristic indexed trust and group membership indicators in the paper are able to capture an unobservable construct of neighborhood social capital. In this respect, the empirical approach is quite amenable to the expansion of the theory in relation to social capital and resilience, especially resilience to food insecurity. As many papers are limited in terms of building the role of social capital in the cross-sectional design (Macintyre et al., 2002), dealing with a zero time lag between exposure and outcomes has become one of the more challenging tasks in research (Blakely & Woodward, 2000). In this respect, a plausible explanation for the impact of trust and group membership in 2013 on the outcomes of pillars and RCI in 2016 is not likely to be instantaneous but rather a long-term effect. Specifically, this paper contributes to the literature on resilience to food insecurity measurement through RIMA (Figure A2.6) by providing empirical evidence of the impact of trust and group membership. In particular, both trust and membership are likely to improve IFA, APT, AC and RCI. In the case of ABS, group membership is not associated with improvement. Generally, the findings are coherent with other discussions showing the association between social capital and resilience capacity (d'Errico et al., 2018). Moreover, the results are congruent with the idea that the role of social capital for the conceptualisation of resilience should be measured and integrated into the resilience approach (Maxwell et al., 2015).

Since social capital approaches are likely to provide important leverage in resilience thinking, building household resilience to food insecurity should go beyond interventions focusing simply on food security outcomes. It is crucially important to consider trust and membership as potential for improving income and food security access. Future target policies should pay attention to livelihood-related infrastructure in which mitigating activities from shocks can be realised on a household level. The presence of trust in the community may provide an additional margin to enhance household resilience when access to community services is improved. Moreover, interventions should recognise the role of networks that can serve as a basis for adaptive coping strategies. This finding, accentuating the importance of trust in the community and membership in different organisations, explains how households adapt and organise themselves through unofficial channels. Meanwhile, state support for weather forecasting and extension services is needed, as it may improve dissemination mechanisms for enhancing adaptive strategies. Further support of social capital in Kyrgyzstan will shape policy effectiveness in formulating the development of livestock and crop productions that may have a spurring effect on building resilience capacity.

I conceptualised the relationship between social capital and resilience, keeping in mind some related limitations. As long as a study focuses on quantified characteristics of resilience, self-perceived or subjective measures of resilience may provide complementary guidance in understanding household resilience and food security. Studies measuring household resilience through subjective measures, for example, have helped to show the importance of resilience through cognitive and self-evaluation of capacities (Béné et al., 2019; Crookston et al., 2018). As information about shocks is collected from self-reported subjective responses, there is probably a low accuracy of the information, because respondents may overestimate or underestimate different types of shocks. A similar problem for analysing the relationship between shocks and food security is raised by d'Errico et al. (2018). In addition to this, high shock experiencing households in the previous year might be characterised by activating coping strategies in order to balance their livelihood. A strong coping strategy and mechanism during a high shock period may have a positive impact on both resilience and food security outcomes (Lascano Galarza, 2020). Therefore, further studies should take the role of shocks in resilience studies into account, including exogenously estimated shock events. As long as power relations in the household shape social aspects, findings can be improved if gender roles are considered when analysing the relationship between social capital and resilience. For this reason, further attempts should recognise the exclusiveness in power relations. Another major limitation is that the findings did not cover the strength of local institutions and organisations, which is a very regional-specific aspect. Although people are intricately linked with community organisations, it should be considered which organisations or institutions perform in the community, including their different functions and their varying quality. Since there is a pervasive Soviet-based notion of 'does not bother, does not help' when it comes to the relationship of societal actors, this kind of societal stigma is also likely to produce controversial results for an analysis of relationships when building resilience.

4. Household Resilience and Coping Strategies to Food Insecurity: An Empirical Analysis from Tajikistan

Abstract: By applying Resilience Index Measurement Analysis (RIMA) to data from Tajikistan, this paper measures food insecurity resilience capacity. Another objective of this paper is to construct and integrate coping strategies into resilience discussions. The final objective is to analyze the role of resilience capacity and coping strategy in food security with an Instrumental Variable approach. Our results generally confirm that resilience and coping strategies increase food security, determined by food expenditure, household adequacy of fruit and vegetable consumption, and household food expenditure share. Moreover, resilience capacity has a moderating role in mitigating negative impacts of shocks on food security.[6]

[6] This chapter is based on article: Egamberdiev, B., Bobojonov, I., Kuhn, L., Glauben, T., and Akramov, K. (2024). Household resilience and coping strategies to food insecurity: An empirical analysis from Tajikistan. *Applied Economic Perspectives and Policy*. *46*(4), 1646-1661. https://doi.org/10.1002/aepp.13422

Resilience has become one of the most important cornerstones in addressing poverty and vulnerability of a population exposed to different types of shocks. In this respect, the study of resilience provides an excellent platform for analyzing household and community response mechanisms for dealing with shocks. Practically, the ubiquity of resilience ideology in socio-economic science is explained by its capacity to preserve and improve livelihoods in the face of shocks (Choularton et al., 2015; FAO, 2013), indicating a nontrivial relationship with vulnerability (Gallopín, 2006; Silici et al., 2011), sustainability (Maleksaeidi & Karami, 2013), or agricultural development (Sinclair et al., 2014). Recently, the concept has become relatively more influential in food security studies (Ansah et al., 2019). The enhancement of resilience in the food system is inextricably linked with household level capacities to activate response mechanisms, in which different types of abilities or capacities are interrelated (d'Errico & Smith, 2019). Therefore, treating resilience as a capacity is likely to be promising in food security analyses.

Although the resilience concept has become one of the core directions to explain how it mediates the shocks to food security (Ansah et al., 2019), data-driven evidence from context specificity is still limited. Moreover, resilience definitions and measurement techniques for food security outcomes are heavily contested. There are generally two rival methods to operationalize resilience towards development studies, particularly in household food security outcomes (d'Errico & Smith, 2019). The most widely applied method is a Resilience Index Measurement Analysis (RIMA) model by FAO (2016), while the second approach is based on the Technical Assistance to NGO's International (TANGO International) framework. TANGO is widely applied for food security analysis, comprising absorptive, adaptive, and transformative capacities of resilience (Constas, Frankenberger, Hoddinott, et al., 2014; Smith & Frankenberger, 2018). Technically, both approaches measure resilience under the capacity index towards food security outcomes. However, one of the distinctive differences is that shock coping strategies are easily incorporated into modelling with the RIMA approach (Ansah et al., 2019). Moreover, a comparative study by Upton et al. (2022) confirmed that the RIMA approach is likely to be efficient in linking resilience pillars to wellbeing outcomes. Therefore, this paper applied the RIMA approach to detect a causal effect of household resilience on food security in the presence of coping strategies.

By detecting a relationship between resilience and food security outcomes, this paper accomplishes several contributions to the current literature. First, there are discussions which prominently integrate coping strategies and resilience to predict food security outcomes (Lascano Galarza, 2020; Murendo et al., 2021; Murendo et al., 2020). However, the existing literature using coping strategies alone to predict food security outcomes underestimates resilience effects, particularly in the long term (Ansah et al., 2019). In this respect, coping strategies representing a short-term response mechanism mediate between the resilience and food security relationship (Otchere & Handa, 2022); therefore, it is sometimes operationalized as a proxy to food insecurity resilience (d'Errico et al., 2023). In order to deal with the problem of heterogeneity in the coping strategies, we applied latent class analysis (LCA) to identify meaningful and homogeneous classes that are not directly observable (Collins & Lanza, 2009). Second, this paper applies both static and dynamic natures of food security to identify a causal relationship between resilience and food security. In the regression analysis, the measured household resilience capacity in t_0 is regressed on future food security outcomes at t_1 period. Moreover, the assumption of a positive relationship between resilience and food security attainments should also confirm that food security loss between t_0 and t_1 is likely to decrease due to resilience. The paper also applies the mitigation effect of resilience capacity and shock in order to explain how resilience is effectively able to moderate the adverse effects of shocks on food security outcomes. In the estimation, it was considered to adopt an Instrumental Variable (IV) approach for detecting causal relationships between resilience capacity and food security outcomes.

As a case study, we chose the country of Tajikistan by employing a dataset from the Tajikistan Living Standards Survey (the TLSS) and the Tajikistan Household Panel Survey (THPS). Although trade reforms in postcommunist countries are reflected in improved food security outcomes (Krivonos & Kuhn, 2019), food security remains in a critical condition in Tajikistan (Kawabata et al., 2020). While more than 40% of households in Tajikistan generate income from agriculture, households are characterized by having a weak adaptive capacity to food insecurity due to low income, education, diversification, and seasonality (WFP, 2017). To deal with the problem, the government of Tajikistan established an Agrarian Reform Program for 2012-2020 and a National Development Strategy for the period up to 2030, in which the enhancement of national food and nutritional security is prioritized (FAO, 2022a).

The labour migrants from Tajikistan represent one-fifth of migrants in Russia (MPI, 2019) making Tajikistan the world's sixth remittance recipient country (McAuliffe & Triandafyllidou, 2022). The uneven nature of implementations towards migration policy is very oscillating between permissive and restrictive regimes; therefore, it is applied as one of instruments by the Russian Federation to enlarge the Eurasian Economic Union (EAEU) to the other post-Soviet countries, particularly to Tajikistan (Kluczewska & Korneev, 2022). However, non-EAEU countries such as Tajikistan and Uzbekistan do not still find beneficial results in joining into EAEU regarding free trade and investment (Kemme et al., 2021). From another side, an increasing male migration in Tajikistan poses another challenge adding extra stress and socio-economic responsibilities of abandoned women (ADB, 2020). It is also negatively associated with the left-behind children of migrant families, where there is high school dropout rate (Murakami, 2019).

Interethnic relations in Central Asia, particularly in livelihoods in Tajik-Kyrgyz border communities, persist in the current situation. For example, tensions noticeably rose due to access and use of pasture and water between 2004 and 2021, deteriorating social, financial, and natural resources (Sullivan, 2021; Xenarios et al., 2018). In this case, household resilience capacity is one of the direct ways to mitigate the effects of violent conflict in cross-border regions (Brück et al., 2019). By acknowledging different reform programs in Tajikistan, it is not hard to envision that resilience thinking in the interventions may contribute to more inclusive outcomes. In this case, providing a useful approach to address complexity in resilience thinking requires an understanding of the adaptive and emergent features of households (Sellberg et al., 2021). This in turn helps to understand how building resilience may intermediate in food security improvement.

4.1 Conceptual Framework

With respect to resilience definitions, a condition or system is considered to be more resilient if there is no shifting into an alternative circumstance (Walker et al., 2006), making the perturbations more endurable or stable at least (Holling, 1973). Recent bodies of literature explain the resilience concept using the idea of bouncing back as a response to changes in a dynamic or adaptive environment (Capdevila et al., 2021). Looking at the socioeconomic definition, resilience is defined as "*...the ability of communities or households to manage changes by maintaining or transforming livelihoods in the face of shocks or stresses without compromising their long-term prospects*" (DFID, 2011).

Although food security and resilience are intertwined, the RIMA model does not fully measure the effect of resilience on food security outcomes. A more comprehensive RIMA-II methodology treats resilience as a latent variable or food security as a separate outcome variable (Ansah et al., 2019). According to this methodology, household resilience to food insecurity depends on several pillars: access to basic services (ABS), assets (AST), social safety nets (SSN), adaptive capacity (AC), and sensitivity (S). In the framework, each pillar has its own role as the precondition for household mechanisms when a shock occurs between t_0 and t_1 times. Resilience Capacity Index (RCI) in the framework is therefore measured with the above-mentioned four pillars. As the centerpiece of food security analysis, the endogenous ABS, AST, SSN, AC and S pillars define RCI at t_0, which in practice has a relationship with food security at t_1.

Looking at previous RIMA-II results, there are findings showing a reciprocal relationship between resilience and food security. For example, RCI as a function of different pillars has a positive association with food security outcomes (d'Errico et al., 2018; Sibrian et al., 2021). Although it is difficult to define a causality between RCI and food security, some authors have detected a causal relationship (d'Errico & Pietrelli, 2017; Egamberdiev et al., 2023; Murendo et al., 2020). Some scholars have extended the framework by including the interaction terms between RCI and shocks (d'Errico et al., 2018; Egamberdiev et al., 2023; Murendo et al., 2020; Ouoba & Sawadogo, 2022; Sunday et al., 2022). Their findings concluded that resilience capacity has a moderating role in improving food security outcomes or decreasing the likelihood of food security worsening when shocks intensify.

4.2 Materials and Methods

4.2.1 Data

The analysis in this paper is based on two surveys: the Tajikistan Living Standards Survey (the TLSS) in 2007 and 2009 by the World Bank, as well as the Tajikistan Household Panel Survey (THPS) in 2011 by the Leibniz Institute for East and Southeast European Studies (*Leibniz-Institut für Ost- und Südosteuropaforschung* – IOS) in cooperation with the Research Center Sharq in Dushanbe. As part of the Living Standard Measurement Survey, TLSS is nationally representative by including 1500 households interviewed in 4 regions and the capital city of Dushanbe (TSSA, 2009). TLSS is based on a stratified clustered random sampling technique in which the sample was stratified according to *oblasts* (regions) and urban/rural settlements. The second THPS data set fully represents TLSS, because the survey aimed to generate unique panel data based on migration and remittances in Tajikistan by reinterviewing the same households surveyed in 2009 (Danzer et al., 2013c). Thus, the observations of THPS are merged with TLSS to create a final panel dataset for further analysis.

4.2.2 Estimating the resilience capacity index

The measurement framework of RIMA-II is based on a two-stage procedure. The first stage uses a factor analysis to construct pillars, after which the second stage employs a Multiple Indicators Multiple Causes (MIMIC) model to estimate RCI from pillars for the relationship between RCI and food security outcomes (FAO, 2016). In this manuscript, we apply a principal component analysis (PCA) on the following resilience pillars: ABS AC, AST, SSN, and Sensitivity S. In addition to this, we use a structural equation modeling (SEM) as a robust to explore a complex relationship between the mentioned four pillars (Alinovi, Mane, et al., 2010). The description of each pillar with related statistics is provided in Table A3.1. After measuring and scaling the score of each pillar, RCI is itself constructed through PCA and SEM. As a data reduction method, PCA allows us to obtain a set of uncorrelated linear combinations of the variables retaining most of the variance. As a family of multivariate statistical analysis, SEM is used to model a structural relationship between pillars. This method accordingly gives us the possibility to evaluate the relationship between the pillars by holding other indicators constant and include the measurement error in the model. With the help of SEM features, we look at the modification indices to calibrate the model until it reaches the best fit. The score of each pillar and RCI in PCA is measured through the *weighted sum method* suggested by Bartlett (1937). A similar approach is applied in order to construct pillars and RCI, where each factor is multiplied by the proportion of variance (Alinovi, d'errico, et al., 2010). As for SEM, pillars and RCI are measured through an analog of regression scoring. For factorability and validity analysis, findings for each pillar and RCI are based on the requirements recommended for implementing PCA and SEM (Appendix 3.1 and Table A3.2). In the same way, Figure A3.1 provides details for the SEM analysis. We applied the MIMIC model in the second stage, showing the relationship between observable and unobservable variables (Appendix 3.2 and Figure A3.2). In other words, MIMIC allows us to integrate both formative and reflective models (Bollen, 2011).

4.2.3 Estimating latent coping strategy

Detecting a household difference or heterogeneity in resilience studies is an important but complex issue. Known as a *variable-oriented approach*, related traditional approaches emphasizing the relationship between observed variables in the dataset might be limited in detecting the heterogeneity (Bergman et al., 2003). Therefore, we proposed to apply *a person-centered approach* to emphasize the patterns of individual characteristics in order to categorize the behavior of people with a latent analysis rather than using arbitrary cutoff points (Hickendorff et al., 2018). One way to deal with heterogeneity through the person-centered approach is to use LCA to identify subgroups under similar patterns of characteristics. LCA referred to a mixture model is used to define unobserved categorical variables by dividing the population into mutually exclusive latent classes (Collins & Lanza, 2009). In this paper, LCA helps to manage response patterns about 10 types of subjective coping strategies to such an extent that we are able to discern meaningful and scientifically interesting classes. In this case, we can observe that 10 subjective coping strategies represent different socioeconomic aspects, where more than one-third of households got financial aids from friends or family, sent a member to work as a seasonal worker, increased food production, worked more than normally, and sent household members to work who normally did not work (Appendix 3.3 for model specification details and class identification, Table A3.3 and Table A3.4 for statistical information, and Figure A3.3 for identified classes).

In order to express the essence of selected coping strategies generalized in latent classes, we primarily drew on a *three-step approach* including (1) estimating a standard latent class model without covariates, (2) assigning subjects to the classes, and (3) analyzing a categorical latent variable with predictor auxiliary variables (Van Den Bergh & Vermunt, 2019). In this case, our categorical latent variable is taken as one of the covariates into further modelling for the relationship between resilience and food security.

4.2.4 Identification strategy

As the situation of food security can be represented by food expenditure (Moltedo et al., 2014), we included *a household food expenditure* per week in Tajikistan Somoni (TJS). Since the prevalence of availability and access in fruit and vegetable consumption is important to understand a nutritional situation in developing countries, we also used a *household adequacy of fruit and vegetable consumption* showing the number of grams of fruits and vegetables consumed per capita per day for the household (INDDEX, 2018; Moltedo et al., 2014). In addition to this, we included the third indicator through a *household food expenditure share*. A major reason behind using this indicator is explained by the fact that poor and vulnerable households may spend a larger share of the income on food. Moreover, households in developing countries are likely to be sensitive to food price fluctuations that may change the share of the consumption (Amolegbe et al., 2021).

We expect that there is a positive relationship between resilience and food security. In order to obtain the results, two-stage least square regressions (2SLS) and IV Probit models are used:

$$FS_{h,t} = \beta RCI_{h,t-1} + \gamma C_{h,t} + \tau X_{h,t} + \epsilon_{h,t} \qquad (1)$$

where subscript h represents the household and t is the time. $FS_{h,t}$ is the dependent food security variable which is either *food expenditure, the adequacy of fruit and vegetable consumption* or *household food expenditure share*. To capture a dynamic perspective, dummy losses are included for both indicators that occurred between the 2009 and 2011 waves. The main independent variable is $RCI_{h,t-1}$, measured though five pillars explained in the previous section. $C_{h,t}$ represents a latent variable for the subjective coping strategy explained previously. $X_{h,t}$ is a vector of household characteristics including dummy rural household, household size, age of head and dummy female head of household. $S_{h,t}$ is a shock explained by the number of moderate and/or severe drought events for the last 12 months of 2011, obtained from the Standardized Precipitation Index (SPI) (summary statistics of all variables in the identification are shown in Table A3.5). Furthermore, the interaction term between RCI and shock ($RCI_{h,t-1} \times S_{h,t}$) is included in the model, aiming to capture a mediating role of resilience.

We assume that resilience is endogenous. Although our estimation strategy is based on the relationship between $RCI_{h,t-1}$ and $FS_{h,t}$, RCI is still to be correlated with the error term of the estimated model, causing the problem of endogeneity. Correspondingly, the endogeneity of RCI is likely relevant for the endogeneity of the interaction term (Bun & Harrison, 2019). In order to deal with this issue, we proposed to apply the IV approach. In this respect, IV estimations provide a consistent estimator after finding a valid (strong) instrument in which the instrument z should be correlated with the explanatory variable and uncorrelated with the error term.

$$RCI_{h,t-1} = \alpha z_{h,t-2} + \gamma C_{h,t} + \tau X_{h,t} + \epsilon_{h,t} \qquad (2)$$

We included the *distance from population point in the community to the capital (Dushanbe)* as an instrument variable. As for the exclusion restriction, the relationship between geographic distance and resilience has already been mentioned by scholars making use of distance as a good proxy for resilience (Ickowicz et al., 2012; Sadri et al., 2018). Another similar study confirms that the distance to the nearest border is likely to be a good instrument to control the problem of endogeneity in the effect of RCI on food security outcomes (Egamberdiev et al., 2023). One possible explanation in the context of Central Asia is that areas far from the capital experience high long-distance migration to particularly Russia. This has already been mentioned by FAO's policy recommendation under a regional cross-border approach for food security resilience (FAO, 2018). Neighbouring countries, particularly Kazakhstan, and non-bordering Russia are likely to provide an important livelihood and resilience basis for rural areas of Tajikistan. From another perspective, some authors consider the distance variable as a good proxy for the pillars of RCI (Wang & Do, 2023). The expansion of the resilience framework in relation to social capital has already captured different nonphysical aspects of resilience. For example, findings by Egamberdiev (2024) indicate that social capital elements are likely to strengthen food insecurity resilience in Central Asian Kyrgyzstan, particularly in areas far from capital of Bishkek. Accordingly, building intercommunity relationship and networking in rural areas manifest themselves as plausible factors to strengthen household resilience capacity towards different types of shocks. Therefore, the distance to the capital can be a good proxy for the unofficial networking channels in Tajikistan. For the validity of IV, see Appendix 3.4 and Table A3.6. Since we have both continuous and binary outcome variables, 2SLS and IV Probit models are adopted. For robustness checking, we provide both 2SLS and IV Probit models for binary outcomes by applying an approximate conversion ($\beta_{Probit} = 2.5\ \beta_{OLS}$) (Cameron & Trivedi, 2009).

