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CLIMATE CHANGE AND INTERNATIONAL MIGRATION: EVIDENCE FROM TAJIKISTAN

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Abstract

This paper investigates the impact of environmental factors that indicate climate change on household decisions to migrate abroad in the case of Tajikistan, an environmentally vulnerable and a labor-migrant source country in Central Asia. Both long-term climate variation (measured by weather anomalies) and short-term weather shocks (proxied by floods) are considered as environmental factors that could induce migration from Tajikistan. Using two waves of a nationally representative household survey and employing an empirical method within the New Economics of Labor Migration theory framework, the results highlight the differing effects of environmental factors (depending on their type and intensity) on the probability to migrate abroad. The findings show that a rise in air temperature from its long-term average reduces emigration, while changes in precipitation have a non-linear impact on emigration. There are substantial differences in seasonal weather anomalies, of which winter temperature and precipitation have the most significant impact on household decisions to migrate. Sudden onset environmental shocks appear to have a lagged impact on emigration.

Keywords: migration, climate variation, environmental shock, Tajikistan

JEL Classification: F22, O12, D10, C20

Contents

1. INTRODUCTION

Scientific arguments and evidence have drawn increasing attention to changes in the global climate in terms of rising global air temperature and sea level, retreating snow cover and glaciers, altered precipitation patterns, and more frequent extreme weather events (National Centers for Environmental Information 2020). While the Intergovernmental Panel on Climate Change (IPCC 2014) has argued that the greatest impact of climate change could be on human migration and has predicted that 200 million people will have migrated from their place of origin by 2050, the evidence for the effect of environmental factors on human migration, particularly on temporary migration as an adaptive strategy to confront climate stress, remains inconclusive. Because environmental factors affect both the incentive and the ability to migrate, the relationship is not straightforward and involves many complexities.

Environmental factors could exert substantially heterogeneous impacts on migration depending on the initial climatic and socio-economic conditions of the countries in question (Obokata et al. 2014; Berlemann and Steinhardt 2017). Many developing countries are predicted to be disproportionally affected by climate change due to their geography, agriculture-based economies, and lack of adaptive mechanisms (Beine |and Parsons 2017). Particularly, climate change poses tremendous challenges to livelihoods based on agriculture around the world (Cattaneo and Peri 2015), and people seek out informal ways of coping including migration when formal mechanisms such as insurance and credit markets are ill-functioning or inaccessible (Lewin et al. 2012).

Some studies view migration as a common mechanism, historically, for adapting and coping with climate and weather-related shocks, because migration helps mitigate the adverse effects of such events on livelihoods. Climate change and natural disasters could induce migration if individuals do not have any other mitigation strategies. If migrants send remittances home, migration could even have income diversification and consumption smoothing effects on the left-behind household members when formal safety nets and insurance markets are incomplete or absent (Wouterse and Taylor 2008). For example, Filipino households with overseas migrants can reduce adverse income shocks with receipt of remittances, while households without overseas migrants cannot (Yang and Choi 2007).

Conversely, the impact of environmental factors may be marginal if people cannot afford to migrate or if there are alternative coping strategies available that would allow them to alleviate the adverse effects of environmental stressors. Migration is costly both financially and psychologically. Studies have shown that people in the lowest income quantile do not necessarily migrate in the aftermath of natural disasters, as they lack the means to finance such migration. While environmental stressors may increase incentives to migrate abroad, these may not materialize if individuals are credit constrained. For instance, Bazzi (2017) has found that persistent income shock and liquidity constraints reduce emigration from rural Indonesia, while Bryan et al. (2014) have argued that liquidity constraints are a barrier to seasonal rural-urban migration in Bangladesh. The latter authors randomly assigned monetary incentives to rural farmers in Bangladesh and found that the incentive significantly increased rural-urban seasonal migration by easing such constraints. Similarly, individuals at the top of the income distribution are also less likely to migrate as a response to environmental shocks because they have other mitigating strategies available to them (Drabo and Mbaye 2015).

The intensity, frequency and the types of environmental shock play crucial roles in determining whether households engage in international or domestic migration, or stay in their place of origin. Studies have shown that sudden-onset and high-intensity environmental stressors such as floods, tsunamis, and earthquakes result in an immediate increase in short-distance or domestic migration. On the other hand, medium- and long-term environmental stressors such as long-term variations in temperature and precipitation and the subsequent degradation of natural resources—which cause repeated livelihood failures—often lead to long-distance or international migration (Brember and Hunter 2014). For example, Marchiori et al. (2012) have found that climate change, measured by long-term climatic variations (i.e., rising temperature and altered precipitation patterns from the historical averages) push migrants from developing countries to developed countries. Knowing what type of environmental stressors affect households and cause them to engage in international rather than internal migration would have implications for the cost and affordability of relocation, policy management of migrants, the size of future remittances, and the economic prospects abroad versus at home. These implications are likely to be country specific depending on the initial socio-economic conditions, geography, and capacity for adaptive mechanisms. Empirical evidence is needed to inform policymakers about the different migration responses to climate change and natural disasters in the country-specific context.

In this area, Tajikistan is an interesting case for at least two reasons. First, temporary labor migration from Tajikistan plays a vital role in keeping the Tajikistan economy afloat via remittances from Tajik migrants abroad (particularly in the Russian Federation). A recent report on a nationally representative household survey in Tajikistan found that about 40% of households have at least one member who has migrated abroad, while only 3% of households had internal migrants in 2018 (Japan International Cooperation Agency 2020). According to the report, out of all total international migrants, almost 99% chose the Russian Federation as their destination due to the well-established migration corridor and the historical tie through the former Soviet Union. Remittances from migrant workers have been a major contributor to Tajikistan’s economy, constituting 30%–50% of its GDP since the mid-2000s, and making the country one of the top remittance-dependent countries in the world (World Bank 2020).

Second, Tajikistan is highly vulnerable to climate change due to its specific orography and climatic conditions, as well as low capacity for adaptation and coping (World Food Programme 2017). About a half of Central Asia’s glaciers are located in Tajikistan, stretching over 8.5 thousand square kilometers (UNDP 2012). These glaciers serve an important climatic role in retaining water, controlling flows, and regulating the climate not only in Tajikistan, but also in Central Asia. According to the World Bank (2020), there has been a significant increase in the annual average air temperature (a rise by 0.2°C–1.2°C since 1940) in Tajikistan, which has caused melting of seasonal snow cover and glaciers. The IPCC (2014) has predicted that the average surface temperature in Tajikistan will rise a further 1°C–3°C by 2050. Tajikistan has also experienced a sharp increase in the intensity and frequency of extreme weather events, particularly floods and mudflows related to the melting of glaciers. These environmental stressors threaten livelihoods in Tajikistan, especially among those dependent on agriculture and natural resources. Environmental mismanagement and poor infrastructure are ill suited to mitigating such environmental shocks. Due to the lack of coping mechanisms, labor migration could serve as a way to diversify household income and reduce economic stress triggered by environmental shocks in Tajikistan.

