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Article

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Determinants of shock-coping mechanisms adoption and rural household consumption in Rwanda: A two-stage analysis considering both idiosyncratic and covariate shocks

Fabrice Nkurunziza^{1,2*}, Richard Kabanda³ and Patrick McSharry⁴

Abstract: This study investigates the features that contribute to shock-coping mechanisms in rural households in Rwanda, making a significant contribution by considering both idiosyncratic and covariate shocks. We employ a combination of multinomial logit regression (MLR) and two-level hierarchical linear modeling (2-HLM). The study focused on two main characteristics: household characteristics like employment and asset ownership, and shock-coping mechanisms. 4782 Rwandan rural households that experienced shocks were analyzed, exploring variations in factors by consumption level (low, medium, high). The findings of the study revealed that: (1) shock-coping mechanisms are driven by several factors like household characteristics, particularly household composition and employment status, as well as shocks related to covariate

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PUBLIC INTEREST STATEMENT

Rwanda's efforts to build resilience and coping mechanisms in the face of severe shocks have been recognized as essential for sustainable development. The country's geographic location and climate make it susceptible to various shocks, including natural disasters such as extreme rainfall, floods, and landslides. Understanding the determinants of shock-coping mechanisms adoption and their relationship with rural household consumption are of paramount importance for policymakers and stakeholders. It enables the identification of factors that influence the adoption of effective coping strategies and sheds light on their implication for household welfare and resilience. The study's finding highlight the importance of disaggregating households' employment features, and shock-coping mechanisms into household consumption clusters. For instance, when faced with covariate shocks, households headed by women were observed to spend significantly less on food, non-food items and overall expenses compared to those headed by men.

shocks, and (2) women spend noticeably less on food, non-food items, and overall expenses than those headed by men when they face covariate shocks. The study suggests that increasing more members employed in non-agricultural businesses and raising livestock, particularly goats could be a pro-low-consumption household strategy in response to shocks. Overall, the study's findings provide valuable insights into the factors that contribute to effective shock-coping mechanisms in rural households and highlight the importance of considering household consumption levels when designing policy interventions.

Subjects: Rural Development; Environmental Economics; Economics

Keywords: shock-coping mechanisms; household consumption; Rwanda

1. Introduction

To understand how rural households deal with unforeseen circumstances, it is important to take into account the effect of their consumption levels. Rural households in developing countries are especially prone to shocks, with a significant proportion being impacted by both individual (idiosyncratic) and shared (covariate) shocks, as observed in Madagascar (Gunther & Harttgen, 2009). Additionally, many rural households in developing economies depend on economic activities such as farming, which are highly vulnerable to natural conditions and climate change (Gezie & Tejada Moral, 2019; Tran, 2015).

The African continent has experienced various shocks that have affected its development, including climate change, natural disasters, and economic crises. For example, weather shocks have significantly impacted the livelihoods of rural poor in different countries such as Benin, Ghana, and Tanzania just to cite a few by reducing expenses, food consumption, and household asset, promoting outmigration, and destabilizing household welfare (Afriyie et al., 2018; Letta et al., 2018; Lokonon, 2019; Mueller et al., 2020). These shocks have had considerable effects on Africa's efforts towards reducing poverty, achieving economic growth, and ensuring food security. Rwanda, similar to other African nations, has encountered different shocks that have had a greater impact on the rural sector (Booth & Golooba-Mutebi, 2014).

The government of Rwanda (n.d.) has implemented various key programs, and plans to address unforeseen circumstances, including heavy rainfall, and other related challenges. Notably, National Contingency Plan for Floods and Landslides and National Contingency Plan for Drought aim to enhance the country's resilience to natural disasters and climate-related hazards. In response to the food supply shocks that resulted in widespread food prices increase, the government of Rwanda has been enacting different measure. These include expanding irrigation scheme, providing subsidies for agricultural inputs like improved seeds, and fertilizer. Additionally, the government has been actively promoting clean and efficient cooking energy technologies under Green Climate Fund project. These initiatives highlight the government's proactive plans in managing both idiosyncratic and covariate shocks. Consequently, there is a compelling need to understand shock-coping mechanisms in relation to the rural household consumption.

Diverse coping strategies are likely to be adopted depending on the nature and characteristics of a household, for example, households are expected to engage in off-farm activities or employment (Gao & Mills, 2018; Kochar, 1999), plant drought-tolerant varieties (Abid et al., 2019), extracting natural resources or selling durable assets (Nguyen et al., 2020), self-insurance strategies (Heltberg et al., 2015), deplete savings (Khan et al., 2015; Paumgarten et al., 2020), and borrowings (Khan et al., 2015; Tran, 2015).

Numerous scholars have shown interest in examining shock-coping mechanisms and identifying the factors that influence households' decision-making regarding ex-post coping strategies (Berloff & Modena, 2013; Khan et al., 2015; Kusunose & Lybbert, 2014; Nguyen et al., 2020). Furthermore, many researchers have been exploring the use of non-linear machine learning techniques, such as logistic regression models, to gain insight into household consumption and poverty. Accurate estimates of household consumption levels are critical for a variety of reasons, including poverty analysis, resource allocation, and development planning. However, the current literature does not adequately consider the role of shock-coping mechanisms.

The novel contribution of this paper is two-fold. First, this paper contributes to the literature by considering both idiosyncratic and covariate shocks as understanding the dynamics and responses to both types of shocks provided a more comprehensive understanding of how shocks and household characteristics influence the shock-coping mechanism. Using a rich cross-sectional dataset, coping strategies are quantified using all sources and matched with shocks and household-level consumption. Few studies attempted to quantify shock-coping mechanisms but their results differ across countries and fields (Kemper et al., 2013; Nguyen et al., 2020; Pradhan & Mukherjee, 2018; Yilma et al., 2014), while others studies are health shocks specific (Fadlon & Nielsen, 2015; Genoni, 2012; Islam & Maitra, 2012), and rainfall shocks specific (Amare et al., 2018; Baez et al., 2017; Porter, 2012).