4.3 Results

4.3.1 MIMIC

The following descriptive part of findings generally targets pillar rankings to resilience. Figure 4.1 shows that not all pillars are statistically significant. The pillars for descriptive interpretations are based on loadings or coefficients of observable variables in each obtained factor. The result of the MIMIC model indicates that ABS, AST, and SSN are the most relevant pillars, showing a significant relationship with RCI (Appendix 3.5 and Figure A3.4-Figure A3.8). Findings discussed by some scholars have concluded that similar pillars are strongly correlated with RCI (d'Errico & Pietrelli, 2017; Lascano Galarza, 2020). This is particularly true for those households creating unofficial safety nets to strengthen RCI in rural areas of Central Asia (Egamberdiev, 2024).

4.3.2 RCI and Food Security

There is a positive relationship between RCI and food security outcomes in models (1), (3) and (5) of Table 4.1. More precisely, one index point higher in RCI positively affects the adequacy of food intake (AFV), increasing it by an average of 6.79 grams/capita/day. A similar situation is true for food expenditure (FE), which makes up an average TJS 24.23 per index rise.

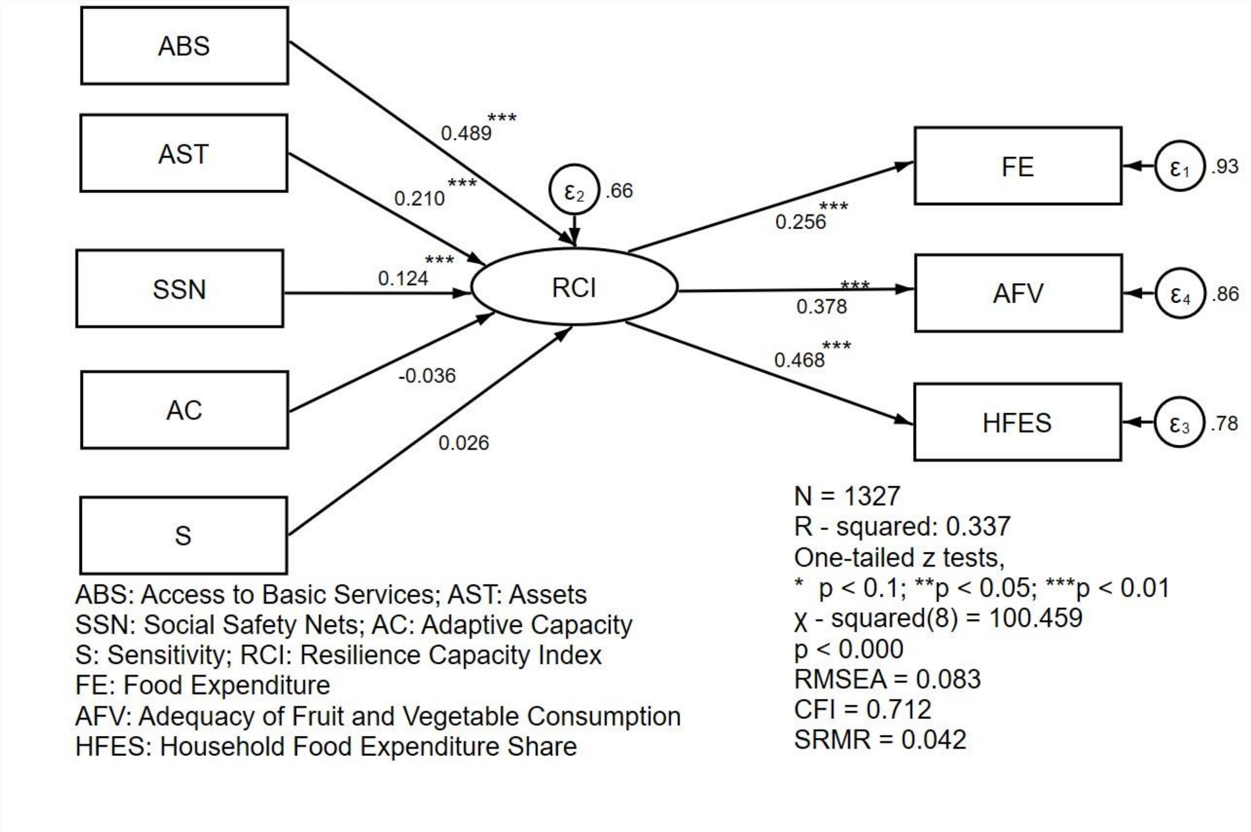

Figure 4.1 MIMIC Model

Source: compiled by the authors

This finding is consistent with Murendo et al. (2020), who found a positive relationship between RCI and diet diversity as well as food consumption score. A positive relationship between the RCI and food expenditure share (HFES) indicates that a higher RCI increases the ratio by 0.01. A higher share of expenditure on food might be due to increased dietary-diversity of food consumption or food expenditure as mentioned in model (1) and (3). As the mean value of HFES at around 17% (Table A3.5) is far below the threshold of food insecurity level by Smith and Subandoro (2007), it is more realistic to expect the increased monetary value of food consumption in more resilient households. In agreement with above findings, the relationship between SEM-based RCI and food security indicators is positive (Table A3.8). Compared to the reference class, households characterized by the *"High Coping Strategy"* class are likely to have a higher AFV and FE explained by 12.58 grams and TJS 77.52, respectively. However, the relationship between coping strategy and adequacy is statistically insignificant. As expected, the *"High Coping Strategy"* class is significantly negative by decreasing HFES by around 0.03.

Although this finding does not indicate the entire history of household food security resilience, coping strategies are still found to be significant as a short-term response mechanism. Indeed, it explains the prominence in household adaptability in the short term that is likely to increase the long-lasting adaptive capacity of resilience (Alinovi, d'errico, et al., 2010). Moreover, Lascano Galarza (2020) confirmed the role of non-food consumption smoothing to improve food security outcomes in the household. As for other controlling variables, the household size is negatively associated AFV and HFES, but it has a positive relationship with FE.

Table 4.1 Resilience and Food Security Outcomes

	AFV		FE		HFES	
	(1)	(2)	(3)	(4)	(5)	(6)
RCI	6.798**		24.239***		0.006***	
	(2.635)		(6.078)		(0.001)	
RCI*Shock		1.668***		5.943***		0.001***
		(0.639)		(1.460)		(0.001)
High Coping Strategy	12.589	12.028	77.524***	75.542***	-0.028***	-0.029***
	(11.971)	(11.833)	(27.340)	(26.856)	(0.008)	(0.008)
Head female	-29.793**	-31.439**	-28.477	-34.433	-0.001	-0.001
	(13.873)	(13.757)	(31.752)	(31.292)	(0.009)	(0.009)
Head age	0.808*	0.902*	-0.147	0.180	0.001***	0.001***
	(0.470)	(0.470)	(1.076)	(1.069)	(0.001)	(0.001)
Household size	-58.239***	-61.239***	80.572***	69.897***	-0.012**	-0.015***
	(7.020)	(6.403)	(16.098)	(14.579)	(0.004)	(0.004)
Sq. Household size	2.276***	2.383***	-2.301***	-1.921**	0.001**	0.001***
	(0.356)	(0.341)	(0.816)	(0.776)	(0.001)	(0.001)
Rural	47.056	37.075	94.967	59.245	-0.004	-0.013
	(30.314)	(26.600)	(69.821)	(60.826)	(0.021)	(0.018)
Drought Shock Events	2.526	-33.125*	-24.873*	-151.847***	-0.017***	-0.050***
	(6.276)	(18.034)	(14.391)	(41.255)	(0.004)	(0.012)
Constant	386.810***	546.550***	-680.465***	-110.561	0.078	0.225***
	(97.617)	(45.951)	(224.964)	(104.797)	(0.068)	(0.031)
Observations	1327	1327	1333	1333	1333	1333
Cragg-Donald F Stat.	103.633	141.522	102.587	140.354	102.587	140.354

**** p<0.01, **p<0.05, *p<0.1. The reference class is "Low Coping Strategy". Standard errors in parentheses*

Source: compiled by the authors

A changed sign for the squared measure of household size in the outcome indicates a nonlinear relationship. The age of the household head is positively associated with AFV and HFES. This result might be due to farming experience determining resilience to food insecurity (Ado et al., 2019). There is a negative relationship between female-headed households and adequacy ratio. This might be due to either less women's empowerment role in the family (Sraboni et al., 2014) or high occurrences of labor migration among male population (Kim et al., 2019). As for shock, there is a negative relationship between the number of drought events and food security outcomes. The interaction terms between RCI and shock in models (2), (4) and (6) are positive and significant: the interpretation of this finding can be that households experiencing higher resilience are likely to activate it in order to mitigate the influence of shocks on food security. This finding is consistent with discussions confirming a moderating role of resilience to sustain food security when shocks intensify (Egamberdiev et al., 2023; Murendo et al., 2020; Sunday et al., 2022). By controlling residual error correlations, the SEM approach also provides very similar results indicating a significant mediating role of resilience on food security outcomes when shocks intensify (Table A3.8).

Table 4.2 Resilience and Food Security Loss Outcomes

	AFV		FE		HFES	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
RCI	0.026***		-0.044***		-0.025***	
	(0.006)		(0.006)		(0.006)	
RCI*Shock		0.006***		-0.010***		-0.006***
		(0.001)		(0.001)		(0.001)
High Coping Strategy	-0.008	-0.010	-0.084***	-0.081***	-0.004	-0.002
	(0.030)	(0.029)	(0.030)	(0.028)	(0.028)	(0.027)
Head female	-0.010	-0.017	-0.003	0.007	0.108***	0.114***
	(0.034)	(0.034)	(0.035)	(0.033)	(0.032)	(0.032)
Head age	-0.001	-0.001	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Household size	0.049***	0.038**	-0.107***	-0.088***	-0.028*	-0.017
	(0.017)	(0.016)	(0.018)	(0.015)	(0.016)	(0.015)
Sq. Household size	-0.001	-0.001	0.003***	0.003***	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Rural	0.251***	0.212***	-0.316***	-0.251***	-0.211***	-0.174***
	(0.076)	(0.067)	(0.078)	(0.065)	(0.072)	(0.063)
Drought Shock Events	-0.053***	-0.191**	0.092***	0.326***	0.038***	0.170***
	(0.015)	(0.045)	(0.016)	(0.044)	(0.014)	(0.042)
Constant	-0.357	0.258**	1.762***	0.713***	1.302***	0.712***
	(0.245)	(0.116)	(0.251)	(0.112)	(0.232)	(0.108)
Observations	1327	1327	1333	1333	1333	1333
Cragg-Donald Stat.	103.633	141.522	102.587	140.354	102.587	140.354
Wald test Stat.	0.000	0.000	0.000	0.000	0.000	0.000

**** p<0.01, **p<0.05, *p<0.1. The reference class is "Low Coping Strategy". Standard errors in parentheses*

Source: compiled by the authors

Table 4.2 shows that RCI negatively affects the probability of food security worsening in the outcomes of FE and HFES. The relationship is statistically significant in all outcomes. In model (3), a one-point index rise in RCI shows a decrease in the probability of FE loss explained by 0.04 in 2SLS (rescaled IV Probit outcome: 0.10). This negative relationship is also true for the outcomes of HFES loss in model (5) decreasing the probability loss by 0.02 in 2SLS (rescaled IV Probit outcome: 0.05). This finding is consistent with a similar study by some scholars who found a negative relationship between RCI and the likelihood of suffering from a decrease in dietary diversity (d'Errico et al., 2018; Egamberdiev et al., 2023). However, there is a positive relationship between RCI and loss in AFV in model (1). It is similar to the findings discussed by Egamberdiev et al. (2023) indicating inconclusive results in terms of the relationship between RCI and loss in AFV in the case of Kyrgyzstan.

The relationship between the latent coping strategy and FE loss is negative and statically significant. There is a positive relationship between head female and HFES in model (5). Moreover, bigger-sized or rural households are negatively associated with loss in models (3) and (5). However, this relationship is significantly positive in terms of AFV loss in model (1). Rural households are likely to suffer from the loss in AFV provided in model (1). As provided in models (3) and (5), households exposed to a higher level of shocks are likely to experience a loss in their food security status. This is not true for the case of model in (1). Findings in the relationship between RCI and loss in food security outcomes are similar to those findings in which RCI was constructed through SEM (Table A3.9). Looking at the coefficients of the interaction term in models (2), (4) and (6) of both Table 2 and Table A9, the estimates are quite robust, indicating the same sign and significance to the one estimated without interaction effects. Findings for the interaction terms in models (2), (4) and (6) through SEM in Table A3.9 provide similar results.

4.4 Conclusion and Discussion

This study contributes to the building evidence on the role of resilience to food security outcomes. From our analysis of separate resilience pillars in MIMIC, policies aimed at building overall resilience and food security should first of all focus on improving the ABS. Here, one focus should be to invest in affordable heating and gas for everyday life of Tajik households, which was found to be one of the largest contributors to resilience capacity. In addition to this, the diversification of energy-generating sources in rural areas is likely to increase equal access to energy consumption. This is relevant also with respect to the "National Development Strategy-2030" of Tajikistan, which aims to ensure energy security and efficient use of electricity (WB, 2018).

Central Asia is particularly sensitive to the regional integration, aiming for various objectives because it is landlocked and shares borders with the Russian Federation, China and Afghanistan (Leskina & Sabzalieva, 2021). In addition to the intra-Central Asia initiatives, Tajikistan should deal with extra-regional partners such as the Russian Federation and China. At this juncture, a lack of progress in attracting Tajikistan to join EAEU due to the pressure of Russia (Mostafa & Mahmood, 2018), China's 'one belt, one road' (OBOR) is becoming more attractive to Central Asian countries (Leskina & Sabzalieva, 2021) by promising economic and energy exchange partnerships (Silin et al., 2018).

Further implications are provided by our analysis of AST and SSN pillars; formal transfers are strongly playing into resilience capacity. In practice, the existence of both formal and informal transfers by strengthening household resilience are strong mechanisms to deal the problem of food security in Central Asian countries (d'Errico et al., 2023; Egamberdiev et al., 2023). In this case, both cash and in-kind assistance received from the households are at the forefront of building or strengthening household resilience because they act an efficient response mechanism when shocks intensify. As a policy response, the government should strengthen financial institutions with its existing mechanisms and new possible approaches. For example, a comprehensive National Financial Inclusion Strategy for 2022-2026 aims to spur financial services and improve financial literacy of citizens (IFC, 2022). In order to steer towards more resilience seeking policies, interventions aligned with this strategy should encourage households to make financial decisions on the transfers. In addition to this, the quality of institutions should be improved that conduce to the effectiveness of formal transfers. Finally, social-security programs, particularly associated with women and children left behind, should be prioritized by the Tajik government. Although the manuscript does not directly include women's empowerment or gender role relations, we believe families enmeshed in negative consequences of continuous migration should be strongly supported by the government by empowering women who are left behind.

A causal relationship indicates that household resilience has a positive effect on food security while the reverse is true on the probability of loss. The study also introduced the interaction terms of resilience and shocks (RCI*Shock) to estimate the effectiveness of resilience in its mitigation of shocks on food security outcomes. Findings conclude that the interaction between RCI and shock is still significant at improving food security outcomes when shocks intensify. It therefore indicates that resilience has its protective effect, particularly important for decreasing any loss. This finding, through the operationalization of resilience as a concept, might be feasible for policy formulations, especially in the focus of large-scale interventions in Tajikistan. This is mainly because the operationalization of resilience recognizes different aspects of livelihood by strengthening or building capacities that are likely to bring positive outcomes in the long run (Béné, Headey, et al., 2016). Therefore, it helps to understand how to increase the interconnections of livelihood, social protection, health protection, nutritional development and others under the intervention objective of building resilience.

Finally, our study provides an extension of the RIMA-II framework by adding subjective measures of coping strategies. Herein, we follow d'Errico et al. (2018), who advocated for empirical evidence on whether subjective measures contribute to the RIMA-II analytical framework to explain the resilience to food insecurity. By including household coping strategies under subjective responses to different types of shocks, we provided additional evidence for the relation between RCI and coping strategies with food security outcomes. A negative relationship between coping strategies and RCI indicates that less resilient households are more likely to activate coping strategies in the short term to deal with shocks.

Our findings for the relationship between resilience and food security may still remain obscure in the context of livelihood strategies, particularly in relation to income generation or agricultural activities. For example, a study showing the role of household livelihood strategies towards resilience and food security explains how RCI is differentiated across different socio-economic groups (Alinovi, d'errico, et al., 2010). Therefore, it would be interesting to build the relationship between resilience and food security outcomes by defining livelihood strategies. In order to understand the relationship between resilience and food security outcomes, there should be related factors or variables describing subjective or self-perceived resilience that may connect the concept of resilience to insecurity. Findings by Crookston et al. (2018) concluded that self-perceived resilience and characteristics of actual resilience do not match at all times.

5. Conclusion

Resilience, linking household options and capacities with food security outcomes, is a pervasive approach. Many measurement and operationalisation methods, particularly in the presence of shocks, have been offered to conceptualize household resilience capacity towards food insecurity. One such approach is FAO's RIMA, which measures household resilience or RCI as a latent variable. Using RCI in the first manuscript in Chapter 2, the panel data of Life in Kyrgyzstan (LiK) was used to analyse the effect resilience capacity on several food security indicators. The manuscript adopted the RIMA methodology to construct RCI at the Kyrgyz household level. The descriptive analysis indicates that SSN and AC are the most important pillars to determine household resilience capacity. Since SSN represents official and unofficial channels, the Kyrgyz government should improve SSN, targeting unofficial channels in rural areas. For example, the state arrangements for the formal social security institutions may consider the existing informal and traditional rural arrangements. Informal safety channels are sometimes sophisticated in Kyrgyz rural areas; moreover, they may lead to pressures on available resources in households or communities. In this case, formal social arrangements are needed to establish the mechanisms that may consistently reach vulnerable groups. In addition, supporting digital services and easy access to safety nets are important indicators of the system for simply improving the coverage, adequacy, and effectiveness of social protection systems. As for the adaptability mechanism of the Kyrgyz household, the intervention programs should incentivize income source diversification and remittance mechanisms. It further requires reforms to improve transparent and accountable governance and enhance a monetary policy in Kyrgyzstan. In addition, household adaptive capacity depends on the institutional qualities needed to provide adequate support to the most vulnerable.

The analysis of the shocks in the manuscript indicates that subjective shock perceptions are highly heterogeneous in Kyrgyz households. Although it is not easy to generalize from the subjective shock perceptions, accurately categorizing shock groups indicates that household food security outcomes are negatively associated with exogenous shocks. This finding indicates that household resilience capacity as a response after the shock is of particular importance. A causal analysis of the relationship between resilience and food security outcomes in the presence of endogenous and exogenous shocks indicates that RCI is likely to improve dietary diversity, food expenditure, and the adequacy of fruit and vegetable consumption. From another perspective, the results for the effect of resilience capacity or RCI on food security losses are congruent with the static food security condition. To be more precise, higher resilience capacity is likely to decrease the loss in dietary diversity and food expenditure. The last outcome confirms a moderating role of resilience capacity, indicating that resilience capacity effectively dampens the adverse effects of exogenous and endogenous shocks on food security.

The implication of this study is to enhance resilience to food insecurity. The findings of the first manuscript would help establish regional intervention policies, supporting households to address the multiple threats and shocks to food insecurity. A solid and positive relationship between household resilience and food security implies that the policy focusing on supporting household resilience is necessary. In this case, policy actions and interventions for building household capacity should consider the possibility of recovering from the shock in the long term. The interventions should also consider that resilience is not a momentary phenomenon but shows dynamic relationships between determinants over time. For this reason, the cumulative effects of determinants or pillars of resilience are essential to be considered. From another perspective, the findings suggesting how to implement prevention and mitigating measures might help improve short-term response policies that would bring the benefit of mitigating the adverse consequences of shock in the long term.

By capturing the multi-dimensional nature of resilience, the following findings from the case of Kyrgyzstan in Chapter 3 point to the significance of social capital for resilience thinking. The article contributes to building a confirmation on the effect of social capital, measured through Trust and Group Membership, on household resilience capacity (RCI) and its pillars (IFA, ABS, APT, and AC). Using the two waves of LiK, the manuscript indicates that IFA, APT, and AC are noticeably important in strengthening household resilience (RCI). A causal claim between social capital and resilience pillars indicates that Trust and Group Membership positively affect IFA, APT, and AC. Moreover, both social capital indicators significantly affect the improvement of RCI.

