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Climatic variability, remittances and household consumption volatility In developing countries

Romuald S Kinda
Universite Thomas SANKARA

Hajer Kratou
Ajman University

Abstract

This paper addresses the effect of climatic variability on household consumption volatility and explores the role of migrants' remittances in smoothing the household consumption during time of harsh climatic events over the period 1980–2019. Using panel data for 110 developing countries and the instrumental variables technique, results show that climatic variability increases household's consumption volatility. More interestingly, they reveal that the positive effect of climatic variability on household's consumption volatility decreases with remittances. Results are robust to additional checks such as the two-step generalized method of moments (IV-GMM) estimator and the GMM-System. For policymakers, these insights reveal that migrant remittances are an important lifeline that can mitigate climate shocks damages, but success relies on transparent pricing and initiatives to encourage competition in the transfer services market.

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Contact: Romuald S Kinda - kindaromuald@gmail.com, Hajer Kratou - hajerkratou63@gmail.com.
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1 Introduction

Among the many definitions of climatic variability, Molua et al. (2010) define this form of events as "the increased frequency of extreme weather events, flooding, storms, drought, desertification, increases in sea temperatures and heat and cold waves that can reinforce the socioeconomic challenges to access to adequate and nutritive food". Whatever the form of climatic shock, the consequences for the economy and the society are inevitably perilous. Climatic shocks are supposedly to be felt by the vulnerable households (the poorest of the poor), they are predominantly in developing countries (Musah Surugu et al, 2017). Their vulnerability is due to the fact of being mainly located in the tropics. Also, demographic, socioeconomic and policy factors are limiting their financial capacity to cope and adapt to climatic variability Molua (2012). Climate shocks have strongly shaped not only the food access but also the non-food consumption (Skoufias and Vinha, 2011). Changing in environmental factors can influence households plan of consumption if they are more susceptible to climatic damages and are being vulnerable to insecurity of consumption and possibly use more saving due to higher expenditure to accommodate repairs (Henry et al., 2020). The chaos and damages these climate events bring cause many to question how can mitigate their repercussions on households' consumption volatility. Inexorably, attention turns to remittances, as an external financial flow, and whether the money streams generated by migrants to finance vulnerable households can be stemmed as a way to mitigate the damage of these shocks. In this regard, remittances have been considered to be a complementary funding adaptation to climate shocks through the ability to finance consumption need and incremental expenses of households' infrastructure to be occasioned by climate events (Musah Surugu et al., 2017). Further, remittances allow vulnerable people to recover from shocks and reduce their vulnerability to disasters (Le De et al., 2013). It is therefore crucial to examine whether remittances enable smoothing consumption in developing countries during time of climatic variability, as remittances to developing countries reached US$ 550 billion in 2019, exceeding the other external financial flows (i.e. Official development assistance, ODA and Foreign Direct Investment, FDI) (Plaza et al., 2019) Hence, this research analyzes the role of remittances in the mitigation of the effects of climatic variability on households' consumption volatility with a large panel study of 110 developing countries over the period 1980 - 2019. Two important hypotheses are tested. First, what is the effect of climate variability on households' consumption volatility? Second, does remittances smooth consumption over time in recipient countries during climatic variability? The answer to these questions has clear policy implications for the way remittances are handled. This is especially vital for policymakers in countries that face climate events because a robust smoothing effect from remittances to households' consumption over time may suggest a strong need to encourage and facilitate the flow of remittances to these countries.

Unlike other studies, we test these relationships in a large panel covering 110 developing countries. We recognize that most studies focus solely on single case-country study (Musah Surugu et al., (2017) on Ghana; Bando and Lopez-Calva (2004) on Mexico). This is due to the fact that the dynamics of this topic can be better captured at the micro-level, using data at the household level. For the purpose of comparability of data and to cover the gap in empirical contribution, we are interested in the macro analysis of the above relation, because this enables us also to generalize the channels of transmissions across developing countries. Further, previous empirical studies emphasize on the food security issue, we leave room for whether remittances contribute in the mitigation of the effects of climatic variability on households' consumption volatility. Our results show that climatic variability increases the volatility of households' consumption per capita. More interestingly, it shows that remittances contribute to dampening the negative effect of climatic variability on households' consumption volatility.

