Dynamics of food consumption during political instability: evidence from Kyrgyzstan

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Abstract

Shocks might affect consumers quite differently. Traditional regression to the mean approaches neglects the within-sample heterogeneity. This paper evaluates households' food consumption in Kyrgyzstan conditional upon their consumption "intensity" based on nationally representative household panel surveys before and after the two revolutions. A complete demand system is estimated, considering quality biases, spatial and temporal variations, and differences in household characteristics. Our results reveal that households are susceptible to income shocks for fruits & vegetables and meat & fish, which accounts for more than 50% of households' food expenditures. The first revolution worsened household food consumption by widening the gap between urban and rural areas, while the adaptive capacity of households, driven by improved income stability, increased during the second revolution, allowing rural households to improve their diets with consumption of different types of products. The results of the more stable period show an improvement in the country's food consumption; however, dietary habits have shifted towards over-processed and energy-intensive foods, posing a threat of overweight and related health problems.

Keywords: QUAIDS, demand elasticities, food consumption, revolution, Kyrgyzstan

JEL Classification: D12, I12, O12

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1 Introduction

About 800 million people worldwide faced hunger and depended on food aid at any time of the year in 2020 (FAO, 2021[18]). Food insecurity with serious and long-lasting consequences for human well-being is increasingly concentrated in conflict-affected regions (Martin-Shields & Stojetz, 2018[36], Bruck et al., 2018[7]). According to Global Report on Food Crises 2018, political instability such as protests, riots, and social unrest exacerbated food insecurity in 18 countries, home to 74 million food-insecure people (FSIN, 2018[20]).

Kyrgyzstan is the only Central Asian country beginning to emerge from two political upheavals (2005 and 2010), followed by inter-ethnic clashes between Uzbeks and Kyrgyz in the South, resulting in 300 deaths and 400,000 displaced from their homes in June 2010 (Solvang & Neistat, 2010[45]). The country was a regional forerunner in political and economic reform during the first presidential term of Kyrgyzstan's first post-Soviet president, Akayev (Anderson, 1999[1]). However, the process stalled, the economy collapsed, and the country's relatively democratic system became corrupt and autocratic as Akayev gained more power for himself and his family during his second presidential term (Kubicek, 2011[31]). The Akayev regime developed a patronage system in which politicians from the South could not form a solid electorate base resulting in only six opposition candidates getting seats in the 75 seat Parliament (Radnitz, 2010[41]). Consequently, the United Opposition organized massive protests in the South, which spread to the capital in the North, culminating in the storming of the White House, forcing the president to flee the country in 2005 (Kroeger & Anderson, 2014[30]). The movement that ousted Akayev became known as the "Tulip revolution."

The leader of the United Opposition, Kurmanbek Bakiyev, became the temporary then permanent head of government but he lost the support of his allies within a year, trying to maintain the basic elements of the "patronal presidentialism" (Hale, 2006[21]). The Bakiyev regime was even more corrupted and the economy was stagnant, resulting in a significant increase in utility prices such as fuel, cell phone service, electricity, and heating (Kroeger & Anderson, 2014[30]). Severe economic conditions, combined with income inequality between Uzbek and Kyrgyz households in the South of the country (in favor of the Uzbeks), exacerbating interethnic rivalry, led to another uprising of the people (Steiner & Esenaliev, 2011[48]). As in 2005, protesters occupied government buildings across the country and, despite deadly violence from government security forces, toppled the Bakiyev government in April 2010.

Costly efforts are made to prevent inter-ethnic conflict between Kyrgyz and Uzbeks, to reform the super-presidential system into a semi-presidential one, to strengthen the management of the regulatory framework in all strategic areas by increasing the country's external debt to 83.8% of GDP in 2018 (Vinokurov et al., 2020[49]). However, the eradication of corruption remains a major challenge at many levels of government

in many forms affecting governance, the rule of law, and the country's economic development. As the backbone of the economy, agriculture suffered the most, decreasing from 34.2% to 11.6% in GVA during 2000-2018 (World Bank, 2020[50]). Contrary to expectations, the food security of Kyrgyzstan has gradually strengthened in recent years. Relying on the definition of food security introduced by Barrett (2010)[4] (i.e., the three pillars: availability, access, and utilization), food availability and the provision of some staple foods over consumption rate increased due to imports, constituting 28.2 million USD in 2019 (EEUS, 2019[19]). Food access is also improving due to overall economic growth (3.76% GDP), poverty reduction (from 38.0% to 22.4% during 2012-2018), low inflation (less than 2% on average during 2016-2018), and remittances from labor migrants (World Bank, 2020[50]).

Policy-makers recognizing the causal effects of food insecurity, especially in conflict-afflicted countries, seek to understand the link between food insecurity and political instability based on evidence for timely intervention. However, understanding the potential of any food policy requires knowledge of demand elasticity and households' consumption patterns, including their preferences on different food products. Previous analyzes on the impact of conflicts on food consumption are often limited on estimating food demand using a reduced-form single equation model, ignoring the critical role of food price substitution effects on consumption patterns (D'Souza & Jolliffe, 2013[16], Ihle & Rubin, 2013[24], San Ahmed & Holloway, 2017[44]). In addition, studies are concentrated on estimating food consumption by the mean approaches neglecting the within-sample heterogeneity where "extreme" consumers' demand elasticities may differ in sign from the one shown by the average consumer (Hussein et al., 2021[23], Roosen et al., 2022[42]).

By addressing these research gaps, the present study makes a unique contribution to the broader literature on the impact of political conflicts on food demand in Kyrgyzstan. First, it examines Kyrgyzstan's complete food demand system using representative household survey data for the last 17 years that covers almost 400 different food items. In addition to estimating the elasticity of demand with respect to food expenditure, we estimate income elasticity using a two-stage budgeting system to satisfy the weak separability assumption of the complete demand system. Second, we present income elasticity estimates considering the combined effect of location and time (during and after conflicts), assuming that these factors can significantly influence a household's consumption patterns. Previous studies have reported regional changes in income elasticity estimates for people with low and high income (Korir et al., 2020[29], Law et al., 2020[32], Hoang 2018[22]). Thus, our estimates of income elasticities can be significant and helpful in developing appropriate responses to Kyrgyzstan's obvious food security challenges.

Finally, we conduct a separate analysis of the impact of income and socio-demographic variables on various consumption shares before and after revolutions[1]. Most of the research has focused on the expected

[1]We use the terms "conflict", "upheaval", and "revolution" interchangeably in this study.

value of the conditional distribution. The present study aims to describe in detail the characteristics of the conditional distribution, considering the quantiles of consumption. For instance, demand elasticities for some food items may differ according to the consumer's behavior. Differentiating consumer preferences can be critical for Kyrgyz consumers, given the dramatic changes in food choices during the transition period.

The rest of the paper is organized as follows. The next section describes the data and associated descriptive statistics. Section 3 discusses two-stage budgeting system process and model specifications. Section 4 presents estimation results with discussion. Finally, section 5 concludes the study with policy implications.

2 Data and descriptive statistics

We use data from the Kyrgyz Integrated Household Survey (KIHS) which is conducted quarterly by the National Statistical Committee (NSC) of the Kyrgyz Republic. The KIHS is a rotating panel[2] covering a nationally representative sample of nearly 5000 households at each point in time since its inception in 2003. The sampling procedure is stratified into urban and rural areas within each of the seven provinces (oblast) and the two largest cities (Bishkek and Osh), resulting in 16 sampling strata. The full survey contains 18,784 households with information on education, health, migration, employment, housing conditions, assets, income, expenditures, and sociodemographic characteristics. For this study, we use data from household expenditure, household income, and household demographics sections covering 18,719 households, including 11,883 urban and 6,836 rural households. Summary statistics for the whole sample by household types are presented in Table 1.

Table 1: **Summary statistics for household demographics**

	All	Urban	Rural
Total biweekly expenditure on food[3] (KGS)	4,137	4,165	4,095
Household size (count)	2.83	2.61	3.15
Gender of household head (1 = male)	0.64	0.59	0.72
Age of household head (years)	52.23	51.87	52.76
Household heads with basic education (=1 if yes)	0.12	0.10	0.15
Household heads with secondary education (=1 if yes)	0.69	0.65	0.75
Household heads with higher education (=1 if yes)	0.19	0.25	0.11
Number of surveyed households	18,719	11,883	6,836
Number of observations	3,359,680	1,999,390	1,360,290

