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Resilience mobility in Uganda: A dynamic analysis

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A B S T R A C T

Household resilience to food insecurity can be considered as the capacity that ensures stressors and shocks do not have long-lasting adverse development consequences; it is, nowadays, one of the key words in the policy debate on development. Measuring resilience capacity and how it varies over time is extremely significant for policy makers and people living in risk-prone environments. More specifically, there is a gap of empirical evidence about what drives changes in resilience capacity status (i.e. moving from a low resilience profile to a high one, and viceversa). This paper applies econometric techniques for estimating household resilience and adopts transition matrices to estimate how it changes over time. Finally, multinomial logit and bivariate probit models are estimated to identify the main drivers of change. Our study finds that female headed households are less likely to become the most resilient; also this paper demonstrates that education and participation to household enterprises are positively associated with increased resilience capacity. This paper innovates the resilience literature by providing an evidence based analysis of the main drivers of resilience; it brings this evidence in the Uganda's context, focusing the attention of the policy makers on sub-sample of population which are worse off. More generally, our study suggests that resilience enhancing policies can bridge humanitarian and development interventions by demonstrating how long-term perspectives (i.e. those investing in education) can lead to an immediate increase of resilience.

1. Introduction

The concept of economic resilience is of increasing interest to policymakers. However, despite the growing importance of the idea of resilience, the concept has not yet been carefully defined or measured (Resilience Measurement Technical Working Group, 2013). It is still sometimes confused with the similar yet technically distinct concept of vulnerability (Adger, 2006).

Resilience is one of the key concepts for measuring household capacity to cope with shocks. As such, resilience is a crucial driver for projects, programs, actions and interventions in development economics.

The majority of the proposed approaches for measuring it reflect the diversity of disciplines and sectors (Benè, 2013) in which resilience has been applied. Several definitions of resilience are being used in the development and humanitarian space, and they all tend to share three common elements: (i) the capacity to bounce back after a shock; (ii) the capacity to adapt to a changing environment; and (iii) the transformative capacity of an enabling institutional environment.

When it comes to measurement, resilience proved to be a challenging concept. This is mainly due to the fact that resilience is not measurable *per se*. The Food and Agriculture Organization of the United Nations (FAO) has a lengthy history in measuring it, being the first to adopt the concept of resilience in the food security context (Pingali, Alinovi, & Sutton, 2005) and having proposed an econometric approach to measure it since 2008 (Alinovi, Mane, & Romano, 2008). More recently, Frankenberger, Spangler, Nelson, and Langworthy (2012), Vaitla, Maxwell, Tesfay, and Rounseville (2012), Smith et al. (2015); and Alfani, Dabalen, Fisker, and Molini (2015) have proposed different approaches, while d'Errico, Garbero, and Constas (2016) set the principles for quantitative measurement.

In this paper, resilience is defined as '*the capacity that ensures stressors and shocks do not have long-lasting adverse development consequences*' (Constas, Frankenberger, & Hoddinott, 2014; RMTWG, 2014). Given this definition, any analytical framework for measuring resilience should respect the following principles.

Resilience has to be benchmarked to an outcome: it includes the agent's status with reference to a given, normatively established output level (e.g. poverty line, minimum food caloric intake, etc.). In the socio economic analysis, the most widely outcome employed

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is food security (see Constas et al., 2014; FAO, 2016a; Smith et al., 2015).[1]

Resilience is a genuinely dynamic (i.e.: time-dependent) concept: it includes preparing for, being reached by and react to shocks. This implies that the analytical framework cannot be static and an appropriate time frame must be defined. Also, this implies dynamic frameworks with defined time intervals; panel data are the best solution in order to properly measure it. Unfortunately, finding panel data sets is not always easy; this is one of the reasons for the scarcity of literature on dynamic resilience (Ciani & Romano, 2011).

The analytical framework must be able to capture all possible pathways for achieving or deteriorating resilience. As a result, the analytical framework must be able to capture both negative shocks affecting the outcome (e.g. food security) and coping strategies that can be put in place. Shocks can be defined as "external short-term deviations from long-term trends, deviations that have substantial negative effects on people's current state of well-being, level of assets, livelihoods, or safety, or their ability to withstand future shocks" (Zseleczky & Yosef, 2014). As a consequence they can be both idiosyncratic (e.g.: death of breadwinner; livestock and other assets reduction; crop failure) and covariate (e.g.: climatic shocks; inputs/outputs price shocks; conflicts).

Resilience is context-specific: it is comprised of a set of ex-ante characteristics describing the relationship between shocks and development outcomes, such as food security (Barrett & Constas, 2014; RMTWG, 2014) that need to be specified case-by-case. As a consequence, every measurement model needs to be designed against a given case-study.

Based on this analytical framework, Uganda seems to be the most appropriate case study for a dynamic analysis.

Uganda's economic situation makes it a unique example of a country that struggles between efficiency (for instance, it is a major provider of food and agricultural products for neighbouring countries) and food security threats. This makes Uganda particularly prone to shocks and sensible to macro and micro economic fluctuation that can affect both resilience and food security. Uganda is one of the poorest nations in the world; in 2005, 31.1 percent of the population lived below the poverty line. Although this figure decreased over time, it is still quite significant (World Bank, 2016). Even though enormous progress has been made in reducing poverty incidence, poverty remains chronic in rural areas, where more than 85 percent of households mostly rely on farming as the main source of income.

Marked disparities remain between urban and rural population. Poverty is 14 percent higher in rural than urban areas, and is highest in the Northern and Eastern regions, estimated at 44 percent (Uganda Bureau of Statistics, 2013). Inequalities among economic and social environments are still particularly relevant.

The Central region of Uganda, where the capital is located, is privileged in both infrastructure and economic infrastructure (see Table 11). Meanwhile, the Northern region suffers from economic and social deprivation.

Moreover, given its heavy reliance on agriculture and the aridity of some areas, Uganda is still highly exposed to climatic shocks that can affect food security and reduce resilience. Agriculture is the dominant sector in the economy; however the household level of production often falls below the needs of the household, making those families particularly vulnerable to food insecurity (USAID – United States Agency for International Development., 2011).

Climate change can expose households to challenges that are fundamentally different than those routinely considered; these are either an *unknown unknown* (for instance completely new shocks) or a *known unknown* (that is, known types of shocks that affect households differently than they did before). Climate change is closely correlated to food insecurity. Poor households often cannot cope with shocks and this makes them more exposed to a loss of food security; quite often they need to adopt risk management strategies that can compromise their future income generating capacity (that is, assets smoothing).

Still more, Uganda has a recent past history of well-documented conflicts that took place in the Northern region. Conflict is a precipitating cause of food insecurity both directly (FAO, 2016b; Howe, Stites, & Akawai, 2015; Miguel, Satyanath, & Sergenti, 2004; Simmons, 2013; Fearon, 2010; Fearon & Laitin, 2003; Hsiang, Burke, & Miguel, 2013; Miguel, 2007) and indirectly (Blattman & Miguel, 2010; Brinkman & Hendrix, 2011; Cramer, 2003; De Waal, 2015). This is especially relevant for Uganda's Northern region, together with other factors such as lack of income and assets to meet basic needs like food, shelter, clothing and acceptable levels of health and education. Households faced conflict-related shocks with long-term impacts, including the fragmentation of families, death of a parent, long-term insecurity or long-term effects of insecurity (for example loss of a spouse, particularly true for female-headed households, who are widowed over a long period; or casual labour in remote and infertile areas that rarely contributes to the accumulation of assets).

This paper employs FAO Resilience Index Measurement and Analysis (RIMA) methodology (FAO, 2013). It contributes to existing literature by presenting a dynamic analysis of resilience, looking at changes of the resilience capacity within households, taking into account the key determinants of top-down resilience movement from the highest to the lowest resilience capacity and vice versa. The analysis is made not only from the national point of view, but also takes into account regional disparities, giving special attention to the Northern region, which has been significantly battered by conflicts.

The paper is organised as follows: section 2 briefly recalls the importance of a resilience-based analysis of development issues. The next two sections describe the methodological steps for carrying out the resilience index estimation at the household level and the analysis of its changes over time. Then, after a brief introduction to the Uganda case study and the data used in the empirical application, the most important results are discussed in the next two sections. These are focused on the comparison of resilience index estimates from three different years and on the analysis of determinants of the resilience index dynamics over time. Finally, a concluding section summarises the most important findings of the paper.

2. Theoretical framework

Resilience is a dynamic concept, showing complex and far-from-equilibrium dynamics (Batabyal, 2003; Levin et al., 1998). A dynamic analytical framework is essential to better understand the household livelihood strategies used in the case of shocks, given that both positive and negative shocks could affect a household.[2] Ideally, the two effects need to be captured to better analyse the long-term effect of shocks and the related coping strategies. In the case of consumption or assets smoothing strategies, reducing short-term consumption could become a positive coping strategy in the long-term perspective of investments.[3]

Resilience measurement should be able to capture all possible pathways to well-being in the face of shocks. Fig. 1 describes what happens to a household's well-being when a shock occurs and resilience mechanism enters into action.

[1] Further discussions on the linkages between food security and resilience can be found in Alinovi et al. (2008).

[2] High food price shock could have a negative effect on some households but could translate into a positive effect for producers and sellers.

[3] One can focus on capital accumulation in a high food price moment, investing in food production in order to promote a longer period of well-being.