Second, we are filling the gap related to the role of shock-coping mechanisms' impact on household consumption by combining multinomial logit regression and two-level hierarchical linear modeling, the model identified the household-level variables that are most strongly associated with consumer behavior, as well as the region-level factors that influence consumer behavior across regions. This provided a more wide-ranging understanding of the factors driving household consumption. In addition, there is little consideration of Rwandan literature. This approach of combining a multinomial logistic regression model with a two-level hierarchical linear model to understand household consumption behavior has been used by several authors in the literature (Börner et al., 2012; Brown & Uyar, 2004). This approach accounts for the hierarchical structure of the data, where observations are nested within households or communities, by using a two-level hierarchical linear model.

Following the introduction, the paper proceeds to section 1, which contains a review of the relevant literature. Section 2 describes the materials and methods employed in the study, while section 3 presents and examines the findings. The last section provides concluding remarks and offers suggestions for future research.

2. Literature review

Rwanda, a country located in East Africa, has a predominantly agricultural economy, and the livelihoods of many rural households depend on it. For instance, agricultural activities are widely practiced in around 2.3 million households in Rwanda, which accounts for 69% of private households. Among these, approximately 2.1 million households, or 63% of private households, engage in crop farming, with the most commonly grown crops being beans, maize, cassava, and sweet potato, in that order. Moreover, livestock ownership is prevalent among around 1.7 million households, or 50% of private households, with cows being the most common type of livestock, followed by goats, pigs, and chickens (National Institute of Statistics of Rwanda [NISR], 2023). However, due to various natural and human-induced shocks, such as droughts and economic, these households often face significant economic challenges. To cope with these shocks, households adopt various coping mechanisms, such as reducing consumption or selling assets. However, these mechanisms have long-term effects on household consumption and overall well-being. Therefore, understanding the determinants of shock-coping mechanisms adoption and their effect on rural household consumption in developing economies, particularly Rwanda is critical.

2.1. Shock-coping strategies in the literature

Shock-coping mechanisms are strategies that households adopt to help them withstand shocks such as natural disasters, economic downturns, or health crises. These mechanisms include a range of activities, such as saving money, borrowing, diversifying income sources, or relying on social networks for support. The adoption of these strategies can have significant implications for rural household consumption, which is a critical determinant of rural livelihoods.

Dhanaraj (2016) discovered that borrowing was the most widely used shock-coping strategy to deal with economic shocks, whereas household consumption reduction was the primary coping strategy in the case of health shocks. In contrast, Santos et al. (2011) found that non-poor households in Bangladesh faced a larger share of asset-related, climatic, economic, and health shocks than poor households, and their primary coping responses were savings and asset depletion. Additionally, Berloff and Modena (2013) showed that the response to shocks differed between non-poor and poor households. Poor households were more likely to adjust their labor supply, take out a loan, and cut expenditures, while non-poor households mainly depleted their savings. Murakami (2017) found that households with disabled or chronically ill members primarily curtailed their consumption and borrowed money, whereas non-poor households were more prone to sending household members to work, akin to elderly female-led households in Tajikistan. Finally, according to Nguyen et al. (2020), selling durable assets, child labor, and natural resource extraction were the primary coping responses to shocks in rural Cambodia.

Besides, these studies suggest that different households utilize different strategies to cope with various types of shocks. While borrowing and consumption reduction were common strategies across households, non-poor households tend to rely more on savings depletion and sending household members to work, whereas poor households tend to adjust their labor supply, take out a loan, and cut expenditures. Therefore, policymakers must consider the diversity of shock-coping strategies utilized by different households while formulating policies to mitigate the effects of shocks.

2.2. Determinants of shock-coping mechanism in the literature

Various studies have investigated the determinants of shock-coping mechanisms adoption. For example, Börner et al. (2012) identified asset ownership, shock characteristics, and savings as the primary determinants of shock-coping mechanisms in developing countries. In addition, Nguyen et al. (2020) found that age plays a critical role in shock vulnerability, with older households being more vulnerable to natural disasters in rural Vietnam due to limited physical mobility and access to information. Similarly, Mutenje et al. (2010) unveiled that in Southeast Zimbabwe, the most important factors determining the adoption of coping mechanisms in response to shocks were the number of cattle owned by the household, the education level of the household head, income, and the value of physical assets. Furthermore, Gautam et al. (2021) highlighted the nature of shocks, geographic context, and socio-economic factors in rural Nepal as the main determinants of shock-coping mechanisms.

Overall, these studies suggest that shock-coping mechanism adoption is influenced by various factors such as asset ownership, shock characteristics, savings, age, education, income, and geographic context. Instead of taking a one-size-fits-all approach, policymakers must consider the diversity of factors that influence shock-coping mechanism adoption across different contexts.

2.3. Shock-coping mechanisms adoption and rural household consumption smoothing

The impact of shock-coping mechanisms adoption on rural household consumption has also been extensively studied. For example, Poor households experience varying effects on their household consumption depending on the coping strategies they adopt when their current income change (Berloff & Modena, 2013). Specifically, the study found that non-poor farmers tend to balance their consumption with their income, whereas poor households make up for their loss in income by increasing their labor supply. Likewise, a research study conducted in Cambodia discovered that

most shared (covariate) shocks have a significant and negative influence on household consumption. Specifically, floods have an unfavorable impact on both total expenditure and food consumption, whereas livestock diseases have a negative effect on household education expenses. Moreover, these shocks force households to adopt coping strategies such as selling long-lasting assets and exploiting natural resources (Nguyen et al., 2020). On the other hand, a study conducted in Ethiopia found that households that engaged in coping mechanisms such as asset sales and borrowing were more likely to experience a decline in their consumption levels compared to households that did not engage in these mechanisms (Dercon & Krishnan, 1996). The study suggests that these coping mechanisms may have negative long-term effects on household consumption, as they can deplete households' assets and increase their debt burden. Moreover, a study conducted in rural areas in Nigeria found that although climatic and idiosyncratic shocks did not have a substantial impact on household consumption, price shocks had a significant negative effect. Furthermore, the results from the disaggregated sample suggested that non-poor households remained effectively insured against the impact of idiosyncratic and climatic shocks on their consumption in the past, while poor households were unable to insure themselves against shocks related to death, livestock loss, climate change, and price changes in the past (Shehu & Sidique, 2015).