This paper considers the impact of environmental factors that gauge climate change on household decisions in Tajikistan to send one or more household members abroad temporarily to work. The paper uses data from the Tajikistan Living Standards Survey (TLSS) conducted in 2007 and 2009. The contribution of the paper is twofold. First, it examines the effects of both long-term climatic shocks[1] and short-term natural disaster shocks on the migration decision. Most studies analyze either long-term climatic variability or short-term weather shocks for their effects on migration decision. However, long- and short-term environmental factors are perceived differently by households and may have different associations with their migration decisions. It is therefore important to see how the impact of slow-onset or long-term climate variability differs from sudden-onset or short-term natural disasters on the decision to migrate under the same household setting. A further contribution is that this paper considers the individual impacts of seasonal climate variations measured by seasonal temperature and precipitation anomalies in addition to annual average weather anomalies. For short-term environmental shocks, data on the incidence of floods at the district level were used.

Second, this is, to the best of the author's knowledge, the first study to analyze the impact of climate variability and weather shocks on international migration in Tajikistan. Given the importance of Tajikistan's geography for normalizing weather in Central Asia, climate change could have an extensive impact on the livelihoods not only of the Tajik people, but also of citizens in neighboring Central Asian countries. Understanding whether environmental stressors lead to international migration is crucial to help formulate policy recommendations to manage climate change and consequent natural disasters and to support the livelihoods of those affected.

The findings suggest that environmental factors have some liquidity constraint–related effects on international migration decisions, as the long-term increase in temperature and precipitation from historical averages are found to reduce emigration. The findings also show that seasonal weather changes have differing impacts on migration. Throughout the course of a year, the most significant changes in weather have been occurring in winter, which coincides with the return of temporary migrants from the Russian Federation and the planting of crops such as winter wheat, which is a staple food in Tajikistan. Consequently, the rise in winter temperatures and precipitation increases emigration from Tajikistan and suggests the lack of other coping mechanisms for migrants.

This paper is organized as follows. Section 2 describes the data sources used and the current state of climate change and migration in Tajikistan. Section 3 explains the theoretical model and empirical strategy applied in this study. Section 4 presents and discusses the results. Section 5 summarizes the main findings and gives perspectives for future research.

2. DATA

This paper makes use of three sources of data: (1) a nationally representative panel dataset constructed from two rounds of the TLSS conducted in 2007 and 2009; (2) monthly terrestrial air temperature and precipitation data from Matsuura and National Center for Atmospheric Research Staff (2020); and (3) information on the prevalence of disasters from the ReliefWeb (2020) Disasters website.

TLSS 2007 and 2009 were designed by the World Bank and UNICEF and implemented by the Statistical Agency of Tajikistan. The TLSS 2007 sample covered 4,860 households representative at the national, regional, and urban/rural levels. Of the 2007

[1] In the literature, the term "climatic shocks" refers to variations in temperature and precipitation from their long-term average values. Climatic shocks are often measured in terms of weather anomalies. This paper follows the literature in this regard.

sample, the TLSS 2009 tracked 1,503 households representative at the national level. Table 1 shows the sample allocation of households in the panel survey.

Table 1: Sample Allocation of Households in TLSS 2007 and 2009

	Urban	Rural	Total
Dushanbe	270	0	270
Sughd	135	261	396
Khatlon	63	315	378
Region of Republican Subordination (RRS)	54	261	315
Gorno-Badakhshan Autonomous Region (GBAO)	18	126	144
Total	540	963	1,503

Source: Author's computation based on TLSS 2007 and 2009.

The main purpose of the TLSS was to evaluate the living standards of the population and measure the poverty rate in Tajikistan. The TLSS 2007 data were collected through three distinct questionnaires: a household questionnaire, a female questionnaire, and a community questionnaire. The TLSS 2009 used only the household questionnaire, which covered household roster, food and non-food consumption, education, health, migration, access to utilities, private and social transfers, and subjective poverty. The migration module of the surveys covered internal and international migrations for current household members, as well as migration for family members living away from their households.

In the TLSS, a household is defined as a group of people who live together, pool their finances, and eat at least one meal a day together during the survey reference period or the last 12 months. For the purpose of this paper, an international migrant is defined based on two criteria: (1) a current household member who has been away for at least three months during the survey reference period or the last 12 months prior to the day of the interview, or (2) a non-current household member (but a family member) who has been away to work abroad for more than 12 months. Thus, those who have been away for less than three months are not counted as migrants. A migrant household is defined as a household that has at least one international migrant member, and a non-migrant household is defined as a household without any international migrant members.

Based on the above definition, the sampled households are divided into two groups: migrant and non-migrant households. Table 2 summarizes the variables used in the study for 2009.

To control for time-invariant unobserved components and omitted variable bias, a fixed-effects logistics model was applied on a sample of households that experienced a change in migration status between 2007 and 2009. Because fixed effects analysis uses only within-household variation, for those households whose migration status has not changed, there is no within-household variation on the response variable, so they are excluded them from the sample. The total sample for the analysis was therefore restricted to 424 households that experienced migration status change between 2007 and 2009, of which 256 households became migrants and 168 households returned from migration.

Table 2: Summary Statistics

	Migrant Households		Non-migrant Households		All Households	
Variables	**Mean**	**Std. Dev**	**Mean**	**Std. Dev**	**Mean**	**Std. Dev**
Temperature anomaly, Celsius	–0.06	0.72	0.02	0.65	–0.03	0.69
Winter temperature anomaly	1.31	0.94	1.42	0.84	1.35	0.90
Spring temperature anomaly	–0.56	0.53	–0.44	0.50	–0.51	0.52
Summer temperature anomaly	–0.99	0.82	–0.91	0.76	–0.96	0.79
Autumn temperature anomaly	0.00	0.81	0.03	0.73	0.01	0.78
Precipitation anomaly, cm	0.69	2.92	0.78	3.02	0.72	2.96
Winter precipitation anomaly	12.61	11.94	10.43	10.76	11.74	11.53
Spring precipitation anomaly	2.27	7.59	4.95	8.09	3.33	7.89
Summer precipitation anomaly	–2.09	1.97	–1.71	2.07	–1.94	2.01
Autumn precipitation anomaly	–10.04	3.04	–10.54	2.72	–10.24	2.92
Flood	0.17	0.38	0.18	0.39	0.18	0.38
Household size	7.23	3.04	7.10	2.84	7.18	2.96
Number of employed	1.80	1.53	1.90	1.41	1.84	1.48
Moderately poor	0.28	0.45	0.29	0.46	0.28	0.45
Non-poor	0.59	0.49	0.58	0.50	0.58	0.49
Wage employment (head)	0.32	0.47	0.33	0.47	0.32	0.47
Self-employment (head)	0.19	0.39	0.26	0.44	0.22	0.41
Mean wage rate at PSU	6.74	0.61	6.72	0.62	6.73	0.61
Number of workers in PSU	1.56	0.18	1.62	0.20	1.59	0.19
Number of migrants in PSU	2.04	1.65	1.67	1.36	1.90	1.55
Number of observations	256		168		424	

Note: Std. Dev. = Standard Deviation; PSU = Primary sampling unit.