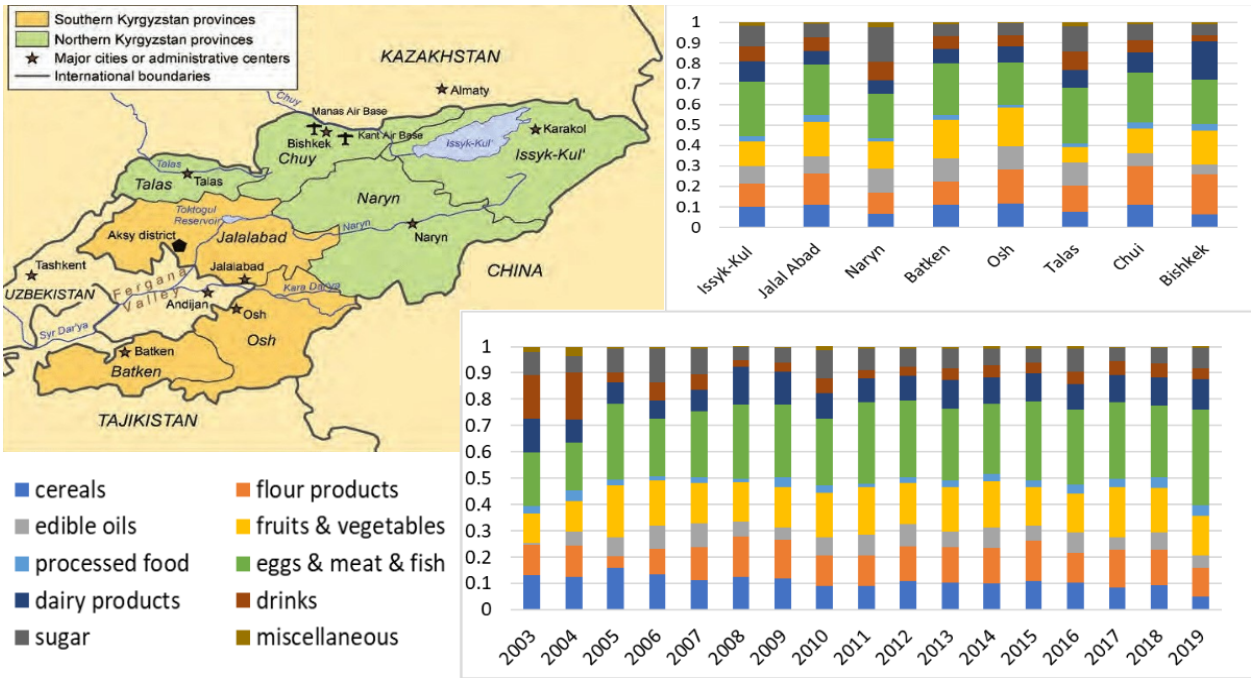
[2]The KIHS sample was fully renewed in 2013.
[3]Total food expenditure spent at home and outside the home.

2.1 Data for demand elasticity estimation

Data on food consumption and expenditures include food items that are purchased, home-produced, given as gifts or as in-kind contributions, and obtained from hunting, covering 359 different items[4]. The purchased and consumed amount of food is recorded separately based on recall over the last 14 days. Consequently, recorded expenditures are higher than consumption for some households, while others register zero purchases, even if they consume a positive amount. As in Attanasio et al. 2013)[2], we include all households in our estimation because we aim to assess the sensitivity of consumption of various foods to prices and income.

Estimation of the demand elasticities required us to perform several data transformations. First, we convert the quantities of certain food items into kilogram equivalent using conversion factors. The total value of food consumption for each household includes reported expenditure for purchased items and home-produced items. Consequently, we calculate the value of home-produced food items using median prices in the locality.

Figure 1: **Expenditure shares by food groups**



Source: Authors' figure.

Second, we compute unit prices by dividing the reported expenditure by the corresponding quantity of the food item. Missing unit prices due to zero consumption or omitted quantity are imputed by median prices. As discussed in Deaton (1988)[15] and Crawford et al. (2003)[12], this approach may suffer from quality

[4]Tobacco expenditures are excluded from the food basket.

effects and measurement errors which we tackle using the communal mean price method initially developed by Cox and Wohlgenant (1986)[11].[5] In addition, we consider another issue related to price changes due to inflation using the FAO Monthly Consumer Price Index (CPI)[6] for food as a price deflator to determine real prices.

Third, we aggregate all food items into ten groups[7]: cereals, flour products, edible oils, fruits & vegetables, processed food, eggs & meat & fish, dairy products, drinks, sugar, and miscellaneous.[8] Our choice of food group aggregation is according to the state classifier of the Kyrgyz Republic. Then, we calculate the quantity consumed and expenditure for each food group. Figure 1 shows the share of expenditures by food group for each year and across provinces. Descriptive statistics on biweekly quantity purchased and food expenditure at the household level by quantiles of monthly income per person are presented in Table 2.

Table 2: **Biweekly quantity purchased and food expenditures at household level by quantiles of monthly income per capita**

Food groups	Quantity (kg)				Biweekly expenditure (KGS)				Expenditure shares (%)			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
CER	2.29	2.25	2.12	2.07	87	100	102	108	4.83	6.14	6.75	6.62
FLO	1.99	2.58	2.90	3.23	104	139	161	193	5.77	8.53	10.69	11.90
OIL	0.61	0.63	0.68	0.70	64	66	70	70	3.52	4.05	4.64	4.32
FRU	3.96	5.50	6.48	7.59	88	133	172	229	4.90	8.15	11.43	14.15
PRO	0.34	0.41	0.35	0.38	82	92	64	67	4.56	5.65	4.26	4.16
MEA	0.77	1.04	1.29	1.58	186	254	331	426	10.28	15.57	21.96	26.30
DAI	1.00	1.62	1.90	2.22	106	155	167	193	5.88	9.50	11.06	11.95
DRI	1.99	1.27	0.89	0.80	922	554	325	218	51.11	33.97	21.52	13.44
SUG	0.97	0.94	0.91	0.94	86	92	90	95	4.79	5.65	5.96	5.88
MIS	0.84	0.60	0.41	0.35	78	45	26	21	4.35	2.78	1.73	1.29
Total	**14.76**	**16.84**	**17.93**	**19.86**	**1804**	**1631**	**1508**	**1618**	**100**	**100**	**100**	**100**

2.2 Data to estimate the impact of revolutions

In order to obtain roughly the same number of years before and after a revolution, the total sample has been divided into three subsamples. Recalling the years of revolutions (2005 and 2010), we divide our sample into three subsamples. The first and second subsamples include five years from 2003 to 2007 and from 2008 to 2012, respectively. The third subsample covers from 2013 to 2019, where the sample was fully renewed. We employ households that continuously took part in the survey for at least four out of five years

[5]See Appendix A of Hoang (2018)[22] for more details on procedures for obtaining quality-adjusted unit prices.

[6]Data can be found at `http://www.fao.org/faostat/en/#data/CP`.

[7]Henceforth, we denote the food groups as CER=cereals, FLO=flour products, OIL=Edible oils, FRU=Fruits & vegetables, PRO=Processed food, MEA=Eggs & meat & fish, DAI=Dairy products, DRI=Drinks, SUG=Sugar, MIS=Miscellanous.

[8]Table X of Appendix X presents food groups that are aggregated by food similarity classification.

in the first and second subsamples. The years of revolutions are excluded from the estimation dividing our three subsamples into two pre-revolution (2003-2004 and 2008-2009) and three post-revolution (2006-2007, 2011-2012, and 2013-2019) periods.

The total household income is calculated as the sum of recorded and deflated individual earnings that are aggregated into three main groups: wages, social transfers, and remittances. Demographic variables used in the estimation include provinces, dummy variables for a rural and urban location, household size, household food consumption outside the home, household head's age, gender, education, and a dummy variable for a change of household head. Our sample for the current analysis consists of 14,398 households with 452,820 observations over 68 quarters, which can be identified as repeated observations. Descriptive statistics for each subsample are presented in Table 3.

Table 3: **Summary statistics for household income**

	Subsample I (2003-2007)		Subsample II (2008-2012)		Subsample III (2013-2019)
	Pre	Post	Pre	Post	
Monthly income, KGS	6151	7703	10379	11804	17323
Wages, KGS	4523	5912	7430	8156	11884
Social transfers, KGS	1002	1088	1303	2424	3379
Remittances, KGS	627	702	1647	1224	2060
Income per capita, KGS	2496	2947	4091	4546	6603
Number of households	3015		4107		7276
Number of observations	134120		179600		139100

