ORIGINAL RESEARCH

Contrasting Monetary and Multidimensional Poverty Measures in a Low-Income Sub-Saharan African Country

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Abstract

Despite significant progress in poverty measurement, few studies have undertaken an in-depth comparison of monetary and multidimensional measures in the context of low-income countries and fewer still in Sub-Saharan Africa. Yet the differences can be particularly consequential in these settings. We address this gap by applying a distinct analytical strategy to the case of Rwanda. Using data from two waves of the Rwandan Integrated Household Living Conditions Survey, we combine comparing poverty rates cross-sectionally and over time, examining the overlaps and differences in the two measures, investigating poverty rates within population sub-groups, and estimating several statistical models to assess the differences between the two measures in identifying poverty risk factors. We find that using a monetary measure alone does not capture high incidence of multidimensional poverty in both waves, that it is possible to be multidimensional poor without being monetary poor, and that using a monetary measure alone overlooks significant change in multidimensional poverty over time. The two measures also differ in which poverty risk factors they put emphasis on. Relying only on monetary measures in low-income sub-Saharan Africa can send inaccurate signals to policymakers regarding the optimal design of social policies as well as monitoring their effectiveness.

Keywords Poverty · Measurement · Multidimensional poverty · Low-income countries · Sub-Saharan Africa

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1 Introduction

In 2013, 767 million people around the world were living on less than $1.90 a day (World Bank 2018). In the same year, 100–150 million more people were suffering from chronic hunger or were not able to read and write. 100 million more did not have access to clean drinking water within a round trip of 30 min. Nearly 200 million more people still had to practice open defecation (UNESCO Institute for Statistics 2013, 2015; FAO 2013; WHO and UNICEF 2018). So, how many people should be considered poor?

An income of US$1.90 a day represents the World Bank's global poverty line. By this metric, 'only' 767 million people were considered poor in 2013. However, other measures indicate that significantly more than 767 million people were severely deprived in education, health, and standards of living. Few would argue that these deprivations are not signs of being poor, but the threshold of US$1.90 per day does not adequately account for them.

The importance of capturing multiple dimensions of poverty is particularly relevant in the context of the global development agenda for 2030, the Sustainable Development Goals (SDGs). Goal 1 is to 'End poverty in all its forms everywhere'. In order to achieve this ambitious goal we need to understand poverty and its causes, and know how to tackle it effectively and efficiently. We need to know where and who the poor are. We need to be able to keep track of it and adjust intervention strategies as needed. Finally, by 2030, we need to be able to tell whether our efforts have been successful. While the SDG framework is a step forward from the Millennium Development Goals (MDGs) in terms of presenting a more unified system of goals and better indicators, more work needs to be done to integrate interlinked dimensions of these goals, work out a better conceptual framework for indicator development, and carefully select indicators with the focus on their relevance (Le Blanc 2015; Hák et al. 2016).

Until the 1980s, the monetary approach was the dominant way of conceptualizing and measuring poverty. However, during the 1980s, alternative approaches emerged, most importantly the capability approach pioneered by Amartya Sen (1980, 1984, 1985, 1999). The capability approach demands a shift away from the exclusive focus on monetary indicators to a broader, multidimensional conceptualization and measurement of poverty. It understands poverty as a lack of capabilities; that is, a lack of freedom to live the life one wants to live. In the 1990s and 2000s, the capability approach became one of the main subjects of debate in development and poverty research and policy (Kanbur 2003). Multiple attempts have been made to specify and operationalize the capability approach for poverty measurement, encountering significant challenges and issues (Nussbaum 2000; Baulch and Masset 2003; Kwadzo 2015; Klasen 2000; Alkire and Foster 2011; Alkire and Santos 2014). In recent years, the main research focus has been on contrasting and comparing both approaches.

Existing studies focus on conceptual issues pertaining to different approaches of measuring poverty (Johannsen et al. 2007) as well as exploring empirical consequences of using different poverty measures (Baulch and Masset 2003; Kwadzo 2015; Ruggeri Laderchi 2008; Suppa 2016). However, to the best of our knowledge, very few studies undertake an in-depth comparison of monetary and capability measures in low-income countries and in Sub-Saharan Africa. For instance, Tran et al. (2014) as well as Housseini (2014) focus mostly on measuring multidimensional poverty, Alkire et al. (2017) compare income and multidimensional poverty in Sub-Saharan African countries, but only in terms of aggregate trends, not overlap and risk factors, Baulch and Masset (2003) conducts an in-depth comparison in the context of Vietnam, and Suppa (2016) in the context of Germany. However,

poverty problems are acute in low-income countries and in Sub-Saharan Africa, where 27 out of 34 low-income countries are located (World Bank 2017a). Furthermore, in low-income countries the levels of public service provision, infrastructure development as well as administrative and financial capacities tend to be lower than in medium-income nations (Andrews et al. 2012). For these reasons, a systematic examination of monetary and capability measures in this context is particularly relevant for policy debate.

To address this gap, we undertake an extensive conceptual and empirical comparison of monetary and capability poverty measures in Rwanda. In doing so, we address two major questions. First, how different are poverty measures based on the capability approach from standard monetary poverty measures? and what are the consequences of only using monetary measures for empirical poverty assessment?

Building on existing research, we contend that capability poverty measures are more accurate as they better account for the complex nature of poverty, are based on more realistic assumptions, measure well-being outcomes rather than resource input, better capture the duration of poverty, and are not more problematic to operationalize than monetary measures. We use data from two rounds of the Rwandan Integrated Household Living Conditions Survey in 2010/11 and 2013/14 to examine these hypotheses. Specifically, we compare the official Rwandan consumption-based poverty measure with a multidimensional capability poverty measure that is adapted from the 2014-revised version of the Multidimensional Poverty Index.

Our empirical analysis finds that using only monetary measures results in significant downward bias in terms of estimating poverty rates and trends. We also find some significant differences in identifying poverty risk factors. Finally, we find a relatively weak link between the standard poverty indicator—consumption—and multidimensional poverty.