Source: Author's computations.

At a glance, migrant households are slightly larger and from communities with relatively more emigrants and a smaller number of employed people. Non-migrant households have more employed members and a head who is likely to be self-employed. In terms of poverty status and average community wage rate, there are no significant differences between migrant and non-migrant households.

Climate change is often defined as a long-term climate variation, which in turn is measured by temperature and precipitation anomalies. Weather anomaly variables were constructed based on monthly terrestrial air temperature and precipitation data obtained from Matsuura and National Center for Atmospheric Research Staff (2020), who provide gridded monthly values for precipitation and temperature as a local point estimate at a resolution of 0.5° longitude-latitude. Temperature and precipitation anomalies are more insightful for studying climate changes than absolute measures, because they show departures from the long-term averages or reference values. In the climate change literature, it is often recommended to take 30 or more years of temperature and precipitation data averages as references for calculating weather anomalies. In this paper, 50-year averages prior to each survey round were used as references. More specifically, the following calculation was used to obtain weather anomalies at each survey reference year:

$$anomaly_t = w_t - \frac{\sum_{t=t-50}^{t} w_t}{50} \quad (1)$$

where w_t is the mean (annual or seasonal) air temperature in Celsius or precipitation in centimeters, $anomaly_t$ is the temperature or precipitation anomaly at year *t*, and *t* is the survey year 2007 or 2009. A positive anomaly indicates that the observed temperature or precipitation was higher than the long-term average, while a negative anomaly means the opposite. The temperature and precipitation anomalies were linked with the household data using geographical coordinates recorded at the primary sampling unit (PSU) level within the TLSS data. The seasonal anomaly variables were constructed in the same way for Tajikistan's four distinct seasons.[2]

Table 2 shows that the mean annual temperature was slightly cooler than the reference temperature, but this masks the variations in seasonal temperature anomalies. Winter temperature anomalies show that it was warmer by 1.3°C, while spring and summer were 0.3°C–0.9°C cooler than their respective reference temperatures in 2009. Similarly, the mean annual precipitation conceals seasonal variations in precipitation anomalies. The most prominent changes in precipitation patterns were recorded in winter and autumn. An increase of almost 12 cm in precipitation was observed in winter, while an approximate 10-cm decline in precipitation was detected in autumn in 2009, compared to the long-term averages. Weather anomalies also differ across space. Table 3 presents the annual mean and winter temperature and precipitation anomalies across regions.

Table 3: Temperature and Precipitation Anomalies

	Temperature Anomalies, Celsius		Precipitation Anomalies, cm	
	Annual	**Winter**	**Annual**	**Winter**
Dushanbe	0.2	1.4	0.2	6.0
Sughd	0.3	2.1	1.5	5.9
Khatlon	0.3	1.6	–0.5	12.4
RRS	–0.1	1.3	–0.6	7.2
GBAO	–1.4	–0.6	5.1	37.6

Source: Author's compilation based on Matsuura and National Center for Atmospheric Research Staff (2020).

The temperature anomalies across the regions show that those in the north and west are getting warmer, while those in the southeast have become cooler than the reference period. As shown in Tables 2 and 3, the most prominent changes in temperature and precipitation are in winter. Over the course of the year, the winter months have become warmer than their long-term averages, particularly in the northwest region of Sughd, where winter temperatures have risen by 2°C. Out of the five regions of Tajikistan, only the Gorno-Badakhshan Autonomous Region (GBAO) has seen a decline in winter air temperatures by about 0.6°C.

The annual mean precipitation anomalies show that the most noticeable change has occurred in GBAO, where the annual precipitation has increased by more than 5 cm. The annual precipitation has also increased in Sughd by about 2 cm, while the increase in Dushanbe is slightly less than a centimeter. Like the temperature anomalies, the winter months have experienced the highest increase in precipitation. All regions have had an increase in seasonal precipitation, among which GBAO's winter precipitation has risen by 38 cm, mainly from the sudden onset of heavy snow during the winter

[2] Tajikistan has four distinct seasons: winter (December–February), spring (March–May), summer (June–August), and autumn (September–November).

of 2008–2009. Although the amount of precipitation has increased, climate reports demonstrate that the onsets of heavy snow and rain have increased, while the number of snowy days has declined (World Bank 2020). Much of the precipitation is also falling in the form of rain rather than snow due to warming temperatures.

Longer dry spells and sudden heavy precipitation coupled with higher temperatures has led to the melting of glaciers, which are the major regulators of the climate not only in Tajikistan but also in neighboring Central Asian countries. The melting of glaciers due to rising temperatures has make Tajikistan extremely prone to recurrent flush floods and mudslides (UNDP 2012). During the survey period, about one third of all districts were affected by recurrent floods and mudslides, which caused substantial damage to human lives, livelihoods, and infrastructure. In our sample, 18% of households were affected by floods. There was no substantial difference in flooding risks faced by migrant- and non-migrant households.

Finally, a number of local community-level variables were included, following the theory of New Economics of Labor Migration (NELM). As a local community, the smallest possible unit that could be observed in the data is PSU. The PSU-level average wage rate, number of wage earners, and the number of migrants were therefore considered as community-level variables. There was no substantial difference in mean wage rate between migrant and non-migrant households.

3. THEORY AND EMPIRICAL STRATEGY

The theoretical and conceptual framework of this paper is based on the NELM theory, which argues that migration is a mutual decision by household members to maximize household utility and to diversify risks to household income and wellbeing. In other words, the NELM theory postulates migration as a household strategy for livelihood diversification to minimize risks and uncertainties (Stark and Bloom 1985). The NELM framework is particularly suitable for explaining situations in which a household send some of its members to get remittances that diversify household income sources and smoothen consumption.

Environmental factors such as temperature and precipitation shocks and variations may affect livelihood viability, especially in agriculture and resource-based economies (Eakin 2005). When faced with environmental shocks, households may allocate some of their labor supply to urban or foreign labor markets (Massey et al. 1993). If there is a strong pre-existing cultural tie and migration corridor, international migration is more likely due to economic motivations driven by income gaps with the destination countries.