3 Methodology for assessing food demand and the impact of revolutions

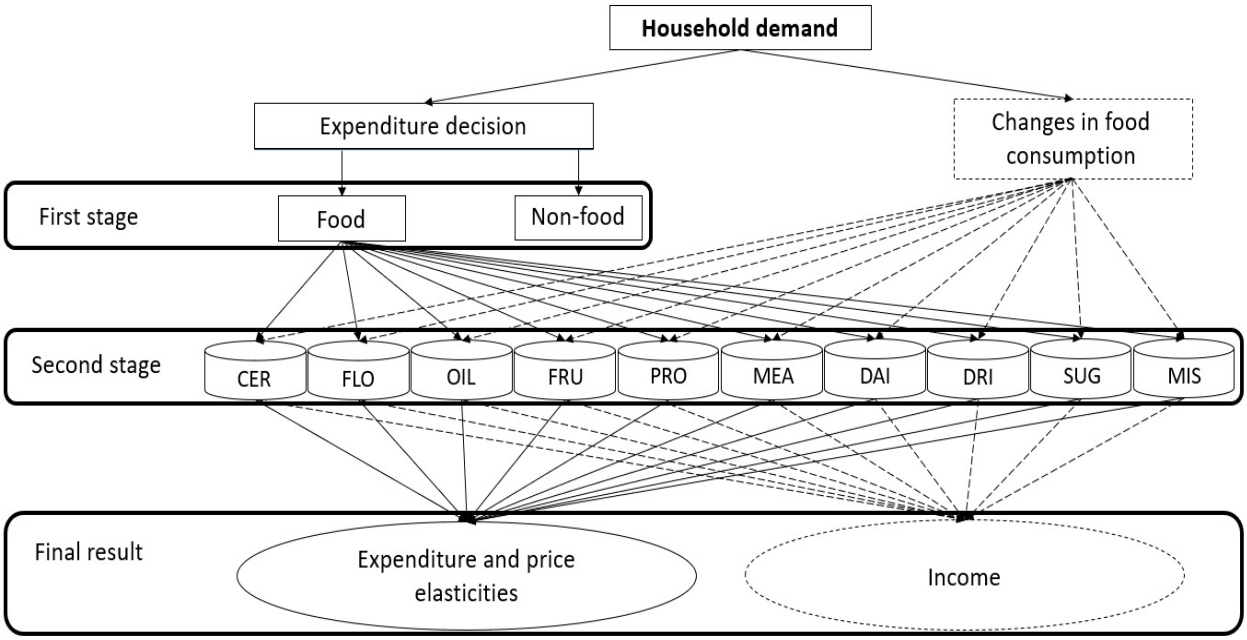
Changes in consumption patterns require an econometric analysis of demand that focuses on consumer responses to price, willingness to pay, and changes in income. So far, there have been two main approaches that are rooted in neoclassical consumer theory. In the first approach, income elasticity can be derived by analyzing the relationship between consumption and income for a particular good or a bundle of goods (Ogundari & Abdulai, 2013[38]). This approach is often called a reduced-form demand model and is estimated using a single equation model (Stewart & Dong, 2018[46], Colen et al., 2018[10]). A weakness of this model is the lack of accounting for interdependencies between commodities arising from budgetary constraints and reflected in relative prices (Sadoulet & de Janvry, 1995[43]).

The second approach proceeds in two stages. In the first stage, the household decides how to allocate

total expenditures between food and non-food items. In the second stage, the household allocates total food expenditure across different commodity groups. This approach provides an efficient method for determining the interdependencies and substitution effects between food items and price changes by estimating fully defined demand systems such as the linear expenditure system (LES) (Stone, 1954[47]), the Rotterdam model (Barten, 1969[6]), the indirect translog system (ITS) (Christensen et al., 1975[13]), the almost ideal demand system (AIDS) (Deaton & Muellbauer, 1980[14]), and the quadratic almost ideal demand system (QUAIDS) (Banks et al., 1997[3]).

Estimation of demand systems has concentrated on the expected value of the conditional distribution, that is, the "average" behavior of the consumer. However, Manning et al. (1995)[35] pointed out that consumers of a particular good facing the same income and prices can behave differently depending on consumption intensity. To explain the different patterns of demand for "average" and "extreme" consumers before and after political conflicts, we use the Quantile Regression (QR) method. Thus, our analysis of estimating patterns of food demand requires several estimations with multi-stage procedures, as shown in Figure 2.

Figure 2: **Household budgeting approach for food demand in Kyrgyzstan**



Source: Authors' figure.

3.1 Two-stage budgeting

Estimation of a complete demand system requires weak separability in the consumers' preferences and independence in allocation expenditure within the group (Edgerton, 1997[17]). Consumer's utility maximization decision can be decomposed into several separate stages to estimate a weakly separable food demand system. We suppose two-stage budgeting, where households determine the share of income allocated to food and non-food items employing the Working-Leser model in the first stage. Since the analysis of separable food demand systems often reveals non-linear Engel curves, the flexibility of QUAIDS allows the analysis of aggregate commodity groups characterized by non-linear Engel curves. Therefore, we use QUAIDS allocating household expenditure across ten different food groups in the second stage. We model conditional demand at each stage independently and add up estimated conditional elasticities with unconditional (total) elasticities over steps to obtain price and expenditure elasticities.

3.1.1 Working-Leser model

Following Chern et al. (2002)[9] and more recently Hoang (2018)[22], we employ the standard budget share model borrowed from Working (1943)[51] and Leser (1963)[33] as follows:

$$\ln \omega_t = \alpha_0 + \alpha_1 \ln M_t + \alpha_2 \ln \mathbf{P_t} + \sum_n \beta_n z_{nt} + \epsilon_t \tag{1}$$

where ω_t is the share of food in total expenditure in period t and M_t is total income per capita, which is the income a household receives from all sources such as business, remittances, salary, budgetary transfers, and agriculture. $\mathbf{P_t}$ is Laspeyres price index, defined as:

$$\ln \mathbf{P_t} = \sum_i \overline{w_i} \ln \mathbf{p_{it}} \tag{2}$$

where $\overline{w_i}$ is the mean budget share and $\mathbf{p_i}$ is the price of the good i. Household characteristics z_{nt} include household size, provinces, urban dummy variable as well as age, gender, education of the household head. This vector of variables is employed in the price adjustment estimation except for the household head. ϵ_t is an error term.

3.1.2 QUAIDS

We model food demand based on Banks' et al., (1997)[3] QUAIDS with scaled approach implemented by Lecocq & Robin (2015)[34] into *aidsills*[9] to account for the household demographics. This approach generates

[9]Command in STATA.

expenditure share equations that simulate their counterparts without demographic data. Assuming a utility-maximizing household with s demographic characteristics represented by vector z is scaled by the following function:

$$m_0(\mathbf{p}, z, u) = \overline{m_0}(z)\phi(\mathbf{p}, z, u) \tag{3}$$

where $\overline{m_0}(z)$ measures the increase in a household's expenditures in terms of demographic characteristics holding consumption patterns constant. The second term, $\phi(\mathbf{p},z,u)$, controls for differences in relative prices and actual goods consumed. The budget share equation of Banks et al., (1997)[3] derived from maximizing the indirect utility function and augmented with a vector of demographic variables z becomes:

$$w_{it} = \alpha_i + \sum_j \gamma_{ij} \ln p_{jt} + (\beta_i + \eta_i' z) \ln \left[\frac{m_t}{\overline{m_0}(z) a(\mathbf{p_t})} \right] + \frac{\lambda_i}{b(\mathbf{p_t}) c(\mathbf{p_t}, z)} \left\{ \ln \left[\frac{m_t}{\overline{m_0}(z) a(\mathbf{p_t})} \right] \right\}^2 + \epsilon_{it} \tag{4}$$

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

Price indices are defined as:

$$\ln a(\mathbf{p_t}) = \alpha_0 + \sum_i \alpha_i \ln p_{it} + \frac{1}{2} \sum_i \sum_j \gamma_{ij} \ln p_{it} \ln p_{jt}. \tag{5}$$

$$b(\mathbf{p_t}) = \prod_i {p_{it}}^{\beta_i} \tag{6}$$

$$c(\mathbf{p_t}, z) = \prod_j p_{jt}^{\eta_i' z} \tag{7}$$

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

3.2 Estimating demand elasticities

Using the procedure given in Banks et al. (1997)[3], demand elasticities for aggregated food groups are derived by partially differentiating the equation (4) with respect to $\ln m_t$ and $\ln p_{jt}$ such that:

$$\mu_{it} \equiv \frac{\partial w_{it}}{\partial \ln m_t} = \beta_i + \eta_i' z + \frac{2\lambda_i}{b(\mathbf{p_t}) c(\mathbf{p_t}, z)} \ln \left[\frac{m_t}{\overline{m_0}(z) a(\mathbf{p_t})} \right] \text{ and} \tag{8}$$

$$\mu_{ijt} \equiv \frac{\partial w_{it}}{\partial \ln p_{jt}} = \gamma_{ij} - \mu_{it}\left(\alpha_j + \sum_k \gamma_{jk} \ln P_{kt}\right) - \frac{\lambda_i(\beta_i + \eta_i' z)}{b(\mathbf{p_t})c(\mathbf{p_t}, z)}\left\{\ln\left[\frac{m_t}{\overline{m_0}(z)a(\mathbf{p_t})}\right]\right\}^2 \tag{9}$$

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

Then the expenditure and the uncompensated price elasticities are respectively computed as $\varepsilon_{it} = \mu_{it}/w_{it} + 1$ and $\varepsilon^u_{ijt} = \mu_{ijt}/w_{it} - \delta_{ijt}$ where δ_{ijt} represents Kronecker delta taking value 1 if $i = j$ and 0 otherwise. Using the Slutsky equation, we can finally compute the compensated price elasticities as $\varepsilon^c_{ijt} = \varepsilon^u_{ijt} + \varepsilon_{it} w_{jt}$.

3.3 Quantile regression

We analyze the change in budget share of food groups with respect to income and other sociodemographic variables before and after revolutions as follows:

$$\hat{w_i} = \alpha_0 + \alpha_1 M + \sum_n \beta_n z_n + \epsilon_i \tag{10}$$

where $\hat{w_i}$ is an estimated budget share of food group i. M and z_n represent total income and the household characteristics mentioned in the Working-Leser model, respectively. ϵ_i is an error term.