While many studies have explored the determinants of shock-coping mechanisms adoption and their impact on rural household consumption, few have examined these issues in the context of Rwanda. Moreover, previous studies have primarily used linear regression models, which do not account for the hierarchical nature of the data.

3. Materials and methods

3.1. Theoretical framework

We hypothesized that the adoption of a particular coping strategy is modeled in a random utility framework. As per Teklewold et al. (2013), we assume that a household has an aim in a multinomial selection model of minimizing the cost associated with each shock C_i , by comparing the cost associated with alternative S coping strategies. Thus, a household i will choose a specific shock strategy j , over an alternative shock strategy k , if

$$C_{ij} < C_{ik}, k \neq j.$$

The cost minimization, C_{ij}^* that a household derives from the adoption of a particular coping strategy j is the hidden variable determined by observed household, employment, ownership, and shock-level characteristics (X_i) and unobservable characteristics (μ_{ij}):

$$C_{ij}^* = X_{ij}\beta_j + \mu_{ij} \quad (1)$$

Let (C) be an index that indicates a household's choice of a particular shock-coping strategy, such that:

$$C = \begin{cases} 1 & \text{iff } C_{i1}^* < \min_{k \neq j} (C_{ik}^*) \text{ or } \eta_{i1} > 0 \\ \vdots & \vdots \\ J & \text{iff } C_{iJ}^* < \min_{k \neq j} (C_{ik}^*) \text{ or } \eta_{iJ} > 0 \end{cases} \text{ for all } k \neq j \quad (2)$$

From above, $\eta_{ij} = \min_{(k \neq j)} (C_{ik}^* - C_{ij}^*) > 0$. Eq. (2) suggest that i^{th} household will adopt a particular shock-coping strategy j , that provides minimum cost than any other shock-coping strategy $k \neq j$, that is, if $\eta_{ij} = \min_{(k \neq j)} (C_{ik}^* - C_{ij}^*) < 0$. Following McFadden and Train (2000), the probability that i^{th} a household with characteristics X_i will select the shock-coping strategy j can be measured by a multinomial logit model:

$$P_{ij} = \Pr(\eta_{ij} > 0 | X_i) = \frac{\exp(X_i \beta_j)}{\sum_{k=1}^J \exp(X_i \beta_k)} \quad (3)$$

Two-level hierarchical linear modeling was used to predict household expenditure using both household and region-level variables. In this type of model, household-level variables are nested within regions. The basic mathematical equation for a two-level hierarchical linear model for household consumption prediction is written as:

Level 1 (household level):

$$Y_{ij} = \beta_{0j} + \beta_{1j}X_{ij} + \varepsilon_{ij} \quad (4)$$

Level 2 (region-level):

$$\beta_{0j} = \gamma_{00} + \gamma_{01}Z_j + \mu_{0j} \quad (5)$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}Z_j + \mu_{1j} \quad (6)$$

Where:

Y_{ij} Represents the household expenditure for a household i in a region j . X_{ij} Represents the predictor variables for a household i in the region j . β_{0j} and β_{1j} are the intercept and slope coefficients for the region j , respectively. ε_{ij} Represents the error term for a household i in the region j . Z_j Represents the predictor variables for region j . γ_{00} and γ_{10} are the fixed effects intercept and slope coefficients, respectively. γ_{01} and γ_{11} are the random effects coefficients that measure the association between the predictor variables and the intercept and slope, respectively. μ_{0j} and μ_{1j} represent the random effects of the intercept and slope for region j , respectively.

This model accounts for the fact that households within a region may be more similar to each other than to households in other regions, and allows for the estimation of both fixed and random effects at the household and regional levels. The two-level hierarchical linear model was fitted using Mixed-effects REML regression.

3.2. Data

This study used the subset of the EICV 5 dataset, which was carried out by the National Institute of Statistics of Rwanda between October 2016 and October 2017. It focused on 4782 households situated in rural regions that had encountered shocks. Table 1 presents shocks and coping mechanisms typology used in this study and their definitions.

Table 2 displays the proportions of different methods of coping that were employed for different categories of shocks. For households that experienced covariate shocks, the most commonly adopted coping strategy was reducing expenditure (34.37%), followed by others such as withdrawing children from school (23.99%). Selling durable assets was the most common coping strategy for households that experienced idiosyncratic shocks (25.91%), followed by reducing expenditure (24.52%). These findings align with other studies that have shown households facing idiosyncratic shocks such as high food prices and the death of household heads are more likely to reduce their durable assets. On the other hand, covariate shocks like irregular rains and floods typically result in reducing consumption expenditures (Börner et al., 2012).

Table 1. Shocks and coping strategies typology

Type of shocks		Definition
Covariate shocks		
	Weather shocks	Irregular rains, drought, Floods, prolonged dry spells, landslides, mudslides
	Epidemic shocks	An abnormally elevated incidence of human illnesses
Idiosyncratic shocks		
	Agricultural shocks	Unusually high levels of crop pests & diseases, livestock diseases, prices for food, and cost of agricultural inputs seed, fertilizer, etc.
	Health shocks	Serious illness or accident of household member, and the passing away of the household-head
	Economic shocks	The decrease or loss of employment or income for a member of the household.
Others		Fires, Not Specified

Source: Authors' categorization of shocks.

3.3. Description of variables and hypothesis

The study draws on previous research to identify important variables that impact shock-coping mechanisms, including studies by Nguyen et al. (2020), Heltberg et al. (2015), Berloff and Modena (2013), and Gunther and Harttgen (2009). Household features such as size, head characteristics (level of education, gender, and age), employment features, village-level features, and nature of shocks are considered essential determinants of shock-coping strategies, as established by Mutenje et al. (2010). Age is an important factor in coping strategy, as older household heads are likely to have accumulated more durable assets (Manda et al., 2016). Gender is another important predictor, as females tend to be more risk-averse than males (Arano et al., 2010; Fletschner et al., 2010). Better jobs also play a significant role in enhancing resilience to external shocks (Liang & Goetz, 2016), while female-headed households are most vulnerable to shocks due in part to less involvement in off-farm employment (Akampumuza & Matsuda, 2017). Asset ownership may impact coping strategy, as owning fewer assets might reduce a household's ability to raise money through sales (Akampumuza & Matsuda, 2017). The nature of shocks similarly plays a role in determining coping strategy (Börner et al., 2012).