Within the NELM framework, individual, household, and community characteristics—including household composition, gender, educational attainment, employment, and social networks—are important determinants of migration decisions in response to shocks. To estimate the impact of environmental factors on migration decisions within the NELM framework, the following simple model is used:

$$\ln\left(\frac{p_{it}}{1-p_{it}}\right) = \mu_t + \beta x_{it} + \gamma z_i + \varepsilon_i \quad (2)$$

where p_{it} is the migration probability for household *i* at time *t*; μ_t is an intercept that may be different for each period *t*; x_{it} is a vector of time-varying predictors (such as household size, the number of employed adults, and environmental factors); z_i is a vector of time-invariant predictors (such as the completed education of household adults, the gender of the household head, and the location of the main household); ε_i indicates the combined effects of all time-invariant unobserved variables; and β and γ are the coefficient vectors. To control for unobserved time-invariant components and omitted variable bias with respect to household migration decisions, equation (2) is estimated by a fixed effects conditional logit model. Because we have only two time periods (2007 and 2009), the conventional maximum likelihood approach was applied to estimate the following variation of model (2):

$$\ln\left(\frac{p_{it}}{1-p_{it}}\right) = (\mu_2 - \mu_1) + \beta(x_{i2} - x_{i1}) \quad (3)$$

A logistic regression of the migration decision on the difference scores for the time-varying predictors was applied on a sample of households whose migration status changed between the survey reference periods. Because fixed effects analysis uses only within-household variation (Allison 2009), the sample is restricted to those households who changed their migration status between 2007 and 2009. Households whose migration status did not change between 2007 and 2009 were excluded, as they had no internal variations on the response variable.

As the migration response to environmental factors is complex and has no priori direction, several specifications of model (3) were estimated, including:

(i) only the weather anomaly as a covariate,

(ii) household and community characteristics described in Table 2 in addition to the weather anomaly,

(iii) all covariates in specification (ii) and the squared weather anomaly variable to test if changes in temperature and precipitation have non-linear effects, and

(iv) all covariates in specification (ii) and interactions of the weather anomaly with an indicator of household head's engagement in agricultural activities to test if environmental factors have different impacts for agriculture-dependent households.

These specifications of model (3) were estimated separately for each weather anomaly and the incidence of flood variables described in Table 2.

4. RESULTS AND DISCUSSIONS

This section presents and discusses the results of the application of the empirical strategy described in Section 3. Table 4 presents the estimated results for the impact of the annual mean temperature anomaly on the decision to migrate abroad using the four specifications previously; columns (1)–(4) correspond to specifications (i)–(iv) described in Section 3. The estimated coefficients are reported in odds ratios, so coefficient values less than one indicate that the probability of migrating is lower than the probability of staying, and vice versa. The coefficients for the temperature anomaly variable were statistically significant and less than one in all four specifications, indicating that an increase in annual mean temperature from its long-term average is associated with lower migration abroad. In columns (3) and (4), the squared temperature anomaly and the interaction term of the temperature anomaly with an indicator variable for agricultural households were not statistically significant, rejecting the hypotheses that the effect of temperature anomaly is non-linear and that its impact differs for agricultural households. Conversely, household and community characteristics were found to be important determinants of the migration decision, as many of these covariates were statistically significant and of the expected signs or consistent with the NELM theory predictions. The preferred specification in Table 4 is thus column 2, which includes all household and community characteristics in addition to the temperature anomaly.

Table 4: Impact of the Change in the Annual Mean Air Temperature on Migration

	(1)	(2)	(3)	(4)
Temperature anomaly	0.53***	0.63**	0.42**	0.63*
	(0.09)	(0.15)	(0.15)	(0.15)
Temperature anomaly^2			0.77	
			(0.14)	
Temperature anomaly × Agricultural household				1.04
				(0.42)
Agricultural household				0.67
				(0.19)
Household size		1.05	1.05	1.04
		(0.05)	(0.05)	(0.05)
Number of employed adults		0.83**	0.83**	0.83**
		(0.07)	(0.07)	(0.07)
Moderately poor[a]		0.68	0.66	0.69
		(0.17)	(0.17)	(0.17)
Not poor[a]		0.72	0.70	0.72
		(0.19)	(0.18)	(0.19)
Head is wage-employed[b]		0.59**	0.60**	0.62**
		(0.13)	(0.13)	(0.14)
Head is self-employed[b]		0.51***	0.51***	0.60*
		(0.12)	(0.12)	(0.16)
Log of mean PSU wage		1.03	1.06	1.04
		(0.13)	(0.14)	(0.13)
Share of wage-earners in PSU		0.96	0.86	0.98
		(0.26)	(0.24)	(0.27)
Number of migrants in PSU		1.15**	1.14**	1.15**
		(0.07)	(0.07)	(0.07)
Observations	848	848	848	848
Number of households	424	424	424	424

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are in parentheses. Results are reported in odds ratios. a – Reference group is extremely poor. b – Reference group is unemployed.

Source: Author's estimations.

The household and community covariates show that employment is an important factor that affects the decision to migrate. According to the NELM, a household allocates its labor supply to diversify risks and increase the overall household utility. In the absence of local job opportunities, households seek opportunities outside their community and even abroad. Due to a lack of domestic job opportunities, many Tajiks wish to go to the Russian Federation and other Central Asian countries because they have higher potential wages than in Tajikistan. The results here indicate that households with more employed adults and self-employed household heads are less likely to send members abroad to work. Individuals with stable jobs or well-established careers in Tajikistan are less likely to migrate abroad, because there is no guarantee that they would have the same job prospects upon return if they leave their current employment (Olimova and Kumar 2010).

Another important determinant of migration within the NELM framework is the presence of a migration network, which reduces the costs of migration and the search for employment abroad. We use the number of migrants in the PSU, excluding the household itself, as a proxy for the migration network. The estimated coefficient for the migration network variable was statistically significant and greater than one, implying that having migration network increases the probability of migration. A well-established migration network and the associated higher potential wages at the destination are perhaps key reasons that Tajik migrants choose to go to the Russian Federation instead of pursuing domestic migration, which provides smaller economic motivations.