Including social capital elements in the pillars of resilience might capture multidimensional characteristics to such an extent that specific intervention policies can be formulated. The improvement of operationalization of resilience, particularly focusing on the relationship between social capital and pillars, is likely to explain more about the mechanisms through which the household resilience capacity is indexed. For the policy recommendations, community-based organizations and social networks facilitate the formal and informal exchange of resources; therefore, the interventions should consider the scope and context of organizations and networking in the community. For example, the use of financial resources in the community or household may depend on the type of social capital or bonding relationship in the community. Looking at the relationship between determinants and resilience, policies and intervention programs working on improving household resilience towards food insecurity might be particularly sensitive to income access, agricultural practices, and household adaptability. In this case, the efforts might be driven by understanding how to support income sources and agricultural production, particularly in rural areas. In addition, policymakers should also recognize the importance of adaptive capacity in strengthening household resilience. Therefore, mobilizing resources by understanding context-specific social capital may efficiently build household resilience through income sources, agricultural practices, and adaptability toward the changes.

The last manuscript in Chapter 4, analysing the relationship between RCI and food security outcomes in the context of Tajikistan, also confirms that RCI has a positive effect on food security outcomes. The reverse is true for the relationship between resilience capacity and loss in food security, indicating a protective effect from the loss when shocks intensify. The finding is also consistent with the first manuscript in Chapter 2, indicating a mediating effect of resilience. Findings from MIMIC confirm that ABS, AST, and SSN pillars are positively associated with food security outcomes. Using a household coping strategy, obtained as a subjective response, confirms that there is a significant relationship between RCI and the coping strategies. Meanwhile, an activating coping strategy is also positively associated with better food security outcomes.

The findings from the SEM and MIMIC models show which pillar contributes to strengthening resilience capacity and food security outcomes. The results indicate that safety nets and adapting ability are the most contributing factors and could be a reasonable priority for the intervention in Tajikistan. The safety net might complement the social security mechanism, increasing household resilience towards food insecurity. The insurance function of social safety nets allows the households to manage costly or irreversible coping mechanisms.

One of the policy recommendations is to make SSN an integral part of the social protection systems in Tajikistan. In this case, the programs can be implemented through the unified information system for social insurance, in which a data exchange should be fully automated. In addition, Tajikistan needs a robust administrative and institutional system to implement SSN in a timely and cost-effective way. Finally, strengthening SSN without undermining macroeconomic pressure, the Tajik government should implement an accountable and transparent fiscal policy. In the meantime, access to services and assets found through ABS are critically important; therefore, the state should prioritise modernizing the infrastructure. In this perspective, the resilience strategy of the intervention should establish accountable standards and measures to improve the available infrastructure. Since AST is found to be positively associated with RCI, strong law enforcement is needed to protect the property rights. When assets directly contribute to income-generating activities in the household, a proper role of the government is essential to enhance economic effectiveness.

The static nature result showing a positive relationship between resilience and food security improvement indicates that the intervention programs consider strengthening household resilience; therefore, resilience-building activities should aim for the most relevant determinants of resilience. A dynamic nature finding is genuinely a validation response to ensure that policy interventions to sustain food security consider household resilience capacity when a household deals with the consequences of shocks.

5.1 Limitations

The resilience concept should characterize agency, power, and resilience capacity. However, one of the most fundamental limitations is the need for more gender-sensitive assumptions in the conceptualization of resilience towards food security. It precludes the possibility that the framework conceptually captures gender roles or gender dynamics in households. The significance of the gender lens in resilience thinking may show the entry point in dynamic relations to strengthen a household food security condition, particularly from women's perspectives. It is especially true in Central Asia, where limited access to resources and decision-making generally hampers women's contribution to building or strengthening household resilience. As for resilience measurement techniques, many attempts include a dummy gender or female variable without implying gender role dynamics in decision-making and resource ownership in households. Our limitation in three articles was also related to the point that gender dynamics are missing. However, we still believe that using a gender lens in the resilience framework may provide new insights, particularly addressing women's needs and the potential for enhancing food insecurity resilience.

A scalability challenge explains another limitation in the resilience framework. A scaling approach in social construction refers to differentiating levels or systems, in which decision units or bodies make a decision for livelihood. Importantly, making resilience scale-sensitive allows approaches to be holistic and multi-dimensional that should integrate household, community, or country levels. This scenario also provides alternative solutions to substantive issues, such as dealing with endogenous and exogenous shocks at different levels. In this case, the above-discussed manuscripts conceptualize food insecurity resilience at household level. Accounting for the scaling approach in food insecurity resilience may provide more holistic solutions by integrating the transformation or transition in different levels.

Another critical point is an understanding that the primary objective of policy interventions should consider well-being, poverty, or food security conditions as the primary target but not resilience alone. In other words, enhancing or sustaining resilience is an instrument to improve food security but not a central aim. Therefore, our conclusions are based on the premise that household resilience capacity is a solid instrument to improve food security outcomes, particularly when shocks become severe. The discourse on research should consider a resilience intervention for achieving the targeted food security outcomes, and from this perspective the implemented policy should build a growth agenda that links resilience and the development outcomes without romanticizing the resilience concept.

In the same line of limitations, pillars or determinants of resilience do not always show positive relationships with resilience capacity. Although resilience is measured from different capacity-related variables, the measurement is notoriously challenging due to synergetic and trade-off-based relationships between determinants or pillars. In other words, increasing or strengthening resilience capacity might be at the expense of pillars. However, we still believe it is not anomalous to have different directions between determinants and resilience due to household, shock, or even perception nature. For example, the association findings indicate that ABS and SSN mostly have a negative relationship with RCI. This situation implies that increasing adaptive ability or AC in a household might be at the expense of ABS or SSN; therefore, the limitation still exists to capture a dynamic relationship between the pillars. Taking this into account, Chapter 4 proposes to use the SEM method to control a relationship between the resilience pillars.

It is also imperative to understand that the implementation of early policies to support or enhance resilience-building activities become more susceptible to further costs. Therefore, costs or direct losses might be embedded in the strategy to make households resilient to shocks. Of course, these characteristics of resilience make any intervention more nebulous. Therefore, household strategies or policy implementation to strengthen resilience might be beneficial to livelihoods if socio-economic, ecological, and psychological costs are accurately measured. For example, findings in Chapter 4 mainly show a negative relationship between resilience and coping strategies. This result means that costs incurred in implementing or activating coping strategies in the households might be high for less resilient households. It makes the intervention more sensitive when the efforts are given to the adaptive preferences in resilience-building strategies for less resilient households.

From a food insecurity perspective, the resilience framework representing household capacity plays a significant role in understanding household abilities to react to shocks. Since shocks are becoming more severe and volatile, the "analytical" role in resilience becomes more critical for scientific scholars and policymakers. In this case, all three articles operationalize resilience as household capacity pertinent to food security outcomes.

5.2 Methodological recommendations

Three manuscripts measuring household resilience capacity or RCI indicate that the context and evidence-based construction of resilience are essential. In this case, a number of observable variables should be included to construct each pillar because the corresponding resilience capacity is context, level, time, shock, and outcome specific. The reason behind making resilience context-specific is explained by the local settings that may directly and indirectly shape resilience and create its mechanism. For example, the findings from Kyrgyzstan and Tajikistan indicate that the variables included are different with the estimated weights; therefore, applying any constant weights may produce biased results. From another perspective, a context-specific assumption helps to explain resilience in the regional settings. Therefore, the contextual factors such as socio-economic, cultural, historical, environmental, geographical, and political aspects should be taken into account in the measurement of resilience.

Since resilience is not an end process, it is indissolubly linked to specific outcomes such as food security, well-being, poverty, and others. Applying resilience to a particular outcome allows building a theoretical foundation by focusing on certain observable variables. Since we included different types of food security indicators in the analysis, we particularly indexed household resilience capacity to food security. However, the relationships should be inferred by taking the changes in food security between two points in time. This approach requires panel data to follow the changes (e.g., the loss in food security outcomes) in food security.

Another particular characteristic of resilience is its level of specificity. In other words, it is multifaceted, representing different aspects at different levels. For example, this phenomenon can be extended to food system resilience at the state or country level. A methodological perspective should always consider intimate interdependence between the levels when there are particular efforts to measure resilience at any level. A multi-scale measurement sometimes requires the measurement of resilience capacity at different levels. Although the manuscripts are based on the household-level approach, we tried to integrate the community-level dimensions. However, it sometimes may create operational challenges in the measurement because the dimensional metrics used in resilience are dynamic, not at one unique level of resilience.

Another important consideration is that resilience is not transient. In other words, it should represent the condition from the long-term perspectives and dynamic changes over the period. For example, we applied the changes in resilience capacity and food security outcomes in Chapter 2. Chapter 4 also captured the dynamic and sophisticated analysis that includes the changes in food security outcomes.

The last important consideration is shock that is used to conceptualize and measure resilience. In this case, food insecurity resilience should be measured by considering specific shocks, requiring the relationship between shocks and resilience. The growing prominence of the resilience concept is particularly due to the possibility of applying the framework in the context of disasters and shocks. However, integrating the frequency and severity of shock events may be challenging due to modelling difficulty or data limitation. Pursuant to the methodology, we included different shocks in our estimation strategies. A pertinent remark is that a mitigating effect of resilience also requires the integration of shocks in the estimation.

In order to expand the RIMA approach by including social capital as a separate and additional pillar, further thoughts should be made to confirm a “good fit” for the following reasons. Firstly, social capital elements can be conceptually compatible to measure resilience capacity towards food insecurity. By understanding how social capital contributes to building resilience, policy recommendations would reflect valuable recommendations to consider nonphysical aspects of the livelihood. Secondly, the variables included to measure social capital should accurately indicate the direction of resilience (e.g., higher social capital and more resilient households). Such a joint distribution of social capital and resilience could be a solid argument for considering social capital as possibly one of the pillars or determinants of RCI. Since social capital statements are obtained from different levels, rich data combining individual and household levels is required.

Since resilience is a dynamic concept, a short-term coping strategy may show an immediate response mechanism in the households. In this case, the effect of the shocks might be managed by coping mechanisms of the household, in which the adverse effects should not have a long-lasting effect on food security outcomes. For this reason, a distinction between resilience capacity as long-term and coping strategy as short-term mechanisms should be identified. Many attempts use the coping strategy index as one of the pillars of resilience capacity; however, the results should be robust and more consistent, explaining the association between resilience and coping strategies.

The challenge is operationalizing the resilience framework for estimating the relationship between the resilience capacity index and food security outcomes. In this case, the estimation strategy should be specified based on the *correlational* or/and *causal relationship,* with *dynamic* and *mitigating role perspectives*. Although there are many attempts to detect the relationship between resilience capacity and food security outcomes, the impact analysis still needs to be improved. However, a causal analysis that solves the problem of reverse causality and other sources of endogeneity requires substantive approaches. A dynamic assumption allows an understanding of how resilience can affect the loss or recovery condition of food security. From another angle, a dynamic resilience change is also important in explaining the trajectory of changes in the capacity when shocks intensify. The last crucial methodological recommendation is about the mitigating role of resilience. This claim is based on the premise that the household resilience capacity should be able to mitigate the effect of shocks on food security outcomes. Overall, the need for causal and mitigating claims of resilience capacity is a fundamental challenge that should always be considered for empirical analysis.

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Appendix 1: Household Resilience Capacity and Food Security: Evidence from Kyrgyzstan

Table A1.1 Summary statistics

	Mean	Std. Dev.	Min	Max
RCI	17.610	15.133	0	100
Exogenous Shock	1.212	0.409	1	2
Endogenous Shock	1.135	0.342	1	2
Age HH head	54.029	13.377	21	90
Female head	0.252	0.434	0	1
Head married	0.615	0.488	0	1
HH size	5.253	2.537	1	17
Rural	0.612	0.487	0	1
Issyk-Kul and the Tian-Shan	0.122	0.328	0	1
Fergana Valley	0.442	0.496	0	1
Bishkek and the Northwest	0.337	0.472	0	1
Dietary Diversity in 2016.[7]	0.873	0.062	0.262	0.959
Food Expenditure in 2016	2035	1064.609	0	17180.09
Adeq.Fruits and Vegetables in 2016	391.424	313.849	11.773	3892.857
Dietary Diversity in 2013	0.899	0.041	0.580	0.958
Food Expenditure in 2013	1504	774.646	110.769	12282.31
Loss in Dietary Diversity (2013-2016)	0.668	0.470	0	1
Loss in Food Expenditure (2013-2016)	0.280	0.449	0	1
Loss in Adeq.Fruits and Vegetables (2013-2016)	0.624	0.484	0	1
Loss in Dietary Diversity (2012-2013)	0.274	0.446	0	1
Loss in Food Expenditure (2012-2013)	0.356	0.478	0	1
Loss in Adeq.Fruits and Vegetables (2012-2013)	0.651	0.476	0	1

Source: compiled by the authors

[7] It is based on Simpson index. The value ranges from 0 to 1, where 1 represents the maximum value of diversity. The equation of Simpson index for diet diversity: Simpson index = $1 - -\sum_{h=1}^{n} p_h^2$, where p_h is the proportion of household consumptions in a sample of n food groups.

Table A1.2 Variables used to estimate pillars

			Mean	Std.Dev.	Min	Max
Access to Basic Services - ABS	Infrastructure index	Infrastructure Index measured through factor analysis includes three variables: 1) Improved drinking water sources – dummy is equal to one for public water type, water pipe available in the dwelling and public water plumbing; otherwise, it represents artesian, dam, lake, river, aryk (small aqueduct) and pounder water sources. 2) Improved heating – dummy one represents central and electric installed-type equipment. Otherwise, it includes stove heating, transportable-type of electric heating, gas heating and others. 3) Improved cooking sources – one in the dummy indicates stove with pipe supply and balloons, electric stove and small electric hot plat. Unimproved zero indicates tandyr (tandoor) and others.	0.505	0.336	0	1
	Doctor consultation	It shows the number of consultation with doctors for health issues occurred over the last 12 months.	2.113	3.413	0	33
	Distance to main road	This variable is in kilometers representing the distance from household to the main road. The variable is transformed into a closeness scale with min-max re-scaling (0 is the maximum distance and 1 is the minimum distance).	0.960	0.089	0	1
	Distance to next agricultural and livestock market	It shows the distance in kilometers to reach the nearest livestock market from home. The variable is transformed into a closeness scale with min-max re-scaling (0 is the maximum distance and 1 is the minimum distance).	0.891	0.180	0	1
	Distance to school	It is the distance in kilometers between household and school. The variable is transformed into a closeness scale with	0.935	0.082	0	1

		min-max re-scaling (0 is the maximum distance and 1 is the minimum distance).				
	Distance to the community center	It is a kilometer based distance between home and community center. The variable is transformed into a closeness scale with min-max re-scaling (0 is the maximum distance and 1 is the minimum distance).	0.932	0.136	0	1
	Distance to the hospital	It is a kilometer based distance between home and hospital. The variable is transformed into a closeness scale with min-max re-scaling (0 is the maximum distance and 1 is the minimum distance).	0.932	0.118	0	1
	Distance to the pharmacy	It is a kilometer based distance between home and pharmacy. The variable is transformed into a closeness scale with min-max re-scaling (0 is the maximum distance and 1 is the minimum distance).	0.950	0.118	0	1
Assets - AST	Wealth Index per capita	This proxy is measured by factor analysis from different types of 32 non-productive assets available per capita for the last 12 months in the household.	0.209	0.171	0	1
	TLU per capita	This proxy is used to measure a single unit of measurement to represent available livestock per capita in the household for the last 12 months. In order to measure, a conversational factor is applied (horse-0.8, cow-0.8, donkey-0.5, pig-0.2, sheep-0.1, rabbit-0.02 and chicken-0.01).	0.332	0.732	0	14.8
	Per capita land (ha)	Land area of the parcel (hectares) available in the household per capita.	0.135	0.310	0	5.2
	Number of plots and parcels per capita	It represents the number of plots and parcels of land per capita, including household gardening used for agricultural purposes.	0.429	0.494	0	4.5
	Agricultural assets and vehicle per capita	It represents the number of agricultural properties and vehicles per capita available for the last 12 months.	0.008	0.043	0	0.5

Adaptive Capacity - AC	Income source	This variable includes 14 household income sources (income from crop farming enterprises, other agricultural activities, individual entrepreneurship, non-agricultural enterprises; property income from rent of accommodations/building(s), land, interests and dividends; income from employment, irregular on-time work; and income from inheritance, alimony, scholarships and other sources).	1.322	0.812	0	5
	Income earner share	This variable represents the number of people in the household who are potentially able to earn (their age is between 15 and 65 years old).	0.666	0.250	0	1
	Informal Networking Index	This index is designed to understand how well households are able to reconfigure themselves by using their informal networking channels. The index is based on variables measured by questions corresponding to financial and non-financial aids possibly given to the household during or after the shock in the last 12 months (the number of people are able to give 2000 KGS urgently; to how many people household gave any financial help; from how many people household received any financial help; to how many people household gave any non-financial help; and from how many people household received any non-financial help).	0.013	0.032	0	1
	Migration share	It represents the share of household adult members who are currently working abroad.	0.039	0.103	0	0.666
	Migration share for five years	It indicates the share of household adult members who have worked abroad for more than one month during the last 5 years.	0.014	0.062	0	0.666

	Average Education	This variable represents average years of education (secondary and post-secondary) achieved by household members.	10.571	2.807	0	17
	Saving account	It is a household saving account available in banks or other financial institutions.	0.229	0.420	0	1
Social safety Nets - SSN	Money transfers from persons living abroad	It is money received during the last 12 months from abroad sent by household migrant members.	0.177	0.382	0	1
	Number of times receiving money from migrants working abroad	It represents how many times household received a money aid from migrant members in the last 12 months	0.805	2.327	0	12
	Money aid from persons living in Kyrgyzstan (from relatives and friends)	It is the aid received from relatives and friends living in Kyrgyzstan.	0.065	0.247	0	1
	Old age pension	It is a support from the state available for old-aged members of the household.	0.376	0.484	0	1
	Unified monthly allowance	It represents a variable for receiving the allowance as a low-income family.	0.028	0.167	0	1
	Other allowances	It represents other monthly allowances received.	0.003	0.062	0	1

Source: compiled by the authors

Table A1.3 Factorability Analysis

Index	Component	Cumulative variance	
Infrastructure Index			
	1	0.5359	
Bartlett Test			735.535***
KMO			0.583
determinant of R-matrix			0.751
Wealth Index			
	1	0.2628	
	2	0.3474	
	3	0.4023	
	4	0.4572	
	5	0.5015	
	6	0.5450	
	7	0.5822	
Bartlett Test			30779.289***
KMO			0.920
determinant of R-matrix			0.000
Networking Index			
	1	0.6508	
Bartlett Test			8627.654***
KMO			0.785
determinant of R-matrix			0.035
ABS			
	1	0.2267	
	2	0.4410	
	3	0.6023	
Bartlett Test			4359.356***
KMO			0.563
determinant of R-matrix			0.182
AST			
	1	0.3668	
	2	0.5737	
Bartlett Test			1258.371***

KMO			0.628
determinant of R-matrix			0.614
AC			
	1	0.2294	
	2	0.4048	
	3	0.5643	
Bartlett Test			1118.459***
KMO			0.523
determinant of R-matrix			0.645
SSN			
	1	0.2799	
	2	0.4576	
	3	0.6256	
Bartlett Test			1558.949***
KMO			0.505
determinant of R-matrix			0.545
RCI			
	1	0.4314	
	2	0.7303	
Bartlett Test			1998.237***
KMO			0.506
determinant of R-matrix			0.453

Source: compiled by the authors

Table A1.4 Shock summary statistics

N.O	Shock events	Mean	St.Dev.	Min	Max
		Exogenous Shock			
1.	Drought	0.158	0.365	0	1
2.	Cold weather	0.248	0.432	0	1
3.	Flood	0.329	0.470	0	1
4.	Border closure	0.052	0.222	0	1
5.	Neighborhood violence	0.013	0.117	0	1
		Endogenous Shock			
1.	Diseases of crops or livestock	0.163	0.369	0	1
2.	Insufficient water supply for farming or gardening	0.153	0.360	0	1
3.	Insufficient energy supply	0.053	0.225	0	1
4.	Destruction of household assets	0.005	0.076	0	1
5.	Loss of jobs	0.056	0.230	0	1
6.	Death of major breadwinner	0.014	0.120	0	1
7.	Illness of a major breadwinner	0.039	0.195	0	1
8.	Accident	0.015	0.123	0	1

Source: compiled by the authors

Table A1.5 First-stage regression results

	RCI	RCI	RCI
Border distance	-0.123***	-0.126***	-0.124***
	(0.030)	(0.030)	(0.030)
DD_2013	-5.352		
	(8.147)		
FE_2013		0.001**	
		(0.000)	
AFV_2013			-0.000
			(0.001)
Age HH head	0.964***	0.872***	0.963***
	(0.159)	(0.158)	(0.159)
Sq.Age HH head	-0.007***	-0.007***	-0.007***
	(0.001)	(0.001)	(0.001)
Female head	-0.661	-0.068	-0.707
	(1.087)	(1.068)	(1.096)
Head married	-2.140*	-1.688	-2.169*
	(1.109)	(1.090)	(1.115)
HH size	1.057**	0.710	1.051**
	(0.426)	(0.438)	(0.433)
Sq. HH size	-0.040	-0.026	-0.040
	(0.030)	(0.030)	(0.031)
Rural	1.470**	1.906***	1.480**
	(0.692)	(0.705)	(0.695)
Exogenous shock	1.873**	1.857**	1.889**