The remainder of the paper is set out as follows. Section 2 briefly discuss a selected theoretical and empirical studies that are focused on the effect of climate variability on households' consumption volatility. We further refer to the literature on the smoothing effect of remittances on households' consumption volatility in recipient countries, during climatic variability. Section 3 presents the data sources, empirical model, and estimation strategy used to analyze the hypotheses. Section 4 provides a discussion of the main results and the robustness checks. Finally, Section 5 presents the conclusion and the policy implications.

2 Literature review

We emphasize on two strands of literature to define the theoretical framework of this study. The first argues the potential channels by which climatic variability increases households' consumption volatility. The second, addresses if remittances smooth the household's consumption volatility during climate variability.

H1. Climate variability increases households' consumption volatility.

Climatic variability can increase household's consumption volatility in developing countries through its effect on food price shocks, households' revenues and government social policies. First, climatic variability can increase household's consumption volatility through the food price shocks. According to the economic literature, such as Minot (2010); Combes et al. (2014) and Arezki and Bruckner (2011), food prices shock is a factor of households' consumption volatility. In addition, several authors have shown that by affecting price shocks, climatic shocks can have negative impact on households' consumption (Gao and Mills, 2021). From one side, households with land are more likely to be affected by a loss of assets and livestock and a rise in input and other commodity prices (Nguyen and Woden, 2014). Furthermore, climatic shock causes a damaging in the farmer output and declines in production. The food stock is easily depleted and as a consequence the food prices are high (Banerjee and Maharaj, 2020). Beyond its effect on households that depend on agriculture, Gao and Mills (2021) have shown that weather shocks can negatively affect those that do not rely on rainfed agriculture through increases in food prices and disturbances in non-farm production activities, household wealth and other dimensions of economic well-being. For instance, Saiful Islam et al. (2022) show that floods jeopardize households' consumption for cereal and oblige them to purchase from other sources and consequently soar cereal prices. Extreme drought conditions can also lead to water shortages and increase water prices (Mwabumba et al. 2022). Similarly, temperature rises the demand for consuming bottled water and the volume consumed (Zapata, 2021). Since food is a basic necessity good and its demand is highly price inelastic, climatic variability can seriously increase the consumption volatility of households who spend larger proportions of their budgets on foods (Mitchell, 2008, the World Bank 2019).

Second, climatic variability can influence household's consumption volatility through their incomes. Indeed, according to several authors such as Mitra et al. (2008), households in developing countries are highly vulnerable to climatic events because the income of their economies are closely linked to climatic sensitive sectors such as agriculture. For instance, climatic variability such as an extreme heat could jeopardize animal husbandry and livestock fertility, limit the formation of grains such as wheat and rice, which damage the size of harvest and lead to sharp decrease in income for farmers. By increasing uncertainty in agricultural production and incomes, climatic variability can generate a fluctuation in the households 'incomes and generate consumption volatility.

Third, at the national level, climatic variability can affect households' consumption through its negative effect on economic growth and government social policies such as subsidies and transfers. Literature such as Acevedo et al. (2020); Dell et al. (2012) and Burke et al. (2015) have concluded that climatic shocks can reduce economic growth in developing countries, especially the poor ones. This is because they are less diversified and their incomes heavily depend on climatic sensitive sectors. Thus climatic shocks can decrease the level of output

through a reduction in agricultural production and exports (Jones and Olken, 2010), investments in research and development and human health and labor productivity (Acevedo et al. 2020). By reducing economic performance and resources, climatic shocks decrease the ability of government to implement social policies such as government subsidies and transfers (cash transfers and food distribution). These latter policies are supposed to allow households to have access to basic needs and improve their consumption over time.

H2. Remittances can smooth households' consumption over time in recipient countries, during climatic variability

In another stream of the literature, a considerable number of empirical researches discuss how migrants' remittances could be a useful tool to mitigate the climatic variability damages on households. There are two main motives for migrants to send money home. We refer in this study to the altruistic motives and its key contribution to reduce poverty (Abdih, et al., 2012); income inequality (Kratou and Goaied, 2018) and to stimulate growth in the home country (Ramcharran, 2020) through different channels (mainly by increasing income, removing credit constraints, saving, smoothing consumption, investment, human capital accumulation and health insurance…)