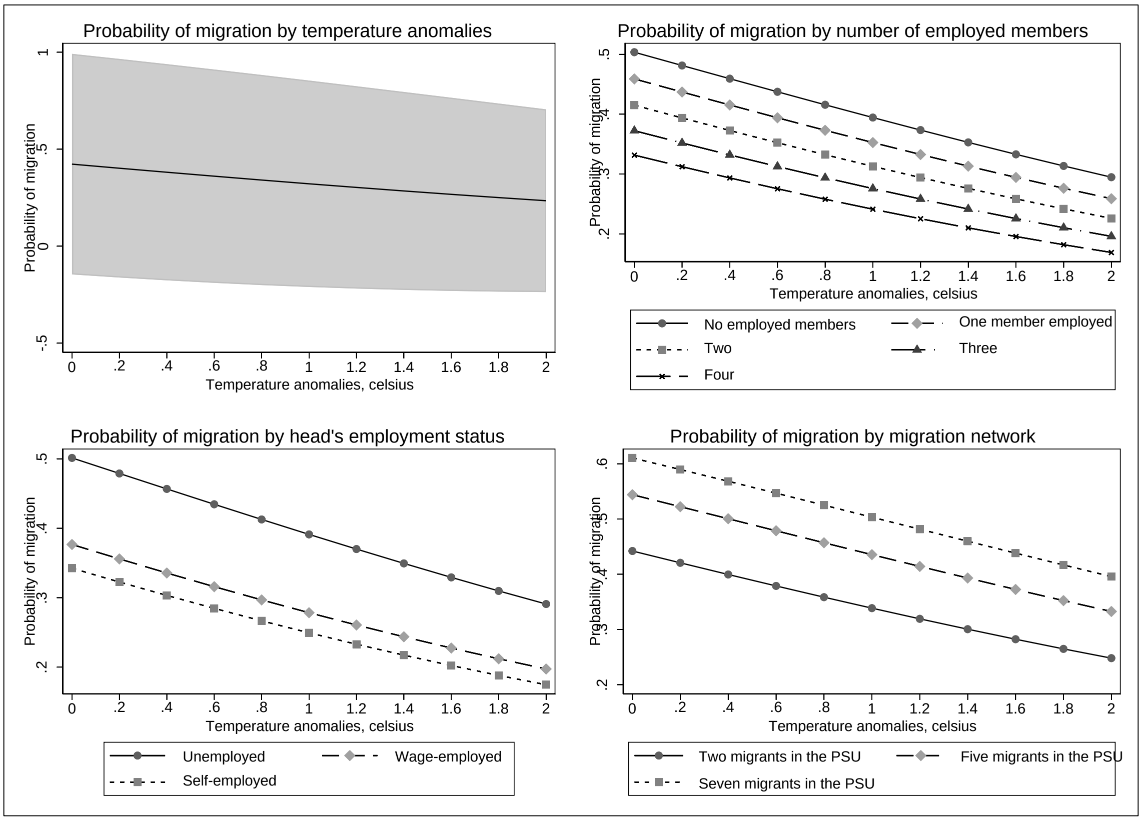
The remaining household and community variables were of the expected signs and consistent with the NELM, although they were not statistically significant. For example, an increase in the average wage rate at the community or PSU level, which could be interpreted as a proxy for PSU-level living standards, could lead to more migration because international migration is costly and liquidity constrained individuals are often unable to move. An employment opportunity at home is therefore an important determinant of migration, as the results showed that an increase in the share of wage earners in the PSU reduced international migration. Sending an emigrant abroad also depends on a household's available labor supply; larger households have more people to send abroad, while still maintaining income-earning activities at home.

The literature suggests that agriculture is a possible transmission channel through which climate change affects migration (Cattaneo and Peri 2015). To test whether climatic variations have a different effect on agricultural households compared to non-agricultural households, the indicator variable for agricultural households was interacted with the weather anomaly variables in the estimations. Although statistically insignificant, the results indicated that the climate change effect on agricultural household could induce migration. The long-term climatic shocks—namely gradual warming of temperature and altering pattern of precipitation—could dampen agricultural productivity, which in turn would increase migration. However, more evidence and a longer span of panel data are needed to prove this hypothesis.

While odds ratios are useful for identifying whether the probability of migration is greater than that of staying given household conditions of the household, it is more intuitive to estimate marginal effects in terms of predicted probabilities. Figure 1 shows the predicted probabilities of migration conditional on the statistically significant variables obtained in columns 2 of Table 4. The upper left panel of Figure 1 shows the probability of migration as air temperature rises above its long-term average. Despite a large 95% confidence interval (the shaded area in gray), there is a significant negative relationship between the temperature anomaly and migration. The estimated marginal effect is −0.1 at the p=0.05 significance level, indicating that a one degree rise in air temperature above its 50-year average lowers the probability of migrating abroad by 10 percentage points.

Being employed is found to be a major determinant of migration, regardless of variations in air temperature. The top right panel of Figure 1 shows that the more household members are employed, the less migration takes place. The probability of migration decreases proportionally to increases in the temperature anomaly, regardless of the number of employed household members. However, households with unemployed members are more likely to send their members abroad to work. This pattern is also consistent with the employment status of the household head. Households with an unemployed head are more likely to send a migrant than households with employed heads. Among households with employed heads, those with self-employed heads are least likely to send migrants. Although the probability of migration decreases for all households as the temperature rises, for households with unemployed heads or members this decline disproportionally greater than for households with employed heads and members. This could indicate that a large increase in temperature could affect the ability of households to migrate, especially those who are credit constrained.

Figure 1: Predicted Probabilities of Migration by Temperature Anomalies and Household Characteristics



Note: Shaded area is 95% confidence interval.

Source: Author's estimations.

The lower right panel of Figure 1 shows the probability of migration related to migration network as the temperature rises. Consistent with the NELM, the migration network is found to be associated with a higher probability of migration, because it is assumed to reduce migration and job-search costs. As the temperature rises, the probability of migration goes down proportionately, regardless of the migration network. However, at any given temperature level, the probability of migration is higher for individuals from PSUs with many migrants.

As with the temperature anomaly, specifications (i)–(iv) are estimated for the annual precipitation anomaly. Table 5 presents the estimated results, and each column corresponds to the four specifications. Among the specifications, the preferred one is column (3), which indicates a non-linear relationship between precipitation and migration. The precipitation anomaly variable is also significant in specification (4), where it is interacted with the agricultural household indicator. However, as the interaction term is insignificant, specification (4) was not chosen as the preferred model. The non-linear relationship in specification (3) indicates that a rise in precipitation initially increases migration and gradually reduces it after a certain level of precipitation is reached.