Our contribution is threefold. First, our study is what we believe to be the first systematic comparison of monetary and multidimensional poverty measures in Rwanda and one of the few such comparisons in the context of low-income countries and Sub-Saharan Africa. Second, we add to existing empirical studies (Kwadzo 2015; Baulch and Masset 2003; Klasen 2000) by constructing and examining the multidimensional poverty index that allows capturing multiple country-specific dimensions of poverty and determining intra-dimensional and cross-dimensional poverty measures specific for Rwanda. Third, we extend the research on poverty measurement by employing a distinct analytical strategy that combines comparing poverty rates cross-sectionally and over time; examining the overlaps and differences in the two measures; investigating poverty rates within population sub-groups with different locational, community, household, and individual characteristics; and estimating a set of logistic regression models to assess marginal effects of a set of locational,[1] community, household and individual factors on the risk of being monetary and multidimensionally poor.

The paper proceeds as follows. First, based on a theoretical and conceptual comparison, we present a critical evaluation of the two sets of poverty measures and show detailed reasons for why capability-based multidimensional poverty measures should at least supplement standard monetary measures. Second, we outline the research design. Then we present the results and discuss the findings of our empirical analysis. We conclude by

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[1] By "marginal effect" we are not implying a causal relationship but rather referring to how a dependent variable changes when a specific independent variable changes by one unit, holding other covariates constant (Cameron and Trivedi 2005; Long and Freese 2006).

summarizing our main arguments and findings and identifying implications for policymakers and future research.

2 Why Should Multidimensional Poverty Measures Supplement Monetary Measures

Our view on poverty builds on developments across social sciences regarding understanding deprivation and poverty. From this position, we see monetary measures as often based on knowledge and assumptions about human reasoning and behavior that are shown to fall short of being accurate by accumulated evidence. Specifically, capability-based measures can be better suited to accurately account for the complex—compound and variegated—nature of poverty than standard monetary measures, avoid unrealistic assumptions underlying the monetary approach, and measure outcomes rather than solely inputs that may or may not translate into well-being. In contrast to monetary measures, they are less likely to be driven by temporary deprivations. Finally, they are not more problematic to operationalize than monetary measures. We elaborate on each of these points below.

2.1 The Multidimensionality of Poverty

Poverty is increasingly understood as a complex, compound and variegated phenomenon (Kakwani and Silber 2008). Poverty extends far beyond the monetary dimension and is more than just deprivation in income or ability to consume (Anand and Sen 1997). If poverty is a "manifestation of insufficient well-being" (Bourguignon and Chakravarty 2003, p. 26), it is highly unlikely that it depends solely on monetary factors—non-monetary variables should be included (Bourguignon and Chakravarty 2003).

Income is only moderately correlated with subjective well-being (Luhmann et al. 2011). Kahneman and Deaton (2010) find that while larger income can improve evaluation of life, it does not necessarily improve emotional well-being. Lamu and Olsen (2016) show that the respective marginal contribution of income to subjective well-being is about 7 times lower than that of social relationships and 2.6 times lower than that of health (p. 176). In addition, financial satisfaction is derived from more than objective income, including general life satisfaction (Diener and Oishi 2000). Furthermore, the effect of economic status on subjective well-being is stronger when it is defined as wealth and not as income (Howell and Howell 2008).

The strength of the association between income and well-being is also different across high-, medium- and low-income countries. Howell and Howell (2008) found the link between economic status and subjective well-being to be "strongest among low-income developing economies and for samples that were least educated" and "weakest among high-income developing economies and for highly educated samples" (p. 536). Many low-income country citizens have volatile incomes, yet temporary changes in income are weakly related to changes in subjective well-being (Luhmann et al. 2011). Furthermore, the relationship between what the poor get and what they pay varies between high-, medium- and low-income countries, and fiscal impoverishment— "when a substantial proportion of the poor are made poorer (or non-poor made poor) by the tax and transfer system" (Higgins and Lustig 2016, p. 63)— "can be quite pervasive and, in low-income countries, larger in magnitude than fiscal gains to the poor" (Lustig 2017, p. 35).

People can be deprived in many other ways, particularly in education, health, or housing. They can lack access to basic services and health care, or can be excluded from participation in social life (Deleeck and Bosch 1992). A purely monetary measure is insufficient to adequately capture poverty and its manifestations in various dimensions. In contrast, a poverty measure based on the capability approach can better account for this multidimensionality.

To use education as an illustration, if one has an income above a given threshold but is illiterate or innumerate, such a disadvantage will probably translate into restricted learning, impeded communication, and, ultimately, low chances of improving one's situation. Individuals' "cultural capital"—conceived as resources that are embodied in a person, such as academic knowledge and conversation skills, or exist in institutionalized form, such as academic qualifications—considerably affects their social position, their access to resources and opportunities, and ultimately, their well-being (Bourdieu 1986; Hulme and McKay 2007; Jæger 2009; Jæger and Holm 2007). Of course, with higher income one might afford investing in one's education. But is such an investment possible if access to schooling is restricted due to low provision of education as a public good (e.g., no school in the neighborhood) or if one is excluded from learning due to her social position (e.g., ethnic, racial, class or gender discrimination)? Yet such problems are common in developing countries (World Bank 2017b).

The capability approach conceptualizes poverty as a multidimensional phenomenon. Instead of understanding well-being purely in terms of utility, it is defined in terms of capabilities. Consequently, poverty is defined as the "failure to achieve certain minimal or basic capabilities" (Laderchi et al. 2003, p. 14). Basic capabilities thereby refer to "the ability to satisfy certain crucially important functionings up to certain minimally adequate levels", where the term functionings denotes achieved beings or doings (Laderchi et al. 2003, p. 14). Such functionings can be located in any dimension of human life, such as health, education, employment, housing, political freedom, and social participation. Thus, a poverty measure that appropriately reflects these conceptualizations should be better able to capture the multidimensional nature of poverty.

2.2 Avoiding Unrealistic Assumptions

Multidimensional poverty measures based on the capability approach avoid unrealistic assumptions that underlie the monetary approach, particularly about human behavior, the nature of well-being, and the workings of markets. Individuals' behavior is assumed to be rational and driven by utility maximization (Johannsen et al. 2007). Individuals' utility is assumed to be equal to well-being, and utility can only be received from market goods (Thorbecke 2007; Kuklys and Robeyns 2004). No intrinsic value can be attached to choice and "utility is independent of the non-chosen goods or services" (Johannsen et al. 2007; Kuklys and Robeyns 2004, p. 13). Individuals' preferences and needs are assumed to be homogenous. And individuals only differ in their exogenously-given budget constraints.