In addition, we use the QR method to assess the impact of income and sociodemographic variables on high and low-consumption households. QR defines the conditional quantiles of the dependent variable as a function of the independent variables, so it allows us to describe the entire conditional distribution of the dependent variable given the explanatory variables. The QR model initially proposed by Koenker & Basset (1978)[25] can be written as follows :

$$y_i = x_i'\beta_\theta + \epsilon_{\theta i} \quad \text{and} \quad Q_\theta(y_i|x_i) = x_i'\beta_\theta \tag{11}$$

where $Q_\theta(y_i|x_i)$ denotes the θ^{th} conditional quantile of y_i. The QR estimator of β_θ is found by solving the following problem:

$$\hat{\beta}_\theta = \underset{\beta_\theta \in \mathbb{R}^k}{\operatorname{argmin}} \frac{1}{N}\left\{ \sum_{y_i \geq x_i'\beta_\theta} \theta|y_i - x_i'\beta_\theta| + \sum_{y_i \geq x_i'\beta_\theta} (1-\theta)|y_i - x_i'\beta_\theta| \right\}. \tag{12}$$

The minimization problem can be solved by linear programming for the different quantiles of the dependent variable after some slight modifications. Barrodale & Roberts (1974)[5] developed an algorithm for the median case. Koenker & d'Orey (1987[26], 1994[27]) described implementation for the general quantile problem with desirable properties for a small to a medium number of observations. Portnoy & Koenker

(1997)[40] showed that an alternative interior method published by Koenker and Park (1996)[28] is competitive to least-squares estimation even for extensive data sets such as our data.

Quantile estimators are reliable and less affected by outliers in the dependent variable than least squares regression. When the error term is non-normal, QR estimates can be more efficient than least squares estimates (Buchinsky, 1998[8]). In addition, it is particularly useful in the presence of heteroscedasticity in error terms because the estimated coefficients have different values in different QRs. Potentially different solutions for different quantiles can be interpreted as differences in the response of the dependent variable to changes in covariances at different points in the conditional distribution of the dependent variable. Quantile regressions, like the OLS method, are invariant to linear transformations.

4 Results and discussion

4.1 Demand elasticities

Table 4 reports expenditure, uncompensated price, and compensated price elasticities from the QUAIDS analysis evaluated at the sample mean for the entire sample and across regions, respectively. Expenditure elasticities, which measure the proportionate change in quantity demanded in response to a proportionate change in income, are positive and statistically significant, with values ranging from 0.357 to 1.654. Surprisingly, only edible oils and sugary foods are inelastic, while the expenditure elasticities on staple foods in the diet of Kyrgyz households, such as flour products (0.948), dairy products (0.936), fruits & vegetables (1.126), and meat & and fish (0.938) are relatively high. Fruits & vegetables are expected to be a luxury as they are very seasonal in Kyrgyzstan; however, elasticity was unexpected for flour products and meat & fish since they are considered the staple food in the North. Imported cereals, processed food, and miscellaneous products are highly elastic and considered luxuries.

Table 4: **Demand elasticities**

	CER	FlO	OIL	FRU	PRO	MEA	DAI	DRI	SUG	MIS
Expenditure	1.192	0.948	0.357	1.126	1.203	0.938	0.936	1.654	0.492	1.364
	(-0.004)	(-0.004)	(-0.006)	(-0.003)	(-0.010)	(-0.003)	(-0.005)	(-0.007)	(-0.006)	(-0.018)
Uncompensated										
CER	**-1.440**	0.324	0.237	0.085	0.104	-0.350	-0.064	-0.186	0.256	-0.157
	(-0.009)	(-0.012)	(-0.007)	(-0.006)	(-0.004)	(-0.014)	(-0.005)	(-0.006)	(-0.008)	(-0.002)
FLO	0.298	**-1.090**	0.214	0.154	-0.095	-0.049	-0.211	-0.079	-0.095	0.006†
	(-0.008)	(-0.012)	(-0.007)	(-0.006)	(-0.004)	(-0.013)	(-0.006)	(-0.006)	(-0.008)	(-0.002)
OIL	0.468	0.484	**-0.404**	-0.428	0.150	-0.790	0.011†	0.232	-0.007†	-0.073
	(-0.009)	(-0.013)	(-0.008)	(-0.006)	(-0.005)	(-0.015)	(-0.006)	(-0.007)	(-0.009)	(-0.003)
FRU	0.070	0.112	-0.252	**-0.723**	0.003†	0.523	-0.087	-0.541	-0.121	-0.110
	(-0.007)	(-0.010)	(-0.006)	(-0.005)	(-0.003)	(-0.011)	(-0.004)	(-0.005)	(-0.006)	(-0.002)
PRO	0.373	-0.443	0.282	0.004†	**-1.080**	-1.524	-0.451	0.737	0.527	0.372
	(-0.021)	(-0.031)	(-0.018)	(-0.015)	(-0.010)	(-0.035)	(-0.014)	(-0.016)	(-0.020)	(-0.006)
MEA	-0.129	-0.025	-0.264	0.346	-0.181	**-0.558**	0.065	0.027	-0.241	0.021
	(-0.007)	(-0.010)	(-0.006)	(-0.005)	(-0.003)	(-0.011)	(-0.004)	(-0.005)	(-0.006)	(-0.002)
DAI	-0.052	-0.312	-0.031	-0.118	-0.147	0.182	**-1.033**	0.244	0.248	0.082
	(-0.011)	(-0.015)	(-0.009)	(-0.007)	(-0.005)	(-0.017)	(-0.007)	(-0.008)	(-0.010)	(-0.003)
DRI	-0.295	-0.218	0.102	-1.044	0.254	-0.097	0.194	**-0.700**	0.106	0.044
	(-0.017)	(-0.025)	(-0.015)	(-0.013)	(-0.009)	(-0.028)	(-0.011)	(-0.013)	(-0.016)	(-0.005)
SUG	0.487	-0.122	-0.016†	-0.168	0.255	-0.751	0.359	0.226	**-0.777**	0.014
	(-0.010)	(-0.015)	(-0.009)	(-0.007)	(-0.005)	(-0.016)	(-0.006)	(-0.007)	(-0.010)	(-0.003)
MIS	-1.040	-0.007†	-0.370	-1.011	0.667	0.193	0.394	0.242	-0.005†	**-0.427**
	(-0.040)	(-0.055)	(-0.032)	(-0.029)	(-0.021)	(-0.061)	(-0.025)	(-0.028)	(-0.036)	(-0.014)
Compensated										
CER	**-1.308**	0.428	0.320	0.264	0.140	-0.056	0.042	-0.086	0.339	-0.137
	(-0.009)	(-0.012)	(-0.007)	(-0.006)	(-0.004)	(-0.014)	(-0.006)	(-0.006)	(-0.008)	(-0.002)
FLO	0.402	**-0.964**	0.281	0.296	-0.066	0.185	-0.127	0†	-0.030	0.022
	(-0.008)	(-0.012)	(-0.007)	(-0.006)	(-0.004)	(-0.014)	(-0.006)	(-0.006)	(-0.008)	(-0.002)
OIL	0.507	0.531	**-0.379**	-0.374	0.161	-0.702	0.043	0.252	0.018	-0.067
	(-0.009)	(-0.013)	(-0.008)	(-0.007)	(-0.005)	(-0.015)	(-0.006)	(-0.007)	(-0.008)	(-0.003)
FRU	0.194	0.260	-0.174	**-0.554**	0.038	0.802	0.014	-0.446	-0.043	-0.091
	(-0.007)	(-0.010)	(-0.006)	(-0.005)	(-0.003)	(-0.011)	(-0.004)	(-0.005)	(-0.006)	(-0.002)
PRO	0.506	-0.284	0.365	0.185	**-1.043**	-1.227	-0.343	0.838	0.611	0.392
	(-0.021)	(-0.030)	(-0.018)	(-0.015)	(-0.011)	(-0.035)	(-0.015)	(-0.016)	(-0.020)	(-0.006)
MEA	-0.025	0.099	-0.198	0.487	-0.152	**-0.326**	0.149	0.106	-0.176	0.036
	(-0.007)	(-0.010)	(-0.006)	(-0.005)	(-0.003)	(-0.011)	(-0.004)	(-0.005)	(-0.006)	(-0.002)
DAI	0.052	-0.188	0.034	0.023	-0.118	0.413	**-0.950**	0.323	0.313	0.098
	(-0.011)	(-0.015)	(-0.009)	(-0.007)	(-0.005)	(-0.017)	(-0.007)	(-0.008)	(-0.010)	(-0.003)
DRI	-0.113	0.001†	0.217	-0.795	0.305	0.312	0.341	**-0.561**	0.220	0.072
	(-0.017)	(-0.025)	(-0.015)	(-0.013)	(-0.009)	(-0.028)	(-0.011)	(-0.012)	(-0.016)	(-0.005)
SUG	0.541	-0.057	0.018	-0.094	0.271	-0.629	0.403	0.268	**-0.742**	0.022
	(-0.010)	(-0.015)	(-0.009)	(-0.007)	(-0.005)	(-0.017)	(-0.007)	(-0.007)	(-0.009)	(-0.003)
MIS	-0.889	0.174	-0.275	-0.806	0.709	0.530	0.515	0.357	0.090†	**-0.403**
	(-0.041)	(-0.055)	(-0.032)	(-0.030)	(-0.021)	(-0.061)	(-0.025)	(-0.027)	(-0.035)	(-0.014)

Note: All elasticity estimates are statistically significant at 1% level, whereas †denotes statistically insignificant results. Robust standard errors are given in parentheses.