Table 5: Impact of the Change in the Annual Mean Precipitation on Migration

	(1)	(2)	(3)	(4)
Precipitation anomaly	0.99	0.98	0.99	0.97*
	(0.01)	(0.01)	(0.02)	(0.02)
Precipitation anomaly^2			0.99***	
			(0.00)	
Agricultural household				0.65
				(0.18)
Precipitation anomaly × Agricultural household				1.01
				(0.05)
Observations	848	848	848	848
Number of households	424	424	424	424
Covariates	No	Yes	Yes	Yes

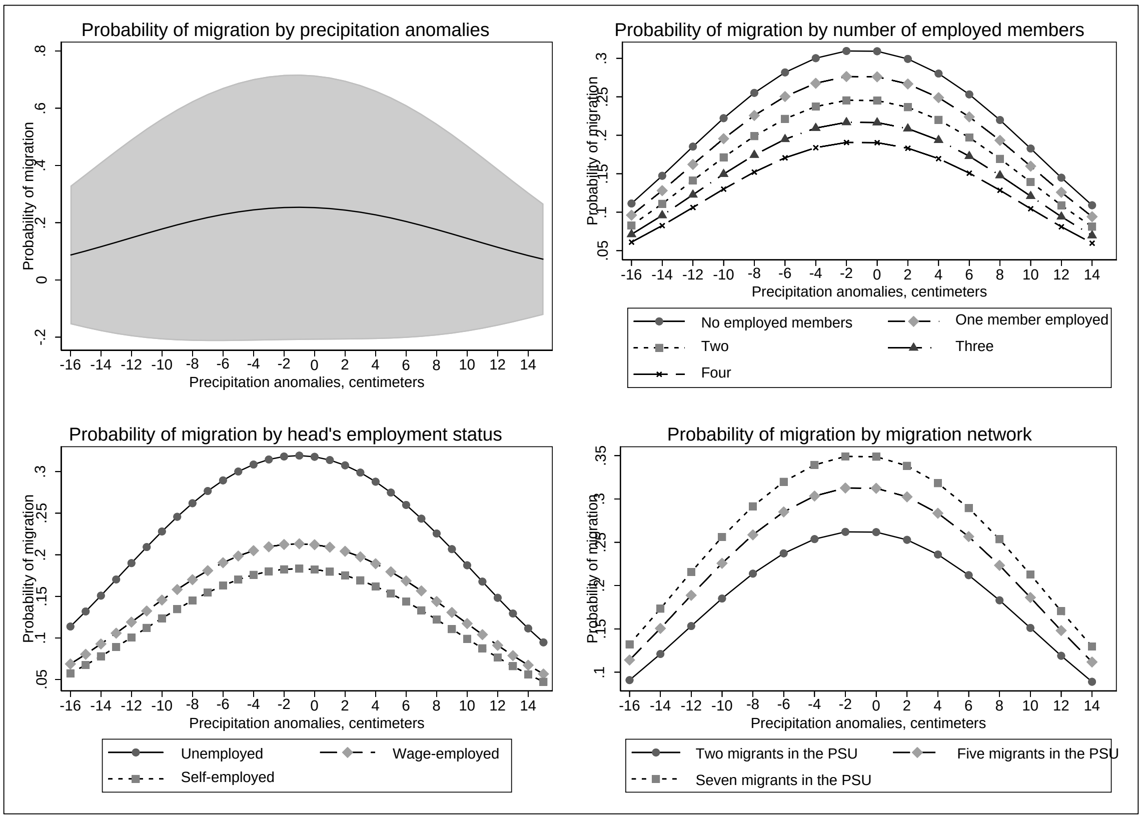
Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are in parentheses. The results are reported in odds ratios. The full set of estimated coefficients is available upon request.

Source: Author's estimations.

To further interpret the results, the marginal effects were estimated based on the results shown in Table 5. Figure 2 depicts the plots of the marginal effects for precipitation and other significant coefficients obtained. The top left panel of Figure 2 presents the probability of migration as precipitation rises. When the precipitation anomaly is negative or the level of precipitation is lower than its long-term average, an increase in precipitation is likely to lead to migration. Conversely, when the precipitation anomaly is positive or the level of precipitation is higher than its long-term average, an increase in precipitation reduces migration. In other words, the vertex of the quadratic function is roughly where the precipitation anomaly value equals zero. Migration rises with precipitation when it is drier than the historical average and falls when it is wetter than the long-term average.

Regarding the other covariates, employment plays an important role in determining the decision to migrate. Households with unemployed heads and members are more likely to migrate than those with employed members. Among employed household heads, the self-employed are least likely to migrate. Another important determinant of migration is the migration network, measured by the number of migrants in the community.

Figure 2: Predicted Probabilities of Migration by Precipitation Anomalies and Household Characteristics



Note: Shaded area is 95% confidence interval.

Source: Author's estimations.

While the annual average weather anomalies are useful to see how air temperature and precipitation deviate from their long-term averages, there are substantial differences in weather anomalies over the course of a year. Tajikistan has four distinct seasons, and the climate variation is uneven across seasons, with winters being affected the most. Table 6 shows the impact of seasonal air temperature anomalies on migration, applying specifications (i)–(iii). Because the effect of the temperature anomaly does not seem to differ between agricultural and non-agricultural households in Tajikistan, specification (iv) was not estimated in Table 6.

The results indicate that, regardless of season, temperature anomalies have a linear effect on migration as the squared temperature anomalies are not significant for all specifications. A rise in winter temperature increases migration, while increases in spring and summer temperatures reduce migration. The change in autumn temperature does not seem to affect migration decisions at all.