As increasingly shown by works from across various disciplines, these assumptions rarely hold in everyday lives of many people (Akerlof and Shiller 2010; Ashraf et al. 2006; Green and Shapiro 1996). Particularly under conditions of scarcity individuals may not behave rationally. Scarcity can change individuals' behavior by changing their mindset (Mullainathan and Shafir 2013). Once a need is unfulfilled, the mind automatically orients toward it on a subconscious level. The feeling of scarcity captures a person's attention, changing what they see and how they interpret the world, resulting in overemphasizing the

perceived scarcity. Consequently, scarcity reduces individuals' mental capacity, limiting their ability to process information. This can affect their choices and decisions, in a way that perpetuates scarcity. In general, poverty "reduces a person's cognitive capacity more than going one full night without sleep" (Mullainathan and Shafir 2013, p. 13).

In contrast, the capability approach is based on a different set of assumptions. First, it is assumed that having a choice can indeed have intrinsic value and thus contribute to well-being (Johannsen et al. 2007). Sen argues that "non-utility features may have intrinsic and direct relevance" to well-being (Sen 1987a, p. 5, as cited in Johannsen et al. 2007, No 159:11). Accordingly, poverty is understood as s lack of freedom of choice that results in non-achievement of well-being functionings. Furthermore, the capability approach acknowledges the existence of externalities, public goods and other market failures as well as their relevance for well-being (Thorbecke 2007; Kuklys and Robeyns 2004). Finally, it recognizes that individuals' preferences and needs are not homogeneous (Kuklys and Robeyns 2004). Individuals differ in terms of personal characteristics as well as environmental, political, social and cultural circumstances. Therefore, they might require different amounts of resources to achieve the same standard of living.

2.3 Measuring Poverty More Directly

Capability-based measures are likely to be more accurate because they measure well-being outcomes rather than resource inputs. Inputs might or might not be converted into well-being functionings. Their conversion depends on a range of factors intervening at various stages of the well-being production process. These factors include individual, environmental, economic, political, social, institutional and cultural variables (Johannsen et al. 2007). On the individual level, different characteristics, such as health or gender, might result in different needs, which require more or less resources to be fulfilled. Important environmental variables might be institutional constraints, social norms, or the climate (Suppa 2016). Capability-based measures can account for these differences in needs, by measuring well-being outcomes directly. Suppa (2016) provides a useful illustration of this process, the different stages of poverty measurement, and of factors intervening in between the stages.

Monetary measures typically focus on the resource input stage, measuring market income, after-tax income, or consumption. However, such indicators neglect crucial individual or environmental conversion factors, which might cause deprivation despite sufficient monetary resources, for example through racial discrimination, weak protection of property rights, or arid climate. Monetary measures also neglect well-being effects of public goods, externalities and other market failures. A well-functioning health care system, for instance, might enable high levels of well-being in terms of health, despite individuals' lack of resources. Capability-based measures, in contrast, focus on the output stage, on achieved outcomes rather than resource inputs, taking such conversion factors into account.

It can be objected that poor outcomes might be the result of sub-optimal choices. In certain cases, this might lead to the misidentification of poverty, since bad outcomes would be identified as deprivations, even if they had been the result of choice. This indeed points to one of the key issues in operationalizing the capability approach (Thorbecke 2007). It is indeed challenging to measure potential well-being outcomes. While measuring outcomes *ex post* already involves significant challenges, it is also difficult to determine *ex ante* the set of potential outcomes or beings and doings available to an individual. Thus, it is difficult to account for the value received from the freedom to choose, including choosing bad outcomes. Nevertheless, even if capability-based measures may not account for the value

of choice, they still measure poverty more accurately because they do account for the large number of important conversion factors neglected by monetary measures.

2.4 Accounting for the Duration of Poverty

Multidimensional poverty measures are less likely to be driven by temporary deprivations that might not constitute poverty. As Spicker (2007) explains, "duration is important, because temporary deprivations […] are not enough to constitute 'poverty'" (p. 231). A person whose home has been destroyed through a natural disaster is temporarily homeless but can still have sufficient resources to maintain a decent standard of living and would not necessarily qualify as poor. Short-term deprivation, for instance due to a sudden loss of income, differs starkly from more permanent and structural poverty that is due to a "permanently weak social and economic position of the household" (Deleeck and Bosch 1992, p. 3).

Often the explicit or implicit focus of intervention is on structural poverty as it is more severe and more consequential. Multidimensional measures are more appropriate in this case because they are less likely to capture only temporary deprivations. While standard monetary measures resort to income or consumption indicators, which measure 'flows' and are, therefore, more volatile over time, capability-based measures measure 'stocks' such as education, health, or assets, which tend to fluctuate less.

Arim and Vigorito (2007) compare the evolution of income poverty among households with children between 1991 and 2005 with that of multidimensional poverty using the Bourguignon and Chakravarty (2003) family of indices. They find that the evolution of multidimensional poverty over time is smoother than that of income poverty, as the first one includes less volatile indicators (Arim and Vigorito 2007; Battiston et al. 2013).

2.5 Similar Operationalization Issues

Finally, operationalizing the capability approach to poverty measurement is not more problematic than operationalizing the monetary approach. Both require selecting valid and reliable indicators as well as determining a threshold below which subjects are identified as poor (Johannsen et al. 2007). In the case of multidimensional measures, an additional decision to make is whether and how to weight and aggregate dimension-specific indicators to a multidimensional composite measure.

Both approaches require certain value judgements and involve methodological issues in terms of selecting indicators and determining poverty thresholds. Consumption might be a better monetary indicator than income because it is less volatile over time and accounts for home-produced and non-market goods (Johannsen et al. 2007; McKay and Lawson 2003). However, as previously discussed, it is doubtful that monetary indicators alone represent valid measures of poverty. In addition, the mere act of determining a poverty line represents a significant value judgement and sees poverty as a discrete "yes–no" condition, which is hardly the case in reality. There are various approaches to determining a monetary poverty line, each with its own problems. Two common approaches are the 'food-intake approach' and the 'cost of basic needs approach'. They determine poverty lines according to a minimum level of income or expenditure, which is required to meet basic nutritional or consumption needs. However, such methods are based on average requirements. This does not sufficiently account for individual

heterogeneity, including different tastes and activity levels, for differences in relative prices, or for regional and temporal variation in public good provision.