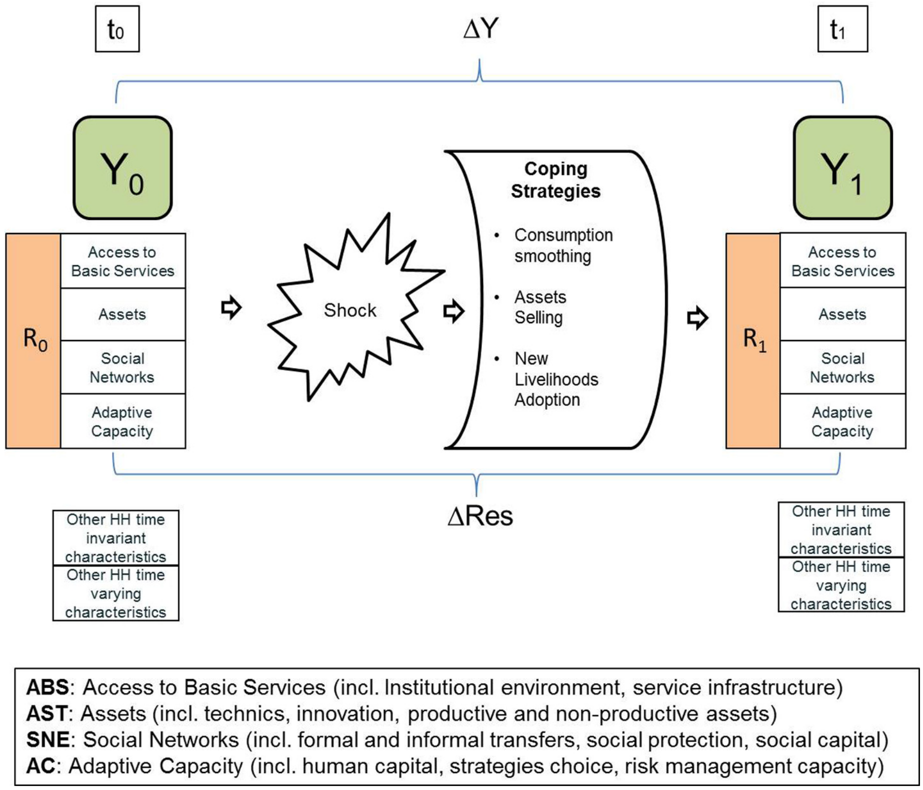

Fig. 1. Resilience conceptual framework.

When a shock occurs, a series of coping strategies are going to be activated, such as consumption smoothing, assets smoothing and the adoption of new livelihood strategies.

Household resilience contributes to these absorptive, coping and transformative capacities in the attempt to bounce back to the previous state of well-being. Over the long term, the strategies could lead to an increase or decrease in Y. Any change in Y has an effect on resilience capacity and, consequently, can limit future capacity to react to shocks.

2.1. Resilience pillars

Building (and measuring) household resilience requires a multi-dimensional approach. The main question concerns which components (from now on referred to as 'pillars') to include in the model construction. This can only be determined by investigating the resilience building strategy.

There is widespread literature[4] highlighting the asset-income-output causal chain as the major source of information in building these pillars.[5] All the major approaches to resilience measurement seem to recognise (implicitly or explicitly) the relevance of two broad areas of indicators: a natural base and an enabling capacity for adaptation and transformation.

Fundamental pillars of resilience could be, therefore:

– Income and Food Access
– Access to Basic Services
– Assets
– Social Safety Nets
– Adaptive Capacity

2.1.1. Income and food access (IFA)

Food access is a prevalent problem in Africa with serious health consequences. Limited food access is pervasive in households with little or no income and the majority of poor inhabitants rely on their income in order to access food.

IFA is an important aspect of household livelihood, having the capacity to bring out income and consequently food security disparities. In the present work, income per capita[6] (total, that is, food and non-food), expenditure per capita and food consumption scores[7] have been used.

2.1.2. Access to Basic Services (ABS)

Having ABS, such as schools, health centres, water and electricity, and nearby markets, is a fundamental aspect of resilience. The assets-based income generating capacity, a key dimension of resilience, is constrained by access to market and non-market institutions, as well as public service provision and public policy (Dercon, Bold, & Calvo, 2007). The data representing ABS are distance variables to major services (such as schools, hospitals, police, public transportation) and infrastructure; data are derived by the Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA) questionnaires conducted by the World Bank. In the present work, an infrastructure index was built though factor analysis using household characteristics (such as cement floor,

[4] See for example Pan (2007), Udry (1995), Rosenzweig and Wolpin (1993), McPeak (2004), Kochar (1999), Paxson (1992), Gertler and Gruber (2002), Kazianga and Udry (2004), Jalan and Ravallion (1997); and Jalan and Ravallion (1998).

[5] As suggested by Dercon (2001): 'Households and individuals have assets, such as labour, human capital physical capital, social capital, commons and public goods at their disposal to make a living. Assets are used to generate income in various forms, including earnings and return to assets, sale of assets, transfers and remittances.'

[6] Income per capita was estimated using the RIGA methodology. For more information, see: http://www.fao.org/economic/riga/riga-database/en/.

[7] Food consumption scores were estimated through the Food Consumption Score methodology by Professor Dan Maxwell. For more information see: https://www.wfp.org/content/technical-guidance-sheet-food-consumption-analysis-calculation-and-use-food-consumption-score-food-s.

stable roof, access to safe water and sanitation, electricity in the house).

2.1.3. Assets (AST)

Productive AST are the key elements of livelihood, enabling households to produce consumable or tradable goods. The indicator includes an agricultural wealth index (obtained through factor analysis of agricultural equipment and tools endowment), wealth index (obtained through factor analysis of non-agricultural equipment, for example, a car or a phone), land owned (estimated as hectares of land owned and cropped) and Tropical Livestock Units (TLU).[8]

2.1.4. Social Safety Nets (SSN)

Access to transfers, whether cash or in-kind, represents a major source of poverty alleviation in many developing countries. Public and private transfers make up a substantial portion of poor households' annual income, providing important cash to generate additional income.

SSN includes both formal and informal transfers. While the former category is easily observed, informal social networks flowing through unrecorded channels are difficult to capture as they are not easily detected and quantified. In fact, they involve forms of exchange that take place outside formally institutionalised channels (Ligon, 2001; Mordoch, 1999).

2.1.5. Adaptive capacity (AC)

AC is the ability of a household to adapt to a new situation and develop new sources of livelihood. For instance, having multiple sources of income may decrease the negative effects of a shock on a household. The observable variables included in this dimension are the average household level of education (estimated as the number of years of education attained), participation in income-generating activities (estimated as the number of income-generating activities in which the household participates,[9]) crop diversification index (estimated as the number of crops cultivated by the household) and dependency ratio (that is the ratio between active people in the household – that is, those who work and earn income – and inactive people in the household (that is, those who are retired, the elderly, and kids).

2.2. RIMA approach

The RIMA approach focuses on two related but distinct analyses of resilience: structure and capacity. The analysis of the **Resilience Structure Matrix (RSM)** aims at identifying the determinants of resilience. First, it assesses the observed variable weights. Second, it identifies their relative contribution in determining the pillars, and lastly, it assesses the pillars' weights in order to identify their contribution to determining the Resilience Capacity Index. The analysis of the **Resilience Capacity Index (RCI)**, compares the resilience index across different households (male-headed vs. female-headed; urban vs. rural; or regional level differences). Thus, it is possible to understand which profiles show a higher or lower capacity of coping with shocks and stressors.

Resilience, considered as unobservable index, is calculated as a function of the five pillars: IFA, ABS, AST, SSN and AC (see Fig. 2), as follows:

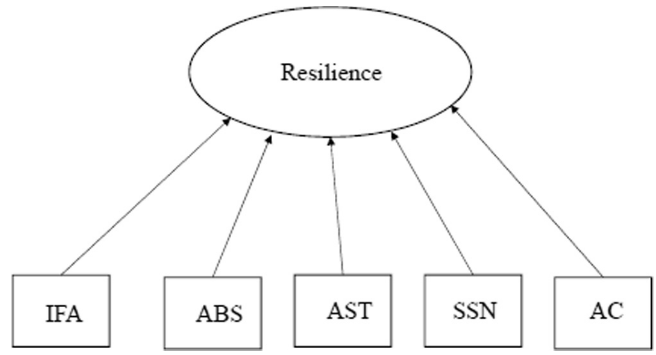

Fig. 2. Analysis of resilience structure according to RIMA.

$$R_{i,t} = f\left(IFA_{i,t}, ABS_{i,t}, AST_{i,t}, SSN_{i,t}, AC_{i,t}\right) + \varepsilon_{i,t} \quad (1)$$

The resilience index of the *i*-th household depends on the levels of IFA, ABS, AST, SSN and AC at time *t*, plus the error term.

The estimation procedure consists of two steps. During the first step, resilience pillars are estimated through factor analysis and they are subsequently employed in the estimation of household resilience capacity. During factor extraction, the shared variance of the variables are separated from their unique variance and error variance to reveal the underlying factor structure; only shared variance appears in the solution. A sufficient number of factors are considered in order to make sure they account for at least 95 percent of the explained variance (Preacher, Zhang, Kim, & Mels, 2013).

Despite the large number of latent variable models, RIMA adopts a structural equation model (SEM), which includes the correlation between residual errors and a number of formal statistical tests and fit indices.

Three are the main advantages of using an SEM (Acock, 2013; Wuensch, 2012). The first is that it is possible to identify direct and indirect effects. Direct effects refer to the direct relation between the dependent variable (the latent one) and the independent variables related to it. The indirect effect takes place when one variable has an impact on another variable through a third dependent or independent variable. An indirect effect indicates, for example, that the age of household heads could have an indirect effect on the RCI. The second advantage of an SEM is the possibility to have multiple indicators explaining the latent variable. This means that it is possible to evaluate the effect of single indicators on the dependent variable, taking into account other indicators. The third advantage is the measurement error inclusion in the model. That is the main difference compared to path analysis. Path analysis includes an error term in the prediction, but unfortunately does not control for measurement error during the process. SEM analysis, in accounting for measurement errors, provides a better understanding of how well the model predicts the actual outcome, minimizing the discrepancy between the covariance matrix of the observed variables and the theoretical covariance matrix predicted by the model structure (Bollen, 1989; Bollen, Bauer, Christ, & Edwards, 2007).

Although this method requires a greater computational effort than factor analysis, it allows for model calibration until a satisfactory level of goodness-of-fit is achieved.

3. Data

The data used for the model estimation comes from the Uganda National Panel Survey (UNPS), which is part of the LSMS-ISA that was conducted by the World Bank.