One of the primordial channels to improve standard of living and to reduce poverty is to increase consumption. This hypothesis has been discussed in the work of Lucas and Stark (1985). Remittances contribute to preserve the consumption and the utility level of left-behind families. More recently, in a panel data study about Emerging Central, Eastern and Southeastern European (CESEE) countries and exploring generalized method of moments, Eftimoski and Josehski (2020) find that remittances significantly decrease households' consumption volatility through their compensatory role. In a study covering Commonwealth of Independent States (CIS) countries, Abduvaliev and Bustillo (2019) show that remittances reduce poverty through increasing income and smoothing consumption. In a study on the MENA region and adopting the Vector Autoregressive (VAR) methodology, Awdeh, (2018) shows that household propensity to consume is significantly determined by the level of remittance inflows. Further, Tansel and Yasar, (2010) find that the correlation between remittances and consumption is positive in Turkey. The above literature opens further discussion on the counter-cyclical behavior of remittances, defined as the upward trend of remittances in the aftermath of unfortunate events, such as health shocks (Beuermann et al, 2016); macroeconomic shocks (Ratha and Mohapatra, 2007) or related to climate change such as disasters; droughts and agricultural shocks (Ramcharran, 2020). In a study covering eleven Latin America and Caribbean countries, the latter claims that remittances play an insurance role by dampening the negative effects on consumption stability; act as a safety net during time of shocks and provide a social insurance mechanism that offers full protection. Combes and Ebeke (2011) showed that remittance inflows dampened the effects of natural disasters on the volatility of the households' consumption per capita. Literature on micro studies corroborates the findings of macro studies. Henry et al. (2020) find that while local households living in less wind damage resistant buildings, are vulnerable to hurricane shocks, remittances enable them to partially buffer the negative effect of tropical storms on consumption. Musah Surugu et al., (2017) show using a qualitative research approach that a large proportion of remittances received in Ghana is spent on climate change effect relief activities. Suleri and Savage (2006) and Bando and Lopez-Calva (2004) show same findings in Pakistan and Mexico respectively. Noting that rural households in countries with high level of poverty, such as the case of majority of developing countries, are more vulnerable to climate shocks consequences since a majority of farming income might depends on climate variations (Masron and Subramaniam, 2019). Hence, enabling the flow of remittances to be at the disposal of these vulnerable families help them to dampen the damage of climate shocks and smooth households' consumption over time.

3 Empirical analysis

This section describes the data sources, empirical model, and estimation strategy to test the two-above hypotheses. First, what is the effect of climate variability on household's consumption volatility in developing countries? Second, does remittances smooth consumption over time in recipient countries during climatic variability?

3.1 Data sources and description of variables

The data cover the period from 1980 to 2019 for 101 developing countries and are compiled in five-year averages (1980-1984, 1985-1989…2015-2019). We justify the choice of the sample that for reliable inferences, we needed a wide sample with recent information, but also the information needs to date back over a sufficient enough length of time. The data on financial development, income per capita, trade openness, government consumption, population growth, foreign aid, income per capita growth, households' consumption per capita, income per capita growth volatility and income per capita volatility are from the World Development Indicators (2021). Those on rainfall are from the CERDI (2020). The definitions, sources and descriptive statistics of the variables are in Appendices.

3.2 Empirical model

The aim of the paper is to analyze the role of remittances in the mitigation of the effects of climatic variability on households' consumption volatility. For this purpose, we follow the following steps:

First, we analyze the effect of climatic variability on households' consumption volatility. Similarly, to previous authors such as Craigwell et al. (2010), the baseline equation is used:

$$HC_{i,t} = \alpha_i + \beta_1 CV_{i,t} + \omega X_{i,t} + \gamma_t + \varepsilon_{i,t} \quad (1)$$

With $HC_{i,t}$ the households' consumption volatility (log) over five (5) years. It is the standard deviation of the real consumption per capita growth rate estimated over 5 years. $CV_{i,t}$ is the variable of climatic variability (log), $X_{i,t}$ is the matrix of control variables, and $\varepsilon_{i,t}$ is the error term, γ_t represents period effect, and α_i the country effects, i and t are the country and the nonoverlapping 5-year period from 1980 to 2019.