The study focuses on investigating shock-coping mechanisms and their influence on household consumption. To achieve this, the study had two main objectives. Firstly, the study aimed to explore whether various household characteristics such as livestock ownership, the level of education of household members, household head characteristics, and the nature of shocks, significantly determine a household's shock-coping mechanism. Secondly, the study analyzed the impact of household characteristics and the nature of shocks on household expenditure. This approach is in line with previous studies by Ansah et al. (2021) and, Shehu & Sidique (2015).

4. Results

4.1. Household features and description of shock-coping mechanisms

Table 3 displays the summary statistics for the explanatory variables used. The study defines low-consumption households (LCHs) as those with annual consumption expenditures less than the

Table 2. Proportions of shocks faced by households versus coping strategies

Shock experienced	Coping strategy					
	Selling durable assets	Reducing expenditure	Used up savings	Borrowings	Migration	Others
Covariate	20.73	34.37	6.03	12.69	2.19	23.99
Idiosyncratic	25.91	24.52	12.87	19.76	2.37	14.57
Not specified	25.54	1.8	6.94	20.97	2.75	33
Total	22.5	3.14	8.03	15.2	2.27	21.86
						100
						100
						100
						100

Table 3. Descriptive statistics (n = 4782)

Variable	Unit	Low		Medium		High	
		Mean	Std. Err.	%	Mean	Std. Err.	%
Household Level							
Household-head(HH) features							
Sex: female, male	Cat.	-	-	10.21, 28.98	-	-	10.88, 31.39
Age	Cont.	45.41	0.023		47.28	0.026	
Household(H)features							
Children (Aged, less than 16)	Cont.	2.7	0.002	-	1.95	0.002	-
Education, with secondary	Cont.	0.19	0.0009	-	0.4	0.0012	-
Employment features (Members in H)							
Employed in the private farm	Cont.	1.81	0.001	-	1.68	0.001	-
Employed in private non-farm	Cont.	0.39	0.001	-	0.45	0.001	-
Employed in public	Cont.	0.015	0.0002	-	0.016	0.0002	-
Ownership features (Total number)							
Land(farmland owned within an H)	Cont.	1.1	0.0005	-	1.08	0.0004	-
Cattles	Cont.	0.24	0.0009	-	0.62	0.003	-
Goats	Cont.	0.47	0.001	-	0.83	0.002	-
Pigs	Cont.	0.16	0.0008	-	0.2	0.0009	-
Shocks type (as the first shock an H experienced)							
Covariate shocks	Cat.	-	-	26.13	-	-	28.51
Idiosyncratic shocks	Cat.	-	-	10.97	-	-	11.13
					-	-	10.89
					-	-	6.31

(Continued)

Table 3. (Continued)										
Variable	Unit	Low		Medium		High				
		Mean	Std. Err.	Mean	Std. Err.	Mean	Std. Err.	%		%
Not specified	Cat.	-	-	-	-	-	-	2.65		1.34
Region (village) level										
Distance to market	Cont.	58.24	0.05	58.12	0.05	54.88	0.08	-		-

NB: Cat. denotes categorical, and Cont. denotes continuous, Region (1-Kigali rural, 2-Southern rural, 3-Western rural, 4-Northern rural, and 5-Eastern rural)
Source: Author's computations using Integrated Household Living Conditions Survey (EICV-5).

national poverty line of Rwf 159,375. Medium-consumption households (MCHs) are those with consumption expenditure between the national poverty line and double the national poverty line, while high-consumption households (HCHs) are those with more than double the national poverty line.

For household head features, the percentage of female household heads ranged from 10.21% to 5.58% across low, medium, and high categories, while the percentage of male household heads ranged from 28.98% to 12.96%. The mean age of household heads ranged from 45.41 to 49.89 years. As the implications, the percentage of female household heads is lower than that of male household heads across all categories, and this difference is particularly stark in the high category. Additionally, the mean age of household heads tends to increase as the category moves from low to high.

For household features, the mean number of children members in each household also varied across categories, with the highest numbers generally found in the low category. The mean of household members with at least a secondary level of education ranged from 0.19 to 0.64 per household. This suggests that there may be significant disparities in educational opportunities and outcomes across different households, which could have implications for issues such as income, employment, and social mobility.

For employment features, the mean number of household members employed in the private farm, private non-farm, and public sectors ranged from 1.81 to 1.33, 0.39 to 0.49, and 0.015 to 0.05, respectively, across categories. In general, the mean number of household members employed in the private farm and non-farm sectors was higher than in the public sector. This could indicate that households in the low category may have more members employed in the agriculture sector, while those in the high category might have more members employed in the formal sector.

Concerning ownership features, the mean number of farmlands owned within a household was highest in the high category at 1.11, compared to 1.08 and 1.1 in the medium and low categories, respectively. The mean number of cattle, goats, and pigs owned within a household was highest in the high category compared to the medium and low categories. This could imply that households in the high category are more likely to have access to resources that allow them to acquire and maintain these assets, such as wealth, land, and labor.

Regarding the shocks that households experienced, covariate shocks were more prevalent in the medium and high categories compared to the low category. On the other hand, idiosyncratic shocks were present in all categories, but they were slightly higher in the low and medium categories, respectively.

Finally, concerning the region-level variables, the mean distance to the market was highest in the low category at 58.24, compared to 58.12 and 54.88 in the medium and high categories, respectively. The high distance to the market in the low category can lead to higher transportation costs and reduced access to goods and services.

4.2. Features explaining the selection of coping strategies

The results (Table 4) present the relative risk ratios (RRRs) for each independent variable at different levels of consumption (low, medium, and high) for each category of coping strategies (selling durable assets, using up savings, borrowing, migration, and other strategies). The base category for the analysis is reducing expenditure. The RRRs indicate the likelihood of each category of coping strategy compared to the base category.