[8] TLU is a common animal unit obtained by converting the number of existing animals into a unique synthetic animal unit. For more information see: http://www.fao.org/Wairdocs/ILRI/x5443E/x5443e04.htm.

[9] This is also driven by the RIGA methodology. For more information, see: http://www.fao.org/economic/riga/riga-database/en/.

The original sample (wave I) was composed of approximately 3200 households including a randomly selected share of split-off households formed after the 2005–2006 Uganda National Household Survey (UNHS). The UNHS is representative at the national, urban/rural and main regional levels (Uganda is comprised of four official regions – the Northern, Eastern, Western and Central regions). The initial sample was visited for two consecutive years (2009–2010 and 2010–2011). The number of original households successfully interviewed during the last round of the survey is 2239 (Uganda Bureau of Statistics, 2013).

An attrition analysis was run in order to assess whether there were any statistically significant differences between the numbers of original households successfully interviewed over three years with or without the split-off households. In particular, a regression analysis revealed that no significant difference existed and, therefore, a decision was made to not follow the split-offs and focus on the original sample.

The original surveys included comprehensive information on household socioeconomic status, including detailed modules for expenditure and economic activities.

4. Resilience comparison at the national level: 2010–2011–2012

The resilience index changed over the considered period,[10] slightly decreasing between 2010 and 2011, but increasing sensibly between 2011 and 2012 (see Fig. 3).

Table 1 shows the results of a *t-test* run to check the significance of the difference in the mean of the resilience index over the three years considered. The differences are all significant.

Looking at the RSM, it is possible to draw out which pillars played the main role in building the RCI.

IFA together with AC are consistently the most relevant pillars in all three of the years, both accounting for more than 30 percent of importance. ABS and SSN are the only pillars that significantly change their relevance over time.

ABS increases from year 1 to year 2, but then decreases from year 2 to year 3. From Table 4 in the annex, it is demonstrated that – keeping distance variables fixed – what creates the difference in the dynamics of the pillar was the infrastructure index. The fact that in year 3 ABS is even lower than in year 1, could suggest that there has been a deterioration in road conditions and in more general infrastructure. Road quality is important for economic development as it enables farmers to be connected to input and output markets outside their local trading centres. There is a wide literature establishing the impact of infrastructural development on economic growth. One of this study is from Kenya. The author finds that maize yield and market participation for milk increased in areas experiencing better road access, and so did farm income (Kiprono, 2014). The relevance of AST is the same across the three years.

Looking at the relationship between resilience and self-reported shocks in each year, weather shocks seem to be the most important of these, although there is great variation (see Fig. 5).

From year 1 to year 2, weather shocks decrease in their frequencies, together with the shocks related to the death of household members. Crop shocks, conflicts and fire significantly increase in frequency. From year 2 to year 3, weather shocks continue to decrease; crop shocks also registered as decreased. Conflicts remain almost the same. Fire shocks, death of a household member and livestock increase. From Fig. 4, crop shocks and conflicts seem to be the most important shocks causing the decrease of the resilience index from year 1 to year 2. As a matter of fact, from year 2 to year 3 crop shocks decrease while conflicts remain almost the same.

[10] The resilience index has been rescaled in order to make a comparison over the three years.

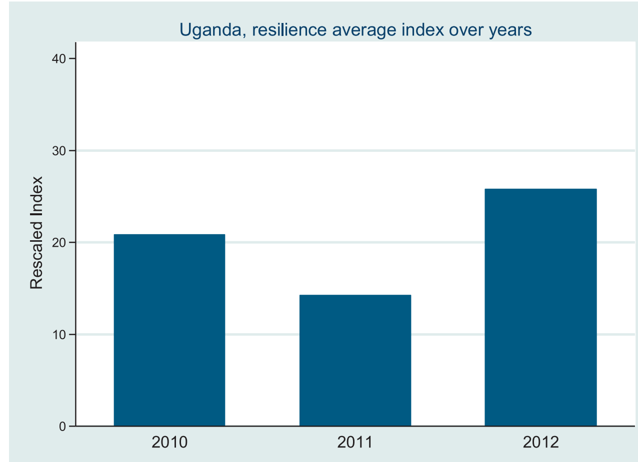

Fig. 3. Resilience index over time.

In order to explore the most relevant livelihood strategies, resilience classes have been created based on the terciles of resilience capacity distribution. The combination of the three terciles (less resilient; average resilient; more resilient) over the three-years period, creates nine classes (see Table 3). Concerning Table 2, four classes have been created in households that have been constantly less resilient over the three rounds; those that have been at least once at the top-resilience level; those that have been at least twice at the top-resilience level; and those that have been constantly the most resilient over the three rounds.

Households being the least resilient all the time are those with the highest crop income share. Of those being most resilient in all the three years the share of self-employment is the highest, considering that more than 47.97 percent of them are specialised in this activity.

There are significant differences among the groups. The most resilient households have self-employment as a major source of income, followed by the non-agricultural wage. They show also a relatively low dependency ratio with respect to those households being always the least resilient (0.73 against 2.09). Also, the most resilient households are more specialised in self-employment, and the percentage of diversification is the lowest among the others. Those being resilient just once in the three-year period also show a higher share of crops together with a relatively low self-employment share.

Given the presence of a huge regional inequality, attention has also been given to the Northern region, where the majority of poor households are concentrated.

The next table depicts the resilience index average score over each region during the three years considered (see Fig. 6).

The Northern region is the one with the lowest resilience index across the three years. On the contrary, the Kampala region is the one with the highest score. Generally there is an overall decrease from year 1 to year 2 and an overall increase from year 2 to year 3 (see Fig. 7).

Given the heterogeneity it is therefore interesting to establish the inner causes of such variability.

One approach is to look at the main determinants of changes in resilience capacity. Resilience analysis may offer limited possibility of carrying out causal inference.[11] This is mainly due to the composite nature of the resilience index; the largest part of the (possible) determinants of loss or gain of resilience has already been employed in the estimation procedure. As a consequence, quite a limited

[11] Although there do exist dynamic latent variable models that could be adopted.

Table 1
T-test results.

Variable	2009–2010 (1)	2010–2011 (2)	2011–2012 (3)	Difference
Resilience index	20.84	14.26		6.57***
	20.84		25.81	−4.96***
		14.26	25.81	−11.54***

*** = significant at 99%, ** = significant at 95%, * = significant at 90%.

Table 2
Specialization among resilience categories.

	Less resilient all times	Resilient Once	Resilient Twice	Most resilient all times
Share of crop income in tot Inc.	51.65%	43.22%	27.68%	11.46%
Share of livestock income in tot Inc.	12.60%	13.18%	9.88%	4.21%
Share of ag. Wage in tot Inc.	10.07%	4.20%	3.08%	1.15%
Share of non ag. Wage in tot Inc.	4.98%	8.98%	16.61%	22.91%
Share of self-employment in tot Inc.	13.85%	19.04%	27.10%	35.12%
Share of transfer in tot Inc.	6.32%	8.12%	7.72%	11.62%
Share of other source of income	0.42%	2.30%	4.07%	8.97%
hh specialized in crop	58.90%	47.51%	29.56%	12.21%
hh specialized in livestock	14.38%	6.36%	6.35%	2.91%
hh specialized in agr wage	8.22%	1.99%	3.59%	0.87%
hh specialized in nonag wage	4.45%	11.93%	21.82%	32.85%
hh specialized in self-employment	13.36%	19.48%	30.39%	47.97%
hh specialized in transfers	4.11%	7.16%	7.46%	12.21%
hh specialized in other	0.34%	1.19%	3.87%	9.88%
Dependency ratio	2.09	1.29	0.94	0.73
hh perc of diversification	52.96%	54.5%	49.86%	40.26%

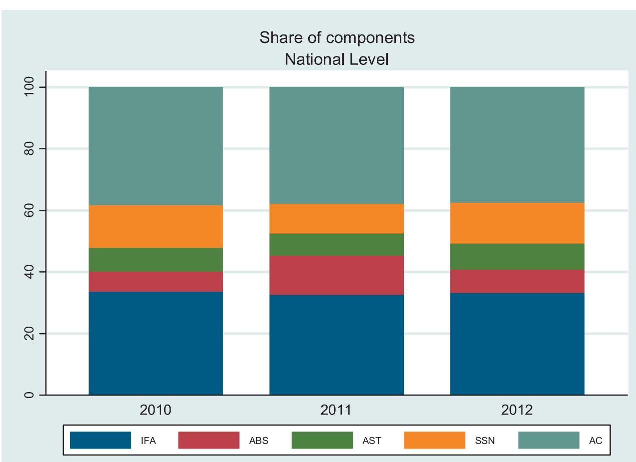

Fig. 4. Resilience structure comparison over years.

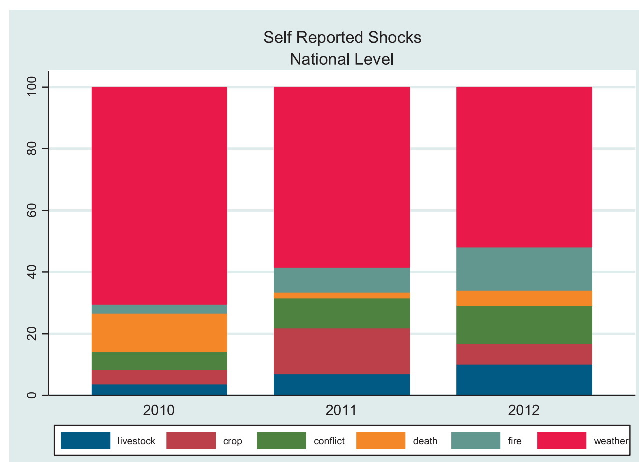

Fig. 5. Shocks Role (%) – National Level.

number of socio-economic variables may be employed in establishing a causal relation with variation in the resilience capacity. Probabilistic models have been employed in the next parts of this paper to explore the main determinants of intra-class movements.