	(0.793)	(0.786)	(0.795)
Endogenous shock	0.700	0.590	0.671
	(0.947)	(0.934)	(0.948)
Issyk-Kul and the Tian-Shan	-1.712*	-1.337	-1.637
	(1.005)	(0.991)	(1.005)
Fergana Valley	6.745***	6.995***	6.887***
	(0.780)	(0.742)	(0.754)
Constant	-11.946	-15.570***	-16.670***
	(8.555)	(4.481)	(4.583)
Observations	2138	2169	2129

****ρ<0.01, **ρ<0.05, *ρ<0.1. A base class for both exogenous and endogenous shocks is "Low Shock" class. Standard errors in parentheses. The excluded regional dummy is Bishkek and the Northwest*

Source: compiled by the authors

Table A1.6 First-stage regression results (mitigating effect of RCI)

	RCI*Exog. Shock	RCI* Endog. Shock	RCI*Exog. Shock	RCI* Endog. Shock	RCI*Exog. Shock	RCI*Endog. Shock
Border	-0.127***	-0.124***	-0.127***	-0.125***	-0.127***	-0.125***
Distance*Shock	(0.030)	(0.027)	(0.030)	(0.027)	(0.030)	(0.027)
DD_2013	1.091	-5.269				
	(11.451)	(10.374)				
FE_2013			0.001**	0.001**		
			(0.000)	(0.000)		
AFV_2013					-0.000	-0.000
					(0.001)	(0.001)
Age HH head	1.173***	1.103***	1.074***	0.994***	1.181***	1.106***
	(0.223)	(0.202)	(0.222)	(0.201)	(0.224)	(0.203)
Sq.Age HH	-0.009***	-0.009***	-0.008***	-0.008***	-0.009***	-0.009***
head	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Female head	-0.689	-1.045	-0.051	-0.225	-0.707	-1.111
	(1.528)	(1.385)	(1.501)	(1.363)	(1.541)	(1.396)
Head married	-1.853	-2.307	-1.375	-1.698	-1.829	-2.341
	(1.559)	(1.412)	(1.531)	(1.390)	(1.568)	(1.420)
HH size	0.887	0.791	0.465	0.381	0.862	0.757
	(0.599)	(0.543)	(0.616)	(0.559)	(0.609)	(0.551)
Sq. HH size	-0.023	-0.021	-0.007	-0.004	-0.022	-0.019
	(0.043)	(0.039)	(0.043)	(0.039)	(0.043)	(0.039)
Rural	0.946	1.910**	1.438	2.420***	0.949	1.928**
	(0.972)	(0.880)	(0.990)	(0.898)	(0.977)	(0.885)
Exogenous	22.890***	2.582**	22.694***	2.407**	22.897***	2.591**
shock	(1.116)	(1.010)	(1.104)	(1.002)	(1.119)	(1.013)
Endogenous	1.749	21.420***	1.417	21.194***	1.733	21.392***
shock	(1.331)	(1.209)	(1.313)	(1.195)	(1.334)	(1.211)
Issyk-Kul and	-3.613**	-1.998	-3.215**	-1.481	-3.589**	-1.905
the Tian-Shan	(1.411)	(1.279)	(1.313)	(1.263)	(1.412)	(1.279)
Fergana Valley	7.822***	7.666***	8.007***	8.025***	7.800***	7.802***
	(1.095)	(0.992)	(1.042)	(0.947)	(1.060)	(0.960)
Constant	-23.667**	-15.816	-21.444***	-19.349***	-22.686***	-20.219***
	(12.024)	(10.892)	(6.293)	(5.715)	(6.441)	(5.835)
Observations	2138	2138	2169	2169	2129	2129

****ρ<0.01, **ρ<0.05, *ρ<0.1. A base class for both exogenous and endogenous shocks is "Low Shock" class. Standard errors in parentheses. The excluded regional dummy is Bishkek and the Northwest;* Source: compiled by the authors

Table A1.7 First stage regression results

	RCI	**RCI**	**RCI**
Border distance	-0.114***	-0.118***	-0.117***
	(0.029)	(0.029)	(0.029)
DD_2013	-8.410		
	(7.462)		
FE_2013		0.000	
		(0.000)	
AFV_2013			-0.000
			(0.001)
Age HH head	0.848***	0.828***	0.843***
	(0.130)	(0.130)	(0.130)
Sq.Age HH head	-0.007***	-0.007***	-0.007***
	(0.001)	(0.001)	(0.001)
Female head	1.133	1.098	1.067
	(0.981)	(0.980)	(0.983)
Head married	0.007	-0.115	-0.077
	(1.003)	(1.001)	(1.002)
HH size	0.624	0.447	0.612
	(0.419)	(0.441)	(0.425)
Sq. HH size	0.002	0.008	0.004
	(0.032)	(0.032)	(0.032)
Rural	2.022***	2.296***	2.051***
	(0.642)	(0.666)	(0.642)
Exogenous shock	-1.594**	-1.472**	-1.508**
	(0.679)	(0.674)	(0.675)
Endogenous shock	-0.621	-0.567	-0.584
	(0.928)	(0.928)	(0.929)
Issyk-Kul and the	-0.989	-0.865	-0.904
Tian-Shan	(0.943)	(0.942)	(0.943)
Fergana Valley	7.275***	7.521***	7.465***
	(0.710)	(0.690)	(0.690)
Constant	-5.443	-13.035***	-12.748***
	(7.605)	(3.615)	(3.673)
Observations	2476	2476	2475
R-squared	0.136	0.136	0.135

***$\rho<0.01$, **$\rho<0.05$, *$\rho<0.1$. A base class for both exogenous and endogenous shocks is "Low Shock" class. Standard errors in parentheses. The excluded regional dummy is Bishkek and the Northwest

Source: compiled by the authors

Table A1.8 2SLS model of food security outcomes

	Diet Diversity (DD)	Food Expenditure (FE)	Adeq.Fruits and Vegetables (AFV)
RCI	0.001***	20.098**	6.519***
	(0.000)	(9.424)	(2.333)
DD_2013	-0.006		
	(0.038)		
FE_2013		0.307***	
		(0.032)	
AFV_2013			0.033
			(0.023)
Age HH head	0.000	-1.168	7.469**
	(0.000)	(13.809)	(3.321)
Sq.Age HH head	-0.000	0.037	-0.058**
	(0.000)	(0.129)	(0.029)
Female head	0.006	-52.797	1.620
	(0.005)	(65.587)	(17.486)
Head married	0.010**	105.658	9.708
	(0.005)	(63.290)	(19.542)
HH size	0.003*	177.133***	-116.306***
	(0.001)	(28.291)	(8.954)
Sq. HH size	-0.000**	-10.227***	4.846***
	(0.000)	(2.064)	(0.550)
Rural	-0.010***	-431.842***	-12.704
	(0.003)	(54.120)	(13.973)
Exogenous shock	0.004	-54.460	21.113
	(0.002)	(47.922)	(12.997)
Endogenous shock	0.014***	204.701**	60.239***
	(0.003)	(85.400)	(19.887)
Issyk-Kul and the Tian-Shan	-0.023***	-437.397***	-48.692***
	(0.004)	(58.310)	(17.138)
Fergana Valley	-0.021***	-236.847***	21.418
	(0.005)	(92.549)	(20.650)
Constant	0.848***	938.127***	463.147***
	(0.038)	(304.970)	(82.457)
Observations	2183	2215	2174

R-squared	0.043	0.192	0.232

****ρ<0.01, **ρ<0.05, *ρ<0.1. A base class for both exogenous and endogenous shocks is "Low Shock" class. Standard errors in parentheses. The excluded regional dummy is Bishkek and the Northwest*

Source: compiled by the authors

Table A1.9 Marginal effects of IV Probit model of food security loss

	Diet Diversity (DD)	Food Expenditure (FE)	Adeq.Fruits and Vegetables (AFV)
RCI	-0.049**	0.030	-0.053*
	(0.024)	(0.032)	(0.031)
DD_2013 loss	-1.292***		
	(0.115)		
FE_2013 loss		-1.137***	
		(0.138)	
AFV_2013 loss			-1.254***
			(0.119)
Age HH head	0.048	-0.006	-0.008
	(0.034)	(0.038)	(0.038)
Sq.Age HH head	-0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)
Female head	-0.138	-0.127	-0.085
	(0.192)	(0.207)	(0.163)
Head married	-0.216	-0.191	-0.141
	(0.186)	(0.206)	(0.183)
HH size	-0.114	0.105	0.235***
	(0.071)	(0.073)	(0.069)
Sq. HH size	0.007	-0.000	-0.002
	(0.005)	(0.004)	(0.004)
Rural	0.153	0.071	0.468***
	(0.133)	(0.134)	(0.130)
Exogenous shock	-0.156	-0.389***	-0.277**
	(0.107)	(0.133)	(0.122)
Endogenous shock	-0.590***	-0.104	-0.122
	(0.140)	(0.164)	(0.145)
Issyk-Kul and the	0.070	0.662***	0.181
Tian-Shan	(0.177)	(0.156)	(0.178)
Fergana Valley	-0.096	-0.085	-0.287
	(0.207)	(0.274)	(0.252)
Constant	-0.431	-1.189	1.562*
	(0.723)	(0.922)	(0.851)
Observations	2122	2122	2113

Pseudo R-squared	0.090	0.028	0.093

****ρ<0.01, **ρ<0.05, *ρ<0.1. A base class for both exogenous and endogenous shocks is "Low Shock" class. Standard errors in parentheses. The excluded regional dummy is Bishkek and the Northwest*

Source: compiled by the authors

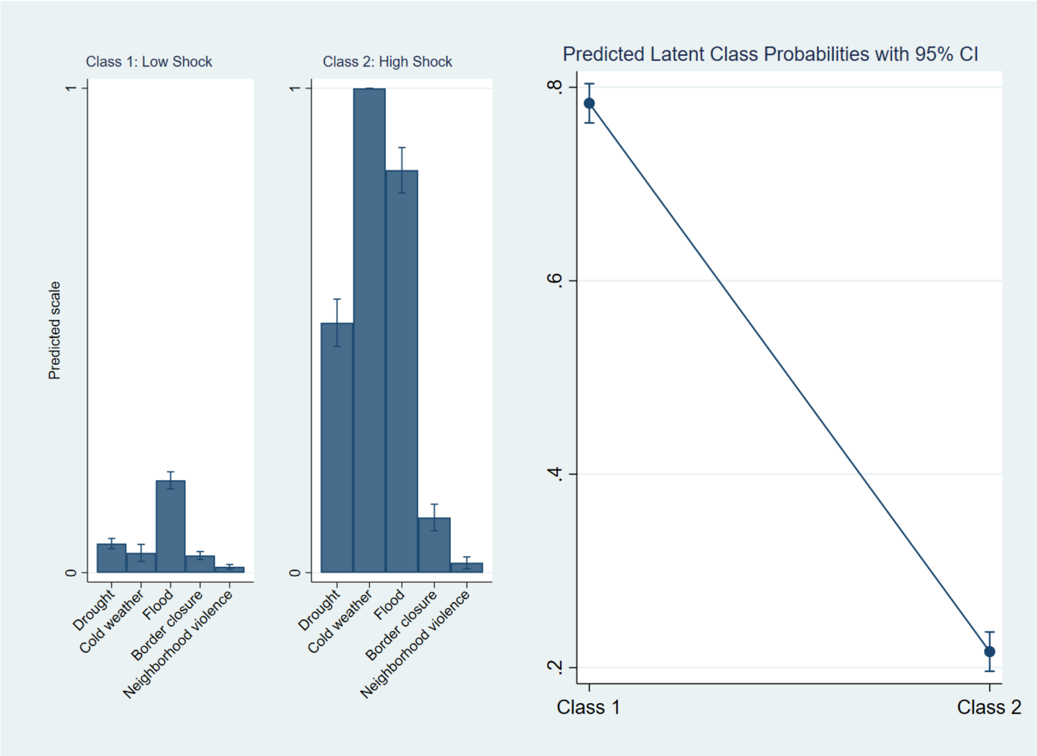

Figure A1.1 Exogenous Shock

Source: compiled by the authors

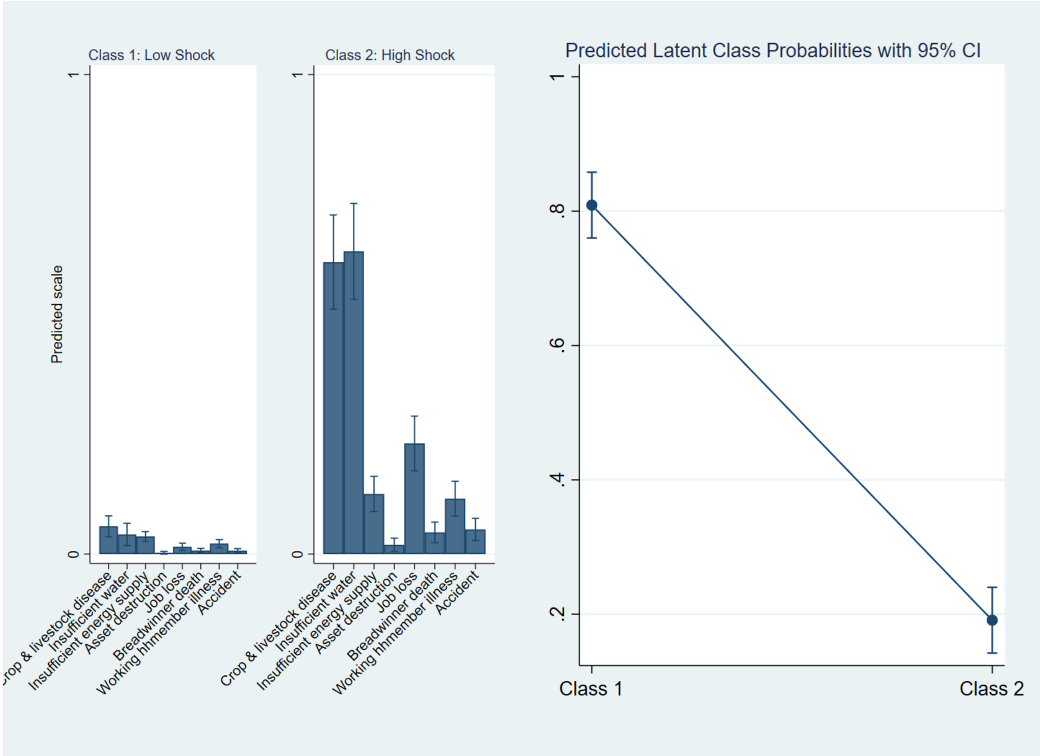

Figure A1.2 Endogenous Shock

Source: compiled by the authors

Table A1.10 SEM (Unstandardized and Standardized Coefficients)

	Unstandardized Estimates	**Standardized Estimates**
AC	1	0.947***
		(0.080)
AST	0.050**	0.057***
	(0.020)	(0.021)
SSN	1.637***	0.764***
	(0.280)	(0.065)
ABS	-0.092***	-0.079***
	(0.027)	(0.021)

****ρ<0.01, **ρ<0.05, *ρ<0.1.*

Source: compiled by the authors

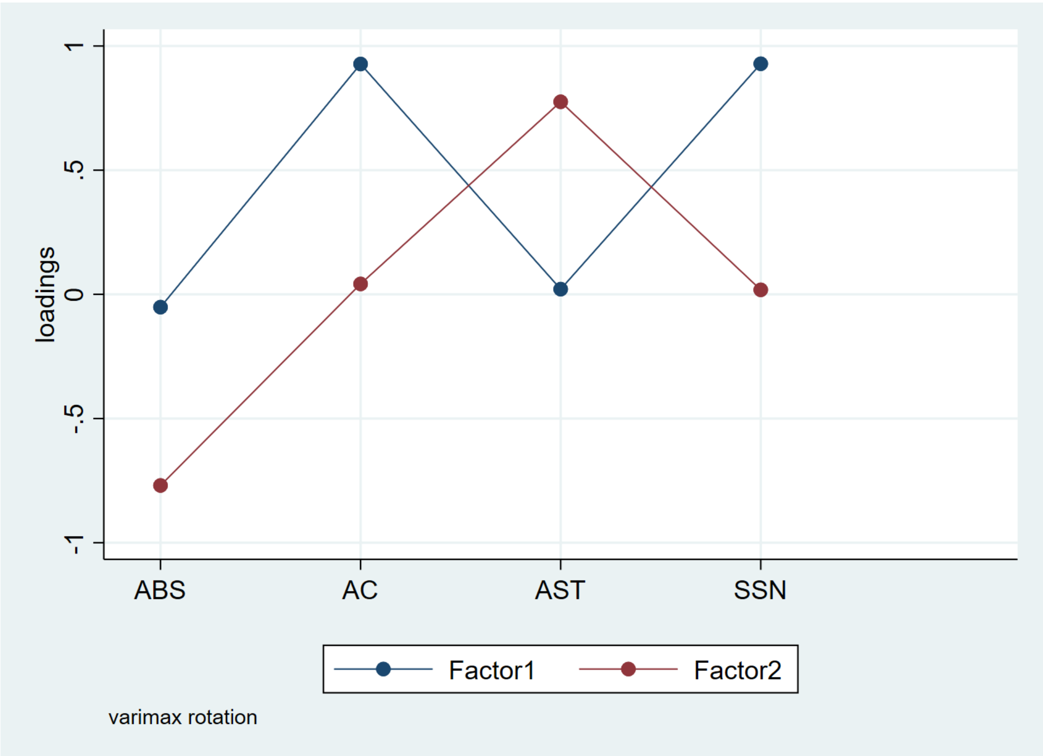

Figure A1.3 Factor loadings of RCI

Source: compiled by the authors

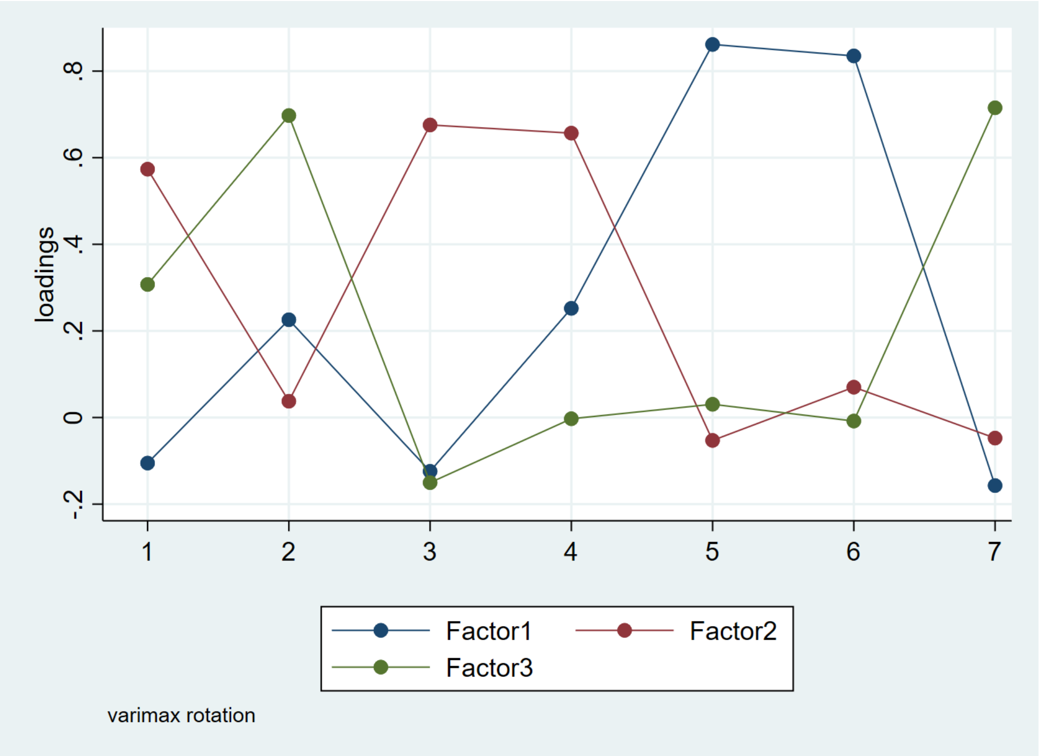

Figure A1.4 Factor loadings of AC

(Notes: 1 – Income source; 2 – Income earner share; 3 – Informal Networking Index; 4 – Saving account; 5 – Migration share; 6 – Migration share for five years; 7 – Average Education)