Table 6: Impact of Changes in Seasonal Air Temperatures on Migration

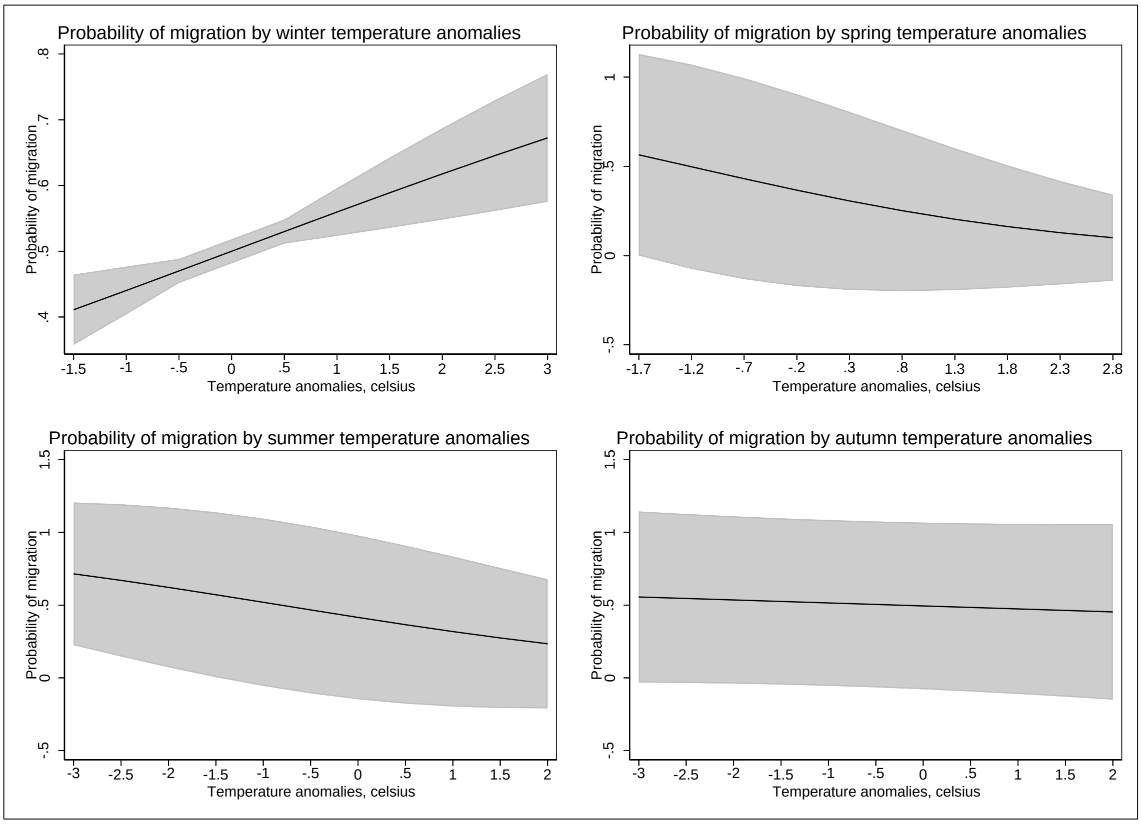
	(1)	(2)	(3)	(4)	(5)	(6)
Winter temperature anomaly	1.27***	1.16	1.11			
	(0.10)	(0.16)	(0.18)			
Winter temperature anomaly^2			1.03			
			(0.07)			
Spring temperature anomaly				0.75***	0.56***	0.55***
				(0.05)	(0.09)	(0.09)
Spring temperature anomaly^2						1.07
						(0.08)
Summer temperature anomaly						
Summer temperature anomaly^2						
Autumn temperature anomaly						
Autumn temperature anomaly^2						
Observations	848	848	848	848	848	848
Number of households	424	424	424	424	424	424
Covariates	No	Yes	Yes	No	Yes	Yes
	(7)	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Winter temperature anomaly						
Winter temperature anomaly^2						
Spring temperature anomaly						
Spring temperature anomaly^2						
Summer temperature anomaly	0.71***	0.64***	0.60***			
	(0.05)	(0.10)	(0.11)			
Summer temperature anomaly^2			0.96			
			(0.06)			
Autumn temperature anomaly				0.84	0.92	1.13
				(0.13)	(0.15)	(0.31)
Autumn temperature anomaly^2						1.16
						(0.19)
Observations	848	848	848	848	848	848
Number of households	424	424	424	424	424	424
Covariates	No	Yes	Yes	No	Yes	Yes

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are in parentheses. Results are reported in odds ratios. The full set of estimated coefficients is available upon request.

Source: Author's estimations.

Figure 3 depicts the marginal effects of each of the four seasonal temperature anomalies on migration. The upper left panel of Figure 3 shows that the impact of winter temperature anomalies on migration is upward sloping. The estimated marginal effect on international migration of a 1°C increase in winter temperature from its long-term average is 0.05, with p=0.001. On the other hand, the top right and bottom left panels show that a 1°C increase in spring or summer temperatures reduces migration by −0.12 and −0.10, respectively. The bottom right panel shows that the autumn temperature does not have any significant effect on migration decisions.

Figure 3: Predicted Probabilities of Migration by Seasonal Air Temperature Anomalies



Note: Shaded areas are 95% confidence intervals.

Source: Author's estimations.

Similarly, the impact of seasonal precipitation anomalies on international migration was estimated using specification (i)–(iii). The results are reported in odds ratios in Table 7. As with seasonal temperature anomalies, specification (iv) was excluded from Table 7, because the interaction term with agriculture indicator variable was insignificant in all models.

Table 7: Impact of Changes in Seasonal Precipitation on Migration

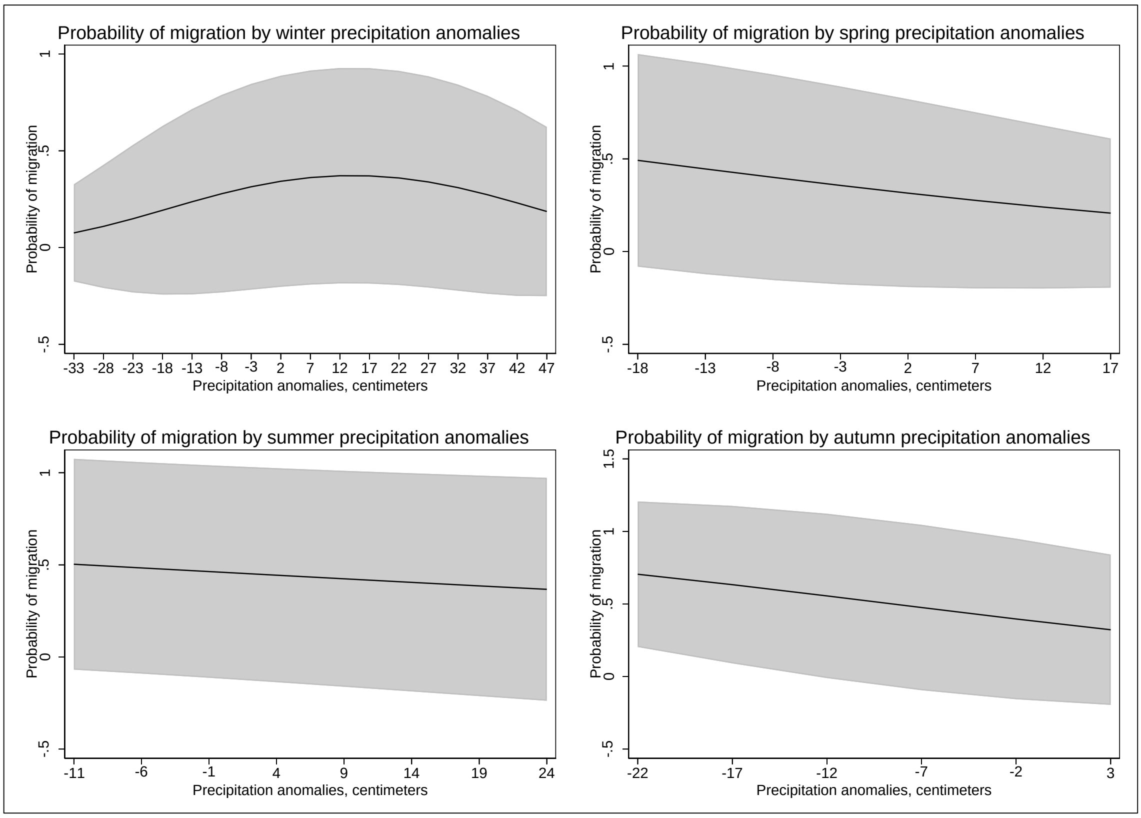
	(1)	(2)	(3)	(4)	(5)	(6)
Winter precipitation anomaly	1.01	1.00	1.03*			
	(0.00)	(0.00)	(0.01)			
Winter precipitation anomaly^2			1.00*			
			(0.00)			
Spring precipitation anomaly				0.96***	0.96***	0.98
				(0.01)	(0.01)	(0.02)
Spring precipitation anomaly^2						1.00
						(0.00)
Summer precipitation anomaly						
Summer precipitation anomaly^2						
Autumn precipitation anomaly						
Autumn precipitation anomaly^2						
Observations	848	848	848	848	848	848
Number of households	424	424	424	424	424	424
Covariates	No	Yes	Yes	No	Yes	Yes
	(7)	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Winter precipitation anomaly						
Winter precipitation anomaly^2						
Spring precipitation anomaly						
Spring precipitation anomaly^2						
Summer precipitation anomaly	0.99	0.98	0.94*			
	(0.02)	(0.02)	(0.03)			
Summer precipitation anomaly^2			1.00			
			(0.00)			
Autumn precipitation anomaly				0.98	0.93**	0.90**
				(0.02)	(0.03)	(0.04)
Autumn precipitation anomaly^2						1.00
						(0.00)
Observations	848	848	848	848	848	848
Number of households	424	424	424	424	424	424
Covariates	No	Yes	Yes	No	Yes	Yes