Another interesting approach is to look at the negative determinants of loss in resilience. In other words, it is interesting to explore the role of shocks in household resilience capacity. Both covariate and idiosyncratic shocks have remained excluded from the estimation model, so that they can be employed as exogenous variables. The next part of this paper will focus on this topic.

5. Risk exposure

Risk exposure refers to the extent to which a household livelihood is affected by a specific shock.[12] If shocks come together (that is, severe shocks repeated over time), then coping is more difficult (Dercon, 2000). It is important to assess the frequency and the intensity of shocks affecting a household over a given period by including continuous variables in the estimation model, which report either the estimated or the actual loss suffered by the household. The central question regards the extent to which the total combination of livelihood strategies can deteriorate because of a single or repeated shock occurring over a given period. Economic shocks and civil wars seem to be the two most important shocks affecting Sub-Saharan African countries. This seems to be in line with growing literature highlighting the association between weather shocks and civil conflicts (Sambanis, 2001).

Shocks could affect resilience in different ways. It mainly depends on the degree of exposure of a household to a specific shock (that is, a pastoralist can be highly – and negatively – affected by drought or animal disease, while they can also gain advantages by an increase in the selling price of animals); on the strength of a shock (a violent disease killing all the animals or a

[12] For instance, a pastoralist whose animals are facing a disease represents a different situation to a farmer or an entrepreneur facing a similar type of emergency.

Table 3
Mobility among resilience terciles.

Percentage / **Frequency**

National

a)

2010	2011 Least Resilient	2011 Less Resilient	2011 Most Resilient
Least Resilient	66%	28%	6%
Less Resilient	29%	47%	24%
Most Resilient	7%	25%	68%

2010	2011 Least Resilient	2011 Less Resilient	2011 Most Resilient	*Row Total*
Least Resilient	486	202	45	733
Less Resilient	220	365	184	769
Most Resilient	54	182	502	738
Column total	760	749	731	2240

b)

2011	2012 Least Resilient	2012 Less Resilient	2012 Most Resilient
Least Resilient	69%	26%	5%
Less Resilient	26%	51%	23%
Most Resilient	3%	25%	72%

2011	2012 Least Resilient	2012 Less Resilient	2012 Most Resilient	*Row Total*
Least Resilient	524	200	36	760
Less Resilient	194	382	173	749
Most Resilient	21	185	525	731
Column total	739	767	734	2240

c)

2010	2012 Least Resilient	2012 Less Resilient	2012 Most Resilient
Least Resilient	69%	28%	4%
Less Resilient	25%	52%	22%
Most Resilient	5%	22%	73%

2010	2012 Least Resilient	2012 Less Resilient	2012 Most Resilient	*Row Total*
Least Resilient	505	202	26	733
Less Resilient	196	403	170	769
Most Resilient	38	162	538	738
Column total	739	767	734	2240

Central with Kampala

a)

	2012 Least Resilient	2012 Less Resilient	2012 Most Resilient
Least Resilient	46%	37%	17%
Less Resilient	15%	46%	39%
Most Resilient	4%	17%	79%

2010	2012 Least Resilient	2012 Less Resilient	2012 Most Resilient	*Row Total*
Least Resilient	53	43	20	116
Less Resilient	28	84	71	183
Most Resilient	15	59	276	350
Column total	96	186	367	649

b)

	2012 Least Resilient	2012 Less Resilient	2012 Most Resilient
Least Resilient	49%	39%	13%
Less Resilient	24%	42%	34%
Most Resilient	2%	18%	80%

2010	Least Resilient	2012 Less Resilient	2012 Most Resilient	*Row Total*
Least Resilient	47	37	12	96
Less Resilient	44	79	63	186
Most Resilient	8	66	293	367
Column total	99	182	368	649

c)

	2012 Least Resilient	2012 Less Resilient	2012 Most Resilient
Least Resilient	51%	42%	7%
Less Resilient	19%	45%	37%
Most Resilient	2%	15%	84%

2010	Least Resilient	2012 Less Resilient	2012 Most Resilient	*Row Total*
Least Resilient	59	49	8	116
Less Resilient	34	82	67	183
Most Resilient	6	51	293	350
Column total	99	182	368	649

Table 3 (*continued*)

Eastern

a)

	2011		
2010	**Least Resilient**	**Less Resilien t**	**Most Resilient**
Least Resilient	65%	29%	6%
Less Resilient	31%	50%	20%
Most Resilient	13%	34%	53%

	2011			
2010	**Least Resilient**	**Less Resilient**	**Most Resilient**	***Row Total***
Least Resilient	130	57	12	199
Less Resilient	61	99	40	200
Most Resilient	18	46	73	137
Column total	209	202	125	536

b)

	2012		
2011	**Least Resilient**	**Less Resilien t**	**Most Resilient**
Least Resilient	70%	26%	4%
Less Resilient	24%	54%	22%
Most Resilient	2%	34%	63%

	2012			
2011	**Least Resilient**	**Less Resilient**	**Most Resilient**	***Row Total***
Least Resilient	146	54	9	209
Less Resilient	48	110	44	202
Most Resilient	3	43	79	125
Column total	197	207	132	536

c)

	2012		
2010	**Least Resilient**	**Less Resilien t**	**Most Resilient**
Least Resilient	68%	27%	6%
Less Resilient	26%	55%	20%
Most Resilient	8%	33%	59%

	2012			
2010	**Least Resilient**	**Less Resilient**	**Most Resilient**	***Row Total***
Least Resilient	135	53	11	199
Less Resilient	51	109	40	200
Most Resilient	11	45	81	137
Column total	197	207	132	536

Northern

a)

	2011		
2010	**Least Resilient**	**Less Resilien t**	**Most Resilient**
Least Resilient	75%	22%	3%
Less Resilient	44%	44%	12%
Most Resilient	15%	35%	50%

	2011			
2010	**Least Resilient**	**Less Resilient**	**Most Resilient**	***Row Total***
Least Resilient	197	59	7	263
Less Resilient	91	93	25	209
Most Resilient	16	36	52	104
Column total	304	188	84	576

b)

	2012		
2011	**Least Resilient**	**Less Resilien t**	**Most Resilient**
Least Resilient	76%	21%	3%
Less Resilient	29%	51%	20%
Most Resilient	5%	33%	62%

	2012			
2011	**Least Resilient**	**Less Resilient**	**Most Resilient**	***Row Total***
Least Resilient	231	63	10	304
Less Resilient	54	96	38	188
Most Resilient	4	28	52	84
Column total	289	187	100	576

c)

	2012		
2010	**Least Resilient**	**Less Resilien t**	**Most Resilient**
Least Resilient	78%	21%	1%
Less Resilient	35%	51%	14%
Most Resilient	9%	26%	65%

	2012			
2010	**Least Resilient**	**Less Resilient**	**Most Resilient**	***Row Total***
Least Resilient	206	54	3	263
Less Resilient	74	106	29	209
Most Resilient	9	27	68	104
Column total	289	187	100	576

(*continued on next page*)

Table 3 (*continued*)

Western

2010	2011 Least Resilient	Less Resilient	Most Resilient
Least Resilient	68%	28%	4%
Less Resilient	23%	51%	27%
Most Resilient	4%	28%	69%

2010	2011 Least Resilient	Less Resilient	Most Resilient	*Row Total*
Least Resilient	106	43	6	155
Less Resilient	40	89	47	176
Most Resilient	5	39	96	140
Column total	151	171	149	471

2011	2012 Least Resilient	Less Resilient	Most Resilient
Least Resilient	66%	30%	3%
Less Resilient	28%	57%	15%
Most Resilient	4%	32%	64%

2011	2012 Least Resilient	Less Resilient	Most Resilient	*Row Total*
Least Resilient	100	46	5	151
Less Resilient	48	97	26	171
Most Resilient	6	47	96	149
Column total	154	190	127	471

2010	2012 Least Resilient	Less Resilient	Most Resilient
Least Resilient	68%	30%	3%
Less Resilient	21%	60%	19%
Most Resilient	9%	28%	64%

2010	2012 Least Resilient	Less Resilient	Most Resilient	*Row Total*
Least Resilient	105	46	4	155
Less Resilient	37	105	34	176
Most Resilient	12	39	89	140
Column total	154	190	127	471

reduction in grass coverage that requires moving the livestock); and on the household's capacity to react to that specific shock.

Households are frequently hit by idiosyncratic shocks (that is, household-level shocks, such as death, injury or unemployment) and covariate shocks (that is, community shocks, such as natural disasters or epidemics) (Günther & Harttgen, 2009). Data on this type of shocks are provided by different sources; in this case, idiosyncratic shocks are self-reported and obtained by the LSMS-ISA database, which is publicly available. The World Bank Living Standard Measurement Studies report includes idiosyncratic self-reported shocks. People are asked about the number of shocks over the last month or even year and the associated losses.

The covariates shocks regarding conflicts, on the contrary, were obtained from different sources.

Conflicts play a relevant role in economic and security conditions in Uganda. In the Northern region of Uganda, 21 years of war between the Government of Uganda and the Lord's Resistance Army (LRA) caused the displacement of a million people (Mazurana, Marshak, Opio, Gordon, & Atim, 2014). Death, disappearances, massive asset stripping, destruction of schools, and erosion of trust within communities and between citizens and the state took place in that period (OHCHR, 2007, OHCHR and Uganda Human Rights Commission, 2011). One-third or more of the population was abducted by the LRA, 45 percent had witnessed the killing of a family member and 23 percent had been physically mutilated in Northern Uganda during the most acute phase of the conflict (Pham, Vinck, Wierda, Stover, & Giovanni, 2005). While these conflicts seriously affected the population for more than 20 years (and their consequences will last much longer), they do not appear in the conflicts datasets employed in this study.

Conflict intensity has been used; data for this are taken from the ACLED – Armed Conflict Location & Event Data Project (Carlsen & Raleigh, 2010). They are based on the screening of news reports and provide geo-referenced information on approximately 4500 violent events in Uganda between 1997 and 2015 (Raleigh, Linke, Hegre, & Carlsen, 2010). The present work focuses on the most recent conflicts based on the data availability, such as conflict from 2009 to 2012. A conflict intensity index is built based on (Bozzoli, Brück, & Muhmuza, 2011). A higher index indicates a greater effect on the household.