Source: compiled by the authors

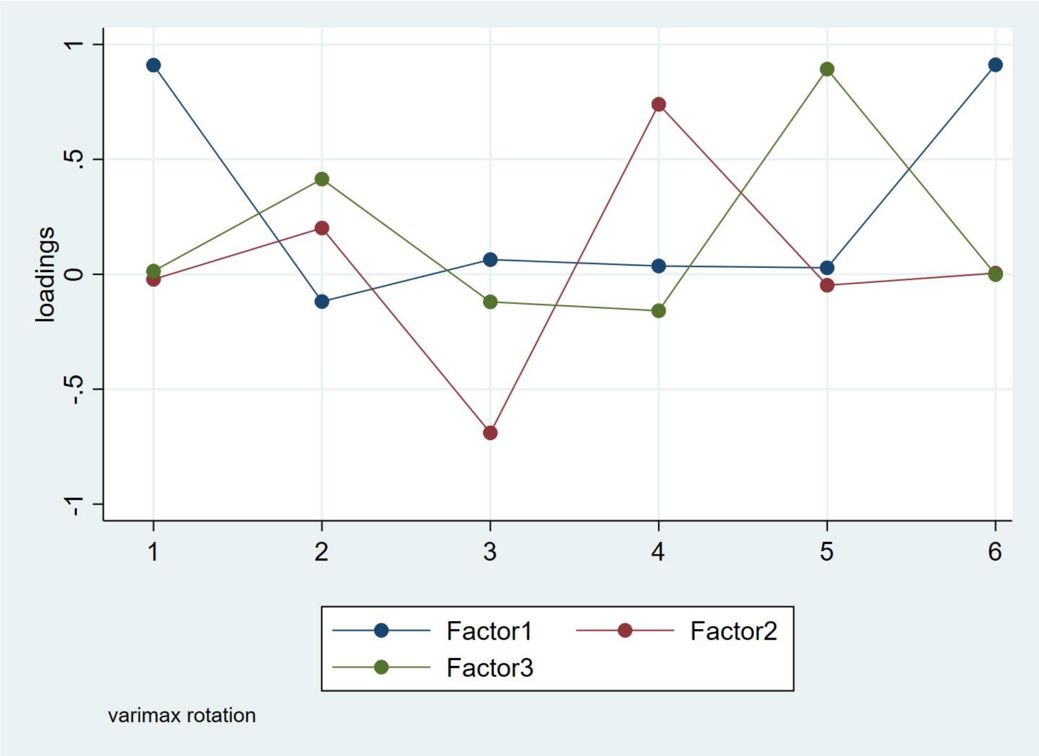

Figure A1.5 Factor loadings of SSN

(Notes: 1- Money transfers from persons living abroad; 2-Money aid from persons living in Kyrgyzstan (from relatives and friends); 3-Old age pension; 4-Unified monthly allowance; 5-Other allowances; and 6- Number of times receiving money from migrants working abroad)

Source: compiled by the authors

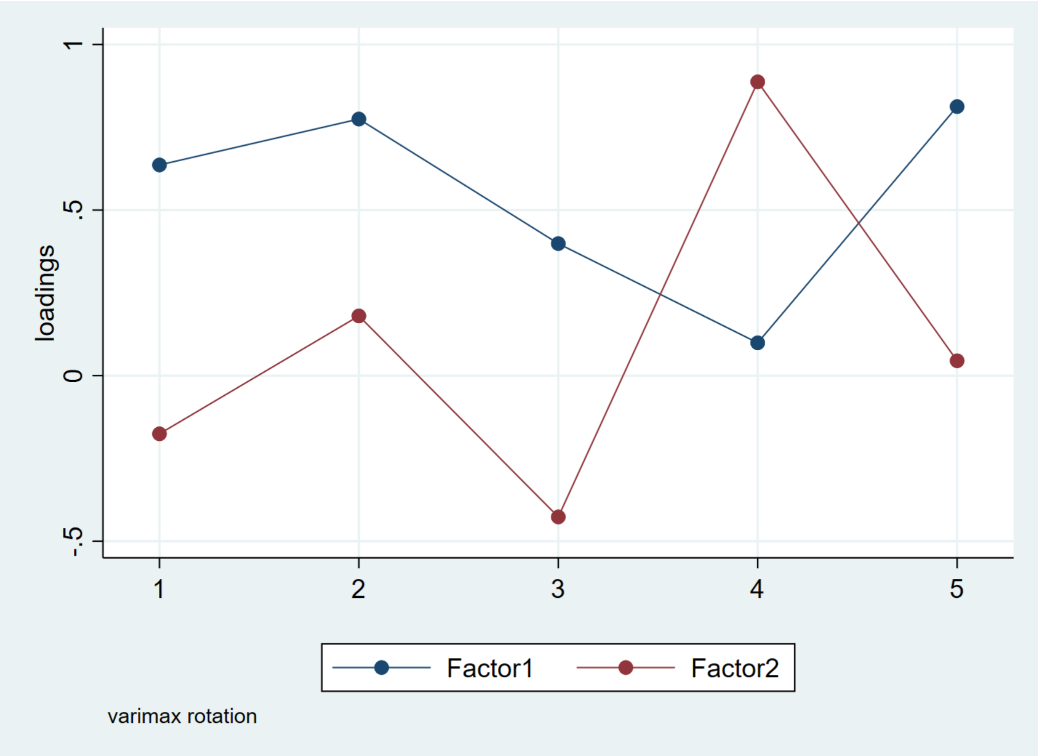

Figure A1.6 Factor loadings of AST

(Notes: 1- TLU per capita; 2– Number of plots and parcels per capita; 3- Agricultural assets and vehicles per capita; 4-Wealth index per capita; 5- Per capita land (ha))

Source: compiled by the authors

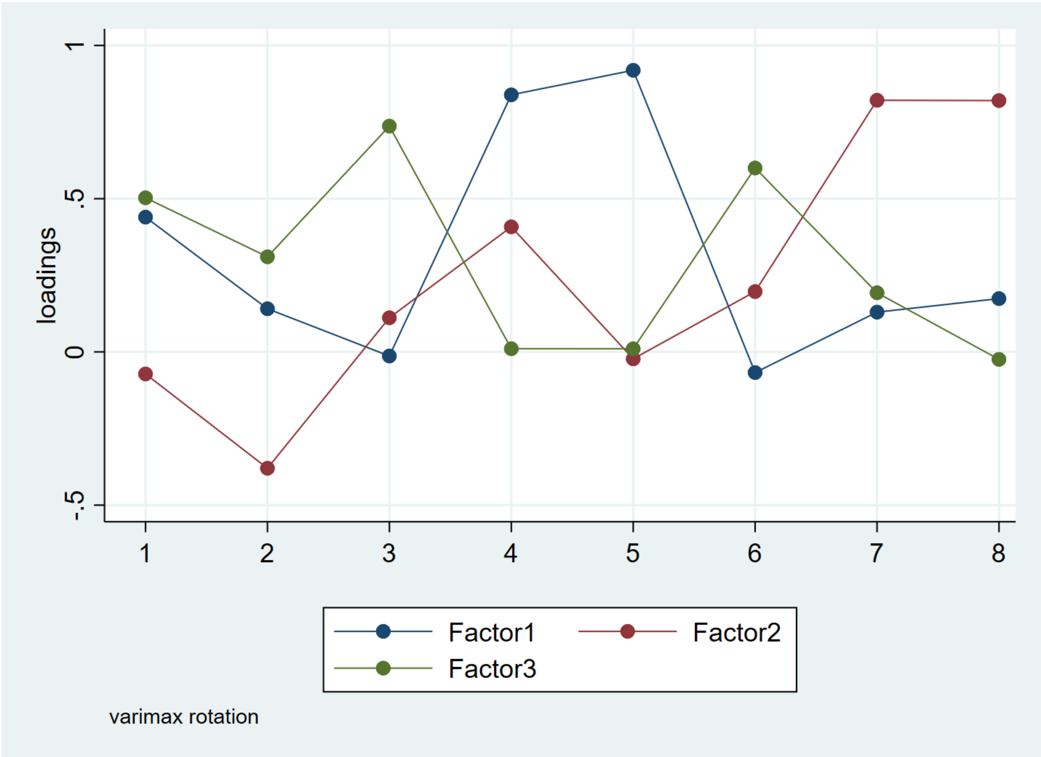

Figure A1.7 Factor loadings of ABS

(Notes: 1 – Infrastructure index; 2 – Doctor consultation; 3 – Distance to main road; 4 – Distance to next agricultural and livestock market; 5 – Distance to the community center; 6 – Distance to school; 7 – Distance to hospital; 8 – Distance to pharmacy)

Source: compiled by the authors

Appendix 2: Social Capital Effects on Resilience to Food Insecurity: Evidence from Kyrgyzstan

Table A2.1 Summary statistics of the variables used in the estimates

Pillar	Variable	Mean	St.Dev	Min	Max
ABS					
	Improved drinking water	0.861	0.345	0	1
	(Dummy variable is equal to 1 for public and pip water types available in the household; otherwise it is for artesian, dam, lake, river, aryk-small aqueduct and pounder water sources).				
	Improved heating	0.269	0.443	0	1
	(Dummy variable is equal to 1 for central and electric installed heating; otherwise it is for stove, transportable electric, gas and other types of heating).				
	Improved cooking source	0.521	0.499	0	1
	(Dummy variable is equal to 1 for stove with pipe supply, balloons, electric stove and small electric plat; otherwise, it is for tandyr - tandoor and others).				
	Next main road (in kilometers)	0.559	0.779	0	7
	Next livestock market (in kilometers)	5.670	8.938	0	45
	Next school (in kilometers)	0.984	1.587	0	45
	Next hospital (in kilometers)	4.036	7.427	0	48

IFA

Diet diversity index (Simpson index is based on more than 30 types of food diversities).	0.873	0.062	0.262	0.95 9
Food expenditure (It is total household spendings in Kyrgyz So'm - KGS on more than 30 items of food bought over the last 12 months).	105862.9	55359.6 5	0	8933 64.6
Adequacy of fruits and vegetable (The score was constructed through summing the total weight in grams of fruit and vegetable consumption by the household. 400 grams/capita/day is recommended as an adequate consumption of fruit and vegetables).	391.4243	313.849 5	11.7739 4	3892 .857
Income from agriculture	.4036624	.490729	0	1
The number of pension types received for the last 12 months *(old-age pensions in Kyrgyzstan; old-age pensions in other countries; disability pensions; pensions on favorable terms of for special working conditions; and survivor's pension)*	.7846338	.843011 2	0	4
The number of allowance types received for the last 12 months (*unified monthly allowance to low-income families and individuals in cash; unified monthly allowance to low-income families and individuals in goods; insurance benefits; and other types of allowances)*	.5816083	.513951 2	0	2
The number of benefit types received for the last 12 months *(trips to resort, sanatoriums, summer camps, etc;*	.1779459	4106595	0	3

	medicaments; health care including dental care; child care including child education; and other types of benefits)				
	Remittance	.1039937	.3053127	0	1
APT					
	Livestock production	0.458	0.498	0	1
	Crop production	0.716	0.450	0	1
	Plot numbers	1.147	0.884	0	5
	Harvest (It is a harvest quantity in kg over the last 12 months).	3567.958	11644.72	0	211600
	Own seed	0.789	0.407	0	1
	Hiring labour in agriculture	0.078	0.268	0	1
	Plantation area (The area is in ha used for the cultivation over the last 12 months).	0.517	2.400	0	77
AC					
	Wealth Index (The index was created through PCA for assets owned by the household over the last 12 months).	0.837	0.154	0	1
	Tropical Livestock Unit (TLU) (TLU was created through the conversation weights: 0.8 cows/horses; 0.5 donkeys; 0.2 pigs; 0.1 sheep; 0.02 rabbits; and 0.01 chicken).	0.783	2.107	0	56.05
	Weather Information	0.555	0.497	0	1

	Extension Service (The score was measured by PCA for 11 types of extension services received by the household over the last 12 months).	0.288	0.118	0	1
	Informal Networking Index (The index was constructed through PCA from corresponding variables representing both financial and non-financial aids over the last 12 months: 1. The number of people are able to give 2000 KGS urgently; 2. To how many people household gave any financial helps; 3. From how many people household received any financial helps; 4. To how many people household gave any non-financial help; and 5. From how many people household received any non-financial help).	0.013	0.029	0	1
	Average household education (It is average number of education in years achieved by HH members).	7.900	4.248	0	54
	Household Stability (The index was created through PCA for variables representing subjective shocks experienced by the household during the last 12 months. Shock variables were rescaled assuming value 1 is for not experiencing shock)	0.631	0.220	0	1
Control					
	Head age	53.977	13.451	21	90
	Head female	0.280	0.449	0	1

Head married	0.694	0.460	0	1
Head education	10.324	3.735	0	19
Household size	5.253	2.537	1	17
Community Stability	0.716	0.165	0	1
(The index was created through PCA for variables representing subjective shocks experienced by the household during the last 12 months. Shock variables were rescaled assuming value 1 is for not experiencing shock)				

Source: compiled by the author

Table A2.2 Factorability analysis (IFA, ABS, APT, AC, RCI, Trust, and Group Membership)

Index	Component	Cumulative Variance	
IFA (Income and Food Access)			
	1	0.227	
	2	0.410	
	3	0.550	
Bartlett's Test of Sphericity (p-value)			< 0001
KMO			0.540
determinant of R-matrix			0.340
Access to Basic Services (ABS)			
	1	0.2545	
	2	0.4741	
	3	0.6348	
Bartlett's Test of Sphericity (p-value)			< 0001
KMO			0.546
determinant of R-matrix			0.316

APT (Agricultural Practices and Technologies)			
	1	0.340	
	2	0.557	
Bartlett's Test of Sphericity (p-value)			< 0001
KMO			0.690
determinant of R-matrix			0.150
Adaptive Capacity (AC)			
	1	0.220	
	2	0.382	
Bartlett's Test of Sphericity (p-value)			< 0001
KMO			0.585
determinant of R-matrix			0.810
Resilience Capacity Index (RCI)			
	1	0.340	
	2	0.561	

Bartlett’s Test of Sphericity (p-value)			< 0001
KMO			0.703
determinant of R-matrix			0.357
Trust			
	1	0.3650	
	2	0.6184	
Bartlett’s Test of Sphericity (p-value)			< 0001
KMO			0.725
determinant of R-matrix			0.321
Group Membership			
	1	0.1232	
	2	0.2214	
	3	0.3141	
	4	0.4066	
	5	0.4957	
Bartlett’s Test of Sphericity (p-value)			< 0001
KMO			0.613

determinant of R-matrix	0.774

Source: compiled by the author

Table A2.3 Trust and Group Membership Statements

Trust	
1	In general, you can trust people.
2	Nowadays, you cannot rely on anybody.
3	Most people who live in this community can be trusted.
4	In this community, you have to be cautious, otherwise someone is likely to take advantage of you.
5	Most people in this community are willing to help if you need it
6	In this community, people generally trust each other in matters of lending and borrowing money.
Membership	
1	Professional union or work-related group
2	Neighborhood/ village committee
3	Religious or spiritual group
4	Political party
5	Sherine
6	Cultural club or association
7	Festival society (yntymak)
8	Credit or savings group (credit union/chernaya kassa)
9	Sports group
10	NGO or civic group
11	Local self-defense unit
12	Other

Source: compiled by the author

Table A2.4 Summary statistics of shocks for Household and Community Stability Index

Household Stability				
Variable	**Mean**	**St.Dev**	**Min**	**Max**
Too much rain or flood	0.670	0.470	0	1
Very cold winter	0.751	0.432	0	1
Frosts	0.769	0.421	0	1
Landslides	0.906	0.290	0	1
Pest or diseases (crops or livestock)	0.836	0.369	0	1
Fire	0.976	0.150	0	1
Insufficient water supply for farming or gardening	0.846	0.360	0	1
Political riots	0.946	0.225	0	1
Theft of assets (cash, crops, livestock)	0.991	0.093	0	1
Destruction of assets (housing, car)	0.994	0.076	0	1
Inability to sell agricultural and other products	0.924	0.263	0	1
Loss of job	0.943	0.230	0	1
Sharp fall of remittances from abroad	0.957	0.200	0	1
Death of a major breadwinner	0.985	0.120	0	1
Death of other HH member	0.974	0.157	0	1
Death of close relative, non-member of HH	0.938	0.239	0	1
Illness of a major breadwinner	0.960	0.195	0	1
Illness of other HH member	0.960	0.195	0	1
Divorce	0.984	0.121	0	1
Disputes on land issues	0.985	0.120	0	1
Accident	0.984	0.123	0	1
Insufficient energy supply	0.946	0.225	0	1
Increased violence in the neighborhood	0.986	0.117	0	1
Border closure for people and goods	0.947	0.222	0	1
Displacement	0.997	0.052	0	1
Community Stability				
Variable	**Mean**	**St.Dev**	**Min**	**Max**
Drought	0.811	0.390	0	1
Too much rain or flood	0.580	0.493	0	1
Very cold winter	0.779	0.414	0	1
Frost	0.786	0.409	0	1
Earthquake	0.965	0.183	0	1

Landslides	0.952	0.212	0	1
Pest or diseases (crops or livestock)	0.790	0.407	0	1
Fire	0.762	0.425	0	1
Insufficient water supply for farming	0.960	0.195	0	1
Political riots	0.915	0.278	0	1
Theft of assets (cash, livestock)	0.877	0.328	0	1
Destruction of property (housing, car)	0.918	0.274	0	1
Inability to sell agricultural and other products	0.961	0.193	0	1
Debates on land issues	0.898	0.301	0	1

Note: Shock variables were rescaled assuming value 1 is for not experiencing shock

Source: compiled by the author

Table A2.5 First-stage regression results

	Trust	Group Membership
The existence of mosques/churches	0.036***	
	(0.010)	
The number of groups in the community		0.037***
		(0.000)
Head age	-0.000	0.000
	(0.000)	(0.000)
Head female	0.009	-0.000
	(0.015)	(0.003)
Head married	0.009	0.004
	(0.015)	(0.003)
Head education	-0.002*	0.001***
	(0.001)	(0.000)
Household size	0.003**	0.000
	(0.001)	(0.000)
Community stability index	-0.192***	-0.005
	(0.025)	(0.006)
Issyk-Kul and the Tian Shan	0.016	0.014***
	(0.013)	(0.003)
Ferghana Valley	0.096	-0.000
	(0.010)	(0.002)
Constant	0.707***	0.125***
	(0.038)	(0.009)

Observations	1785	2162
R-squared	0.120	0.043
Cragg-Donald F Stat.	11.846	34.426
Sanderson-Windmeijer F Sta.	14.930	20.790

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

The excluded regional dummy is Bishkek and the Northwest.

Source: compiled by the author

Table A2.6 Impact of trust and group membership on IFA and ABS: IV-SEM and 2SLS second-stage results

	Income & Food Access (IFA)			Access to Basic Services (ABS)		
	(1)	(2)	(3)	(4)	(5)	(6)
	IV-SEM	2SLS Bootstrap	2SLS	IV-SEM	2SLS Bootstrap	2SLS
Trust	1.359**	1.198***	1.146**	0.541*	0.666***	0.423
	(0.532)	(0.282)	(0.474)	(0.298)	(0.188)	(0.377)
Group membership	1.525*	1.610**	3.436***	-4.491***	-4.626***	-3.724***
	(0.833)	(0.787)	(1.289)	(1.053)	(0.561)	(1.061)
Head age	0.000	0.000**	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Head female	-0.068**	-0.069***	-0.064**	-0.054**	-0.055****	-0.053**
	(0.029)	(0.014)	(0.029)	(0.026)	(0.011)	(0.023)
Head married	-0.019	-0.026***	-0.028	-0.004	-0.014	-0.008
	(0.029)	(0.014)	(0.030)	(0.026)	(0.012)	(0.024)
Head education	-0.004	-0.003*	-0.007**	0.006**	0.006***	0.004*
	(0.003)	(0.002)	(0.003)	(0.003)	(0.001)	(0.002)
Household size	0.016***	0.016***	0.016***	0.005	0.003**	0.005
	(0.004)	(0.002)	(0.004)	(0.003)	(0.001)	(0.003)
Community stability index	0.139	0.123*	0.112	-0.001	0.037	-0.019
	(0.118)	(0.066)	(0.113)	(0.073)	(0.043)	(0.089)
Issyk-Kul and the Tian Shan	0.003	0.031	-0.029	0.157***	0.166***	0.145***
	(0.031)	(0.024)	(0.041)	(0.031)	(0.020)	(0.033)

Ferghana Valley	-0.048	-0.008	-0.029	-0.045	-0.040	-0.035
	(0.053)	(0.029)	(0.048)	(0.031)	(0.016)	(0.037)
Constant	-0.859**	-0.797***	-0.955***	0.392	0.315**	0.379
	(0.402)	(0.206)	(0.456)	(0.258)	(0.129)	(0.369)
Observations	1782	2218	1782	1814	2259	1814
R squared		0.213			0.077	
Chi-square	15.073			16.150		
p-value	0.002			0.001		
RMSEA	0.048			0.049		
CFI	0.982			0.971		
SRMR	0.009			0.010		

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

The excluded regional dummy is Bishkek and the Northwest.