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are in parentheses. Results are reported in odds ratios. The full set of estimated coefficients is available upon request.

Source: Author's estimations.

The results indicate that winter precipitation anomalies have a non-linear effect on migration, while precipitation anomalies in the other seasons have a linear impact. Figure 4 depicts the marginal effects estimated from logit models in Table 7. The marginal effect of winter precipitation is likely to increase international migration until the precipitation amount exceeds the long-term average by approximately 10 cm, at which point it gradually decreases as winter precipitation further increases. The marginal effects of the other seasonal precipitation anomalies are linear and negative. The upper right panel depicts the marginal effect of spring precipitation anomalies on migration probability. The slope of the marginal effect curve is relatively flat and the estimated marginal effect is −0.008. Similarly, the marginal effects of summer and autumn precipitation anomalies are negative, although their magnitude is relatively larger than for spring precipitation, at −0.02.

Figure 4: Predicted Probabilities of Migration by Seasonal Precipitation Anomalies



Note: Shaded areas are 95% confidence intervals.

Source: Author's estimations.

Finally, the impact of sudden-onset natural disaster on household migration decisions in Tajikistan was considered. A binary variable for an incidence of flooding at the district level was used in specifications (i), (ii), and (iv), as spelled out in Section 2. Results are reported in Table 8. Unlike the weather anomaly models, a one-period lagged flood incidence variable was added, under the assumption that disasters like floods worsen liquidity constraints and migration cannot be materialized immediately.

Table 8: The Impact of Floods on Migration

	(1)	(2)	(3)
Flood	1.03	1.32	1.26
	(0.24)	(0.37)	(0.36)
Agricultural household			0.59*
			(0.19)
Flood × Agricultural household			1.98
			(1.15)
Flood $_{t-1}$	1.36*	1.20	1.24
	(0.24)	(0.23)	(0.25)
Flood $_{t-1}$ × Agricultural household			0.85
			(0.50)
Observations	848	848	848
Number of households	424	424	424
Covariates	No	Yes	Yes

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are in parentheses. Results are reported in odds ratios. The full set of estimated coefficients is available upon request.

Source: Author's estimations.

The results indicate that the incidence of flooding has no direct effect, but it does have a one-period lagged effect on emigration. Because environmental stressors affect both the incentive and the ability to migrate, households may lack the resources to reallocate their labor supply immediately after a sudden-onset natural disaster. This result is consistent with past studies, which have also found that severe and recurrent flooding reduce the ability of individuals to finance migration.

5. CONCLUSION

This paper examined whether environmental factors affect household migration decisions in Tajikistan. Both long-term climate variation and short-term weather shocks were considered as environmental factors to study their differing effects on emigration. The findings suggest that the migration impact of environmental factors varies depending on their type, seasonality, and intensity, because environmental changes could affect both the incentive and the ability to migrate.

Under the NELM theoretical framework and empirically addressing unobserved heterogeneities and omitted variable bias, the findings suggest that an increase in annual average air temperature from the long-term average is associated with lower emigration. This could signal household liquidity constraints, because international migration is costly. A deviation in precipitation from the long-term average was found to have a non-linear effect on migration; an increase in precipitation from the historical average is likely to lower migration. Our findings highlight that climate change has unequal consequences in seasonal weather variations. In the case of Tajikistan, winter temperatures and precipitation have risen more than those of other seasons. However, most of the winter precipitation now falls in the form of rain rather than snow due to warming temperatures. The results showed that a 1°C increase in winter air temperature from the long-term average is likely to increase emigration by 5%, while winter precipitation increases emigration until the precipitation level is 10 cm over the long-term average, at which point emigration decreases afterwards. The results also showed that natural disasters—measured by an incident of flooding—have a lagged effect on migration, probably because natural disasters constrain livelihoods while they increase incentives to migrate.

One of the hypotheses posed in this paper was that agricultural households would migrate more because environmental factors disproportionally harm agriculture-based livelihoods. This was measured by including interaction terms with environmental factors and an indicator for agricultural households. Although statistically insignificant, the results suggest that a long-term increase in temperature and precipitation, as well as frequent floods, could induce migration in agricultural households.

While the paper addresses time-invariant unobservable heterogeneities in household migration decisions, the author acknowledges that long-duration panel datasets would be desirable to better understand the long-term effects of climate variations and natural disasters on the household decisions to migrate. The paper also assumed that environmental factors were one of the direct determinants of migration and did not specifically address the various channels through which environmental factors could affect international migration. Future studies should address these issues to better understand the relationship between the environment and migration.

Despite these limitations, the results of this paper have important implications for migrant-related policy management and for the development of adequate coping and adaptation mechanisms against climate change. As the results reveal that climatic variations during off-season months for migrants who return from the Russian Federation are inducing more migration, policymakers need to implement a range of development and environmental policies to improve societal adaptation and mitigation strategies to cope with climatic shocks. If migration is considered one way to cope with adverse shocks triggered by climate change, it is necessary to provide potential migrants with access to formal finances to ease liquidity constraints. Moreover, improving the targeting of aid to areas affected by natural disasters, as well as increasing financial and technical support such as providing job opportunities locally for adaptation to climate change, could be productive policies.

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