Operationalizing the capability approach involves significant challenges as well. First, selecting functionings and indicators is often based on data availability and other feasibility limitations rather than conceptual and/or statistical reasoning alone. While indicators for more tangible basic needs, such as health, education and standard of living, are usually available, other capability dimensions, such as freedom of expression, security, or discrimination, are more difficult to measure. Furthermore, a choice needs to be made whether and how selected indicators should be aggregated. Aggregation can take the form of "summary indices with arbitrarily set weights like the Human Development Index", but ideally the form of "scientifically sound composite measures" (Johannsen et al. 2007, No 159:16). Currently, one of the main research objectives is to find reasonable solutions to these problems.

Recent contributions by Alkire and Foster (2011) and Alkire and Santos (2014, p. 2010) represent significant advancements in this regard. They propose a reasonable choice of dimensions and indicators as well as solid methods and specifications to address the problems of aggregation and determine poverty thresholds. The multidimensional measure used in the empirical part of this study is largely based on their methods.

2.6 Hypotheses

Building on this discussion, we expect that comparing the performance of monetary and capability-based multidimensional poverty measures in Rwanda will result in finding significant disparities between the two measures. Specifically, given the low levels of public service provision and infrastructure development typical for low-income countries and the greater ability of multi-dimensional measures to capture resulting deprivations, we expect that in Rwanda the proportion of individuals identified as poor using the multidimensional poverty measure will be larger than the proportion of individuals identified as poor using the monetary poverty measure. Hence.

Hypothesis 1 Estimated monetary poverty rates are likely to be lower than estimated multidimensional poverty rates

Furthermore, given the differences in assumptions about poverty and the degree of comprehensiveness of measuring its particular aspects, the two measures will show a considerable divergence in what they identify as risk factors for poverty. Hence.

Hypothesis 2 The monetary and multidimensional poverty measures are likely to show associations with the same risk factors that are different in significance, size, and direction of the association.

Finally, given the large variety of intervening variables in the conversion process from resource inputs to well-being outcomes:

Hypothesis 3 Consumption is likely to be a weak proxy for and have a weak link to multidimensional poverty.

3 Research Design

The relatively few existing empirical analyses of multidimensional poverty have mainly included countries in the range from high-income to lower-middle income. However, it is imperative to compare the performance of key poverty measures in a low-income country context. Compared to countries in the middle income group, low-income countries, especially in Sub-Saharan Africa, tend to have lower levels of public service provision, including in social protection, healthcare and education, less developed infrastructure, more informal labor markets, and constrained administrative and fiscal capacities (Andrews et al. 2012). In Africa, around 80% of households were not receiving social protection in 2011. 64% of the population in LICs lived in rural areas with limited access to roads, only 28% of which were paved. The World Bank projects that 50% of households in Sub-Saharan Africa will continue to lack access to electricity in 2050. 48% of the total workforce in low-income countries are informally self-employed, making them difficult to reach through social protection programs. These characteristics make the provision of public goods crucial to individuals' well-being and the prevention of negative externalities and other market failures more difficult. As mentioned before, fiscal impoverishment can be larger in magnitude in low-income countries compared to other countries (Lustig 2017). Consequently, it can be suggested that multi-dimensional deprivations and mismatches between income and multi-dimensional poverty measures would be particularly pronounced in low-income countries.

We address this research gap by conducting an empirical assessment in the context of Rwanda. Apart from being a low-income Sub-Saharan African country, this case is interesting because, in 2011, the Rwandan government adopted a comprehensive National Social Protection Strategy, introducing universal health insurance, free education and social transfers, among others, allocating around 5% of its budget to the social protection sector. The analysis of poverty trends between 2010/11 and 2013/14 can indicate whether this intervention has had an effect. Findings from this study may have significant policy implications by shaping the poverty reduction policies in the country.

We are aware of only one comprehensive empirical comparison of monetary and capability poverty measures in a low-income country, by Levine et al. (2012), who compare poverty measures in Uganda. Our case study of Rwanda expands this important line of research. Rwanda's development trajectory throughout the study period (2010–2014) has been comparable to other East African countries, including Uganda, Tanzania, and, to a lesser extent, Kenya [see Table 1]. Therefore, findings from this study can yield lessons not just for Rwanda but for poverty measurement in the whole region—provided we do it cautiously.

Previous empirical comparisons focus on a large variety of aspects. Most researchers examine the extent to which both measures agree on poverty rates and on who is identified as poor (Baulch and Masset 2003; Klasen 2000; Kwadzo 2015; Laderchi 2008; Laderchi et al. 2003; Suppa 2016). Additionally, several scholars explore the link between both measures, mostly by using correlation analysis (Laderchi et al. 2003; Klasen 2000; Laderchi 2008; Suppa 2016). Some researchers also examine the extent of agreement on poverty risk factors by comparing poverty rates within population subgroups or computing logistic regression models (Tran et al. 2014; Suppa 2016). Finally, only few studies compare how capability and monetary poverty measures perform with respect to assessing poverty dynamics over time (Tran et al. 2014; Baulch and Masset 2003; Suppa 2016). In our empirical analysis, we combine these strategies in order to

Table 1 East African countries in comparison, 2010–2014

	Rwanda	Uganda	Tanzania	Kenya	LIC average	LMC average
GNI/capita (2011, current US$)	650	610	770	1,060	1,707	5,135
GNI/capita (2014, current US$)	700	660	920	1,260	1,965	6,076
Life expectancy at birth (2012, Years)	65	58	62	65	61	67
Infant mortality rate (2012, per 1000 live births)	36.7	46.5	44.8	40.6	56.6	44.0
Adult literacy rate (2012, % of ages 15 +)	68	70	78	78*	58	74
Poverty headcount $1.9/day (2010–12, % of population)	60.3	33.2	46.6	n.a	46.5	20.4
Poverty headcount MPI (2010)	66.1	66.8	66.1	51.2	60.7	28.5

Data sources: World Bank (2018), Gasiorek, Byiers and Rollo (2016) and authors' calculations based on Alkire et al. (2015)

LIC Low income countries, *LMC* Lower middle income countries

*2014 data

provide a comprehensive analysis of the empirical consequences of using different poverty measures.