Source: compiled by the author

Table A2.7 Impact of trust and group membership on APT and AC: IV-SEM and 2SLS second-stage results

	Agricultural Practices and Technologies (APT)			Adaptive Capacity (AC)		
	(1)	(2)	(3)	(4)	(5)	(6)
	IV-SEM	2SLS Bootstrap	2SLS	IV-SEM	2SLS Bootstrap	2SLS
Trust	1.222**	1.028***	1.038**	0.529***	0.475***	0.443**
	(0.486)	(0.310)	(0.466)	(0.198)	(0.105)	(0.187)
Group membership	2.362***	3.116***	4.196***	0.886***	0.898***	1.696***
	(0.904)	(0.832)	(1.344)	(0.319)	(0.294)	(0.530)
Head age	0.001*	0.001***	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Head female	-0.046	-0.057***	-0.042	-0.007	-0.006	-0.005
	(0.028)	(0.018)	(0.029)	(0.011)	(0.005)	(0.011)
Head married	-0.003	-0.013	-0.012	0.013	0.012**	0.009
	(0.028)	(0.018)	(0.030)	(0.011)	(0.005)	(0.012)
Head education	-0.009***	-0.009***	-0.012***	-0.003***	-0.003***	-0.004***
	(0.003)	(0.001)	(0.003)	(0.001)	(0.000)	(0.001)
Household size	0.010***	0.011***	0.010**	0.005***	0.005***	0.005***
	(0.003)	(0.002)	(0.004)	(0.001)	(0.000)	(0.001)
Community stability index	0.085	0.049	0.062	0.109**	0.106***	0.098**
	(0.108)	(0.065)	(0.110)	(0.044)	(0.025)	(0.044)

Issyk-Kul and the Tian Shan	0.111***	0.123***	0.079*	0.065***	0.074****	0.051***
	(0.031)	(0.021)	(0.041)	(0.012)	(0.009)	(0.016)
Ferghana Valley	0.063	0.102***	0.078*	-0.012	0.000	-0.005
	(0.047)	(0.032)	(0.046)	(0.019)	(0.011)	(0.018)
Constant	-0.847**	-0.828***	-0.954**	-0.306**	-0.280***	-0.349*
	(0.371)	(0.234)	(0.458)	(0.152)	(0.080)	(0.184)
Observations	1821	2269	1821	1813	2257	1813
R squared		0.317			0.277	
Chi-square	16.579			16.094		
p-value	0.001			0.001		
RMSEA	0.050			0.049		
CFI	0.984			0.984		
SRMR	0.010			0.010		

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

The excluded regional dummy is Bishkek and the Northwest.

Source: compiled by the author

Table A2.8 Impact of trust and group membership on APT and AC: IV-SEM and 2SLS second-stage results

	RCI		
	(1)	(2)	(3)
	IV-SEM	2SLS Bootstrp	2SLS
Trust	1.026***	0.878***	0.862***
	(0.356)	(0.156)	(0.315)
Group membership	0.965**	1.157***	2.372***
	(0.459)	(0.389)	(0.841)
Head age	0.000	0.000***	0.000
	(0.000)	(0.000)	(0.000)
Head female	-0.036*	-0.035***	-0.033*
	(0.019)	(0.008)	(0.019)
Head married	0.002	-0.000	-0.003
	(0.019)	(0.007)	(0.020)
Head education	-0.004*	-0.004***	-0.006***
	(0.002)	(0.001)	(0.002)
Household size	0.009***	0.009***	0.009***
	(0.002)	(0.001)	(0.002)
Community stability index	0.139*	0.116***	0.117
	(0.079)	(0.037)	(0.074)
Issyk-Kul and the Tian Shan	0.080***	0.097***	0.056**
	(0.020)	(0.012)	(0.027)
Ferghana Valley	-0.016	0.015	-0.002
	(0.035)	(0.016)	(0.032)

Constant	-0.593**	-0.533***	-0.659**
	(0.270)	(0.125)	(0.300)
R squared		0.352	
Observations	1777	2210	1777
Chi-square	14.622		
p-value	0.002		
RMSEA	0.047		
CFI	0.988		
SRMR	0.009		

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

The excluded regional dummy is Bishkek and the Northwest.

Source: compiled by the author

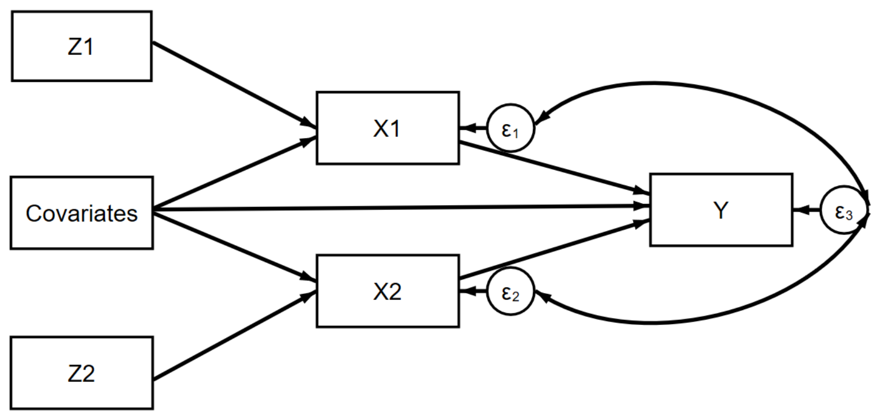

Figure A2.1 SEM-IV Modelling

Note: Z1 (existence of mosques/churches in the community) and Z2 (number of groups in the community) are instrumental variables for X1 (trust) and X2 (group membership) endogenous variables respectively. Y is pillar (IFA, ABS, APT, and AC) or RCI. Covariates include head age, head female, head married, head education, household size, community stability index, Issyk-Kul and the Tian Shan region, Ferghana Valley region, and Bishkek and the Northwest. The random disturbances or errors are included in the model. Their relationships are also considered in SEM model.

Source: compiled by the author

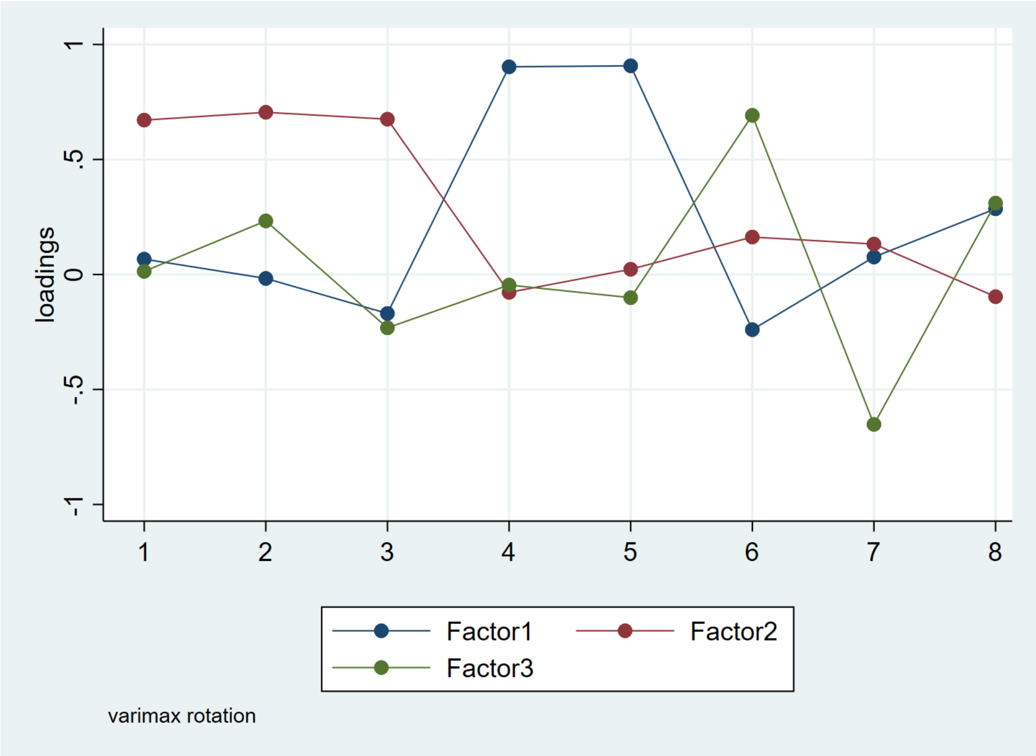

Figure A2.2 IFA

Note: 1-Diet diversity (Simpson index); 2-Food expenditure; 3-Adequacy of fruit and vegetable; 4-Income from agriculture; 5-Pensions; 6-Allowances; 7-Benefits; and 8-Remmitance

Source: compiled by the author

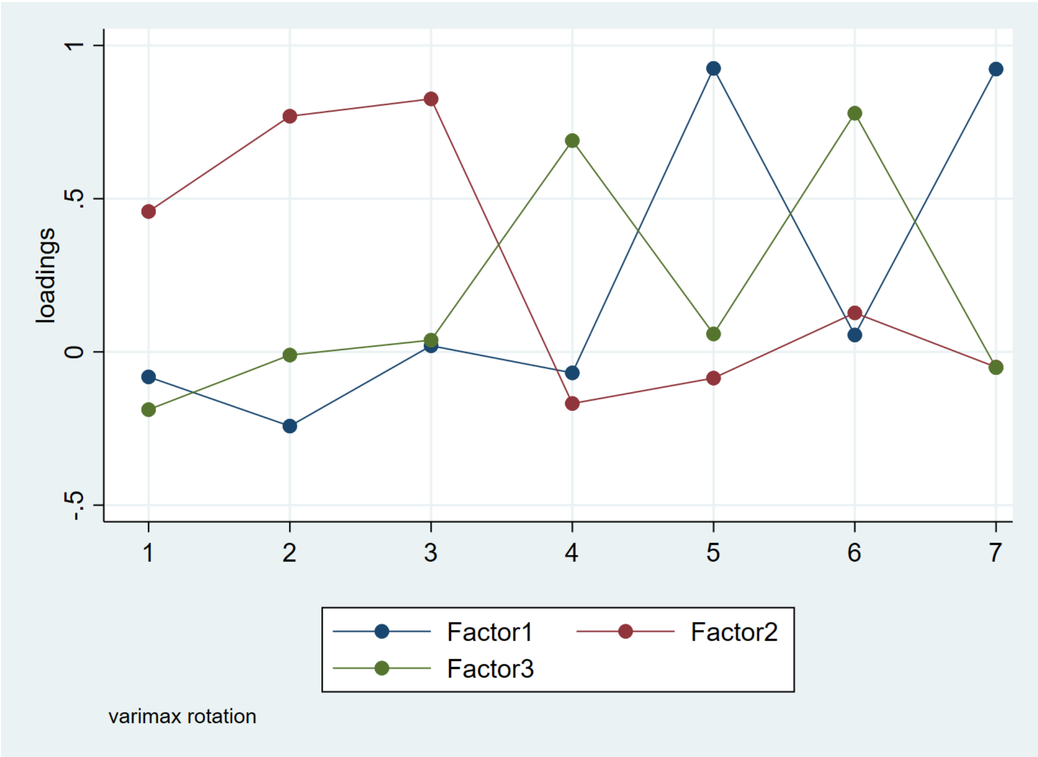

Figure A2.3 ABS

Note: 1-Improved drinking water; 2-Improved heating; 3-Improved cooking source; 4-Next main road; 5-Next livestock market; 6-Next school; and 7-Next hospital

Source: compiled by the author

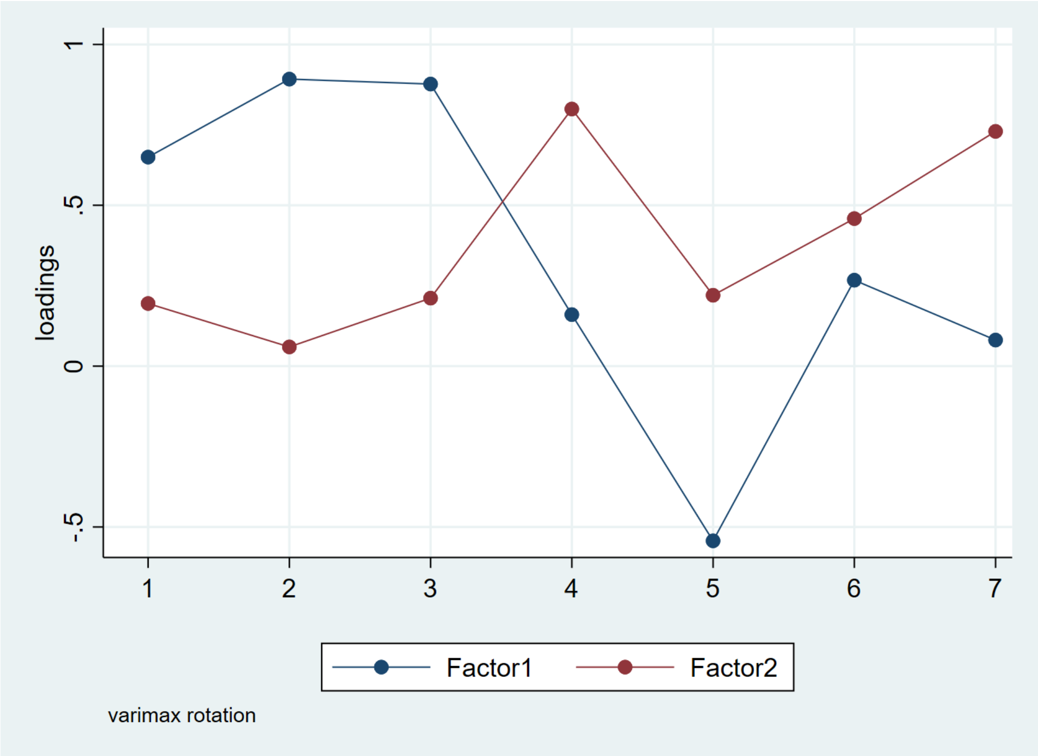

Figure A2.4 APT

Note: 1-Livestock production; 2-Crop production; 3-Plot numbers; 4-Harvest; 5-Own seed; 6-Labour; and 7-Plantation area

Source: compiled by the author

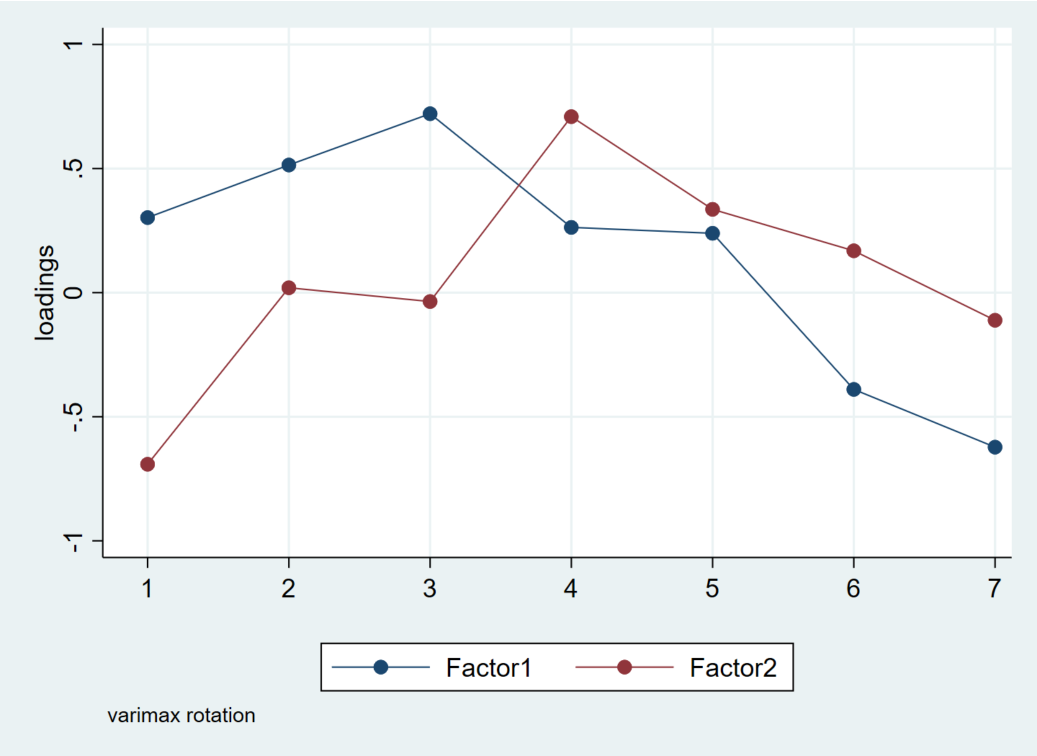

Figure A2.5 AC

Note: 1-Wealth index; 2- TLU; 3-Weather information; 4-Extension service; 5-Informal networking index; 6-Education; and 7-Household Stability Index

Source: compiled by the author

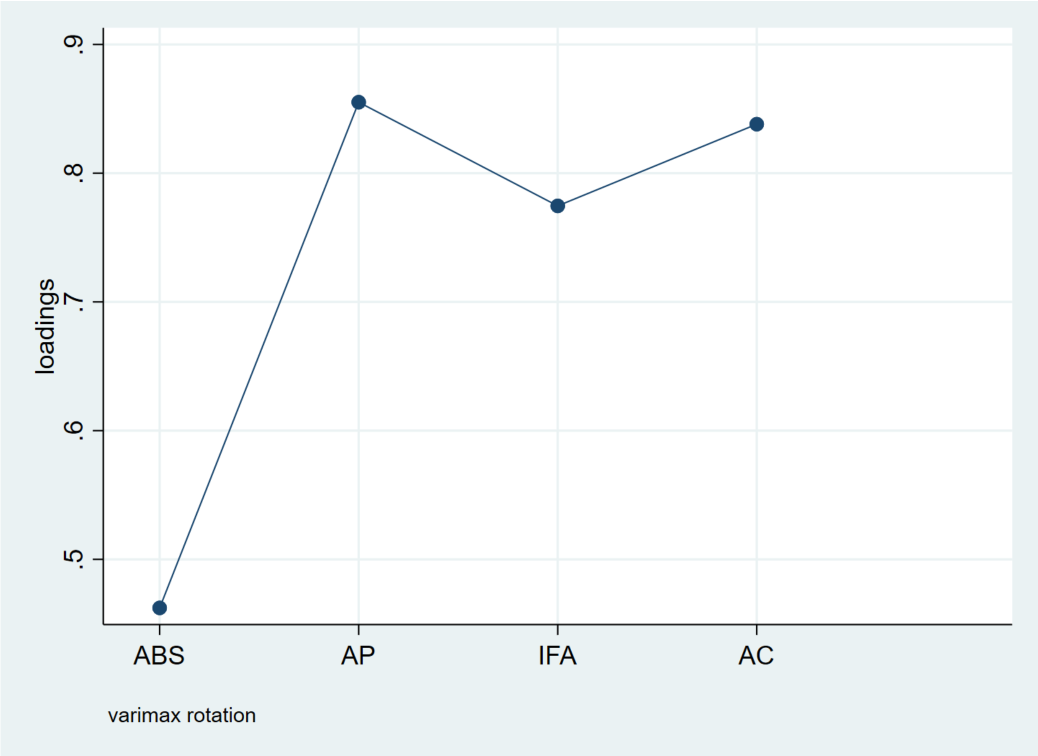

Figure A2.6 RCI

Source: compiled by the author

Appendix 3: Household Resilience and Coping Strategies to Food Insecurity: An Empirical Analysis from Tajikistan

Table A3.1 Descriptive Statistics of RCI Pillars

Pillar	Variable	Mean	St.Dev	Min	Max
Access to Basic Services (ABS)					
	Central heating	0.122	0.327	0	1
	Electricity heating	0.314	0.464	0	1
	Gas	0.324	0.468	0	1
	Improved water source	0.538	0.498	0	1
Assets (AST)					
	Wealth Index per capita from non-productive assets (based on factor analysis)	0.233	0.161	0	1
	Monthly per capita non-food consumption in nominal value	59.919	119.129	0	1958.5
	Monthly per capita expenditures on utilities in nominal value	20.948	22.125	0	265
Adaptive Capacity (AC)					
	Income diversification (based on factor analysis)	0.019	0.043	0	1
	Income earner share	0.616	0.230	0	1
	Secondary education	0.964	0.184	0	1
	Migration	0.330	0.470	0	1
	Number of elderly people (65+)	0.290	0.564	0	2
Social Safety Nets (SSN)					
	Old age pension	0.326	0.469	0	1
	Disability pension	0.103	0.305	0	1
	Survivor pension	0.031	0.174	0	1
	Special merit pension	0.003	0.057	0	1

	Social pension	0.001	0.044	0	1
	Compensation	0.020	0.142	0	1
	Compensation cash	0.029	0.168	0	1
	Compensation bulbs	0.133	0.340	0	1
Sensitivity (S)					
	Life unsatisfaction	0.384	0.486	0	1
	Financial unsatisfaction	0.563	0.491	0	1
	Hospitalization (reversed)	0.712	9,451	0	1
	Hospitalization times (reversed)	17.292	1.750	0	18

Source: compiled by the authors

Appendix 3. 1 Factorability and validity analysis for pillars and RCI

First of all, the *Bartlett Test of Sphericity* is applied by testing the null hypothesis, indicating variables are orthogonal (Bartlett, 1951). In order to check the proportion of variance among variables, we apply a *Kaiser-Meyer-Olkin* test (KMO) (Kaiser, 1974). For the threshold of acceptance of KMO, we use values bigger than 0.5 (Hair et al., 2010). Multicollinearity is checked by using a *correlation coefficient matrix,* which should be greater than 0.00001 for a good model (Field, 2013). In order to determine the number of components in factor analysis, results are based on *Kaiser's rule* (Kaiser, 1960). Factorability results are provided in Table A3.2. In order to facilitate factor interpretations, we use a factor rotation technique. In this case, all pillar and RCI factors are based on the *varimax rotation* technique (as the default option for orthogonal rotation), where efforts are made to maximize the dispersion of loadings to get a small number of variables with relatively higher loadings (Kaiser, 1958).