The control variables are from the economic literature on the determinants of households' consumption volatility (Combes and Ebeke (2011), Craigwell et al. (2010) and, Combes et al. (2014)). They include income per capita, trade openness, financial development, income per capita volatility and government consumption. According to authors such as Auffret (2003) and Bekaert et al. (2006), income per capita reduces consumption volatility. According to them, developed countries are more diversified economies and have developed risk-reduction mechanisms (for instance risk identification, risk mitigation and risk preparedness) that help decrease the consumption volatility. The consumption smoothing can positively depend on the level of financial development. Indeed, according to Ahmed & Suardi, (2009) and Bekaert et al., (2006), the consumption smoothing is positively related to the availability of credit. According to the economic literature financial and trade openness have ambiguous effect on macroeconomic volatility (Di Giovanni and Levchenko, 2009). Indeed, on the one hand, because opened countries are naturally exposed to external shocks, trade openness can increase consumption growth volatility through its negative effect on output volatility (Bekaert et al., 2006). On the other hand, trade openness can favor economic diversification opportunities and reduce consumption volatility. By increasing macroeconomic volatility and economic inefficiencies, government size can increase households' consumption volatility.

Second, we analyze the potential mitigating effect of remittances. To test this hypothesis, the following specification (equation 2) is used:

$$HC_{i,t} = \alpha_i + \beta_1 CV_{i,t} + \beta_2 CV_{i,t} * RM_{i,t} + \beta_3 RM_{i,t} + \omega X_{i,t} + \gamma_t + \varepsilon_{i,t} \quad (2)$$

With $RM_{i,t}$ is the variable of remittances. If the mitigating effect of remittance is proven to be true, the coefficient associated to the interactive term (β_2) should be negative. The hypotheses tested are: $\beta_1 > 0$ and $\beta_2 < 0$. The marginal effect of climatic variability is expressed by: $\beta_1 + \beta_2 * RM_{i,t}$. In other words, equation 2 allows determining the remittances level, which significantly dampens the negative effects of climatic variability on consumption volatility.

3.3 Estimation strategy

In order to estimate our models (equation 1), we can use fixed effects (FE) or random effects (RE) estimators. The ordinary least squares (OLS) estimator is biased because it does not consider unobserved heterogeneity of countries. In order to choose the adequate specific effect, we use the Hausman test. Results show that the Fixed effect is adequate. However, because the marginal effect of climatic variability depends on remittances (equation 2), its coefficient can be biased. Indeed, according to the econometric theory, the main sources of endogeneity related to remittances can the omitted variable bias, reverse causality and measurement error. First, the remittances are characterized by measurement errors. This can lead to biased results. Indeed, to avoid high costs for the money transfer, significant volume remittances can be transferred through informal channels (informal money transfer networks, friends or family members). The dampening of remittances can be underestimate. Second, omitted variables are simultaneously likely to affect remittances and households' consumption volatility (for instance price or political shocks). Third, endogeneity may come from the existence of reverse causality between remittances and households' consumption volatility. Indeed, remittances can be sensitive to economic conditions (output and consumption volatility) in the home economy. To resolve the endogeneity problem, it is important to identify adequate instruments, which should be correlated with the remittances but uncorrelated with the dependent variable. Following the economic literature, we use two instruments that are the GDP per capita gap (as a measure of the income difference) between the migrant's host and origin country (Freund and Spatafora, 2008). This variable is uncorrelated with the dependent variable (i.e. the volatility of consumption of the home country of the migrant). We refer to Chami et al., (2008) for the second instrument, which is the ratio of remittances to GDP in the world (volume of remittances inflows in 110 developing countries of our sample, except the country considered, divided by GDP in the world). By leaving out remittances to the considered country, the variable (instrument) is free of domestic macroeconomic variables (such as the volatility of consumption). From an econometric perspective, the Hansen test reveals the validity of the instrument because the P-value of the test is higher than 0,1.

4 Results

The results of the Hausman test points to the rejection of the null the hypothesis of independence between the unobserved individuals' effects and the control variables for all the specifications. Therefore, the fixed effect model is chosen.

4.1 Baseline results

Table 1 presents the panel fixed effects estimates of the effect of climatic variability on the volatility of households' consumption per capita (equation 1).

Column (1) shows that climatic variability increases the volatility of households' consumption per capita. This result can be explained by two arguments. First, climatic variability generates a high uncertainty in agricultural yields and production. It increases fluctuations in agricultural production and households' incomes and generates, as well, households 'consumption volatility. In addition, an uncertainty in agricultural production can lead to a positive shock on food price which can amplify households' consumption volatility in developing countries. Second, by generating an uncertainty in agricultural yields and production, climatic variability can negatively reduce economic resources and growth in developing countries. This will reduce

the ability of governments to implement social policies such as governments subsidies. These latter policies are supposed to allow households to have access to basic needs and improve their consumption over time.