All uncompensated (Marshallian) own-price elasticities, which measure the proportionate change in quantity demanded in response to a proportionate change in a good's own price, show statistically significant negative signs ranging from (-0.404) to (-1.440). Demand for all food groups except cereals, flour products, processed food, and dairy products can be classified as own-price inelastic as their quantities in response to a change in prices is less than one. The lower own-price elasticities for meat & fish (-0.558) and fruits & vegetables (-0.723) can be related to the relative importance of these products compared to other food products. Meat and fruits & vegetables are the staple foods of Kyrgyz households, accounting for more than 50% of household food expenditures. Therefore, an increase in the price of these staple products may not change their demand.

The compensated (Hicksian) own price elasticity is similar to the uncompensated price elasticity in terms of signs and trends but slightly less in magnitude because it measures the proportionate compensated change in quantity demanded. All food items, except for imported ones, such as cereals and processed products, are own-price inelastic according to the Hicksian elasticity values. However, consumption of staple foods such as flour products (-0.964), dairy products (-0.950), and sugar (-0.742) shows a significant response to changes in own prices. In general, only fruits & vegetables, meat & fish are inelastic, reaffirming the importance of these products for Kyrgyz households.

Compensated cross-price elasticities provide information on the pure substitution effect in response to a price change. Differences in signs of compensated elasticities from uncompensated ones suggest that income effects significantly influence consumer demand decisions. Uncompensated cross-price elasticity measures the response of a one percent change in the price of a food group to the prices of all other food groups. For instance, if the price of flour products changes by one percent, the corresponding cross-price elasticity for meat & fish is (-0.025), so that an increase in prices for flour products will lead to a corresponding decrease in the amount of meat & fish eaten. This complementarity is explained by the fact that the northern residents of Kyrgyzstan mainly prefer to consume flour products with meat & fish due to the cold weather. Meanwhile, southerners do not need to consume high-calorie foods, so they substitute expensive foods such as meat & fish with fruits & vegetables (0.523).

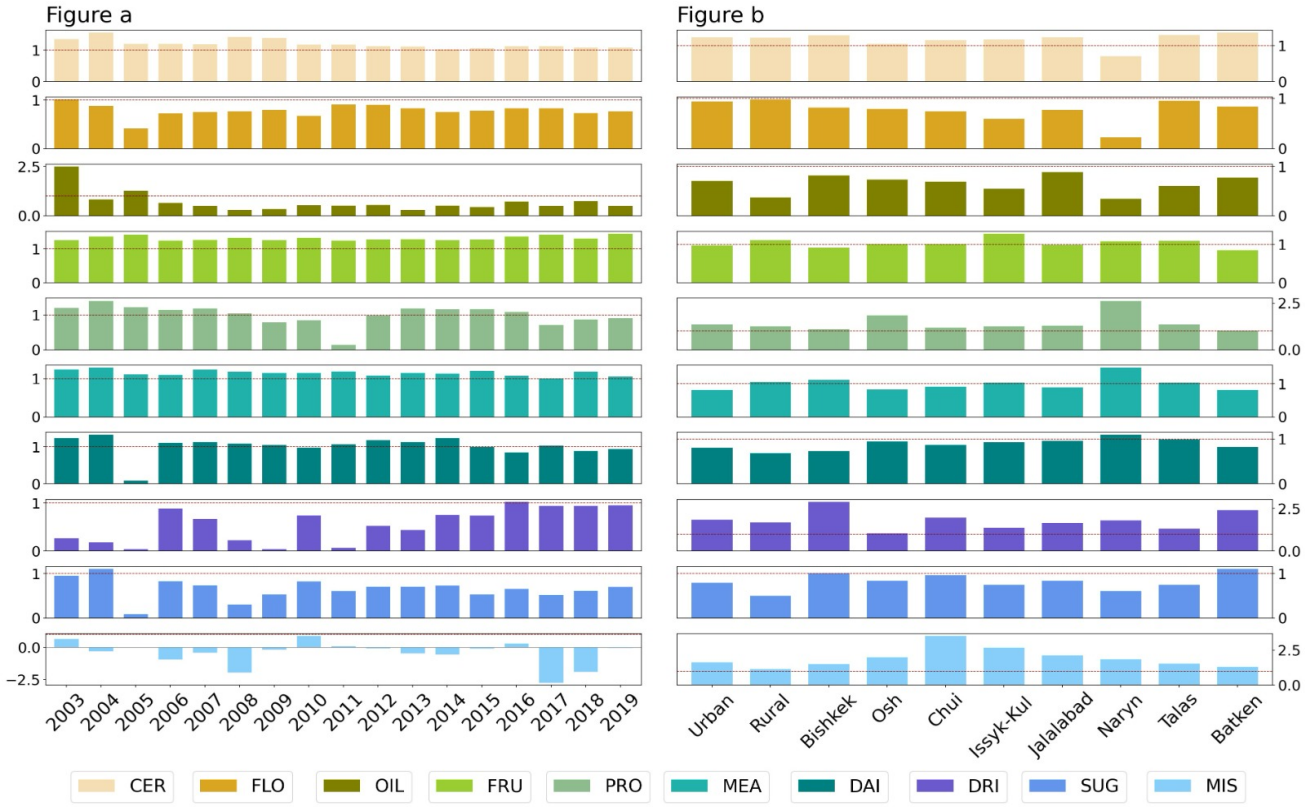
4.2 Dynamics of food demand across regions and years

Considering the differences in consumption shares by region and year observed in Figure 1, we estimate expenditure and uncompensated own-price elasticities across regions and years as shown in Figures[10] 3 and 4. Figure 3 (a) shows that expenditure elasticities for most foods do not vary significantly across years except

[10]The results presented in Figures 3 and 4 are reproduced in Table X in the Appendix.

for 2003, 2005, and 2011, respectively.[11] The possible reason for edible oils being luxury in 2003 could be the bankruptcy of several oil factories in the South. A substantial decrease in elasticities of drinks, dairy, and sugary products in 2005 could be related to the political turmoil that hit the country and households' earnings.

Figure 3: **Expenditure elasticities**



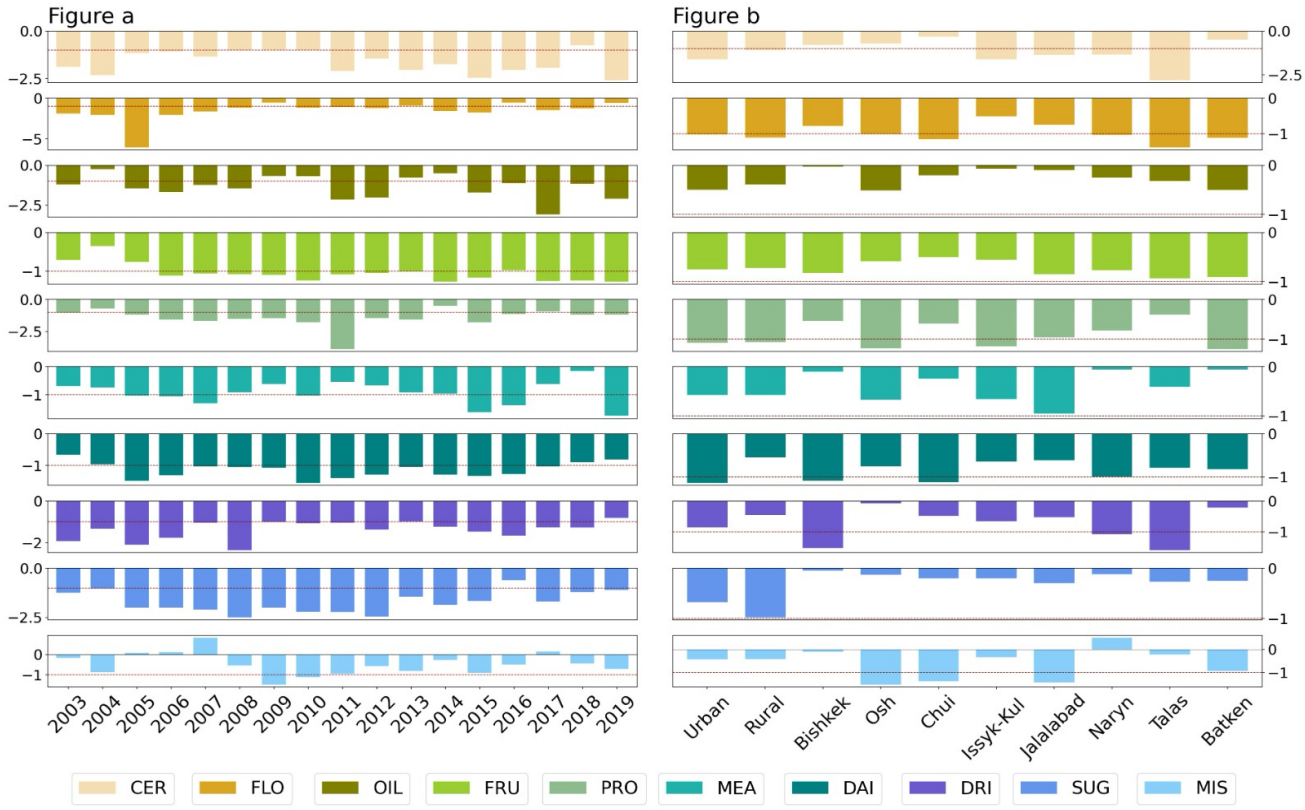
Source: Authors' figure.