3.1 Data

We use the Rwandan Integrated Household Living Conditions Survey (EICV) to conduct rigorous comparisons of the monetary and the multidimensional poverty measures. We chose to use data from EICV instead of Demographic and Health Survey (DHS) because the DHS dataset does not have income / consumption data, without which we would not be able to create the consumption-based monetary measure. We retrieved all information necessary for this analysis from datasets based on two EICV-survey-rounds, which took place in 2010/11 (EICV3) and 2013/2014 (EICV4). The EICV3-sample includes a total of 14,308 households, selected based on a stratified two-stage design (National Institute of Statistics of Rwanda 2016). The total cross-sectional sample in EICV4 includes 14,419 households, composed of 12,312 new households, selected based on a stratified two-stage design, and 2108 households forming part of a panel study sub-sample (see Table 1, Supplementary Material). Both cross-sectional samples are representative of the Rwandan population, given sampling weights are used, which we do in our analysis.

Our unit of analysis are individuals who are assigned household level characteristics. Following the convention, in order to calculate poverty rates at the individual level, the same poverty status is assigned to all household members. Applying this unitary definition of the household might be reasonable with respect to measuring monetary poverty, since it can account for effects of potential household economies of scale and scope as well as consumption smoothing (Alkire and Santos 2014). For measuring multidimensional poverty it might be justified as it can be assumed that the whole household can, for example, benefit from one household member, who has completed primary school and is therefore likely to be literate (Dotter and Klasen 2017). However, it also involves some issues, which we discuss in the limitations section.

3.2 The Official Rwandan Monetary Poverty Measure

We chose the official Rwandan poverty measure as the operationalization of the monetary approach for two reasons. First, it is based on one of the most common methods: the 'cost of basic needs' approach. Second, findings and implications resulting from this study are intended to be of use for stakeholders in Rwanda. Therefore, using the current official poverty measure in Rwanda is the most evident choice.

The official Rwandan monetary poverty measure uses aggregate household consumption per adult equivalent in Rwanda Franc (RWF) as the only indicator (see National Institute of Statistics of Rwanda 2015). Household consumption is calculated by aggregating households' expenditures on food items, consumption of self-produced food items, expenditures on non-food goods and services, including but not limited to expenditures on clothing, education, fuel, health, housing, and transport, and the value of wages received in kind (ibid, p. 30). Non-consumption expenditures, such as expenditures on farm inputs and on large durable goods as well as one-time large expenditures (for example on weddings), are excluded. An adult equivalence scale with scores varying according to age group and

Table 2 Adult equivalence scales

Age range	Gender	
	Male	Female
Less than 1 year	0.41	0.41
1–3 years	0.56	0.56
4–6 years	0.76	0.76
7–9 years	0.91	0.91
10–12 years	0.97	1.08
13–15 years	0.97	1.13
16–19 years	1.02	1.05
20–39 years	1.00	1.00
40–49 years	0.95	0.95
50–59 years	0.90	0.90
60–69 years	0.80	0.80
More than 70 years	0.70	0.70

gender is used to make consumption figures equivalent and comparable across households [Table 2].[2]

The extreme poverty threshold (the food poverty threshold) is determined by estimating consumption levels necessary to purchase a food basket that meets a minimum level of nutritional requirements. The basket is constructed based on expert prescriptions and observed consumer habits. It contains 42 food items in ten categories, mainly roots, tubers, sweet potatoes as well as cassava and its products, enabling the consumption of 2500 cal per adult equivalent per day, and a minimum of proteins and other nutrients. It is costed at 105,064 RWF in January 2014 prices (= 128.6 USD).

The poverty threshold (the consumption poverty threshold) additionally considers the costs of essential non-food items. It is determined by identifying households with a level of consumption within ± 10% of the food poverty line (105,064RWF) and calculating their median proportion of expenditures on food items, which is 0.659. Based on this, the poverty threshold is established at 159,375 RWF.

3.3 Constructing Multidimensional Poverty Measure for Rwanda

We operationalize the capability approach largely based on the specifications of the revised Multidimensional Poverty Index (United Nations Development Programme 2014). We replace some indicators due to data limitations but we do so based on careful conceptual reasoning.

The first major contention today is about how to operationalize the capability approach. The spectrum of alternative options ranges from minimalistic to multidimensional measures. Some scholars avoid the problem of aggregation and employ schematic methods to determine poverty thresholds. Kwadzo (2015), for instance, measures capability deprivation using only one education indicator and determines capability poverty thresholds depending on his monetary poverty measure. Similarly, Baulch and Masset (2003) avoid

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[2] How these scores are established is not clear from the documentation report.

aggregation by using two separate indicators to measure education and nutritional poverty. Rather minimalistic, such operationalization methods scarcely reflect the capability approach.

Conversely, other researchers have attempted to create multidimensional composite measures (Alkire and Santos 2013; Catalan 2019; Klasen 2000; Fattore 2016). For instance, a pioneering work by Klasen (2000) combines 14 capability-dimensions in a deprivation index, including basic capabilities as well as additional capabilities valued by the South African population. In order to weight dimensions for aggregation, he resorts to principal component analysis. However, instead of objectively determining dimension-specific poverty thresholds, he subjectively scores deprivation in each dimension on a scale from 1 to 5, and combines the sum of all scores in a deprivation index. Finally, to identify the capability poor, he simply takes the worst-off 40 percent. Although this represents a solid solution to choosing a comprehensive set of capabilities and weighting, the determination of intra-dimensional and cross-dimensional poverty thresholds remains problematic.

Recent methodological advancements, particularly the Alkire-Foster Method (Alkire and Foster 2011) and the Multidimensional Poverty Index (United Nations Development Programme 2014) arguably overcome many limitations of other multidimensional approaches to measuring poverty. Since these approaches serve as the basis of our method in this article, we discuss them in detail in the research design section.