To test whether our designed measurement aimed to construct pillars and RCI is truly measuring them, we followed the instruction to demonstrate construct validity. For simplicity and given the paucity of evidence, initial studies have not provided sufficient evidence on the construct validity. This study demonstrates construct validity through establishing the *convergent*, *discriminant* and *external validity* (Høgheim et al., 2023; Rönkkö & Cho, 2020).

Since convergent validity indicates whether items truly measure the latent phenomena being constructed (Bagozzi et al., 1991), we use the *communality* as equivalent to the Average Variance Extracted (AVE) (Venturini & Mehmetoglu, 2019). In this case, 1-Uniqueness is referred to *communality*; therefore, it should not be less than 50 percent (Hair et al., 2010). *Communality* information is available in Table A3.2. Convergent validity further requires that measurement model fits data adequately (Hair et al., 2010) and loading coefficients are statistically significant (Dunn et al., 1994). For inspecting discriminant validity, it is based on the comparison of AVE and squared correlations (SC) (Fornell & Larcker, 1981). The main purpose of this test is to demonstrate whether $AVE \geq SC$. In other words, each latent construct should share more variance with the associated indictors compared to other latent variables (Cheung et al., 2023). To generalize the findings from factor analysis, we further apply Structural Equations Modelling (SEM) to construct RCI through ABS, AST, SSN, AC and S pillars obtained from the same observable variables (Figure A3.1).

External construct validity demonstrates whether the constructed instrument is consistent with other derived hypothesis or generalized to other contexts (Lucas, 2003). A rigorous way to provide external construct validity is through hypotheses testing (Bataineh & Attlee, 2021); therefore, we inspect mean-scores of pillars and RCI according to the level of coping strategies. In this case, T-test was used to evaluate whether mean differences across the variables are statistically significant (Appendix 3.6 and Table A3.7 for further details).

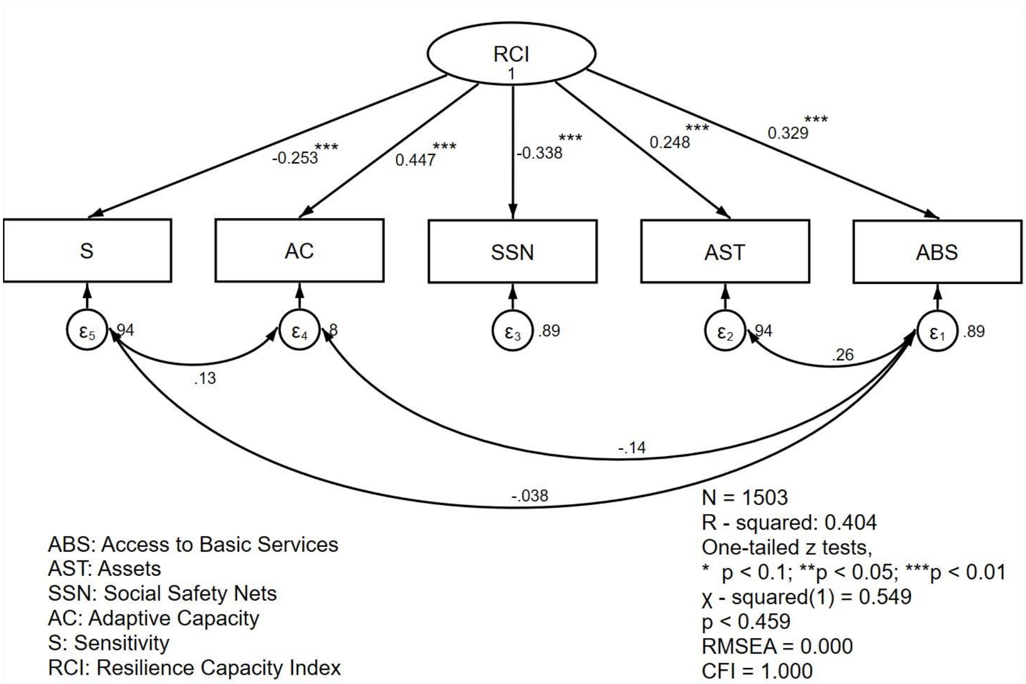

Figure A3.1 Structural Equation Modelling (SEM) for Resilience Capacity Index (RCI)

Source: compiled by the authors

For the SEM approach in Figure A3.1, we apply a *Likelihood Ratio (LR)* test by testing whether selected factors are able to reproduce the entire covariance matrix (Acock, 2013). We also consider a *Root Mean Square Error of Approximation (RMSEA)* to measure the discrepancy or error for each degree of freedom (Steiger, 1990). It is generally recommended to have less than 0.06 for a good fit (Hu & Bentler, 1999). In addition to this, we include a *Comparative Fit Index (CFI)* to measure the relative improvement in a fit (Acock, 2013), which should be bigger than 0.8 in the covariance structure analysis (Hu & Bentler, 1999).

Table A3.2 Factor Post Estimation of Pillars and RCI

Index	Component	Cumulative Variance	
Access to Basic Services (ABS)			
	1	0.435	
	2	0.686	
Bartlett Test			650.671***
KMO			0.648
determinant of R-matrix			0.599
Average communality			0.686
Assets (AST)			
	1	0.530	
Bartlett Test			370.596***
KMO			0.608
determinant of R-matrix			0.781
Average communality			0.529
Adaptive Capacity (AC)			
	1	0.366	
	2	0.618	
Bartlett Test			331.073***
KMO			0.509
determinant of R-matrix			0.802
Average communality			0.617
Social Safety Nets (SSN)			
	1	0.179	
	2	0.320	
	3	0.449	
	4	0.575	
Bartlett Test			253.089***
KMO			0.536
determinant of R-matrix			0.845
Average communality			0.575
Sensitivity (S)			
	1	0.410	
	2	0.754	

Bartlett Test			1022.380***
KMO			0.500
determinant of R-matrix			0.506
Average communality			0.755
Resilience Capacity Index (RCI)			
	1	0.292	
	2	0.502	
Bartlett Test			247.235***
KMO			0.553
determinant of R-matrix			0.848
Average communality			0.506

Source: compiled by the authors

Appendix 3. 2 Multiple Indicators Multiple Causes (MIMIC) in Resilience Index Measurement Analysis (RIMA)

The first part of the relationship in Figure A3.2 indicates the relationship between the pillars of resilience and ε_R, which is the disturbance term of the estimation. The path arrows in the second part of the diagram show the relationship between Resilience Capacity Index (RCI) and food security outcomes with their corresponding error terms.

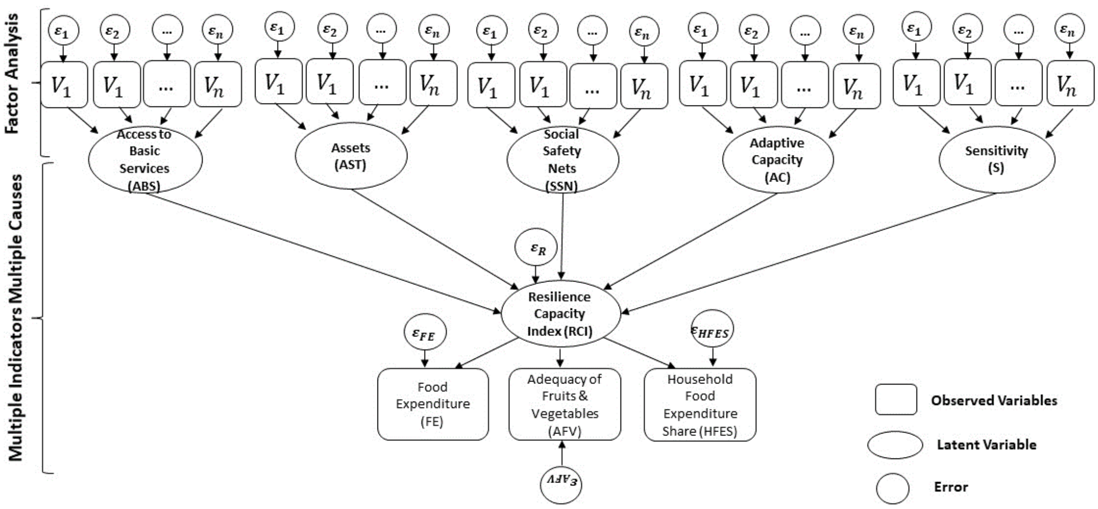

Figure A3.2 Two-step approach for Resilience Capacity Index (RCI)

Source: compiled by the authors

We use Access to Basic Services (ABS), Assets (AST), Social Safety Nets (SSN), Adaptive Capacity (AC), and Sensitivity (S) as observed endogenous variables correlating with RCI. In the formative part, a model represented in Equation (1) shows that resilience is influenced by five pillars:

$$[RCI] = [\beta_1, \beta_2, \beta_3] \times \begin{bmatrix} ABS \\ AST \\ SSN \\ AC \\ S \end{bmatrix} + [\varepsilon_R] \quad (1)$$

According to the measurement or reflective model in Equation (2), it is specified by the weekly food expenditure (FE), adequacy of fruit and vegetable consumption (AFV) and household food expenditure share (HFES).

$$\begin{bmatrix} FE \\ AFV \\ HFES \end{bmatrix} = [\Lambda_1, \Lambda_2, \Lambda_3\ ] \times [\eta] + [\varepsilon_{FE}, \varepsilon_{AFC}, \varepsilon_{HFES}] \qquad (2)$$

As RIMA-II adopts a *min-max rescaling method* (FAO, 2016), we applied this technique based on:

$$RCI^* = (\text{RCI} - RCI_{min}\ ) / (RCI_{max} - RCI_{min}) \times 100 \qquad (3)$$

This approach allows us to interpret changes in RCI as well as the relationship between RCI and food security outcomes.

Appendix 3. 3 Latent Coping Strategy

We utilized a notation from Collins and Lanza (2009) expressed by Equation (4). Accordingly, it shows that the probability of observing any vector response is explained by the function of the probability of membership class (γ) and observing the response conditional on a latent class membership (ρ).

$$P(Y = y) = \sum_{c=1}^{C} \gamma_c \prod_{j=1}^{J} \prod_{r_j=1}^{R_j} \rho_{j,r_j|c}^{I(y_j=r_j)} \tag{4}$$

The element of j of a response pattern y is represented by y_j. The item response probability which is $\rho_{j,r_j|c}$ shows the probability of response r_j to the elements of j, conditional on the membership in latent class c. The indicator function expressed by $I(y_j = r_j)$ is equal to 1 if $j = r_j$; otherwise, it equals 0. In this case, the values of observed variables within latent classes are independent, referred to as *"local independence"* or *"uncorrelated uniqueness"* in factor analysis.

By defining a latent categorical variable it is further possible to use it as a predictor variable in the regression (Collier & Leite, 2017). The optimal number of classes is determined by following *Akaike's Information Criterion* (AIC) (Akaike, 1987a), *Bayesian Information Criterion* (BIC) (Schwarz, 1978) and *Entropy Criterion* (Celeux & Soromenho, 1996). The reason behind including the entropy-based conclusion is that it sometimes outperforms AIC and BIC selection criterion (Larose et al., 2016). In this case, lower AIC and BIC or higher than 0.6 in the Entropy value is recommended to obtain the most parsimonious and correct model (Tein et al., 2013; Weller et al., 2020).

Table A3.3 Descriptive statistics of subjective coping strategies

N.O	Variable	Observation	Mean	St.Dev	Min	Max
1.	Aid from friends or family for money	1503	0.355	0.478	0	1
2.	Borrowed money from a moneylender	1503	0.051	0.220	0	1
3.	Sent a member of the household to work elsewhere as a seasonal worker	1503	0.396	0.489	0	1
4.	Increased the production of food products for own consumption	1503	0.390	0.488	0	1
5.	Cancelled health insurance	1503	0.153	0.360	0	1
6.	Cancelled house or car insurance	1503	0.142	0.349	0	1
7.	Spent savings or investments	1503	0.193	0.395	0	1
8.	Worked more than normally	1503	0.399	0.490	0	1
9.	Sold the harvest in advance	1503	0.181	0.385	0	1
10.	Household members sent to work who normally do not work	1503	0.330	0.470	0	1

Source: compiled by the authors

According to model fit criteria, a two-class model (AIC = 15031.50, BIC = 15143.12 and Entropy = 0.690) is compared to other models as described in Table A3.4. It is chosen for its robust interpretability of classes representing homogenous coping strategies.

Table A3.4 Model Fit

Model	N	LL (model)	df	AIC	BIC	Entropy
One class	1,503	-7971.081	10	15962.16	16015.31	0
Two class	1,503	-7494.751	21	15031.50	15143.12	0.690
Three class	1,503	-7294.332	32	14652.66	14822.75	0.604

Source: compiled by the authors

Latent Class Identification

Figure A3.3 depicts the identified classes and corresponding predicted scales for the 10 selected types of coping strategies. The first class, which accounts for 47% of the sample, is labelled as *"Low Coping Strategy"* with its below-median probability of all selected observed strategies. The second class showing the remaining 53% of the sample is labeled as *"High Coping Strategy"* class due to the presence of higher probability or almost above-median probability of half the selected strategies. See Appendix 3.6 and Table A3.7 for latent class comparison discussion.

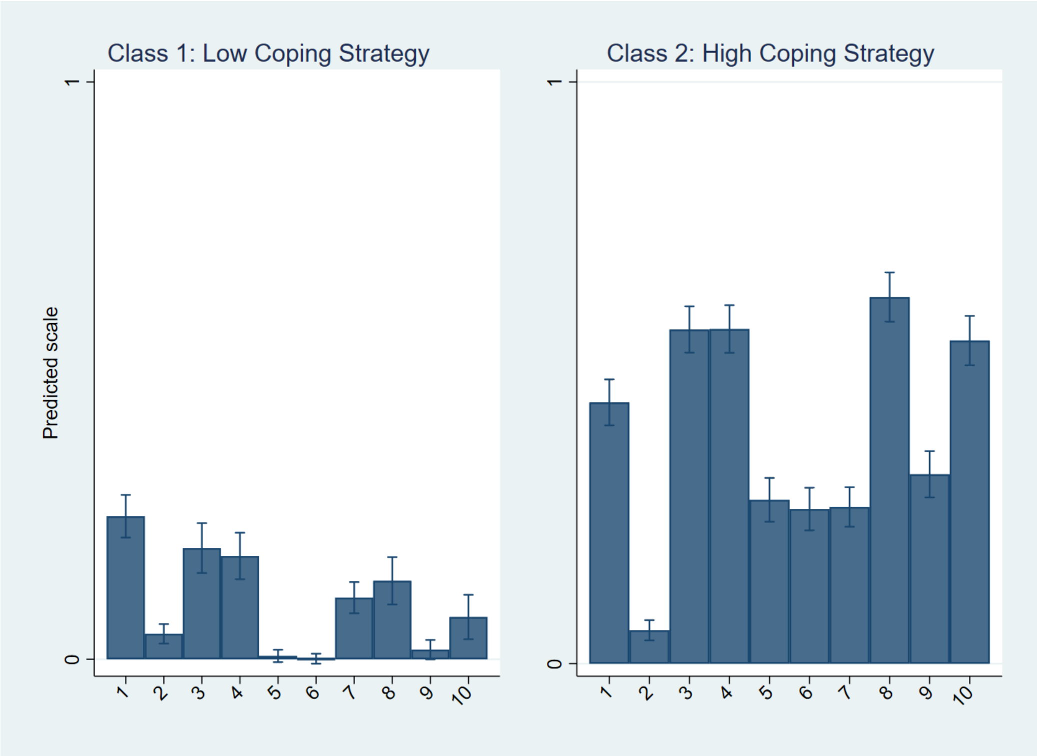

Figure A3.3 Identified Classes and Predicted Scales

Notes: 1: Aid from friends or family for money; 2: Borrowed money from a moneylender; 3: Sent a member of the household to work elsewhere as a seasonal worker; 4: Increased the production of food products for own consumption; 5: Cancelled health insurance; 6: Cancelled house or car insurance; 7: Spent savings or investments; 8: Worked more than normally; 9: Sold the harvest in advance; 10: Household members sent to work who normally do not work

Source: compiled by the authors

Table A3.5 Descriptive Statistics of Controlling and Dependent Variables

Variables	Mean	St.Dev	Min	Max
RCI	23.868	11.143	0	100
RCI (obtained from Structural Equation Modelling or SEM)	51.170	13.332	0	100
RCI*Shock	56.323	52.469	0	400
RCI*Shock (through SEM)	119.063	86.050	0	400
Coping strategy	1.522	0.499	1	2
Head age	54.392	12.982	19	94
Head female	0.252	0.434	0	1
Household size	6.392	3.104	1	26
Rural	0.652	0.476	0	1
Number of moderate and severe drought	0.790	1.364	0	5
Food expenditure (FE)	306.666	452.288	0	15441.3
Adequacy of fruits and vegetables (AFV)	369.517	245.721	17.857	3714.286
Household food expenditure share (HFES)	0.173	0.150	0	0.942
FE loss	0.255	0.436	0	1
AFV loss	0.335	0.472	0	1
HFES loss	0.578	0.494	0	1

Source: compiled by the authors

Appendix 3. 4 Validation of Instrumental Variable Approach

We use *Cragg-Donal F statistics* by having the "rule-of-thumb" with F>10 (Baum, 2006). We also include an *Anderson-Rubin (AR)* significance level as a weak instrument robust test (Riquelme et al., 2013). The results for the first stage estimation show that instrumental variables are significantly correlated with RCI (Table A3.6). Moreover, we apply the *Wald test* of exogeneity by checking the null hypothesis of no endogeneity (Wooldridge, 2010).

*Table A3.6 Instrumenting regression results for RCI and RCI*Shock (First stage)*

	RCI	**RCI*Shock**	**RCI-SEM**	**RCE-SEM* Shock**
Distance	-0.147***	-0.611***	-0.078***	-0.351***
	(0.014)	(0.051)	(0.020)	(0.059)
High Coping	0.161	1.143	0.490	2.467
Strategy	(0.444)	(1.557)	(0.615)	(1.816)
Head female	-0.135	0.498	-1.057**	-3.064*
	(0.516)	(1.805)	(0.715)	(2.106)
Head age	-0.007	-0.084	-0.348***	-0.963***
	(0.017)	(0.060)	(0.024)	(0.071)
Household size	-1.172***	-5.262***	-1.434***	-3.760***
	(0.223)	(0.781)	(0.309)	(0.911)
Sq. Household	0.052***	0.150***	0.047***	0.123***
size	(0.012)	(0.043)	(0.017)	(0.051)
Rural	-9.104***	-31.171***	-6.826***	-23.285***
	(0.519)	(1.814)	(0.719)	(2.116)
Drought Shock	1.010***	25.433***	1.195***	53.533***
Events	(0.192)	(0.672)	(0.265)	(0.784)
Constant	38.130***	59.911***	79.683***	88.417***
	(1.415)	(4.952)	(1.959)	(5.778)
Observations	1333	1327	1333	1327

**** p<0.01, **p<0.05, *p<0.1. The reference class is "Low Coping Strategy". Standard errors in parentheses*

Source: compiled by the authors

Appendix 3. 5 MIMIC Outcomes

In the estimation of pillars, ABS is based on heating, electricity and water sources of the household in Factor 1 and gas in Factor 2 (Figure A3.4). Similarly, a high dependency on heating in Tajikistan causes regular winter energy crises leaving many households more vulnerable (WB, 2015).

As for AST (Figure A3.5), both wealth index per capita and other consumptions have high explanatory weight (loading) in Factor 1. This result implies that households might be able to activate resilience by selling more assets to protect consumption (Zimmerman & Carter, 2003). Therefore, the wealth index representing different types of assets in the RIMA approach is likely to be transferable to the consumption smoothing strategies (FAO, 2016). The coefficient of SSN is also positive and significant. It should be also considered that the present study only covers formal types of transfer (Figure A3.6) showing the significance of social-security support from the state.