From Figure 3 (b), we can see that urban and rural households respond similarly to income changes, except for edible oils, fruits & vegetables, and meat & fish. With slight differences in expenditure elasticities, fruits & vegetables and meat & and fish become luxury food for rural households and staples for urban ones. Consequently, an increase in income may have a greater impact on consuming these foods, switching them away from luxury items to staple foods and altering the diets of rural households. Regarding regions, the most extreme expenditure elasticity responses are observed in Naryn province. Processed food, an exceptional luxury for Naryn province, can be attributed to cold weather and cultural food choices that differ between households in Naryn and other provinces. Naryn province is mountainous and households are mainly engaged

[11] Miscellaneous products appear to be Giffen good for several years but we cannot be sure of results for these products due to the different composition and statistically insignificant results.

in livestock raising; thus, meat, fats, and flour products dominate people's diet.

Figure 4: **Uncompensated own-price elasticities**



Source: Authors' figure.

Unlike the expenditure elasticities, there are substantial differences in the magnitude of the responses of the own-price elasticities by year and region (Figure 4). For example, most products across years are generally own-price elastic, while they are inelastic across regions. In particular, in the post-revolutionary years (2006 and 2011), all products, and in the period of stagnation (2005-2011), almost all products, except for meat and fish, have high own-price elasticity, indicating people's dependence on purchased meat & fish in the diet of Kyrgyz people (Figure 4 (a)). Notably, the high own-price elasticity of sugary products from 2005 to 2017 can be explained by the downtime of the Kaindy sugar factory, which was the leading sugar factory in Kyrgyzstan. After the downtime, Kyrgyz households began to consume imported sugar, which was expensive and of poor quality.

Figure 4 (b) displays high fluctuations in own-price elasticities almost in all products except fruits & vegetables across regions. Cereals, dairy products, and drinks are price inelastic in rural areas, while urban households are not responsive to price changes of edible oils, fruits & vegetables, and meat & fish. We can

see similar responses in southern regions such as Osh, Jalal-Abad, and Batken, meaning cultural similarities in their diets. The different responses to price changes in northern provinces could be related to households' income and distance to the capital city Bishkek.

4.3 Food consumption and political upheavals

We now turn to the results of conditional quantile regression, which is performed by examining the relationship between household food expenditure shares and explanatory variables such as income and sociodemographic variables dividing the entire sample into pre and post-conflict periods. In total, we provide 200 regressions for each food group (10 in total) with four quantiles (0.25, 0.5, 0.75, 0.9) and for five periods (two pre-conflict and three post-conflict periods). Therefore, the best way to present the results is in the form of graphics. Figures 5 (a) and 7 (a) show the estimated impact of income on food expenditure shares in pre and post-conflict periods, with consumption intensity divided into four quantiles. In order to highlight the changes between the two periods, the absolute values of the estimated post-conflict coefficients are divided by their pre-conflict values and displayed in Figures 5 (b) and 7 (b). Thus, values further away from one point to larger changes between these two sub-periods. Figures 6 (a) and 8 (a) show how much urban households' consumption of a particular product has changed compared to rural households, while Figures 6 (b) and 8 (b) display the discrepancy between rural and urban households in food consumption. Figures 9 and 10 show the effect of income and food consumption in urban and rural households on the share of food expenditures, respectively.

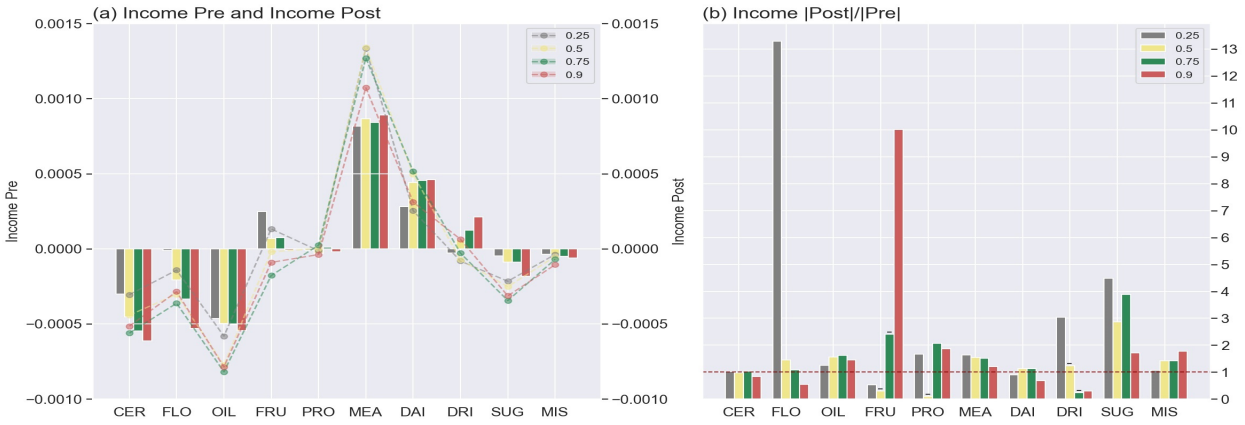
Figure 5: **Income effects on food expenditure shares before and after the revolution I**

Note: The negative sign above the quantile bars in Figure (b) indicate that the actual fraction values are negative.

Figure 5 (b) shows that the first post-revolutionary income negatively affects the consumption of many food groups, demonstrating the deterioration of food security in the country ($|post|/|pre| < 1$). However, the lowest quantiles' fat, fruits & vegetables, meat & fish, and dairy products consumption increased with income ($|post|/|pre| > 1$), suggesting those who consumed less of these foods began to consume more. The importance of processed and dairy products became valuable for the median quantile and sugar for the highest quantile. The increased income accelerated the diets of energy-intensive food lovers in favor of ultra-processed foods such as processed foods, dairy and sugary products, confirming the dietary transition phenomenon observed in developing countries.

Compared to the first post-revolutionary results, the second post-revolutionary results show that income growth positively affected the budget shares for almost all goods, improving food security (Figure 6 (b)). The general trend shows that the lowest quantile increased the share of flour products, processed foods, meat & fish, drinks, and sweets in its diet. In addition, we can observe a sharp increase in the consumption of flour products for the lowest quantile, fruits & vegetables for the highest quantile, and sweets for all quantiles. This suggests that confectionery dominates all households, pushing people away from healthy eating.

Figure 6: **Income effects on food expenditure shares before and after the revolution II**



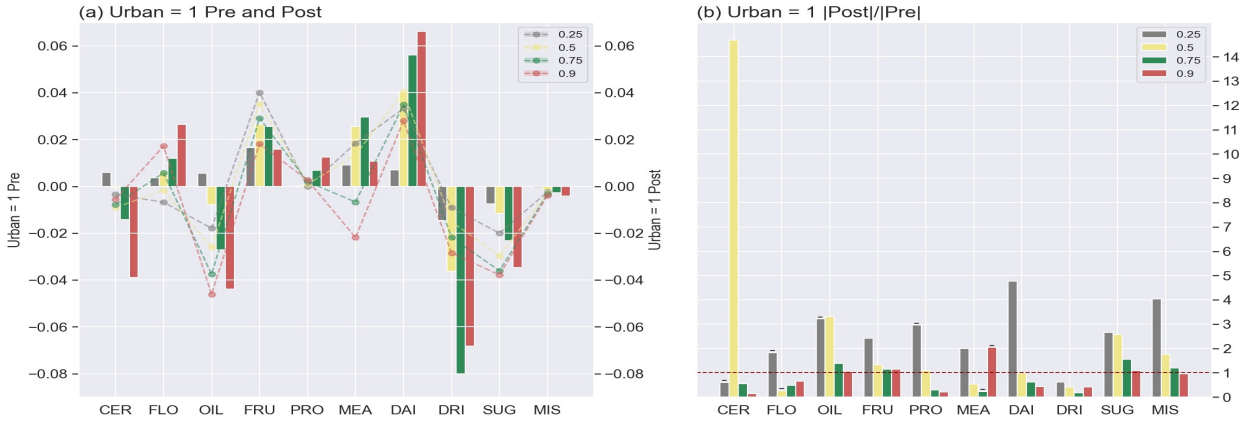
Note: The negative sign above the quantile bars in Figure (b) indicate that the actual fraction values are negative.

Looking at the results from a relatively stable period that spans six years from 2013 to 2019, almost all households have increased their budget shares for high-priced food such as fruits & vegetables, processed foods, meat & fish, and dairy products (Figure 7). Surprisingly, all households reduced their budget share for beverages and sugar consumption by changing their diet towards healthy food. On the one hand, these results are encouraging in terms of human health. However, they are also a cause for concern given the sharp decline in the agricultural sector, heavy reliance on food imports, and the volatility of the domestic food supply.