Looking at the main effects, households with medium and high consumption have a lower likelihood of reducing their expenditures than households with low consumption. In addition,

Table 4. Household and shock-coping features explaining coping strategies adoption

Dependent variable		Selling durable assets	Used up savings	Borrowings	Migration	Others
Medium		28.93*** (38.79)	57.48*** (29.40)	11.33*** (26.09)	86.72*** (21.24)	29.91*** (40.52)
High		2.184*** (7.12)	22.74*** (21.08)	0.858 (-1.30)	2.202** (3.07)	0.171*** (-15.53)
Female		0.566*** (-42.77)	1.071*** (3.49)	1.120*** (8.43)	0.911*** (-3.56)	1.101*** (8.48)
Female*M		1.098*** (5.17)	.825*** (-7.33)	0.768*** (-14.00)	3.077*** (27.90)	0.986 (-0.85)
Female*H		1.934*** (28.65)	.924** (-2.68)	0.815*** (-8.16)	3.228*** (21.81)	1.202*** (8.25)
Age		1.013*** (32.95)	.994*** (-8.88)	1.002*** (3.93)	0.978*** (-24.07)	1.002*** (5.04)
Age*M		0.976*** (-47.05)	.995*** (-6.08)	0.987*** (-22.38)	0.998 (-1.78)	0.983*** (-33.01)
Age*H		1.001 (1.26)	1.011*** (12.43)	0.992*** (-11.75)	1.005*** (3.36)	1.015*** (22.79)
Children (Aged, less than 16)		1.172*** (42.09)	1.017** (2.60)	1.008 (1.85)	0.948*** (-6.54)	0.976*** (-6.58)
Children *M		0.997 (-0.48)	1.126*** (14.17)	1.139*** (21.29)	1.001 (0.07)	1.000 (-0.06)

(Continued)

Table 4. (Continued)

Dependent variable	Selling durable assets	Used up savings	Borrowings	Migration	Others
Children *H	0.921*** (-11.15)	1.016 (1.62)	0.817*** (-22.95)	1.441*** (21.30)	0.926*** (-8.66)
Secondary level of education	1.306*** (28.91)	1.471*** (3.11)	1.235*** (19.92)	0.515*** (-18.03)	1.022* (2.17)
Secondary*M	0.786*** (-21.67)	.679*** (-25.08)	0.861*** (-11.93)	1.044 (0.90)	0.903*** (-8.52)
Secondary*H	0.789*** (-19.31)	.705*** (-22.47)	0.931*** (-5.29)	1.307*** (5.52)	0.892*** (-8.21)
Employed in the private farm	0.964*** (-7.36)	.963*** (-4.52)	0.941*** (-10.40)	1.059*** (4.92)	1.069*** (13.79)
Private farm*M	0.964*** (-5.10)	1.124*** (1.78)	1.072*** (8.55)	0.812*** (-10.23)	1.001 (0.20)
Private farm*H	1.240*** (20.98)	1.155*** (11.20)	1.313*** (23.36)	0.680*** (-11.36)	1.068*** (5.82)
Employed in private non-farm	0.927*** (-9.12)	1.039** (3.02)	1.049*** (5.26)	0.773*** (-12.56)	0.947*** (-6.76)
Private non-farm*M	0.929*** (-6.72)	1.039* (2.41)	0.720*** (-26.09)	0.617*** (-13.42)	0.824*** (-16.78)
Private non-farm*H	1.009	1.004	0.999	0.995	0.759***

(Continued)

Table 4. (Continued)

Dependent variable	Selling durable assets	Used up savings	Borrowings	Migration	Others
	(0.64)	(.22)	(-0.04)	(-0.14)	(-16.37)
Employed in public	0.569***	1.176***	0.786***	1.080	0.667***
	(-14.06)	(3.60)	(-5.88)	(0.97)	(-10.72)
Public*M	0.885	2.413***	2.104***	2.94e-08	3.876***
	(-1.93)	(14.60)	(13.29)	(-0.02)	(26.33)
Public*H	1.833***	1.140*	0.605***	2.37e-08	2.051***
	(12.04)	(2.39)	(-8.35)	(-0.03)	(14.30)
Land	0.652***	.248***	1.119***	1.428***	2.168***
	(-21.62)	(-3.14)	(6.10)	(11.74)	(54.07)
Land*M	0.633***	2.658***	0.581***	0.310***	0.554***
	(-16.14)	(18.23)	(-19.90)	(-17.38)	(-27.50)
Land*H	1.128***	1.706***	0.301***	1.347***	1.006
	(3.67)	(9.52)	(-33.10)	(5.15)	(0.23)
Cattle	1.155***	1.243***	1.185***	0.518***	0.824***
	(17.32)	(17.02)	(17.62)	(-21.32)	(-19.75)
Cattle*M	0.925***	.834***	0.834***	1.538***	0.827***
	(-9.11)	(-13.77)	(-17.74)	(11.41)	(-15.77)
Cattle*H	0.908***	.803***	0.729***	1.267***	0.989
	(-11.21)	(-16.71)	(-27.45)	(5.50)	(-0.89)
Goats	1.115***	1.015	0.967***	1.003	0.942***

(Continued)

Table 4. (Continued)

Dependent variable	Selling durable assets	Used up savings	Borrowings	Migration	Others
	(25.35)	(1.94)	(-6.02)	(0.28)	(-12.31)
Goats*M	1.116***	1.124***	1.143***	1.114***	1.007
	(20.20)	(13.05)	(19.35)	(7.26)	(1.08)
Goats*H	1.183***	1.208***	1.391***	1.390***	1.365***
	(26.24)	(2.44)	(44.09)	(23.77)	(43.23)
Pigs	0.951***	.884***	1.003	1.127***	0.908***
	(-5.43)	(-7.80)	(0.28)	(6.49)	(-9.72)
Pigs*M	0.954***	1.166***	0.766***	1.083**	1.148***
	(-3.73)	(8.04)	(-17.09)	(3.03)	(10.21)
Pigs*H	1.113***	1.434***	0.770***	0.269***	1.118***
	(8.12)	(19.79)	(-15.15)	(-16.04)	(7.35)
Idiosyncratic	1.912***	3.790***	1.930***	1.684***	0.775***
	(58.39)	(78.89)	(53.61)	(22.62)	(-22.07)
Idiosyncratic*M	1.253***	.928***	1.590***	1.097*	1.233***
	(14.42)	(-3.32)	(27.11)	(2.46)	(12.24)
Idiosyncratic*H	0.999	.677***	1.175***	0.443***	1.208***
	(-0.05)	(-16.07)	(7.54)	(-15.80)	(8.81)
Distance to market	1.019***	1.066***	0.981***	1.020***	1.015***
	(20.55)	(42.44)	(-19.81)	(10.95)	(17.54)
Distance to market*M	0.975***	.923***	0.978***	0.942***	0.966***