Results suggest also that control variables (financial development, GDP per capita, trade openness, government consumption, GDP per capita volatility) have all the expected effect. GDP per capita reduces the volatility of households' consumption per capita (Auffret, 2003; Bekaert et al., 2006). Indeed, because they are rich, developed economies are more diversified and are able to implement risk-reduction mechanisms (for instance risk identification, risk mitigation and risk preparedness) that help decrease the consumption volatility. Financial development reduces the volatility of households' consumption per capita whereas trade openness has no effect on it. Indeed, according to Ahmed & Suardi, (2009) and Bekaert et al., (2006), the consumption smoothing is positively related to the availability of credit. The insignificant result of trade openness can be related to its ambiguous effect on volatility of consumption. This is in light of the economic literature, such as (Di Giovanni & Levchenko, 2009). According to some authors such as Bekaert, Harvey and Lundblad (2006), opened countries are naturally exposed to external shocks. Therefore, trade openness can increase consumption growth volatility through its negative effect on output volatility. On the other hand, trade openness can favor economic diversification opportunities and reduce consumption volatility. Government consumption increases the volatility of households' consumption per capita. Indeed, according to Bekaert et al., (2006), because a high government sector can be an indication of high macroeconomic imbalances and economies that do allow capital to be allocated to investments using private market signals, thus government consumption can increase the volatility of households' consumption per capita.

In columns (2, 3, 4, 5) of table (1), additional control variables have been gradually included to check the sensitivity of the effect of climatic variability on the volatility of households' consumption per capita. Results suggest that contrary to population growth and economic growth volatility that increase the volatility of households' consumption per capita (Bekaert et al., 2006), foreign aid (Combes and Ebeke, 2011) and precipitation have no effect on it. The positive effect of population growth can be partially consistent with the Malthus' (1798) hypothesis that population growth follows a geometric progression whereas food production and consumption follow an arithmetic progression. Therefore, countries with high population growth can experience a reduction of households' consumption per capita and an increase of the volatility of households' consumption per capita. As claimed by Combes and Ebeke (2011), foreign aid has no effect on the volatility of households' consumption per capita.

Our results from the baseline equation show that the coefficient of climatic variability is positive and strongly significant at the level of 1% for the different specifications. This finding points to a validation of the first hypothesis.

Table 1: Effect of climatic variability on Households' consumption volatility **(Fixed effects)**

	Households' consumption volatility (log)					
	(1)	(2)	(3)	(4)	(5)	(6)
Climatic variability (log)	0.215***	0.214***	0.207***	0.215***	0.221***	0.212***
	(3.751)	(3.740)	(3.337)	(3.747)	(3.859)	(3.413)
Domestic credit ratio (% GDP)	-0.001	-0.001	-0.002	-0.001	-0.5 e-03	-0.001
	(-0.514)	(-0.517)	(-0.702)	(-0.510)	(-0.203)	(-0.385)
GDP per capita (log)	-0.328**	-0.322*	-0.334*	-0.328*	-0.336**	-0.317*
	(-1.966)	(-1.922)	(-1.777)	(-1.960)	(-2.015)	(-1.671)
Trade openness (log)	0.002	0.003	0.003	0.002	0.002	0.002
	(1.307)	(1.338)	(1.513)	(1.305)	(0.934)	(1.164)
Government Consumption (%GDP)	0.037***	0.037***	0.037***	0.037***	0.038***	0.038***
	(3.633)	(3.550)	(3.435)	(3.627)	(3.744)	(3.455)
GDP per capita volatility	0.115***	0.115***	0.112***	0.115***	0.118***	0.115***
	(9.783)	(9.777)	(9.017)	(9.772)	(9.938)	(9.170)
Population growth		0.021				-0.044
		(0.392)				(-0.708)
Aid Per capita (log)			-0.024			0.021
			(-0.445)			(0.390)
Precipitation				4.82e-06		1.37 e-04
				(0.014)		(0.382)
Economic growth volatility					9.80 e-04**	9.61e-04*
					(2.057)	(1.904)
Constant	-2.042*	-1.945	-2.085	-2.047	-2.162*	-2.056
	(-1.656)	(-1.544)	(-1.486)	(-1.600)	(-1.752)	(-1.379)
Observations	593	593	542	593	593	542
R-squared	0.382	0.382	0.380	0.382	0.385	0.385
Countries	110	110	106	110	110	106

T-statistics in parentheses, *** p<0.01, **p<0.05, *** p<0.10.