Fixed-effects has been used in the impact of shocks on the resilience growth index. A limited degree of endogeneity can be assumed between a vector of shocks (both covariate and idiosyncratic) and time-invariant household characteristics.

More formally:

$$\Delta Res_{h,t} = X_h + S_{h,t} + D_{h,t} + \varepsilon_{h,t} \tag{2}$$

Where the growth rate of resilience capacity of the household h in time t is function of a vector of time-invariant household characteristics[13] X, a vector of shocks that reached household h in time t; a vector of geographical variables reporting in which region the household h is established in time t[14] plus the error term. In (2) it is possible to assume that the error term can be formally seen as $\varepsilon_{h,t} = \alpha_h + u_{h,t}$ while continuing to assume that X is uncorrelated with the error (Cameron & Trivedi, 2005).

Given the spatial variability and the relevance of shocks in various regions, interaction terms between the main types of shocks and regional localisation of the households has been introduced in Table 10.

Model (1) of Table 10 presents the results of the analysis at the National level and includes interaction terms between weather, wage and self-reported conflict shocks with regional localisation.

[13] Typically gender of household head; household size; age of household head – though not really time-invariant, it is possible to assume that this is not going to change that much over a three-year period of time.

[14] Time variance has been assumed for these variables in order to allow the migration from one area to another in case of shocks or any other need.

Table 4
Multinomial logit.

VARIABLES	(2) Most resilient once	(3) Most resilient twice	(4) Always most resilient
Female Household head	−0.503**	−0.765***	−0.529**
	(0.204)	(0.235)	(0.262)
Household size	−0.225***	−0.365***	−0.345***
	(0.0342)	(0.0403)	(0.0435)
HH average year of education	0.601***	0.768***	1.007***
	(0.0663)	(0.0707)	(0.0744)
Chronic poverty (Dummy)	−2.473***	−4.465***	−17.48
	(0.415)	(1.130)	(853.4)
Log of per capita expenditure$_{(t-1)}$	−0.238**	−0.161	−0.584***
	(0.117)	(0.131)	(0.149)
Log of precipitation in mm.	−1.578***	−2.242***	−3.173***
	(0.583)	(0.672)	(0.840)
Average share of crop income	−1.229***	−2.886***	−4.886***
	(0.360)	(0.416)	(0.507)
Average share of self-employment	0.412	0.516	0.618
	(0.446)	(0.474)	(0.497)
Log of humidity index	−0.0588	0.236	−0.344
	(0.522)	(0.619)	(0.782)
Distance from populated center (20,000 k)	−0.00984**	−0.0143**	−0.0461***
	(0.00494)	(0.00592)	(0.00801)
Northern region	−1.545***	−2.141***	−3.586***
	(0.211)	(0.258)	(0.363)
Constant	13.51**	16.71**	26.84***
	(5.917)	(6.950)	(8.937)
Observations	1484	1484	1484

Robust standard errors in parentheses.
$^{***}p < .01$, $^{**}p < .05$, $^{*}p < .1$

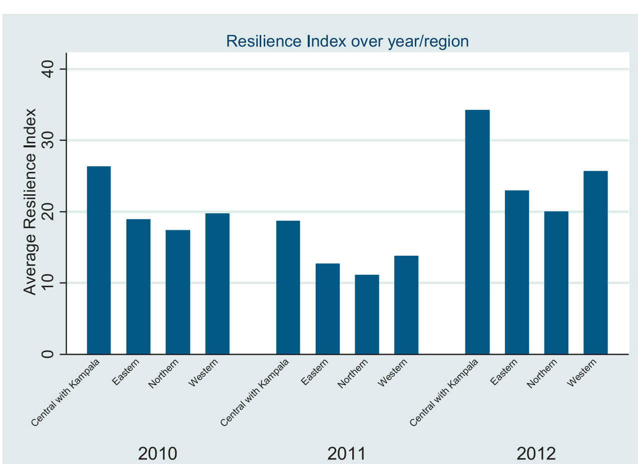

Fig. 6. Resilience Index over years/regions.

Models (2) to (4) disaggregate the results for each regional aggregation (that is, the Central, Eastern, Northern and Western regions). Conflicts, wage- and weather-related shocks negatively affect resilience. Interestingly, the variable for conflict intensity (the one above-mentioned for intensity of conflicts) is not significant, and thus does not have any relevant effect at the national level; the results are different when looking at the disaggregated data by regions. Looking at Model (2) for the Central region, conflict intensity is not significant, meaning that the Central region reflects the national average trend. In the remaing regions, Eastern,

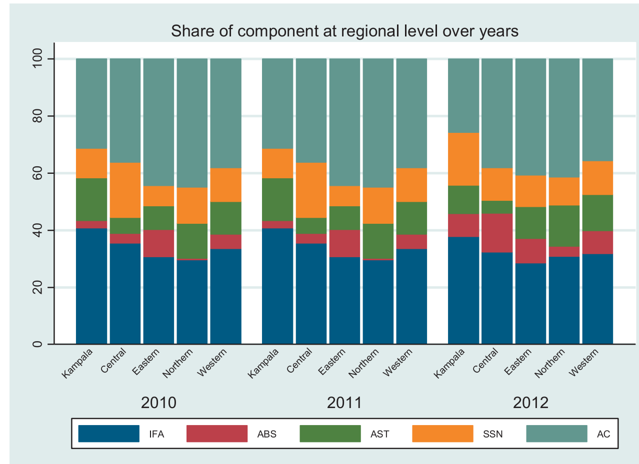

Fig. 7. Share of component – Regional level, over years.

Northern, and Western Uganda, the conflict intensity is highly significant and negatively related to the growth rate of resilience. Even in this case, therefore, there seems to be a lot of spatial variability due to regional specificity (see interaction terms from the national model); this correlates with well-known unstable situations in areas such as the Northern region, which has been particularly exposed to this.

More generally, the regional differences largely explain the effects of shocks on resilience and on resilience growth. Uganda is in fact quite a heterogeneous country with many differences between the Central region and the area where Kampala is located, compared with other regions, especially the Northern region. This will inform the analyses presented in the next chapters.

The results suggest other interesting findings. On average, older household heads pair with greater resilience capacity; however, when they are too old (indicated by the squared age of the household head) resilience capacity slightly decreases (Table 10). It became apparent that older heads of a household have a lower adaptive capacity and less ability to contribute to family income-generating activities.

6. Dynamic analysis

It is possible to measure variations over time in different ways; transition matrices are used in order to measure the capacity of moving from one class to the other. In this paper, those are employed to carry out an inter-temporal analysis of resilience capacity. Transition matrices have been largely employed in poverty analysis environment, in order to distinguish between households that are poor occasionally from those that are chronically poor.

The use of transition matrices might present problems since there are measurement errors in the outcome variable (for example, household poverty, income or resilience). In order to avoid these problems, households are classified into resilience capacity classes (in accordance with the terciles of the resilience index distribution). However, this does not allow for obtaining complete information about the metric distance between two different households. Furthermore, it is not possible to compare transition matrices across different contexts (for example, countries) because the resilience index is context-specific and the time periods spanned by panel surveys may be different (Shepherd & Brunt, 2013).

Resilience Transitional Matrices show the share of households that remain, move out of or move into a given resilience class (that is, RCI terciles: high, medium and low resilience) across different years (Table 3).

At the national level, 6 percent of the households that were in the least resilient status in 2010 become most resilient in 2011; 28 percent migrated to the medium terciles; and 66 percent remained in the same class. Considering the most resilient households in 2010, 7 percent became the least resilient in 2011, 25 percent moved to the medium resilience class and 68 percent remained in the same class (Table 3a).

Those that remain in the least resilient status are consistently less resilient. The mobility across terciles is not so high considering the extreme categories; in fact, in all three sub-tables almost 50 percent of the households remain in the same position of least resilience. The same occurs for those that have been consistently the most resilient households: more than 60 percent of them, on average, remain in the same terciles (most resilient all the time).

69 percent of the least resilient households in 2010 remained in the same status in 2012 (the well-known poverty trap); 28 percent improved their situation, moving into the medium resilient class; 4 percent became the most resilient in 2012 (2010–2012, table c). Interestingly, 25 percent of the middle-resilient households became least resilient, while 5 percent of the most resilient migrated into the least resilient status. However, provided the spatial differences that emerged above, a further disaggregation has been applied and interesting results emerge.

Table 3 also presents the transition matrices for the 4 macro-regions of Central (which includes Kampala), Eastern, Northern and Western Uganda.

The Northern region presents the highest percentage of persistence in the lowest class of resilience capacity (75 percent, 76 percent and 78 percent in tables a, b and c of the Northern region in Table 3). This indicates a lower capacity for transitioning from the bottom to a higher level. Furthermore, the Northern region reports the highest share of households sliding from the middle to the bottom class of resilience capacity (table c across Table 3): 35 percent of households in the Northern region migrated from less to least resilient status between 2010 and 2012 as compared with 26 percent for the Eastern region; 21 percent for the Western region and 19 percent for the Central region. Once again this finding highlights how relevant spatial differences exist within Uganda.

Based on the reported tables, it is therefore interesting to establish causal evidence of determinants of persistence or migration

Table 5
Bi-Probit – National level.