Figure 7: **Income effects on food expenditure shares in a stable period**

After the first revolution, the divergence between urban and rural households in food consumption widened, especially for the lowest quantile, as shown in Figure 8 (b). Budget share for fruits & vegetables, edible oils, and sugary products in urban households in all quantiles increased, while for other food groups, only the lowest quantiles' consumption increased. The sharpest increase occurred in the second quantile (0.5th) of cereals consumption, in the first quantile's (0.25th) consumption of fats, processed foods, and dairy products, suggesting that the consumption of these products in rural households decreased proportionally.

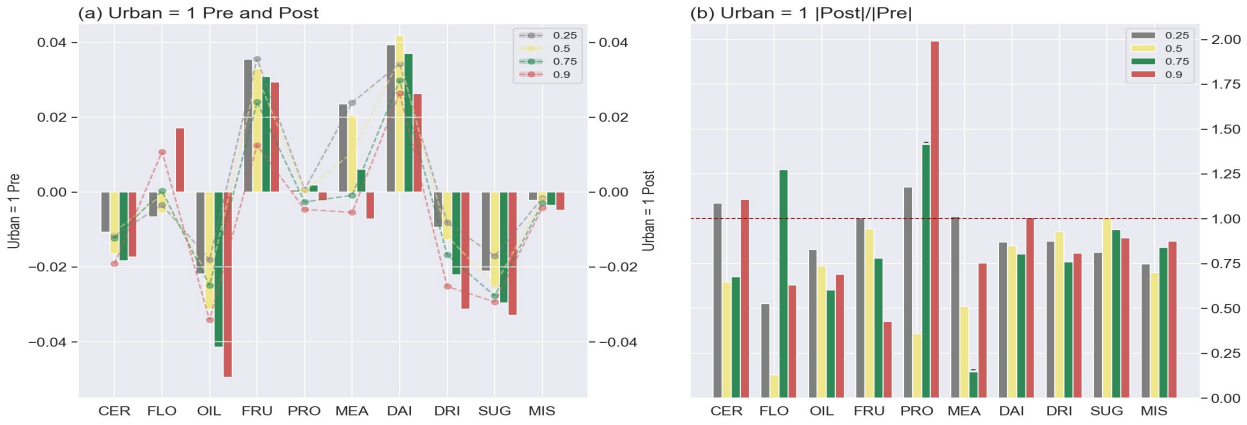
Figure 8: **Regional effects on food expenditure shares before and after the revolution I**



Note: The negative sign above the quantile bars in Figure (b) indicate that the actual fraction values are negative.

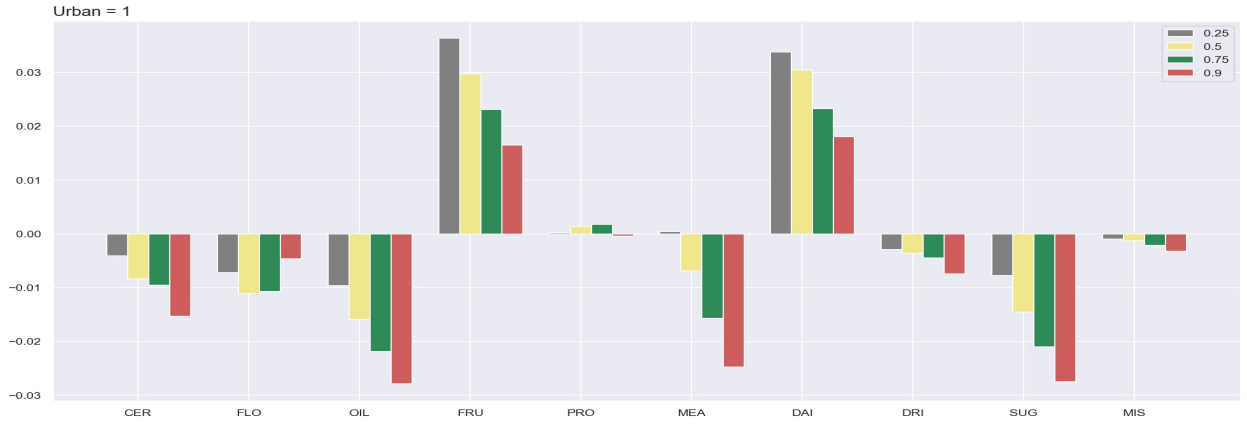
Figure 9 (b) shows that the post-revolution food consumption for urban households generally did not change much compared to the pre-revolution consumption for all products. The gap between consuming different types of food in urban and rural households narrowed when considering ranges along the axes (-

Figure 9: **Regional effects on food expenditure shares before and after the revolution II**



Note: The negative sign above the quantile bars in Figure (b) indicate that the actual fraction values are negative.

Figure 10: **Regional effects on food expenditure shares in a stable period**



0.04 to 0.04). The consumption of processed food has increased significantly among processed food lovers, while fruits & vegetables lovers' preferences have changed. The last figure (Figure 10) presents that only budget shares of fruits & vegetables and dairy products are increased for urban households, referring to the decrease of consumption of these products for rural households. In general, rural households are more likely to benefit from stability in the country.

5 Conclusion and policy implications

This paper presents the elasticity of food demand at the household level and shows which groups of consumers are more affected by political shocks. For present analysis, we use panel data from the KIHS conducted by the NSC of the Kyrgyz Republic quarterly for 17 years. The study first presents a set of

demand parameter estimates for ten major food groups, taking into account quality biases, spatial and temporal variations, and differences in household characteristics. Then, by comparing food consumption shares before and after revolutions, we can identify the causal effects on key outcomes of interest.

Demand elasticity estimates show that all expenditure elasticities are positive and own-price elasticities are negative for the whole sample as well as for regional and temporal subsamples. All foods appear to be normal goods, while cereals, fruits & vegetables, drinks, and miscellaneous are luxuries, suggesting that the latter are more responsive to income shocks. Our expenditure and own-price elasticities reveal that households are less income and more price responsive in different regions over the years. Arguably, a sharp decline in the amount of domestic food supply due to the reduced agricultural sector and dependence on imported goods can be a major reason for the highest response in price elasticities among food groups.

Looking at food expenditure shares (Figure 1), the diet has been shifting from staple food such as flour products to more protein-rich food such as meat & fish and fruits & vegetables. Declining production and rising demand for high-value goods create greater reliance on imported goods while exacerbating price spikes, posing a threat to adequate food consumption and a greater risk of malnutrition for low-income households. Consequently, food security policy needs to focus on increasing agricultural productivity, investments in food marketing and distribution systems, and appropriate trade policy to minimize exposure to fluctuations in world commodity prices. Given the importance of livestock and fruits & vegetables in the diets of Kyrgyz households, more research is needed on environmental governance to protect degraded pastures, improve veterinary services, and greenhouse technologies for fruit & vegetable production.

Our analysis of the impact assessment of the revolutions shows that household food consumption has deteriorated after the first revolution, and the gap between urban and rural households has widened. Arguably, income did not increase equally with price rise affecting households' food consumption in rural areas. After the second revolution, households were more likely to adapt to political shocks and food consumption improved relative to the first post-revolutionary results. In addition, households have changed their dietary habits towards expensive products such as confectionery, convenience foods, and meat & fish. From the period of stability, we can conclude that the volatility between quantiles has decreased, and the intensity of household food consumption has balanced across the quantiles as well as between urban and rural areas.

Dividing our data by five before and after the revolutionary periods, we were able to reveal the importance of political stability for the country's food security. Moreover, we have seen a dietary shift towards readily available, ultra-processed food, especially among northerners. This shift may be the reason for the higher incidence of non-communicable diseases among northerners than people living in the south. According to Otunchieva et al., 2021[39], the number of obese people in the north increased from 95 to 368 per thousand and decreased from 35 to 26 per thousand in the south during 2003-2018. Thus, awareness of this shift

is relevant for the government's nutritional programs aimed at striving overweight and increasing the life expectancy of Kyrgyz people.

Declaration of competing interest

The authors declare that there is no conflict of interest.

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References

[1] Anderson, J. (1999). Kyrgyzstan: Central Asia's island of democracy? Amsterdam: Harwood Academic.