4.2 Do remittances dampen the effect of climatic variability on consumption volatility?

To analyze the potential mitigating effect of remittances on the relationship between climatic variability and households' consumption volatility, equation 2 is used.

Colum (1) of table 2 shows the effect of climatic variability on consumption volatility, depending upon remittances. It presents the instrumental variables (IV) estimates. It shows both first and second-stage results. First, it indicates that the coefficients of the instruments are significant at 1% level and the Fisher test of the weak identification is higher than the critical values of the size of bias as computed by Stock and Yogo (2005). In addition, it suggests that the instruments are valid (exogenous, and not weak) because the P-value of Hansen/Sargan test for over-identifying restrictions is higher than 0,1.

It reveals that the positive effect of climatic variability on consumption volatility decreases with remittances. Indeed, it indicates that the coefficients associated with climatic variability and with the interactive term (climatic variability × remittances) are positive and negative, respectively. This result suggests that remittances contribute to dampening the positive effect of climatic variability on households' consumption volatility. It can be explained by the fact in developing countries, households face liquidity constraints because they have no access to financial services. According to the International Fund for Agricultural Development (IFAD, 2019), the amounts received by the households can represent as much as 60 percent of its total income. Therefore, by easing liquidity constraints and supporting saving, remittances can help

stabilize consumption volatility from fluctuations in households' income generated by climatic variability.

4.3 Robustness Checks

Four robustness checks of the results have been implemented. First, we test the robustness of results by using the two-step generalized method of moments (IV-GMM) estimator developed by Baum et al. (2007) that generates efficient as well as consistent standard error estimates. According to them, the IV-GMM is more efficient than the IV-2SLS because of the overidentifying restriction of the model, the optimization of the weighting matrix and the relaxing of the assumption that the errors are independently and identically distributed (iid). If the model is exactly identified, the IV-GMM estimator and IV-2SLS estimator coincide and in the presence of homoscedasticity and independence, the IV-GMM estimator is more efficient that the IV-2SLS estimator. Column (2) of table 2 shows that results are consistent. Second, a potential weakness of the instrumental variable (IV) strategy to address the endogeneity problem is the fact that it is solely related to the variables of interest (remittances and climatic variability*remittances) while other controls variables could be endogenous. To address this concern, we use the system GMM (Generalized Method of Moments) from Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998). The System GMM is a method that estimates a system of equations (equation in level and equation in first difference). In the equation in first difference, lagged variables in level of at least one period are used as instruments. In the equation in level, variables in first differences lagged of at least one period are used as instruments. The System GMM allows addressing both the endogeneity problem and unobserved heterogeneity (unobserved time-invariant and unobserved individual characteristics). To check the validity of the results, two tests have been used: the standard Hansen test of overidentifying restrictions (in which the null hypothesis is that the instrumental variables are not correlated with the residual) and the serial correlation test (AR (2), in which the null hypothesis is that the errors exhibit no second-order serial correlation). Columns (3) and (4) of table 2 show the results by using the System GMM and the System GMM IV (in which remittances is instrumented by their lagged value and our external instruments). Results reveal that the positive effect of climatic variability on households' consumption volatility decreases with remittances.

Finally, the results may be biased due to endogeneity problems such as an inertia phenomenon characterizing the dynamic of households' consumption volatility. In other words, we check whether the lagged level of households' consumption volatility per capita is a potential determinant of the current level of households 'consumption volatility per capita. Column (5) of table 2 indicates that there is no inertia phenomenon. The coefficient of the interactive term (climatic variability × remittances) shows a negative at statistically significant coefficient at the level of 5% for the different specifications. Our results align with previous findings claiming the role that remittances play by enabling households to face unexpected expenses during time of shock, such as climatic variability (Le De et al., 2013). Furthermore, remittances are used to finance both incremental costs of households' infrastructure and consumption needs, as well as additional investment needs in Ghana due to climate variations (Musah-Surugu et al., 2017).