The mathematical structure of the MPI is based on the Alkire-Foster Method (Alkire and Foster 2011), which proposes a dual cut-off approach to address the problem of determining multidimensional poverty thresholds. First, thresholds are objectively determined for each indicator and a deprivation score (i.e. the sum of weighted deprivations in intra-dimensional indicators) is calculated. Only then households are identified as poor across multiple dimensions, depending on their deprivation score. For the MPI, the cross-dimensional thresholds for poverty and extreme poverty are set at deprivation scores of 33.33% and 50%, respectively. Thus, there are two kinds of deprivation thresholds, ten indicator-specific thresholds, and one cross-dimensional deprivation threshold.

The three dimensions of poverty—health, education and standard of living—as well as the ten intra-dimensional indicators were carefully selected, despite data limitations and the aspiration to design an internationally comparable measure. So were indicator-specific deprivation thresholds, the cross-dimensional threshold, and indicator weights.

Table 3 presents the set of intra-dimensional indicators used in this study as well as the coding rules for determining deprivation in each indicator. We will discuss the selection of each indicator in turn, either referring to the justifications put forward by Alkire and Santos (2014), or explaining the reasoning behind choosing replacement indicators, where applicable.

Similar to the 2014-revision of the MPI, this study uses *School Attainment* and *School Enrollment* as indicators for the educational dimension. *School Attainment* assesses whether at least one household member completed a minimum of six years of schooling, which is equivalent to the duration of primary school in Rwanda. This choice is based on the assumption that "years of schooling provides a rough proxy of basic educational skills: literacy, numeracy and understanding of information" (Alkire and Santos 2014, p. 10). *School Enrollment* assesses whether a school-aged child in the household has not attended school in the previous 12 months. The purpose of this indicator is to verify whether children that are supposed to attend school are exposed to a learning environment.

Due to limited data availability, we replaced the original MPI-indicators for the health dimension. We selected incidence of *Disability* because it has been found to be associated with material deprivations and deprivations in terms of school attainment and enrollment,

Table 3 Measuring multidimensional poverty: dimensions, indicators, weights, and coding deprivation

Dimension	Indicator	Dimension weight	Indicator weight	Household is deprived if…	
				EICV3	EICV4
Education	School Attainment	1/3	1/6 (1/3, if household does not have school-aged children)	No member has completed at least primary school	
	School Enrollment		1/6 (0, if household does not have school-aged children)	At least one school-aged member has not attended school in the previous 12 months	
Health	Disability	1/3	1/6	At least one member has a disability	
	Health Functioning		1/6	> 0 Household member suffered from health problem in previous 2 weeks and could not leave house as a result	> 0 Household member suffered from health problem in previous 4 weeks and could not work or attend school
Standard of Living	Floor Material	1/3	1/18	Household has sand, dung or dirt floor	
	Cooking Fuel		1/18	Household uses dirty cooking fuel (=firewood, charcoal, crop waste, animal dung)	
	Access to Electricity		1/18	Main source of lighting is non-electric	
	Drinking Water		1/18	Nearest drinking water source not improved or more than 3200 m away	Used drinking water source not improved or more than 3200 m away
	Sanitation		1/18	No improved sanitation	Toilet shared or no improved sanitation
	Assets		1/18	Household has 0 assets related to information and 0 assets related to livelihood	Household has 0 assets related to mobility or 0 assets related to livelihood

employment, health and access to health care as well as social participation (Filmer 2008; Eide and Ingstad 2011; Graham et al. 2013; Saleeby 2012). Furthermore, we chose *Health Functioning*, because it measures the effect of health status on "the ability to perform one's roles and participate in life" (Bowling 2004, p. 4). One of the main roles of adult household members usually is to work in order to provide for the household. For school-aged household members, attending school is one of the main roles and ways to participate in life. Therefore, deprivation of health functioning can be reasonably assumed to exist, when, due to health problems or hunger, an adult household member has not been able to work and/or leave the house, or a school-aged household member has not been able to attend school. Furthermore, if any one household member is deprived in health functioning in this way, the whole household can be deprived because this probably results in significant income shortfalls or decreased education spillovers.

Lastly, we selected the same indicators used in the 2014-revised MPI for the standard of living dimension. These are access to *Drinking Water*, *Improved Sanitation*, type of *Cooking Fuel*, *Access to Electricity*, *Floor Material* and household *Assets*. The first three are included in the MPI, because they are MDG indicators, related to health, and affect women in particular. *Floor Material* and *Access to Electricity* provide some indication of the quality of housing. Household *Assets* measure ownership of consumption goods that enable mobility, access to information, and a decent standard of living, including televisions, bicycles and refrigerators. Deprivation thresholds for each of these indicators are specified in Table 3.

3.4 Analytical Strategies

To compare poverty rates and trends according to each poverty measure, we calculate headcounts of poverty and extreme poverty in both EICV3 and EICV4, following the procedures specified above. To analyze the extent of overlap on who is identified as poor and extremely poor in both years, following practices in multidimensional poverty studies analyzing overlap/mismatches (Baulch and Masset 2003; Coromaldi and Zoli 2012; Franco et al. 2002; Notten and Roelen 2010; Laderchi et al. 2003), we cross-tabulate estimated incidence of (extreme) monetary poverty incidence and estimated incidence of (extreme) multidimensional poverty. In addition, we provide a more intuitive comparison, by calculating and reporting the proportions of the monetary poorest 20 percent identified by the multidimensional measure and of the multidimensional poorest 20 percent identified by the monetary measure.[3] Furthermore, to compare both measures' assessment of poverty risk factors, we compute logistic regression models to estimate marginal effects of a set of locational, community, household and individual factors on the risk of being monetary and multidimensionally poor in 2010/11 [for summary statistics see Table 6 in Supplementary Material]. All selected independent variables are factors commonly recognized as key determinants of poverty (Haughton and Khandker 2009). All models are derived using sampling weights and robust standard errors clustered by province to account for province-level geographic, institutional and social differences (NISR 2015; World Bank 2015).

We used two model variations: one including dummy variables for *School Attainment* of the household head and one without. The purpose is to account for possible correlation between *School Attainment* and the multidimensional poverty measure that can be due to

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[3] We thank Reviewer 1 for this valuable suggestion.