	(1) Probability of being the least resilient in 2012 conditional upon being the least resilient in 2010	(2) Probability of being the least resilient in 2012 conditional upon being not the least resilient in 2010
Female household head	0.317***	0.233**
	(0.0860)	(0.0926)
Household size	0.0141	0.0146
	(0.0150)	(0.0155)
HH average year of education	−0.272***	−0.300***
	(0.0244)	(0.0267)
Age of household head	0.00438	0.00252
	(0.00289)	(0.00308)
Chronic poverty (Dummy)	0.513***	0.720***
	(0.141)	(0.140)
Log of per capita expenditure$_{(t-1)}$	0.149***	−0.226***
	(0.0544)	(0.0561)
Log of precipitation in mm.	0.408	0.0693
	(0.252)	(0.282)
Average share of crop income	0.243	0.342**
	(0.154)	(0.156)
Average share of self-employment	−0.692***	−0.726***
	(0.196)	(0.213)
Log of humidity index	−0.291	−0.373*
	(0.206)	(0.216)
Distance from populated center (20000 k)	0.00501**	0.00372
	(0.00248)	(0.00274)
# Weather shocks$_{t-1}$	−0.0246	−0.108
	(0.0821)	(0.0852)
# Wage shocks$_{t-1}$	−0.165	−0.0175
	(0.117)	(0.114)
# Crop shocks$_{t-1}$	−0.354	−0.263
	(0.260)	(0.269)
# Conflict shocks$_{t-1}$	0.0202	0.0948
	(0.327)	(0.318)
# Fire shocks$_{t-1}$	0.301	0.282
	(0.358)	(0.428)
No food to eat$_{t-1}$	0.318***	0.421***
	(0.0953)	(0.0974)
Conflict intensity$_{t-2}$	−0.0468**	−0.0335**
	(0.0193)	(0.0159)
Conflict_intensity$_{t-1}$	0.00616	0.00248
	(0.00982)	(0.00939)
Constant	−0.768	2.231
	(2.518)	(2.613)
Athrho	0.717***	
	(0.0617)	
Observations	2237	2237

Robust standard errors in parentheses.
*** p < .01, ** p < .05, * p < .1.

Table 6
Bi-Probit Central Region (incl Kampala).

	(1) Probability of being the least resilient in 2012 conditional upon being the least resilient in 2010	(2) Probability of being the least resilient in 2012 conditional upon being not the least resilient in 2010
Female household head	0.342*	0.0353
	(0.183)	(0.192)
Household size	0.0231	−0.0265
	(0.0248)	(0.0305)
HH average years of education	−0.227***	−0.201***
	(0.0483)	(0.0556)
Chronic poverty (Dummy)	0.462	1.176**
	(0.522)	(0.529)
Log of per capita expenditure$_{(t-1)}$	0.137	−0.387***
	(0.131)	(0.111)
Log of precipitation in mm.	−0.552	0.292
	(0.697)	(0.741)
Average share of crop income	0.466	0.884**
	(0.336)	(0.358)
Average share of self-employment income	−0.871**	−0.367
	(0.367)	(0.374)
Log of humidity index	1.265	1.922
	(1.814)	(2.121)
Distance from populated center (20,000 k)	−0.00588	0.00371
	(0.00674)	(0.00716)
# Weather shocks$_{t-1}$	0.247	0.0556
	(0.181)	(0.216)
# Wage shocks$_{t-1}$	−0.317	−0.306
	(0.272)	(0.234)
# Crop shocks$_{t-1}$	−0.108	0.747**
	(0.495)	(0.381)
# Conflict shocks$_{t-1}$	−6.771***	−6.432***
	(0.408)	(0.344)
# Fire shocks$_{t-1}$	−5.425***	−5.200***
	(0.303)	(0.369)
No food to eat$_{t-1}$	0.235	0.511*
	(0.235)	(0.300)
Conflict intensity$_{t-2}$	−0.0258	−0.0405**
	(0.0157)	(0.0185)
Conflict_intensity$_{t-1}$	9.61e−05	0.0155**
	(0.00783)	(0.00743)
Constant	−5.082	−16.23
	(16.18)	(19.16)
Athrho	0.521***	
	(0.141)	
Observations	655	655

Robust standard errors in parentheses.
*** $p < .01$, ** $p < .05$, * $p < .1$.

within resilience capacity classes, with particular reference to spatial differences. Many studies have recently used the multinomial logit model to analyse the factors affecting the probability that a household moves from a certain status to another (for instance across different income classes). One of the main advantages of such an approach is its simple specification (Grootaert & Kanbur, 1995; Grosh & Glewwe, 1995).

Multinomial logit models are adopted for studying a dependent categorical variable that can fall into one of several mutually exclusive categories. In this case, three multinomial logit models were run for the three years of study with three possible categories in each year, corresponding to the three aforementioned classes of resilience capacity. Table 4 reports the estimates of multinomial logit, considering households being always the least resilient as the base category and presenting findings for three possible scenarios: (2) most resilient at least once; (3) most resilient twice; (4) persistently most resilient.

The relative probability of being most resilient at least once in the three years (category two), rather than being always the least resilient (base category) is negative for female household heads with respect to male ones. The relative probability of being even most resilient in two years (category three) increases negatively. Education has a positive impact on the relative probabilities of being resilient, once, twice or always rather than being always the least resilient; for instance, the higher the level of a household's education, the higher the relative probability of not being in the base category. This is in line with findings from other studies in Uganda (Mazurana et al., 2014) that highlight the relevance of education in putting people in a better position when facing adverse periods, as this helps to improve adaptive capacity.

The relative probability of being always most resilient (in all the three years) rather than being always the least resilient is lower if the share of crop income increases over time.

That is an interesting finding, because as already said in the introduction, agriculture is still the most dominant sector in Uganda. Households with a higher share of crops in total income (meaning the main activity) are more exposed to climatic shock and are those suffering more from the distance to big city.

One problem when analysing transitions is that the relative probability of making the second transition (say from being the least resilient to being most resilient at least once) depends on whether or not the households have previously made the first transition (that is, being least resilient all the time). The second transition always represents a selected sample. This is known as the

Table 7
Bi-Probit – Eastern Regions.

	(1) Probability of being the least resilient in 2012 conditional upon being the least resilient in 2010	(2) Probability of being the least resilient in 2012 conditional upon being not the least resilient in 2010
Female household head	0.640***	0.409**
	(0.173)	(0.182)
Household size	−0.0139	−0.0189
	(0.0293)	(0.0263)
HH average years of education	−0.252***	−0.400***
	(0.0449)	(0.0517)
Chronic poverty (Dummy)	0.389	0.813***
	(0.253)	(0.258)
Log of per capita expenditure$_{(t-1)}$	0.304***	−0.0744
	(0.105)	(0.104)
Log of precipitation in mm.	−0.486	−0.457
	(1.312)	(1.400)
Average share of crop income	−0.0314	0.0554
	(0.259)	(0.262)
Average share of self-employment income	−0.669**	−0.549
	(0.334)	(0.345)
Log of humidity index	−0.0611	−0.152
	(0.902)	(0.901)
Distance from populated center (20,000 k)	0.00310	−0.00114
	(0.00629)	(0.00683)
# Weather shocks$_{t-1}$	−0.156	−0.0184
	(0.159)	(0.160)
# Wage shocks$_{t-1}$	−0.0476	−0.0107
	(0.196)	(0.201)
# Crop shocks$_{t-1}$	−0.0775	−0.379
	(0.411)	(0.412)
# Conflict shocks$_{t-1}$	−0.731	−11.41***
	(0.788)	(1.086)
# Fire shocks$_{t-1}$	−6.417***	−7.050***
	(0.248)	(0.256)
No food to eat$_{t-1}$	0.232	0.358**
	(0.179)	(0.174)
Conflict intensity$_{t-2}$	0.0323	−0.188**
	(0.0785)	(0.0865)
Conflict_intensity$_{t-1}$	−0.0355	0.0718
	(0.0529)	(0.0557)
Constant	4.549	5.434
	(6.195)	(7.062)
Athrho	0.855***	
	(0.115)	
Observations	535	535

Robust standard errors in parentheses.
*** $p < .01$, ** $p < .05$, * $p < .1$.

independence of invariant alternatives, as a consequence of the implied assumption that there is no correlation between the error terms. The multinomial model does not perfectly suit the analysis of the transitions as it takes initial least resilient status as exogenous, thus requiring that persistence in this status is entirely due to observable explanatory variables. Correlation across time between unobservable variables will therefore create a sample selection bias due to the conditioning of the initial status.

One of the most adopted solutions for avoiding problems related to multinomial logit and independence of invariant alternatives is to consider the factors that are associated with whether a household is the least resilient or the most resilient. This starts with factors associated with changes (or not) in the household's resilience status between 2010 and 2012. The analysis is focused on two conditional probabilities: 1) the probability of being the least resilient in year 3 (that is, 2012) conditional to being the least resilient in year 1 (that is, 2010); and 2), the probability of being the least resilient in year 3 conditional to not being the least resilient in year 1. Covariate shocks and self-reported shocks are reported; analysis is further disaggregated at the regional level, considering the spatial differentiations also presented above (see Tables 6, 7 and 9).

At the national level, the probabilities of remaining the least resilient in year three is highly influenced by the presence of a female-headed household; having a large share of income from crop activities; and having suffered with shocks that ultimately forced the household to stay without food for a number of days. The average educational level, per capita expenditure and participating in a self-managed enterprise reduce the probability of being the least resilient. These findings draw a picture in which the chronically least resilient are those households which are female-headed, more connected to farming activities, less educated, more exposed to difficult situations than male-headed households that invest in education and self-managed enterprises and far from the most populated centres.

Interestingly, no evidence exists in Table 5 of the relevance of conflict on persistence in the same (lowest) class of resilience capacity. However, the figures change dramatically when looking at the same models from the regional perspective. Whereas the Central region roughly reflects the national situation, Table 8

Table 8
Bi-Probit – Northern Regions.