Table 2: Effect of climatic variability on Households' consumption volatility (with alternative estimator: IV-2SLS, GMM-IV, GMM-System)

	Households' consumption volatility (log)				
	(1)	(2)	(3)	(4)	(5)
	IV	GMM-IV		GMM-SYSTEM	
Lag of households' consumption volatility (log)					-0.158
					(-0.963)
Domestic credit ratio (% GDP)	0.002	0.002	0.007	-0.123e-03	0.009
	(0.595)	(0.595)	(0.953)	(-0.037)	(1.298)
GDP per capita (log)	-0.319**	-0.319**	-0.614*	-0.370**	-0.725**
	(-1.960)	(-1.960)	(-1.905)	(-2.117)	(-2.357)
Trade openness (log)	0.004	0.004	-0.003	0.002	-0.007
	(1.305)	(1.305)	(-0.642)	(0.791)	(-1.248)
Climatic variability (log)	0.219***	0.219***	0.312**	0.198***	0.427***
	(2.624)	(2.624)	(2.637)	(2.984)	(2.788)
Government Consumption (%GDP)	0.040***	0.040***	0.059***	0.043**	0.072***
	(3.065)	(3.065)	(3.329)	(2.487)	(3.369)
GDP per capita volatility	0.136***	0.136***	0.121***	0.149***	0.094**
	(8.647)	(8.647)	(3.505)	(3.870)	(2.575)
Remittance /GDP (log)	-0.078	-0.078	0.158	-0.002	0.192
	(-0.588)	(-0.588)	(0.913)	(-0.048)	(1.097)
Climatic variability (log)* Remittance /GDP (log)	-0.366**	-0.366**	-0.330**	-0.152**	-0.387**
	(-2.385)	(-2.385)	(-2.030)	(-2.508)	(-2.024)
Constant			4.550*	2.742**	5.559**
			(1.948)	(2.206)	(2.367)
Observations	487	487	498	488	438
R-squared	0.385	0.385			
Countries	77	77	79	78	79
First stage					
GDP per capita gap migrant's host and origin country (log)	1.92***	1.92***			
	(6.46)	(6.46)			
Ratio of remittances to GDP in the World (except country i)	0.262***	0.262***			
	(2.77)	(2.77)			
Log of GDP per capita gap migrant's host and origin country* climatic variability (log)	0.116	0.116			
	(0.59)	(0.59)			
Other controls	Yes	Yes			
F-stat for weak ident	13.87	13.88			
Hansen test, p value	19.41	19.41			
Instruments			29	40	29
AR (1)			0.000	0.000	0.007
AR (2)			0.659	0.962	0.455
Hansen test			0.296	0.397	0.240

z-statistics in parentheses

5 Conclusion

This paper addresses the role of remittances as a mechanism through which households' consumption could be smooth over time during climatic variability in developing countries. Our results from the baseline equation show that climatic variability increases the households' consumption volatility and points to a validation of the first hypothesis. However, remittances partially offset this positive effect, showing evidence that remittance act as a safety net by stabilizing households 'consumption volatility from climatic variability.

A variety of model specifications confirms the robustness of our findings. Several robustness checks such as additional control variables, the inertia phenomenon characterizing the dynamic of households' consumption volatility, the two-step generalized method of moments (IV-GMM) estimator, the GMM-System have been implemented.

A key outcome of this research is the altruistic behaviours of remittances flows in developing countries, which suggests that harsh climatic variability attracts the flow of remittances to the home countries and help sustaining the consumption level. Undoubtedly, remittances are an important lifeline for vulnerable population, which finance both incremental costs of households' infrastructure and consumption needs during climatic shocks. This result supports previous findings, such as Musah-Surugu et al., (2017), on the case of Ghana; Suleri and Savage, (2006) on the case of Pakistan, among others. Our results should raise the attention of financial institutions, explicitly in developing countries, to facilitate the flow of these external funds. Especially that a rise in remittances results in more disposable income and conceivably help vulnerable households to cope with the financial loss of climatic variability.

Crucial policy implications can be drawn from this research. First, high remittance fees are a drain on the resources of migrants' families, for which remittances are a unique source of income. A commitment to reducing transaction fees means the more of that income will be at the disposal of these vulnerable families. Second, an increased volume of remittances will improve financial access for the poor in developing countries (World Bank, 2006). Both implications are supposed to rise remittances to flow to vulnerable households; many of them are living in regions that are more susceptible to climatic shocks damages.