(Continued)

Table 4. (Continued)

Dependent variable	Selling durable assets	Used up savings	Borrowings	Migration	Others
	(-19.66)	(-4.99)	(-15.86)	(-19.16)	(-27.24)
Distance to market ^H	0.974***	.942***	1.027***	0.967***	1.005**
	(-16.79)	(-28.51)	(15.15)	(-8.93)	(3.29)

Exponentiated coefficients; t statistics in parentheses * p<0.05 ** p<0.01 *** p<0.001

LR chi2(220) 175590.7
Prob > chi2 0
Pseudo R2 0.0618
Log restricted-likelihood -1331936

high-consumption households are more likely to use their savings, while, Medium consumption households are more likely to migrate than low-consumption households in face of shocks. Furthermore, the high consumption class exhibits distinct patterns in adopting coping strategies compared to the medium consumption class across various household characteristics. Notably, the high consumption class shows a lower likelihood of selling durable assets, depleting savings, and engaging in migration when compared to the medium consumption class. These findings suggest that household characteristics play a role in shaping coping strategies, with the high consumption class demonstrating unique tendencies that diverge from the medium consumption class in response to different challenges and resource availability.

Female-headed households have a greater tendency to cut down on their household expenses or utilize their savings in comparison to male-headed households when confronted with shocks. They may even opt to borrow funds instead of resorting to selling their assets or relocating. However, the interaction effect indicates that females-headed in medium as well as high-consumption households are more likely to migrate or sell durable assets than females-headed in low-consumption households in times of shock. Furthermore, females-headed in high-consumption households are even likely to adopt all coping strategies considered in this study over simply reducing expenditure compared to females-headed in both medium and low-consumption households. This findings has important implications as it highlights the role of economic conditions in shaping coping behaviors and how this influence varies across gender and consumption levels.

Older-headed households are likely to sell durable assets and borrow instead of reducing household consumption, and this seems to remain constant for high-consumption households. However, this is not the case for medium household consumption which prefer to reduce consumption in face of shocks than older people in low-consumption households. When there is an increase in the number of children under 16 within a household, it is more likely that the family will choose to sell their durable assets or dip into their savings instead of reducing their household expenses. Interestingly, this trend remains consistent even for medium-consumption households, which still prioritize using their savings over reducing consumption. However, high-consumption households are more likely to migrate than those with children under 16 in low-consumption households. Moreover, households with at least one member who has completed secondary education are more likely to use all coping strategies, except for migration. However, the interaction effect reveals that households with members who have a secondary education level in the medium and high consumption categories are less likely to use all coping strategies when compared to households with members who have a secondary education level in the low consumption category.

Being employed either on a private farm, private non-farm, or in public jobs is negatively associated with selling durable assets, positively associated with migration for the increase in the number of members of the household employed in the private farm, while an increase in many members employed in private non-farm and public jobs is positively associated with using savings. The interaction effect indicates that households with employment in private farms in the medium as well as in high consumption households are more likely to use savings and borrowing and less likely to use migration than households with employment in private farms in low consumption households. Under certain conditions, the outcome could be different because rural land and properties may be sold off to finance the relocation of people to urban areas. Besides, employed in private farm within a high-consumption household have even a significantly higher likelihood of adopting selling durable assets, used up savings, and borrowings compared to households with employment in private farms in medium-consumption households indicating role better financial resources even in rural areas to mitigate the impact of economic downturns.

Owning more land is associated with a lower risk of selling durable assets or using up savings for low and medium-consumption households but not for high-consumption households. Cattle ownership is associated with a higher risk of migration for medium and high-consumption households than low-consumption households. Goats' ownership is associated with a higher risk of all coping

strategies for medium and high-consumption households than low-consumption households, in other words, goats owners prefer to reduce their household expenses in face of shocks. Pigs' ownership is generally associated with reducing expenditure and migration. The interaction effect indicates that medium-consumption households are more likely to use migration in addition to savings, while high-consumption households are more likely to sell assets in addition to savings.

Idiosyncratic shocks in comparison to covariate shocks are consistently associated with a higher risk of all coping strategies for all households, but the effect is more significant for low and medium-consumption households, and households are four times more likely to use their savings in times of idiosyncratic vs. covariate shocks. In contrast, covariate shocks are consistently associated with a higher risk of reducing household consumption in rural areas. Finally, distance to market is associated with a higher risk of all coping strategies except borrowings, while the interaction effect indicates that both medium and high-consumption households are associated with a lower risk of all coping strategies than low-consumption households.

4.3. Household, and shock-coping features explaining household expenditure

The output represents the results (Table 5) of a two-level hierarchical linear model with three separate models for food expenditure, non-food expenditure, and total expenditure. The study found that households led by women spend noticeably less on food, non-food items, and overall expenses than those headed by men when they face covariate shocks. For instance, female-led households that experience covariate shocks reduce their spending on food by 0.18%, non-food items by 0.25%, and their total household expenses by 0.097%. Furthermore, the study found that as the age of the household head increases, the food expenses of households affected by covariate shocks decrease by 0.001%. However, in the case of households affected by both covariate and idiosyncratic shocks, the age of the household head was associated with a reduction of 0.005% and 0.007% respectively in non-food expenses.

Changes in household composition and distribution, such as an increase in the number of children under 16, more members with at least a secondary education, and an increase in the number of members employed in private farms or non-farm jobs, tend to result in higher levels of both food and non-food expenses. However, in response to covariate or idiosyncratic shocks, total household expenses tend to decrease. For example, if a household has more children, its total expenses decrease by 0.15% and 0.16% in response to covariate and idiosyncratic shocks respectively. Similarly, if there are more people employed in private farms, the total expenses decrease by 0.109% and 0.104% in response to covariate and idiosyncratic shocks respectively, but less effect is observed.