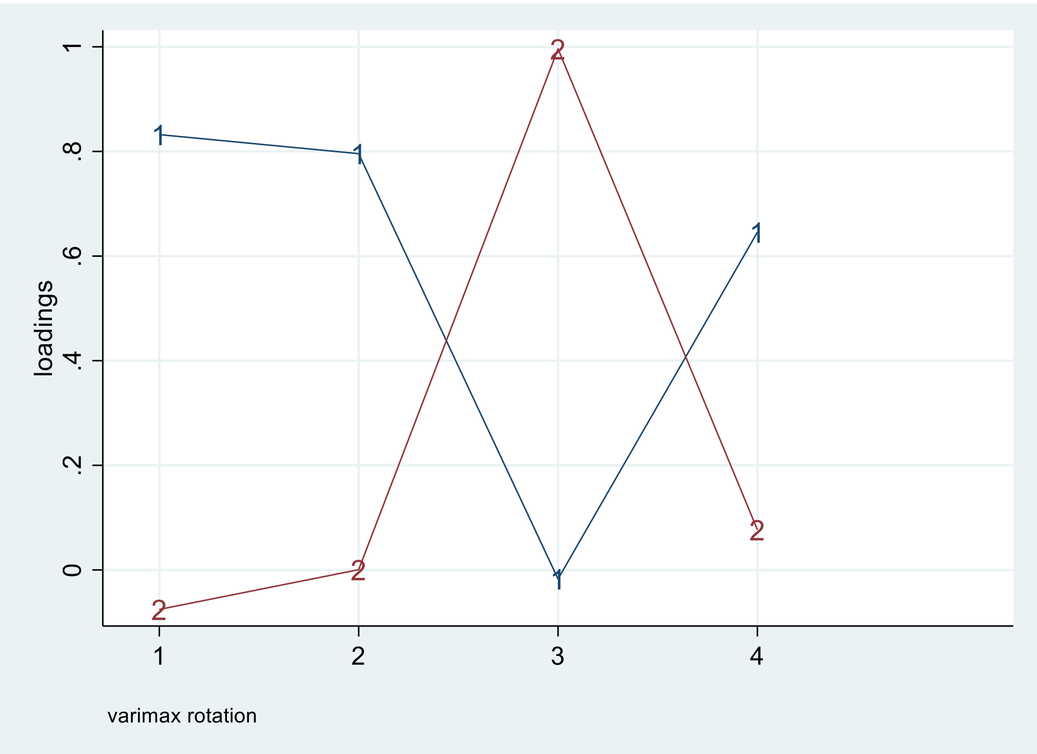

Figure A3.4 Factor components and loadings of ABS

(Note: 1 - Central heating; 2 - Electricity heating; 3 - Gas; and 4 - Improved water source)

Source: compiled by the authors

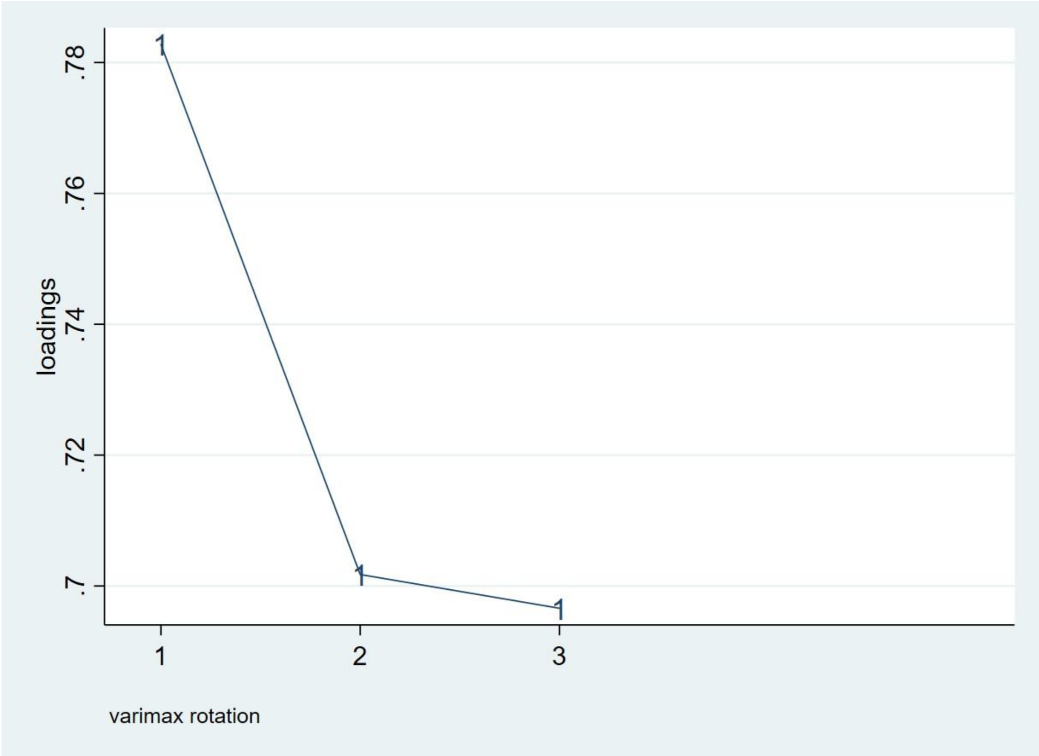

Figure A3.5 Factor components and loadings of AST

(Note: 1 - Wealth Index in per capita; 2 - Non-food consumption in per capita; and 3 - Expenditure of utility consumption in per capita)

Source: compiled by the authors

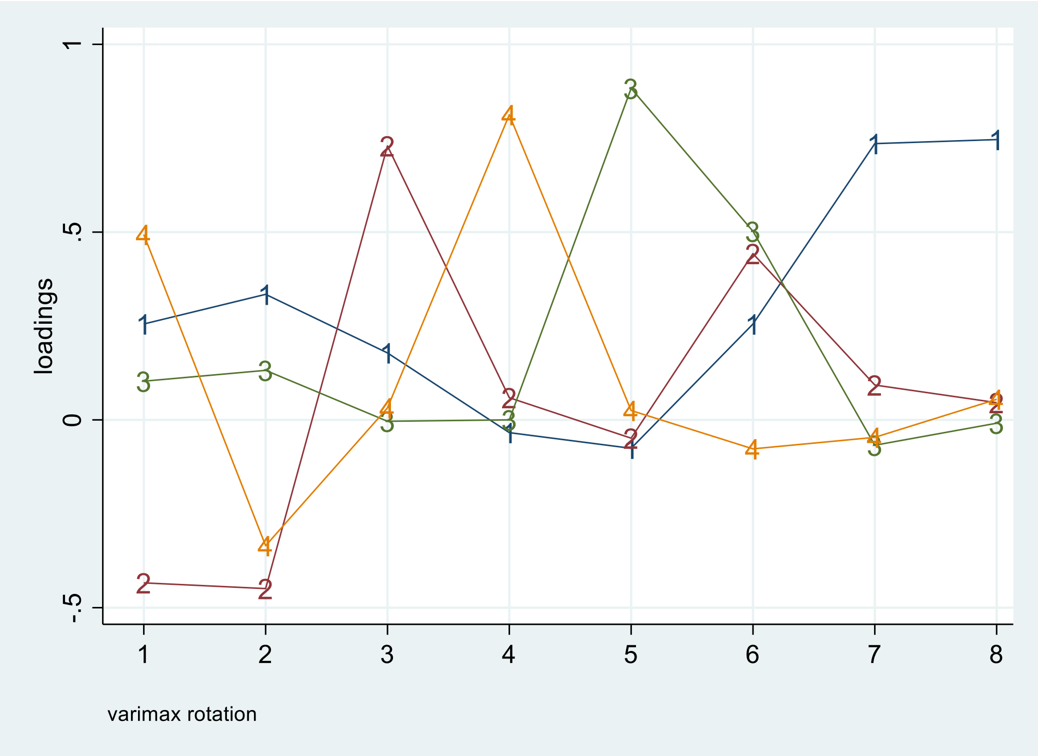

Figure A3.6 Factor components and loadings of SSN

(Note: 1 - Old age pension; 2 - Disability pension; 3 - Survivor pension; 4 - Special merit pension; 5 - Social pension; 6 - Compensation; 7 - Compensation cash; and 8 - Compensation bulbs)

Source: compiled by the authors

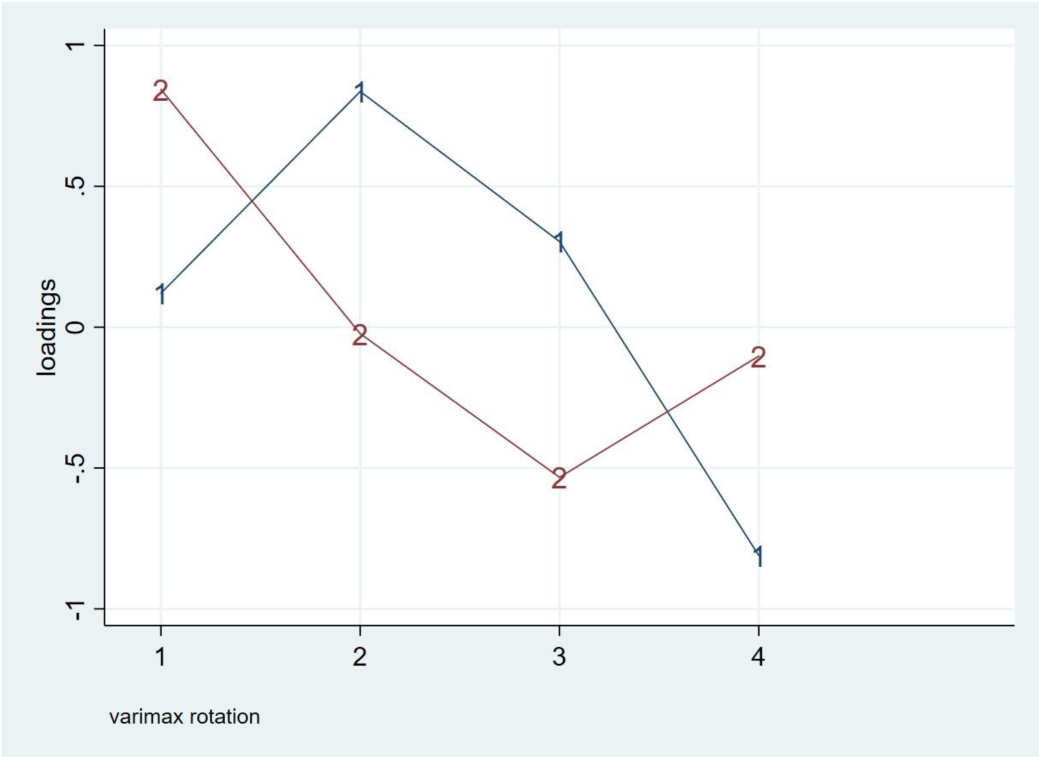

Figure A3.7 Factor components and loadings of AC

(Note: 1 - Income diversification; 2 - Income earner share; 3 - Migration ratio; and 4 - Number of elderly people)

Source: compiled by the authors

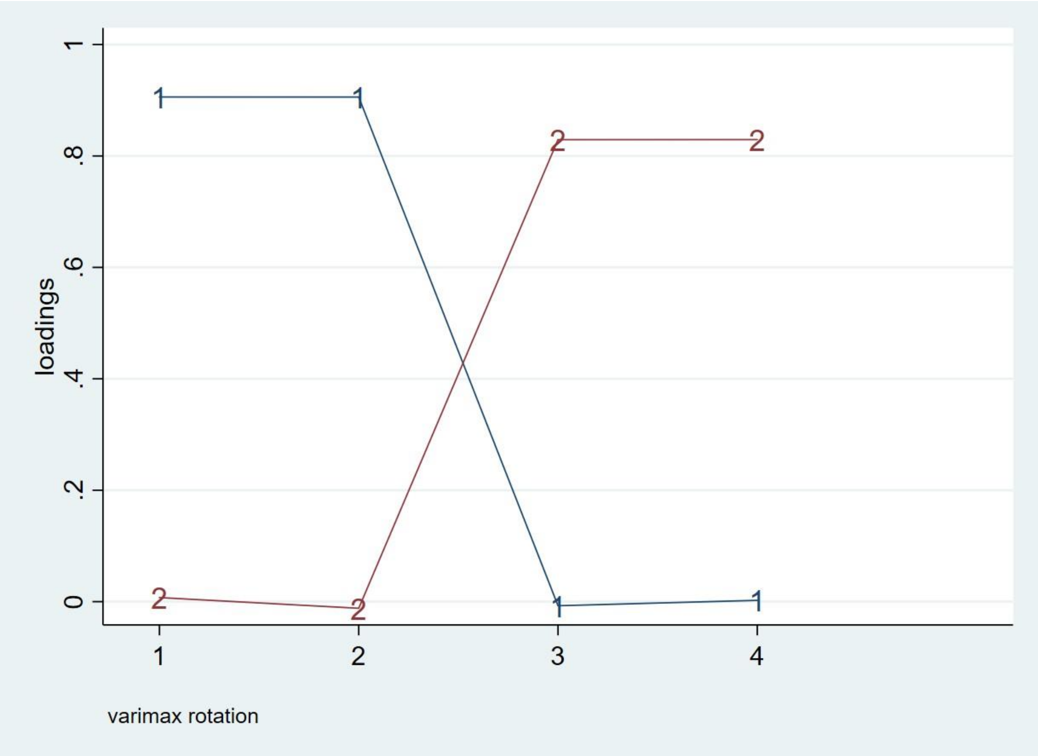

Figure A3.8 Factor components and loadings of S

(Note: 1 - Life unsatisfaction; 2 - Financial unsatisfaction; 3 - Hospitalization (reversed); and 4 - Times of hospitalization (reversed))

Source: compiled by the authors

Appendix 3. 6 Latent Class Comparing

Looking at RCI, households with a higher RCI in 2009 are associated with a lower coping strategy in 2011 (Table A3.7). A negative relationship between coping strategies and resilience has already been mentioned (Nahid et al., 2021). In this case, less resilient households might be highly sensitive to shocks, encouraging them to activate short-term coping strategies. Looking at class comparisons for food security outcomes, FE is higher in the *"High Coping Strategy"* class, but the relationship with AFV is not statistically significant. As it is expected, HFES is lower in the *"High Coping Strategy"* class. The result could suggest that households experiencing better food security outcomes are those who strongly activate coping strategies to deal with the shocks. A similar comment given by Ansah et al. (2019) or Lascano Galarza (2020) accentuated the significance of different types of *ex ante* or *ex post* shock strategies linked with food security outcomes.

Table A3.7 Class Comparison

	Low Coping Strategy	**High Coping Strategy**	**p value**
RCI	24.342 (47.93)	22.208 (52.07)	0.000
RCI (obtained from the SEM approach)	51.709 (47.93)	50.188 (52.07)	0.035
FE	264.345 (47.70)	345.272 (52.30)	0.000
AFV	375.647 (47.49)	363.961 (52.51)	0.358
HFES	0.196 (47.70)	0.151 (52.30)	0.000

Sample size percentage in parentheses

RCI: Resilience Capacity Index; FE: Food Expenditure; AFV: Adequacy of Fruit and Vegetable Consumption; HFES: Household Food Expenditure Share

Source: compiled by the authors

Table A3.8 Resilience and Food Security Outcomes

	AFV		FE		HFES	
	(1)	(2)	(3)	(4)	(5)	(6)
RCI	12.940**		45.470***		0.011**	
	(5.849)		(15.390)		(0.004)	
RCI*Shock		2.901**		10.200***		0.002***
		(1.171)		(2.879)		(0.001)
High Coping	7.287	6.775	59.149	57.308*	-0.033***	-0.034***
Strategy	(14.162)	(12.681)	(37.439)	(31.313)	(0.011)	(0.009)
Head female	-16.638	-21.714	16.338	-1.429	0.011	0.006
	(16.950)	(14.644)	(44.735)	(36.168)	(0.013)	(0.011)
Head age	5.295**	3.557***	15.521***	9.441***	0.005***	0.003***
	(2.155)	(1.258)	(5.647)	(3.082)	(0.001)	(0.001)
Household	-51.580***	-59.107***	104.102***	77.637***	-0.006	-0.013***
size	(10.108)	(7.128)	(26.833)	(17.692)	(0.008)	(0.005)
Sq. Household	2.033***	2.275***	-3.178**	-2.321**	0.001	0.001**
size	(0.463)	(0.371)	(1.231)	(0.920)	(0.001)	(0.001)
Rural	73.244	52.635	184.685	112.187	0.018	0.002
	(46.225)	(33.583)	(122.17)	(82.969)	(0.036)	(0.025)
Drought Shock	-6.036	-146.039**	-54.729**	-546.874***	-0.025***	-0.152***
Events	(10.100)	(64.032)	(26.691)	(157.489)	(0.008)	(0.048)
Constant	-385.457	389.934***	-3379.486***	-656.407***	-0.619*	0.084
	(456.535)	(100.451)	(1200.57)	(157.489)	(0.360)	(0.075)
Observations	1327	1327	1333	1333	1333	1333
Cragg-Donald F Stat.	14.961	34.377	15.215	34.904	15.215	34.904

**** p<0.01, **p<0.05, *p<0.1. The reference class is "Low Coping Strategy". Standard errors in parentheses. RCI: Resilience Capacity Index; FE: Food Expenditure; AFV: Adequacy of Fruit and Vegetable Consumption; HFES: Household Food Expenditure Share*

Source: compiled by the authors

Table A3.9 Resilience and Food Security Loss

	AFV		FE		HFES	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
RCI	0.049***		-0.083***		-0.047***	
	(0.017)		(0.023)		(0.016)	
RCI*Shock		0.011***		-0.018***		-0105***
		(0.003)		(0.003)		(0.003)
High Coping	-0.028	-0.030	-0.051	-0.047	0.014	0.016
Strategy	(0.041)	(0.035)	(0.056)	(0.041)	(0.039)	(0.033)
Head female	0.039	0.020	-0.085	-0.053	0.062	0.080**
	(0.049)	(0.040)	(0.067)	(0.048)	(0.047)	(0.038)
Head age	0.016***	0.010***	-0.028***	-0.016***	-0.015***	-0.009***
	(0.006)	(0.003)	(0.008)	(0.004)	(0.005)	(0.003)
Household	0.075**	0.046**	-0.150***	-0.102***	-0.053*	-0.025
size	(0.029)	(0.019)	(0.040)	(0.023)	(0.028)	(0.018)
Sq.	-0.002	-0.001	0.005***	0.003***	0.001	0.001
Household size	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Rural	0.352**	0.272***	-0.482***	-0.348***	-0.304**	-0.229**
	(0.135)	(0.093)	(0.185)	(0.111)	(0.129)	(0.088)
Drought	-0.086***	-0.626***	0.147***	1.053***	0.069**	0.579***
Shock Events	(0.029)	(0.178)	(0.040)	(0.210)	(0.028)	(0.167)
Constant	-3.333**	-0.345	6.729***	1.718***	4.095***	1.277***
	(1.342)	(0.280)	(1.824)	(0.330)	(1.272)	(0.262)
Observations	1327	1327	1333	1333	1333	1333
Cragg-Donald Stat.	14.961	34.377	15.215	34.904	15.215	34.904
Wald Stat.	0.000	0.000	0.000	0.000	0.000	0.000
AR Stat.	0.000	0.000	0.000	0.000	0.000	0.000

**** p<0.01, **p<0.05, *p<0.1. The reference class is "Low Coping Strategy". Standard errors in parentheses. RCI: Resilience Capacity Index; FE: Food Expenditure; AFV: Adequacy of Fruit and Vegetable Consumption; HFES: Household Food Expenditure Share*

Source: compiled by the authors

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20023-2024	**Journal of International Development** Wiley

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09/10/2024 – 11/10/2024	Household resilience and coping strategies to food insecurity: An empirical analysis from Tajikistan **Life in Kyrgyzstan Conference: Food Security, Diet Diversity and Gender in Rural Tajikistan Panel.** Bishkek, Kyrgyzstan
03/10/2024 – 05/10/2024	The effect of remittance on food insecurity resilience in the presence of COVID-19 shocks **Conference and Workshop - Improving the Functioning of Agri-Food Value Chains in the South Caucasus Region, IAMO and the ISET Policy Institute (ISET-PI)** Tbilisi, Georgia
13/06/2024- 13/06/2024	Household resilience and coping strategies to food insecurity: An empirical analysis from Tajikistan **IFPRI Seminar** Dushanbe, Tajikistan
21/06/2023 – 23/06/2023	Household resilience and coping strategies to food insecurity: An empirical analysis from Tajikistan **IAMO Forum 2023 "Trade, Geopolitics & Food Security"** Halle (Saale), Germany
07/09/2022 – 09/09/2022	Resilience to food insecurity under systematic and individual shocks in Kyrgyz households: Latent class and instrumental variable approaches **62. Jahrestagung der Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaus e. V., Hohenheim, Deutschland** Stuttgart, Germany
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24/06/2020 – 26/06/2020	Attitudes toward gender-roles in Kyrgyzstan and nutritional outcomes: Latent profile analysis. **IAMO Forum 2020: Digital transformation - towards sustainable food value chains in Eurasia.** Halle (Saale), Germany

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- Egamberdiev, B., Bobojonov I., Kuhn L., Glauben, T., Akramov, K. (2024). Household Resilience and Coping Strategies to Food Insecurity: An Empirical Analysis from Tajikistan. Applied Economic Perspectives and Policy 1–16. https:// doi.org/10.1002/aepp.13422
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Halle (Saale), 08.12.2024

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Bekhzod Egamberdiev

Eidesstattliche Erklärung / 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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