	(1) Probability of being the least resilient in 2012 conditional upon being the least resilient in 2010	(2) Probability of being the least resilient in 2012 conditional upon being not the least resilient in 2010
Female household head	0.113	−0.0765
	(0.171)	(0.172)
Household size	0.00595	−0.00458
	(0.0298)	(0.0314)
HH average years of education	−0.345***	−0.369***
	(0.0558)	(0.0495)
Chronic poverty (Dummy)	0.379*	0.731***
	(0.211)	(0.218)
Log of per capita expenditure$_{(t-1)}$	0.135	−0.183
	(0.106)	(0.117)
Log of precipitation in mm.	0.0517	0.133
	(0.631)	(0.593)
Average share of crop income	0.505	0.560
	(0.370)	(0.386)
Average share of self-employment income	0.000370	−0.477
	(0.338)	(0.354)
Log of humidity index	−0.611*	−0.148
	(0.359)	(0.374)
Distance from populated center (20000 k)	0.00375	0.00428
	(0.00381)	(0.00401)
# Weather shocks$_{t-1}$	−0.242*	−0.226
	(0.129)	(0.140)
# Wage shocks$_{t-1}$	0.278	0.234
	(0.264)	(0.260)
# Crop shocks$_{t-1}$	0.730	0.589
	(0.742)	(0.800)
# Conflict shocks$_{t-1}$	1.560***	11.93***
	(0.604)	(1.036)
# Fire shocks$_{t-1}$	1.819***	1.707***
	(0.486)	(0.530)
No food to eat$_{t-1}$	0.216	0.230
	(0.166)	(0.163)
Conflict intensity$_{t-2}$	−0.122**	−0.0478
	(0.0505)	(0.0460)
Conflict_intensity$_{t-1}$	0.0221	0.0809
	(0.0470)	(0.0547)
Constant	4.615	0.812
	(4.662)	(4.642)
Athrho	0.643***	
	(0.106)	
Observations	576	576

Robust standard errors in parentheses.
*** $p < .01$, ** $p < .05$, * $p < .1$

shows that conflict shocks (self-reported) play a major role in explaining persistence in the lowest resilience class. This finding is in line with other relevant studies in Uganda (De Luca & Verpoorten, 2015; Mazurana et al., 2014). On the contrary, the conflict intensity variable does not seem to be able to capture the existence and effect of shocks in the Northern region. Generally, all the models applied to the four regions show that education is one of the major determinants for moving away from the least resilient status. On the other hand, being involved in crop activities seems to be one of the major determinants of persistence in the lowest class of resilience. This is highly correlated with the traditional relevance of farming activities in the area. Chronic poverty is also one of the major determinants of being always the least resilient in almost all the regions (in fact, the variable is always significant at least 95 percent of the time). The chronic poor are unable to resist shocks that further impoverish them, because of their inability to move upwards into a different resilience class. The non-chronic poor can better react to shocks because they have all the material buffers. The non-poor or transient poor are capable of more demanding forms of physical labour than the poor, given that the non-poor have access to adequate food and nutrition, and have more assets that enable them to be more productive and to generate more income. On another note, suffering due to a conflict or reported a loss due to a fire increases the probability of remaining poor over time. This may be connected to the deterioration of assets and the consequent reduction of recovery capacity.

Finally, living in a more humid area in the Northern region reduces the probability of being stuck in the least resilient class. This is clearly connected with living in an area that presents a more productive (or less arid) land. As a consequence, geographical heterogeneity sill plays a large role, as does access to an effective irrigation system.

7. Conclusions

Resilience is, nowadays, one of the key words for any action or program in a development environment. A number of studies have adopted this approach; policy makers have re-tuned their actions. As a result, many attempts at measuring resilience emerged that suggest the need for both quantitative and qualitative approaches. This paper defines resilience as ‘a capacity that ensures stressors

Table 9
Bi-Probit – Western Regions.

VARIABLES – Western	(1) Probability of being the least resilient in 2012 conditional upon being the least resilient in 2010	(2) Probability of being the least resilient in 2012 conditional upon being not the least resilient in 2010
Female household head	0.305*	0.394**
	(0.174)	(0.173)
Household size	0.0479	0.0682**
	(0.0311)	(0.0329)
HH average years of education	−0.322***	−0.269***
	(0.0540)	(0.0446)
Chronic poverty (Dummy)	0.887***	0.549**
	(0.322)	(0.273)
Log of per capita expenditure$_{(t-1)}$	0.0906	−0.261**
	(0.103)	(0.104)
Log of precipitation in mm.	0.241	−0.940
	(0.658)	(0.666)
Average share of crop income	0.204	0.141
	(0.311)	(0.309)
Average share of self-employment income	−1.098*	−1.651**
	(0.610)	(0.664)
Log of humidity index	−0.0548	0.0541
	(0.431)	(0.420)
Distance from populated center (20,000 k)	0.00543	0.00511
	(0.00761)	(0.00778)
# Weather shocks$_{t-1}$	0.119	−0.138
	(0.221)	(0.236)
# Wage shocks$_{t-1}$	−0.396	0.102
	(0.295)	(0.239)
# Crop shocks$_{t-1}$	−0.949**	−0.649
	(0.482)	(0.469)
# Conflict shocks$_{t-1}$	−0.0915	0.342
	(0.786)	(0.816)
# Fire shocks$_{t-1}$	−4.853***	−4.871***
	(0.396)	(0.359)
No food to eat$_{t-1}$	0.556***	0.542**
	(0.214)	(0.210)
Conflict intensity$_{t-2}$	−0.0737	0.0939
	(0.0873)	(0.106)
Conflict_intensity$_{t-1}$	0.0223	−0.204**
	(0.0847)	(0.0910)
Constant	−1.199	6.137
	(5.628)	(5.625)
Athrho	0.821***	
	(0.126)	
Observations	471	471

Robust standard errors in parentheses.
*** $p < .01$, ** $p < .05$, * $p < .1$.

and shocks do not have long-lasting adverse development consequences' (RMTWG, 2014).

Household resilience capacity index is measured using the RIMA approach. This paper estimates dynamic resilience looking at the intertemporal resilience capacity variation and at the transition matrices. Furthermore, multinomial logit and bivariate probit models are run in order to estimate the main drivers of the resilience persistence and the resilience mobility.

The main findings show that Ugandans households with a female head are less likely to stay or enter the most resilient terciles; household size also negatively affects the possibility of being in that tercile. Those households involved in crop activities most likely belong to the bottom terciles. On the contrary, education and participation in self-managed enterprises positively affect the probability of being the most resilient in the country.[15] Finally, conflicts, weather and wage shocks are relevant determinants of persistence in the lowest resilience capacity class, with a strong spatial differentiation.

What emerged from the analysis is the need to improve the economic situation of Ugandan farmers, especially for those households that rely mainly on the income farming activities.

Generally household relying mainly on crop income are those living in the rural area, hence far from the populated centres. Some of the main priorities should also be to build physical infrastructure, to increase education and income from agriculture.

The relationship between better road access and markets is very strong; indeed, facilitation of markets is essential in order to increasing agricultural production and generating economic growth in rural areas. A better access to domestic and international markets means selling more products at higher prices. This would push the farmers to increase quantity, quality and diversity of the goods they produce. Road access is one of the main booster of economic development (Rostow, 1962) and is a particular important factor to the growth of rural areas (de Vera Garcia, 1984). However, the creation of appropriate infrastructure is key in enabling the increase of production and, as a consequence, revenues. A clear distinction between, on one side, perishable and high values products (such as horticultural goods); and maize, cereals, legumes on the other side must be

[15] Mazurana et al. (2014) comes to a similar conclusion with regard to conflict affected population in Uganda.

Table 10
Determinants of Resilience Growth, fixed effect.

		Regions			
Resilience growth rate	National	Central	Eastern	Northern	Western
Female household head (invariant)	–	–	–	–	–
Household size (invariant)	–	–	–	–	–
Household in agriculture (invariant)	–	–	–	–	–
Age of household head	0.0108***	0.0101***	0.0170***	0.00508	0.0182***
	(0.00180)	(0.00298)	(0.00490)	(0.00330)	(0.00471)
Age of household head (squared)	−7.65e−05***	−7.46e−05**	−0.000123***	−3.01e−05	−0.000146***
	(1.78e−05)	(3.08e−05)	(4.64e−05)	(3.37e−05)	(4.31e−05)
Regional interactions					
# Weather shocks – Central region	−0.0391***				
	(0.00762)				
# Weather shocks – Northern region	−0.00906***				
	(0.00221)				
# Weather shocks – Western region	−0.00181				
	(0.00215)				
# Wage shocks – Central region	−0.0236***				
	(0.00861)				
# Wage shocks – Eastern region	−0.0161***				
	(0.00534)				
# Wage shocks – Northern region	−0.00981***				
	(0.00379)				
# Wage shocks – Western region	−0.00612*				
	(0.00332)				
# Conflict shocks – Northern region	0.00256				
	(0.0276)				
# Conflict shocks – Western region	0.0168				
	(0.0151)				
# Conflict shocks – Central region	0.00559				
	(0.00770)				
# Conflict shocks – Eastern region	0.0158*				
	(0.00874)				
# Crop shocks	0.00351	−0.00579	−0.00235	0.0142	0.0283
	(0.0108)	(0.0233)	(0.0135)	(0.0364)	(0.0273)
Conflict intensity	−0.000124	4.97e−05	−0.0269***	−0.00336**	0.0122***
	(0.000220)	(0.000273)	(0.00203)	(0.00144)	(0.00244)
# Input/output shocks	0.0265***	0.0176	0.0188*	0.0547**	−0.0179
	(0.00938)	(0.0258)	(0.00981)	(0.0259)	(0.0433)
Livestock disease	−0.0144	−0.0190	−0.00648	−0.000704	0.0887
	(0.0126)	(0.0254)	(0.0154)	(0.0268)	(0.127)
Length of shocks (# month)	−0.000304	−0.00371*	0.00429**	−0.00112	0.00135
	(0.000910)	(0.00215)	(0.00178)	(0.00139)	(0.00226)
No food to eat (Dummy)	−0.0305***	−0.0500***	−0.0220***	−0.0159***	−0.0316***
	(0.00417)	(0.0107)	(0.00680)	(0.00612)	(0.00944)
# Weather shocks		−0.0209*	−0.00744	−0.0293***	−0.0102
		(0.0112)	(0.00766)	(0.00644)	(0.0104)
# Wage Shocks		−0.0153	−0.0332***	−0.0302***	−0.0247*
		(0.0109)	(0.00901)	(0.00984)	(0.0142)
# Conflict shocks		0.00108	0.0320	0.0203	0.0635*
		(0.0336)	(0.0253)	(0.0194)	(0.0335)
# Other shocks	−0.0164	−0.0126	−0.0260	−0.00339	−0.0186
	(0.0103)	(0.0243)	(0.0290)	(0.0152)	(0.0173)
Eastern region (Dummy)	−0.139				
	(0.0950)				
Northern (non movers)	–				
Constant	−0.267***	−0.263***	−0.464***	−0.136*	−0.474***
	(0.0493)	(0.0713)	(0.125)	(0.0775)	(0.125)
Observations	6719	1967	1611	1728	1413
R-squared	0.060	0.068	0.211	0.084	0.076
Number of hh	2240	657	538	576	471

made. This will ultimately inform decision-making process for the creation of proper market infrastructure.