Livestock composition at the household level was also found to have implications for household expenditures. An increase in some cattle, and goats' would allow households to maintain or increase their household expenses even in face of either covariate or idiosyncratic shocks. For example, households with more land spend significantly less on non-food and total expenditures when facing idiosyncratic shocks, while households with more cattle spend significantly more on non-food and total expenditures than households with fewer cattle when facing either idiosyncratic or covariate shocks. Furthermore, households with more goats spend significantly more on food, non-food, and total expenditures than households with fewer goats when facing covariate shocks.

Households facing covariate shocks tend to spend less on non-food when implementing reducing expenditure strategies, and households facing idiosyncratic shocks tend to spend less on food items when implementing other coping strategies, such as using up savings, or borrowing.

Finally, in the random intercept model results, we saw that the intercept term ($_cons$) for food expenditure, non-food expenditure, and total expenditure are all significant ($p < 0.001$). This suggests that there is significant variation in these outcomes across regions, even after accounting for

Table 5. Household and shock-coping features explaining household expenditure

	Food expenditure	Non-food expenditure	Total expenditure
Male*Idiosyncratic	.136	.147	-.0210
	(1.07)	(.76)	(-.20)
Female*covariate	-.182***	-.252***	-.0978***
	(-6.60)	(-5.99)	(-4.28)
Female*Idiosyncratic	-.181	-.108	-.199
	(-1.40)	(-.55)	(-1.85)
Age* covariate	-.00186*	-.00518***	.000123
	(-2.30)	(-4.18)	(.18)
Age*Idiosyncratic	-.00208	-.00730***	.000550
	(-1.84)	(-4.22)	(.59)
Children*covariate	.0977***	.0930***	-.150***
	(11.68)	(7.31)	(-21.53)
Children*Idiosyncratic	.0840***	.0890***	-.161***
	(6.87)	(4.77)	(-15.79)
Education*covariate	.204***	.359***	.130***
	(13.26)	(15.31)	(1.18)
Education*Idiosyncratic	.200***	.332***	.138***
	(9.62)	(1.54)	(8.03)
Private farm*covariate	.0861***	.121***	-.109***
	(7.46)	(6.82)	(-11.36)
Private farm*Idiosyncratic	.0847***	.131***	-.104***
	(4.93)	(5.05)	(-7.33)
Private non-farm*covariate	.214***	.232***	-.00475
	(11.74)	(8.36)	(-.31)
Private non-farm*Idiosyncratic	.214***	.217***	-.0321
	(8.50)	(5.67)	(-1.54)
Public*covariate	.222**	.118	.0628
	(3.07)	(1.08)	(1.05)
Public*Idiosyncratic	-.0122	.285*	.0567
	(-.14)	(2.15)	(.78)
Land*covariate	-.0356	-.230***	-.118***
	(-.85)	(-3.58)	(-3.37)
Land*Idiosyncratic	-.00200	-.271***	-.0203
	(-.04)	(-3.30)	(-.45)
Cattle*covariate	.00948	.0610***	.0307***

(Continued)

Table 5. (Continued)

	Food expenditure	Non-food expenditure	Total expenditure
	(1.73)	(7.31)	(6.73)
Cattle*Idiosyncratic	.0489**	.146***	.103***
	(2.70)	(5.30)	(6.82)
Goats*covariate	.0305***	.102***	.0367***
	(4.48)	(9.82)	(6.47)
Goats*Idiosyncratic	.0260*	.0597***	.0291**
	(2.33)	(3.52)	(3.14)
Pigs*covariate	.0555***	.0483*	.0500***
	(3.91)	(2.24)	(4.24)
Pigs*Idiosyncratic	.0324	.0825	.0169
	(1.12)	(1.87)	(.70)
Covariate*Reducing expenditure	.0545*	-.0523	.0175
	(2.36)	(-1.49)	(.91)
Idiosyncratic*Other coping strategies	-.0533	.0951	-.0415
	(-1.38)	(1.63)	(-1.30)
Constant	12.41***	1.11***	12.63***
	(88.84)	(83.52)	(175.17)
lns1_1_1			
Constant	-14.97	-6.194***	-14.64
	(-1.71)	(-14.02)	(-1.60)
lns1_1_2			
Constant	-1.320***	-8.689	-2.415***
	(-3.60)	(-.72)	(-5.65)
lnsig_e			
Constant	-.510***	-.0923***	-.694***
	(-49.63)	(-8.63)	(-67.58)
N	4771	4753	4782

t statistics in parentheses * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

household-level variables. For food expenditure, the household-level variable (lns1_1_1) is not significant ($p = 0.136$), indicating that it does not have a significant effect on food expenditure after accounting for region-level differences. For non-food expenditure, the household-level variable (lns1_1_1) is significant ($p < 0.001$), indicating that it has a significant effect on non-food expenditure after accounting for region-level differences. For total expenditure, both household-level variables (lns1_1_1 and lns1_1_2) are significant ($p < 0.001$), indicating that they have significant effects on total expenditure after accounting for region-level differences. Overall, these results suggest that region-level differences play an important role in explaining variation in household expenditures and that different predictor variables may have different effects on different types of expenditures.

5. Discussion

5.1. Features explaining the selection of coping strategies

Our empirical findings align with the previous research that establish a general reluctance among households to reduce their consumption in response to shocks. This resistance can be attributed to the formation of habits, as evidenced by studies conducted by Baghestani and Kherfi (2015), Fisher and Montalto (2011), and Bowman et al. (1999). Similar patterns of savings strategies difference between consumption level (low, medium, high) in the face of shocks have been observed in countries such as Maldives, Ethiopia, and Uganda (Gebrekidan et al., 2020; Heltberg et al., 2015). In addition, our Findings reinforce the existing literature, as demonstrated by Aryal et al. (2021), Akampumuza and Matsuda (2017) and Hisali et al. (2011), highlighting that female-headed households display higher propensity to curtail household expenses or utilize savings compared to male-headed households. However, the interaction effect indicates a distinction in coping strategies among female-headed households based on their consumption levels sheds light on the complex dynamics that influence their decision making process in face of shocks. It is plausible that female-headed households with greater consumption levels (medium, high) have accumulated more assets, making migration or assets liquidation (Paumgarten et al., 2020), a viable option to mitigate the impact of shocks compared to the lower-consumption households.