Table 4 (Extreme) monetary and multidimensional poverty rates in EICV3 and EICV4

Year	Monetary poverty		Multidimensional poverty	
	Population share (%)	95% confidence interval	Population share (%)	95% confidence interval
2010/11 (EICV3)	46.04	[46.01; 46.07]	71.46	[71.43; 71.49]
2013/14 (EICV4)	39.11	[39.07; 39.13]	45.73	[45.70; 45.76]
Year	Extreme monetary poverty		Extreme multidimensional poverty	
	Population share (%)	95% confidence interval	Population share (%)	95% confidence interval
2010/11(EICV3)	21.78	[21.76; 21.81]	43.97	[43.94; 44.00]
2013/14 (EICV4)	16.33	[16.28; 16.32]	27.28	[27.26; 27.31]

the way the measure is constructed. In addition, similar to Tran et al. (2014), we calculate poverty rates within different population sub-groups in order to cross-check the regression estimates. To do this, we created sub-groups based on the same set of factors used for the regression analysis.

To explore the link between consumption and multidimensional poverty, we included the log of aggregate *Household Consumption* per adult equivalent as an additional independent variable in the logit models with multidimensional poverty as the dependent variable. Complementarily, we examine multidimensional poverty rates across consumption quintiles. Lastly, similar to Suppa (2016), within each quintile, we calculate consumption averages and plot them against multidimensional poverty rates, in order to examine the relationship between consumption and multidimensional poverty.

4 Results

4.1 Incidence of Poverty and Trends

Overall, the two measures differ significantly in estimating poverty incidence and trends. Specifically, estimated monetary poverty rates appear lower than estimated multidimensional poverty rates. As Table 4 displays, in EICV3, 46.04% of Rwandans lived in households that would be viewed as monetary poor. By 2013/14, the monetary poverty rate had decreased by around seven percentage points to 39.11%. In contrast, the proportion of individuals living in multidimensionally poor households was 71.46% in 2010/11 and decreased by 25.73 percentage points to 45.73% in 2013/14. The proportions of extremely poor individuals exhibit similarly large disparities. While the population share of extremely monetary poor individuals was 21.78% in 2010/11 and decreased by approximately 5 percentage points to 16.33% in 2013/14, the share of extremely multidimensionally poor was twice as high in EICV3 (43.97%) and still significantly higher in EICV4 (27.28%), despite a decrease by 16.69 percentage points.

4.2 Overlap in Identifying the Poor

The two measures also exhibit significant differences in terms of identifying who is poor (Tables 2, 3, 4, 5, Supplementary Material). In 2010/11, only 37.99% of the population was identified as poor by both measures. While 82.53% of individuals identified as monetary poor were also multidimensionally poor, only 53.17% of multidimensionally poor individuals could be identified as monetary poor. Nearly half of the multidimensionally poor (46.83%) were not identified as poor by the monetary measure and 62.02% of individuals not identified as monetary poor were in fact multidimensionally poor.

These disparities are even more pronounced in the case of extreme poverty. Only 11.9% of the population was identified as extremely poor by both measures. Of those identified as extremely monetary poor, only 54.64 were also identified as extremely multidimensionally poor, and only 27.07% of extremely multidimensionally poor individuals were also extremely monetary poor. Conversely, among individuals not identified as extremely poor by the monetary measure, 40.99% were extremely multidimensionally poor. A share of 72.93% of the extremely multidimensionally poor was not extremely poor in monetary terms.

Of the monetary poorest quintile of households in 2010/11, 89.16% were identified as poor by the multdimensional measure. However, of the multidimensionally poorest quintile only 48.11% were identified as poor by the monetary measure.

Between 2010/11 and 2013/14, the mismatch between both measures seems to have increased. In 2013/14, slightly less than one quarter of the population (23.64%) was living in households that were both monetary and capability poor. Of those identified as monetary poor, only 60.43% were also identified as poor in multidimensional terms. The share of multidimensionally poor individuals also identified as monetary poor was 51.68%. Conversely, the proportion of multidimensionally poor not identified as poor by the monetary measure was 48.32%, and 36.29% of those not identified as monetary poor were identified as multidimensionally poor.

Merely 6.21% of the population was living in households that were identified as extremely poor by both measures in 2013/2014. Of those identified as extremely monetary poor, only 38.05% were also identified as extremely multidimensionally poor. Conversely, of those identified as extremely multidimensionally poor, 77.22% were not identified as extremely monetary poor. Furthermore, 25.18% of those not identified as extremely monetary poor were in fact identified as extremely multidimensionally poor.

Of the monetary poorest 20 percent of households in 2013/14, more than two thirds (70.40%) were identified as poor by the multdimensional measure. However, of the multidimensionally poorest quintile less than half (46.21%) were identified as poor by the monetary measure.[4]

4.3 Poverty Risk Factors

All logistic regression models (Table 5) that were computed to estimate marginal effects on the probability of being poor in 2010/11 have areas under the ROC curve around or larger

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[4] We also compared the profiles of individuals in the groups of poor identified by the two measures (Table 5 in Supplementary material). The descriptive statistics suggest that the characteristics of the poor are similar for the two measures.

Table 5 Estimated marginal effects logistic regression models, EICV3

| Model | Dependent variable | | | | | |
| | Monetary poverty | | Multidimensional poverty | | | |
	(1)	(2)	(3)	(4)	(5)	(6)
Independent variables						
Rural location	0.127***	0.1826***	0.065***	0.109***	0.014	0.029
	(0.021)	(0.021)	(0.016)	(0.018)	(0.0144)	(0.015)
Distance to all-weather roads	0.002***	0.003***	0.002**	0.003***	0.001*	0.001*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Household size	0.068***	0.064***	−0.036**	−0.038***	−0.051***	−0.054***
	(0.004)	(0.004)	(0.002)	(0.002)	(0.003)	(0.003)
Female household head	0.023*	0.042***	−0.068**	−0.049***	−0.075***	−0.064***
	(0.009)	(0.009)	(0.008)	(0.009)	(0.008)	(0.009)
Hours worked	−0.002***	−0.0002***	−0.001***	−0.001***	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.0001)	(0.000)	(0.000)
Household head unemployed	0.056*	0.072**	0.013	0.029	0.015	0.024
	(0.019)	(0.020)	(0.024)	(0.025)	(0.024)	(0.024)
Primary school completed	−0.110***	–	−0.098***	–	−0.070***	–
	(0.016)		(0.009)		(0.009)	
Secondary school completed	−0.433***	–	−0.170***	–	−0.072**	–
	(0.057)		(0.026)		(0.021)	
Secondary plus completed	−0.423***	–	−0.231***	–	−0.107***	–
	(0.031)		(0.013)		(0.013)	
Household consumption (log)	–	–	–	–	−0.141***	−0.157***
					(0.010)	(0.010)
Observations	14,303	14,303	14,303	14,303	14,303	14,303
% Correctly Predicted	0.665	0.645	0.774	0.766	0.787	0.785
Area under ROC Curve	0.722	0.6985	0.717	0.696	0.766	0.759