Finally, it is highly recommended that proper market access is properly linked to appropriate price policies and sales regulations so that the presence of products in the market can be on regular and consistent basis.

That is one of the main reason the Government of Uganda developed the Plan for Modernisation of Agriculture (PMA) in which roads are identify as key in the agricultural modernization drive and indicates that one of its strategies for improving marketing access will be ensuring the implementation of Road Sector Development Programme.

This paper contributes to the literature on resilience dynamics by clarifying the determinants of migration from low to high resilience capacity in the Ugandan context. More still needs to be done in establishing a direct causal relation between resilience capacity and its main drivers. Furthermore, this analysis should be replicated in other case studies in order to check consistency of results.

Table 11
National – Regional Statistics.

Variables	2009/2010						2010/2011						2011/2012					
	National Level	Kampala	Central without Kampala	Eastern	Northern	Western	National Level	Kampala	Central without Kampala	Eastern	Northern	Western	National Level	Kampala	Central without Kampala	Eastern	Northern	Western
Resilience	20.80	35.300	22.900	19.0	17.800	20.10	14.30	23.300	16.400	13.00	11.500	14.10	25.80	0.472	0.295	0.232	0.205	0.249
IFA	0.131	0.191	0.139	0.124	0.112	0.131	0.067	0.112	0.080	0.058	0.050	0.067	0.338	0.444	0.360	0.320	0.304	0.342
Per Capita Monthly Exp.	27.42	66.31	35.88	21.67	19.71	22.59	30.21	74.01	41.04	21.28	21.61	26.25	21.40	68.83	28.79	13.88	13.30	17.84
Per capita monthly Inc.	26.02	77.46	30.60	19.86	15.29	25.92	20.50	55.70	29.79	10.81	13.09	20.16	17.89	35.17	19.74	11.89	13.61	22.85
Food Consumption Score	40.69	45.64	40.29	42.10	35.39	44.57	42.58	47.57	46.10	43.07	34.49	46.62	44.37	49.88	48.01	44.13	37.47	47.49
ABS	0.16	0.32	0.18	0.17	0.12	0.15	0.19	0.36	0.25	0.16	0.12	0.16	0.11	0.16	0.10	0.11	0.13	0.10
Infrastructure Index	0.15	0.48	0.20	0.11	0.09	0.09	0.16	0.45	0.20	0.12	0.12	0.10	0.13	0.43	0.17	0.10	0.09	0.08
Distance from Veterinary Services (KM)	29.71	16.87	18.60	29.30	36.84	37.49	17.72	4.35	12.24	15.18	30.02	15.48	19.91	12.72	19.45	17.41	28.37	15.01
Distance from Government Primary School (KM)	21.98	16.42	24.52	20.40	22.17	22.37	24.02	16.19	23.84	23.41	26.28	24.42	22.33	20.91	24.11	19.23	20.58	26.46
Distance from Government Health Centre (KM)	37.29	17.93	37.81	32.60	44.28	39.19	41.85	12.43	32.98	35.67	60.71	44.13	41.43	31.56	41.10	34.39	53.20	38.29
Distance from Government Hospital (KM)	48.46	32.26	34.05	42.81	70.17	48.96	46.35	25.65	28.89	31.74	92.69	31.55	43.38	32.14	37.57	24.66	78.25	31.74
Distance from Market selling ag inputs (KM)	37.07	14.05	22.47	35.37	54.69	40.29	44.60	11.69	25.67	44.87	64.34	50.54	46.68	33.07	38.56	38.89	65.50	45.45
Distance from Market selling non-ag (KM)	34.60	13.58	22.75	36.57	42.58	41.84	35.36	9.12	16.40	42.28	45.85	43.11	33.53	27.02	29.55	32.98	33.25	40.78
AST	0.043	0.045	0.053	0.042	0.039	0.037	0.076	0.064	0.076	0.075	0.077	0.078	0.034	0.040	0.037	0.031	0.036	0.030
Ag. Wealth Index	0.049	0.007	0.044	0.055	0.058	0.048	0.069	0.015	0.066	0.077	0.075	0.073	0.245	0.196	0.234	0.266	0.276	0.208
Wealth Index	0.153	0.294	0.182	0.129	0.117	0.151	0.136	0.248	0.156	0.118	0.113	0.128	0.146	0.279	0.171	0.122	0.133	0.125
Land owned (Ha)	1.803	0.740	1.587	2.151	2.312	1.335	1.112	0.067	0.885	1.049	1.646	1.083	1.281	0.024	0.859	1.115	1.985	1.440
Tropical Livestock Unit	1.060	0.237	1.353	1.123	1.051	0.921	0.911	0.334	0.698	0.980	1.075	1.032	1.068	0.359	1.089	1.146	1.241	0.953
SSN	0.019	0.040	0.026	0.010	0.009	0.023	0.024	0.044	0.041	0.009	0.008	0.035	0.014	0.050	0.016	0.007	0.009	0.014
Net private transfers	1.47	3.34	2.59	0.86	1.10	0.82	1.71	6.05	2.88	0.84	0.97	1.06	1.42	4.76	2.23	0.81	1.16	0.57
Other Transfers	0.43	0.90	0.44	0.24	0.14	0.84	0.51	0.05	0.89	0.13	0.07	1.18	0.28	1.06	0.16	0.15	0.12	0.53
AC	0.319	0.493	0.342	0.293	0.291	0.303	0.331	0.485	0.358	0.315	0.289	0.322	0.299	0.470	0.326	0.283	0.261	0.281
Income Participation Index	0.448	0.259	0.408	0.494	0.468	0.470	0.436	0.236	0.397	0.468	0.468	0.461	0.433	0.254	0.380	0.462	0.482	0.453
HH Level of education (years)	4.730	6.799	5.243	4.564	4.076	4.541	4.440	5.117	4.857	4.419	3.768	4.628	4.960	7.601	5.414	4.932	4.120	4.748
Dependency Ratio	1.391	0.852	1.338	1.486	1.506	1.360	1.331	0.849	1.345	1.369	1.421	1.303	1.310	0.836	1.388	1.335	1.374	1.258
Crop Diversification Index	0.685	0.964	0.718	0.642	0.667	0.639	0.675	0.974	0.727	0.649	0.611	0.639	0.682	0.970	0.725	0.648	0.640	0.640
Self Reported Shocks																		
# of weather shocks	0.525	0.079	0.610	0.419	0.733	0.432	0.316	0.022	0.387	0.347	0.446	0.131	0.273	0.054	0.260	0.342	0.320	0.213
# of livestock with disease	0.033	0.007	0.068	0.051	0.016	0.002	0.015	0.000	0.015	0.041	0.007	0.000	0.012	0.000	0.008	0.029	0.013	0.000
# of crop shocks	0.052	0.000	0.108	0.094	0.007	0.013	0.018	0.000	0.017	0.029	0.007	0.026	0.022	0.000	0.006	0.052	0.009	0.030
# of input/output shocks	0.040	0.000	0.046	0.107	0.009	0.006	0.021	0.000	0.019	0.057	0.003	0.008	0.027	0.000	0.017	0.075	0.016	0.005
# of wage shocks	0.146	0.086	0.183	0.164	0.141	0.110	0.121	0.153	0.139	0.146	0.101	0.087	0.065	0.054	0.106	0.048	0.051	0.058
# of household death members	0.038	0.022	0.035	0.044	0.030	0.049	0.031	0.029	0.026	0.037	0.030	0.032	0.021	0.000	0.021	0.018	0.018	0.034
# of theft	0.089	0.058	0.153	0.107	0.071	0.030	0.039	0.029	0.057	0.053	0.032	0.015	0.019	0.007	0.037	0.007	0.017	0.019
# of conflicts	0.013	0.007	0.014	0.013	0.019	0.006	0.011	0.000	0.015	0.008	0.015	0.010	0.018	0.007	0.014	0.017	0.028	0.017
# of fire	0.010	0.007	0.008	0.013	0.017	0.000	0.008	0.007	0.008	0.006	0.014	0.004	0.006	0.000	0.006	0.002	0.012	0.004
# of other shock	0.040	0.014	0.023	0.013	0.066	0.064	0.023	0.007	0.027	0.011	0.030	0.028	0.022	0.007	0.031	0.006	0.021	0.035
Length of shocks in the past 12 m	2.7	0.7	3.5	1.8	3.7	2.2	1.5	0.4	1.7	1.3	2.2	1.0	1.3	0.4	1.1	1.5	1.4	1.3
No food to eat	49%	35%	32.4%	52%	72%	38%	23%	17%	12%	25%	40%	15%	22%	9.4%	7.5%	24%	37%	18%
# animals lost/stolen/died	0.290	0.065	0.224	0.155	0.675	0.113	0.174	0.117	0.160	0.135	0.307	0.085	0.019	0.000	0.002	0.003	0.064	0.004
Observations	2239	139	518	536	576	470	2239	137	518	538	576	470	2239	138	518	537	576	470

In particular, latent variable models reduce the possibility of inference. This affects the scope of the analysis that can be carried out and the consequent conclusions that can be drawn.

Dynamic latent variable models can be adopted in order to move the analysis on. Furthermore, the introduction of regression-based approaches for estimating resilience and proxy of resilience broaden the scope and possibilities of the research.

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