6 Reference

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7 Appendices

Appendix 1. Descriptive statistics of variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Households consumption volatility (log)	593	1.184	.860	-3.103	3.969
Domestic credit ratio (% GDP)	721	31.730	25.499	1.266	161.553
GDP per capita (log)	721	7.851	1.076	5.382	10.322
Trade openness (log)	721	76.054	38.522	13.273	276.092
Climatic variability (log)	721	.673	.704	-2.048	2.580
Remittance /GDP (log)	509	.439	1.715	-6.719	5.098
Government Consumption (%GDP)	721	14.552	5.450	1.150	41.274
GDP per capita volatility	721	3.222	2.629	.220	32.579
Population growth	721	1.786	1.255	-3.025	7.126
Aid Per capita (log)	669	3.387	1.288	-1.567	6.738
Precipitation	721	1205.32	820.797	28.494	3757.611
Income Per Capita Gap (log)	509	10.298	.431	8.065	10.969

Appendix 2. Data sources and variables definition

Variables	Definitions	Sources

Households consumption volatility	Standard deviation of the real consumption per capita growth rate estimated over a nonoverlapping 5-year period.	Authors calculation using data on household's consumption per capita from World development Indicators (WDI, 2021)
Domestic credit ratio (% GDP)	Ratio of workers' remittances and compensation of employees to GDP.	WDI (2021)
GDP per capita	GDP per capita constant 2015 (US$)	WDI (2021)
Trade openness	Imports plus exports in percentage of GDP	WDI (2021)
Climatic variability	Standard deviation of the water balance growth rate estimated over a nonoverlapping 5-year period. Water balance is the difference between precipitation and potential evapotranspiration (in thousand square millimeters).	Authors calculation using data from CERDI (2020)
Remittance /GDP	Ratio of workers' remittances et compensation of employees over GDP. Personal remittances comprise personal transfers and compensation of employees. Personal transfers consist of all current transfers in cash or in kind made or received by resident households to or from nonresident households. Personal transfers thus include all current transfers between resident and nonresident individuals. Compensation of employees refers to the income of border, seasonal, and other short-term workers who are employed in an economy where they are not resident and of residents employed by nonresident entities.	WDI (2021)
Government Consumption (%GDP)	Ratio of Government Consumption divided by the GDP	WDI (2021)
GDP per capita volatility	Standard deviation of the GDP per capita growth rate estimated over a nonoverlapping 5-year period. Data on GDP per capita are from WDI (2021)	WDI (2021)
Population growth	Population growth	WDI (2021)
Aid Per capita	Ratio of net official development assistance received (billion constant 2018, US$) over population	WDI (2021)
Precipitation (water balance)	It is water balance. Water balance is the difference between precipitation and potential evapotranspiration (in thousand square millimeters).	CERDI (2020)
Income Per Capita Gap	The income per capita difference between the host and the home country of the migrant	Author' calculation based on WDI (2021)

Appendix 3. Countries

Afghanistan	China	The Gambia	Madagascar	Poland	Tanzania
Albania	Cote d'Ivoire	Guinea-Bissau	Mexica	Paraguay	Uganda
Armenia	Cameroon	Guatemala	North Macedonia	Romania	Ukraine
Azerbaijan	Colombia	Honduras	Mali	Russian Federation	Uruguay
Burundi	Comoros	Haiti	Myanmar	Rwanda	Uzbekistan

Benin	Congo, Dem. Rep	Indonesia	Mongolia	Saudi Arabia	Vietnam
Burkina Faso	Congo, Rep.	India	Mozambique	Sudan	Vanuatu
Bangladesh	Cabo Verde	Iraq	Mauritania	Senegal	South Africa
Bulgaria	Costa Rica	Jamaica	Mauritius	Sierra Leone	Zambia
Bahrain	Czech Republic	Jordan	Malaysia	El Salvador	Zimbabwe
Bosnia and Herzegovina	Djibouti	Kazakhstan	Namibia	Slovak Republic	
Belarus	Dominica	Kenya	Niger	Eswatini	
Belize	Algeria	Kyrgyz Republic	Nigeria	Seychelles	
Bolivia	Ecuador	Cambodia	Nicaragua	Chad	
Brazil	Egypt	Korea, Dem. People's Rep	Nepal	Togo	
Barbados	Fiji	Lebanon	Oman	Thailand	
Bhutan	Gabon	Sri Lanka	Pakistan	Tajikistan	
Botswana	Georgia	Lesotho	Panama	Tonga	
Central African Republic	Ghana	Morocco	Peru	Tunisia	
Chile	Guinea	Moldova	Philippines	Turkey	