The behavior of older-headed households, especially with those with high consumption levels, tend to sell durable assets and borrow instead of reducing household consumption in response to shocks may be attributed to the possession of more physical assets as observed by Tran (2015). The presence of children under 16 ages in a household often leads families to prioritize selling durable assets or using savings instead of reducing household consumption. This preference remains consistent even among medium-household consumption households, highlighting the importance placed on safeguarding children's nutritional wellbeing during crises in developing countries like Uganda (Lawson & Kasirye, 2013).

The distinct patterns observed with employment in private farms, private non-farm, or in public jobs are aligned with the existing research. According to Minale (2018), the increased migration of individuals employed in private farms may be linked to the characteristics of agriculture and rural regions in developing economies. Specifically, when farming experiences a decline of 4.5% due to a negative rainfall shock of 1 standard deviation, there is an approximately 5% rise in migration. Furthermore, Jessoe et al. (2018) discovered that high temperatures in rural areas of Mexico result in a decline in local job opportunities, which in turn increases migration rates from rural to urban areas. The observed interaction effect of households with employment in private farms align with existing empirical evidence. Owning assets like land in rural areas tend to enhance people's standard of living and reduces the likelihood of them relocating to urban areas (Hao & Tang, 2015).

Our analysis of land and livestock ownership in household of different consumption levels reveals notably owning more land is advantageous for low and medium-consumption households, as it reduces the risk of selling assets or depleting savings. However, this association is not observed among high-consumption households, indicating potential divergence in asset management strategies. These nuanced relationship between livestock ownership and coping strategies aligned with Massey et al. (2010), who suggest that owning an asset during crises could serve as collateral for obtaining loans to finance the trip or can provide a specific incentive for migrating, or both.

Finally, the findings from Temesgen et al. (2022), Nguyen et al. (2020), Aryal et al. (2020), and Pradhan and Mukherjee (2018) collectively highlight the importance of savings and informal borrowing as key coping strategies employed by households in times of shocks, encompassing both idiosyncratic and covariate shocks. Savings play a crucial role in mitigating the impact of adverse events, while informal borrowing provides a means to navigate through challenging situations. Notably, idiosyncratic shocks consistently pose a higher risk for all coping strategies, particularly for low and medium-consumption households, resulting in a significant reliance on

savings. Conversely, covariate shocks exhibit a consistent association with a higher risk of reducing household consumption in rural areas, as also observed by Temesgen et al. (2022) and Nguyen et al. (2020).

5.2. Household, and shock-coping features explaining household expenditure

Our findings align with previous research indicating the influence of household composition, distribution, livestock ownership, and shock-coping mechanisms on household expenditures in response to shocks. Specifically, an increase in the number of children, members with secondary education, and individuals employed in private farms or non-farm jobs is associated with higher food and non-food expenses. However, in the face of covariate or idiosyncratic shocks, total household expenses tend to decrease. Livestock composition also plays a role, as households with more cattle are inclined to spend more on non-food items, while those with more goats allocate greater expenditures to food, non-food, and overall expenses when facing covariate shocks. These findings corroborate previous studies highlighting the buffering role of livestock in coping with shocks. For instance, Acosta et al. (2021) emphasize the significance of livestock portfolios in mitigating the impacts of drought on income and consumption. Consumption smoothing strategies, heavily reliant on livestock sales, have been demonstrated by Carter and Lybbert (2012). Overall, household expenses diminish significantly in response to shocks, particularly with covariate shocks, aligning with the conclusions drawn by Temesgen et al. (2022), Nguyen et al. (2020), and Debela et al. (2012).

6. Conclusion

This study has identified various factors that influence households' coping strategies in response to shocks, including asset ownership, employment status, and household characteristics. Our analysis has also revealed that different types of shocks elicit different coping responses from households.

Overall, our discussion has shed light on the complex dynamics of shock-coping mechanisms and their implications for household consumption and welfare. By building on the findings of previous authors and highlighting key gaps in the existing literature, our analysis provides important insights for researchers, policymakers, and practitioners working to support vulnerable households in coping with shocks and improving their welfare outcomes. For example, the results of this study indicate the importance of disaggregating households, employment features, and shock-coping mechanisms into household consumption clusters that reveal a lot of differences otherwise disguised by analyzing the overall coping strategy choice.

Mostly, high-consumption households tend to borrow or reduce expenditure instead of selling durable assets in response to shocks and the difference in the effect is significant when we move from low-consumption households. In addition, being MCH and HCH household-head, one year increase in age is associated with an increase in the likelihood of adopting a reducing expenditure strategy. We found also a difference in the effect of household consumption clusters between female-headed households and male-headed households as 1.210 for adopting migration strategy in response to shocks. In other words, female-headed households from the rich group are likely to migrate in response to shocks. Other important remarks, one additional child to the household in the HCH increase the likelihood of adopting used-up savings or opting for migration, while one additional adult to the household increases the likelihood of reducing expenditure, borrowings, or used-up savings compared to selling durable assets. Generally, owning assets like pigs and/or chickens was found to increase the likelihood of adopting borrowings or used-up savings, especially for low-consumption households in response to shocks. The fact is that currently raising livestock in developing economies like Rwanda is being encouraged as an additional source of income for rural people.

However, our results also highlight the need for further research to fully understand the dynamics of shock-coping mechanisms and their implications for policy and practice. For instance, our analysis is grounded on a cross-sectional dataset, which constrains the capacity to establish

causation. In addition, this study concentrates only on a restricted set of coping mechanisms and does not encompass the complete spectrum of strategies that households may utilize to deal with unexpected events. Lastly, the research is derived from information obtained from a single country, and the conclusions may not apply to other circumstances or nations. For instance, households in other countries may face different types of shocks, have different coping strategies, or face different institutional constraints.

Despite these limitations, our discussion underscores the importance of asset ownership and employment status in shaping households' coping strategies and highlights the need for targeted policies and interventions to support vulnerable households. In particular, our analysis suggests that policies that promote asset ownership and employment opportunities may be effective in reducing households' reliance on negative coping strategies and improving their long-term welfare outcomes.

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