[2] Attanasio, O., Di Maro, V., Lechene, V., & Phillips, D. (2013). Welfare consequences of food prices increases: Evidence from rural Mexico. *Journal of Development Economics*, 104, 136–151. doi:10.1016/j.jdeveco.2013.03.009

[3] Banks, J., Blundell, R., & Lewbel, A. (1997). Quadratic Engel Curves and Consumer Demand. *Review of Economics and Statistics*, 79(4), 527–539. doi:10.1162/003465397557015

[4] Barrett, C. B. (2010). Measuring Food Insecurity *Science*, 327(5967), 825–828. doi:10.1126/science.1182768

[5] Barrodale, I., & Roberts, F. D. K. (1974). Solution of an overdetermined system of equations in the l1 norm [F4]. *Communications of the ACM*, 17(6), 319–320. doi:10.1145/355616.361024

[6] Barten, A. P. (1969). Maximum likelihood estimation of a complete system of demand equations. *European Economic Review*, 1(1), 7–73. doi:10.1016/0014-2921(69)90017-8

[7] Brück, T., d' Errico, M., & Pietrelli, R. (2018). The effects of violent conflict on household resilience and food security: Evidence from the 2014 Gaza conflict. *World Development*, doi:10.1016/j.worlddev.2018.05.00

[8] Buchinsky, M. (1998). Recent Advances in Quantile Regression Models: A Practical Guideline for Empirical Research. *The Journal of Human Resources*, 33(1), 88. doi:10.2307/146316

[9] Chern, W. S., Ishibashi, K., Taniguchi, K., & Tokoyama, Y. (2002). Analysis of food consumption behavior by Japanese households (No. ESA Working Paper No. 02-06). Rome, Italy: Food and Agriculture Organization. http://www.fao.org/docrep/007/ae025e/ae025e00.htm

[10] Colen, L., Melo, P. C., Abdul-Salam, Y., Roberts, D., Mary, S., & Gomez Y Paloma, S. (2018). Income elasticities for food, calories and nutrients across Africa: A meta-analysis. *Food Policy*, 77, 116–132. doi:10.1016/j.foodpol.2018.04.002

[11] Cox, T. L., & Wohlgenant, M. K. (1986). Prices and Quality Effects in Cross-Sectional Demand Analysis. *American Journal of Agricultural Economics*, 68(4), 908. doi:10.2307/1242137

[12] Crawford, I., Laisney, F., & Preston, I., (2003). Estimation of household demand systems with theoretically consistent Engel curves and unit value specifications. *Journal of Econometrics*, 114, 221–241

[13] Christensen, L. R., Jorgenson D. W., & Lau, L. J. (1975). Transcendental Logarithmic Utility Functions *The American Economic Review*, 65(3), 367-383

[14] Deaton A. & Muellbauer J. (1980). An Almost Ideal Demand System *The American Economic Review*, 70(3), 312-326

[15] Deaton, A. (1988). Quality, Quantity, and Spatial Variation of Price *The American Economic Review*, 78(3), 418-430

[16] D'Souza, A., & Jolliffe, D. (2013). Conflict, food price shocks, and food insecurity: The experience of Afghan households. *Food Policy*, 42, 32–47. doi:10.1016/j.foodpol.2013.06.007

[17] Edgerton, D. L. (1997). Weak Separability and the Estimation of Elasticities in Multistage Demand Systems. *American Journal of Agricultural Economics*, 79(1), 62–79. doi:10.2307/1243943

[18] The State of Food Security and Nutrition in the World 2021. *FAO, Rome*, https://www.fao.org/3/cb4474en/online/cb4474en.html.

[19] Eurasian Economic Union statistics 2019.

[20] Global Report on Food Crises 2018. *Food Security Information Network*.

[21] Hale, H. (2006). Democracy or autocracy on the march? The colored revolutions as normal dynamics of patronal presidentialism. *Communist and Post-Communist Studies*, 39(3), 305–329.

[22] Hoang, H. K. (20189). Analysis of food demand in Vietnam and short-term impacts of market shocks on quantity and calorie consumption. *Agricultural Economics*, 49(1), 83–95. doi:10.1111/agec.12397

[23] Hussein, M., Law, C., & Fraser, I. (2021). An analysis of food demand in a fragile and insecure country: Somalia as a case study. *Food Policy*, 101, 102092. doi:10.1016/j.foodpol.2021.102092

[24] Ihle, R., & Rubin, O. D. (2013). Consequences of unintended food policies: Food price dynamics subject to the Israeli–Palestinian conflict. *Food Policy*, 42, 96–105. doi:10.1016/j.foodpol.2013.07.007

[25] Koenker, K., & Bassett, G. Jr. (1978). Regression Quantiles. *Econometrica*, 46(1), 33–50. doi:10.2307/1913643

[26] Koenker, R. W., & D'Orey, V. (1987). Algorithm AS 229: Computing Regression Quantiles. *Applied Statistics*, 36(3), 383. doi:10.2307/2347802

[27] Koenker, R., & d' Orey, V. (1994). Remark AS R92: A Remark on Algorithm AS 229: Computing Dual Regression Quantiles and Regression Rank Scores. *Applied Statistics*, 43(2), 410. doi:10.2307/2986030

[28] Koenker, R., & Park, B. J. (1996). An interior point algorithm for nonlinear quantile regression. *Journal of Econometrics*, 71(1-2), 265–283. doi:10.1016/0304-4076(96)84507-6

[29] Korir, L., Rizov, M., & Ruto, E. (2020). Food security in Kenya: Insights from a household food demand model. *Economic Modelling*, doi:10.1016/j.econmod.2020.07.015

[30] Kroeger, A., & Anderson, K. H. (2014). Remittances and the human capital of children: New evidence from Kyrgyzstan during revolution and financial crisis, 2005–2009. *Journal of Comparative Economics*, 42(3), 770–785. doi:10.1016/j.jce.2013.06.001

[31] Kubicek, P. (2011). Are Central Asian leaders learning from upheavals in Kyrgyzstan? *Journal of Eurasian Studies*, 2(2), 115–124. doi:10.1016/j.euras.2011.03.002

[32] Law, C., Fraser, I., & Piracha, M. (2019). Nutrition Transition and Changing Food Preferences in India. *Journal of Agricultural Economics*, doi:10.1111/1477-9552.12322

[33] Leser, C. E. V. (1963). Forms of Engel functions. *Econometrica*, 31(4), 694–703.

[34] Lecocq, S., & Robin, J. M. (2015). Estimating Almost-ideal Demand Systems with Endogenous Regressors. *The Stata Journal: Promoting communications on statistics and Stata*, 15(2), 554–573. doi:10.1177/1536867x1501500214

[35] Manning, W. G., Blumberg, L. & Moulton L. H. (1995). The demand for alcohol: The differential response to price. *Journal of Health Economics*, 14(2), 0–148. doi:10.1016/0167-6296(94)00042-3

[36] Martin-Shields, C. P., & Stojetz, W. (2019). Food security and conflict: Empirical challenges and future opportunities for research and policy making on food security and conflict *World Development*, vol. 119(C), pp. 150-164, https://doi.org/10.1016/j.worlddev.2018.07.011

[37] Muellbauer, J. (1976). Community Preferences and the Representative Consumer *Econometrica*, 44, 524–43.

[38] Ogundari, K., & Abdulai, A. (2013). Examining the heterogeneity in calorie–income elasticities: A meta-analysis. *Food Policy*, 40, 119–128. doi:10.1016/j.foodpol.2013.03.001

[39] Otunchieva, A., Borbodoev, J., & Ploeger, A. (2021) The Transformation of Food Culture on the Case of Kyrgyz Nomads—A Historical Overview. *Sustainability* 13, 8371. https://doi.org/10.3390/su13158371

[40] Portnoy, S., & Koenker, R. (1997). The Gaussian hare and the Laplacian tortoise: computability of squared-error versus absolute-error estimators. *Statistical Science*, 12(4), 279–300. doi:10.1214/ss/1030037960

[41] Radnitz, S., (2010). Weapons of the Wealthy. Predatory Regimes and Elite-Led Protests in Central Asia. *Cornell University Press*, Ithaca and London

[42] Roosen, J., Staudigel, M., & Rahbauer, S. (2022). Demand elasticities for fresh meat and welfare effects of meat taxes in Germany *Food Policy*, 106, 102194, doi:10.1016/j.foodpol.2021.102194

[43] Sadoulet, E., & de Janvry, A. (1995). Quantitative development policy analysis. Baltimore, London: John Hopkins University Press

[44] San Ahmed, A., & Holloway, G. J. (2017). Calories, conflict and correlates: Redistributive food security in post-conflict Iraq. *Food Policy*, 68, 89–99. doi:10.1016/j.foodpol.2017.01.005

[45] Solvang, O., & Neistat, A. (2010). Kyrgyzstan: Where Is the Justice? Interethnic Violence in Southern Kyrgyzstan and Its Aftermath. Human Rights Watch Report.

[46] Stewart, H., & Dong, D. (2018). How strong is the demand for food through direct-to-consumer outlets? *Food Policy*, doi:10.1016/j.foodpol.2018.04.010

[47] Stone, R. (1954). Linear Expenditure Systems and Demand Analysis: An Application to the Pattern of British Demand. *The Economic Journal*, 64(255), 511. doi:10.2307/2227743

[48] Steiner, S., & Esenaliev, D. (2011). Are Uzbeks Better Off? Economic Welfare and Ethnicity in Kyrgyzstan. Proceedings of the German Development Economics Conference No. 75, Berlin.

[49] Vinokurov, E., Lavrova, N., & Petrenko V. (2020). Kyrgyz Republic Debt Sustainability and External Shocks. EFSD Working Papers. Eurasian Development Bank. https://efsd.eabr.org/en/research/working-papers/

[50] World Bank national accounts data, and OECD National Accounts data files. https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS?locations=KG

[51] Working, H. (1943). Statistical laws of family expenditure. *Journal of the American Statistical Association*, 38(221), 43–56.

Appendices

- **Table A1** Food groups
- **Table A2** Estimates for
- **Table A3** Quality adjusted prices
- **Table A4** Quality adjusted prices
- **Table A5** Estimates of Working-Leser model
- **Table A6** QUAIDS parameters
- **Table A7** Estimates of quantile regressions