Notes The models are survey-weighted (two-stage design with sampling stratified by district) and the standard errors (in parentheses) account for clustering by district. Significance levels: ***=0.001, **=0.01, *=0.05

than 0.7. For core models 1 and 3, the area under the ROC Curve is above 0.7, which indicates fair model fit (Hosmer et al. 2013: 156–164). Models 1 and 2 correctly predict at least 64% of observed incidence of poverty and Models 3 and 4 more than 76%, also indicating fair predictive accuracy of the models (Hosmer et al. 2013: 156–164; Wooldridge 2015: 590–594), more so regarding multidimensional poverty than monetary poverty.

4.3.1 Rural Location

The estimated marginal effect of rural location, compared to location in urban areas, is statistically significant across all model specifications. According to Model 1, rural location is estimated to increase the risk of monetary poverty by 12.7%, holding all other variables in the model constant. When not including dummy variables for educational attainment of the household head (Model 2), the effect increases to 18.26%. In contrast, the estimated marginal effect of rural location on multidimensional poverty is only half as strong (Model

3). However, its strength increases to 10.09%, when education variables are not included (Model 4).

These findings are confirmed when we compare poverty rates within population subgroups of households located in urban and rural areas [Table 7, Supplementary material]. While both measures agree on significantly higher poverty incidence in rural areas, the rate of monetary poor in rural areas is nearly twice as high as in urban areas. However, the disparity in multidimensional poverty incidence between rural and urban areas is less pronounced.

4.3.2 Distance to All-Weather Roads

The estimated marginal effect of households' distance to all-weather roads is statistically significant at least at 0.05 level and positive across all models. The effect is similarly weak in substantive terms for both measures. According to Models 1 and 3, an additional 10 min to all-weather roads merely increases the risk of being poor by approximately 0,2%, controlling for other variables. Without education dummies, the estimated effect slightly increases to around 0,3%.

4.3.3 Household Size

The estimated marginal effect of the number of household members is statistically significant across all models. However, household size has a positive effect on the risk of monetary poverty, while it has a negative and weaker effect on the risk of multidimensional poverty. Each additional household member increases the risk of monetary poverty by around 7%. In contrast, each additional household member decreases the risk of multidimensional poverty by 3–4%, holding all else constant. These contrary effects are also visible in Table 7 in Supplementary material. Monetary poverty rates increase with increasing household size, while multidimensional poverty rates decrease.

4.3.4 Female Household Head

The estimated marginal effect of a woman heading the household is statistically significant with more than 95% confidence across all models. It has a positive effect on the risk of monetary poverty, but a negative effect on the risk of multidimensional poverty. It is estimated to increase the risk of monetary poverty by 2–4%. In contrast, it decreases the risk of multidimensional poverty by 5 to 6%, controlling for other variables. These contrary effects are not reflected in the poverty rates within sub-groups of male and female-headed households, however. Both monetary and multidimensional poverty rates are higher for female-headed households.

4.3.5 Hours Worked

The estimated marginal effects of hours worked are statistically significant at conservative 0.001 level in four models and negative in all models, but negligible in substantive terms. Working 10 more hours only decreases the risk of poverty by 0.01–0.2% in both cases.

4.3.6 Unemployment

Unemployment only has a statistically significant effect on the risk of monetary poverty, but not on the risk of being multidimensionally poor. It is estimated to increase the risk of monetary poverty by 5–7%. By implication, this result suggests that while employment may help alleviate monetary poverty, simply being employed may have little effect on multidimensional poverty.

4.3.7 Educational Attainment of Household Head

The estimated marginal effects of all levels of educational attainment are statistically significant at conservative 0.001 level and negative in all models. However, there are differences in strength. Compared to not having any educational qualification, having completed primary school is estimated to decrease the risk of both types of poverty by approximately 10–11%. Having completed secondary school decreases the risk of monetary poverty by 43%, but the risk of multidimensional poverty only by 17%. Similarly, having completed a level higher than secondary school has a significantly stronger negative effect on the risk of monetary poverty than on the risk of multidimensional poverty. These findings are reflected in the estimated poverty rates within respective population sub-groups.

4.4 The Link Between Consumption and Multidimensional Poverty

Including the log of *Aggregate Consumption* per adult equivalent as an additional independent variable in Models 3 and 4 only slightly increases the percentage of correctly predicted incidence of multidimensional poverty [Models 5 and 6; Table 5]. The area under the ROC curve increases more significantly, yet not so drastically as to indicate strong relevance of consumption as an explanatory variable for multidimensional poverty. The estimated marginal effect of consumption on the risk of multidimensional poverty is highly statistically significant and negative in both models, but not strong substantively. Doubling household consumption per adult equivalent is associated with a decrease in the risk of multidimensional poverty of merely 15%.[5]

Examining multidimensional poverty rates within different consumption quintiles confirms this finding [see Table 10 in Supplementary material]. Incidence of multidimensional poverty continues to be extremely high, even at highest consumption levels, with poverty rates of 68.55% in the fourth quintile and nearly half of the population in the highest quintile.

Finally, the marginal effect of consumption on the risk of multidimensional poverty seems to decrease with increasing consumption levels. At the lowest level, where average consumption is estimated to be approximately 77,000RWF (=76€), nearly 9 out of 10 individuals are estimated to be multidimensionally poor. With increasing consumption, multidimensional poverty headcounts do decrease, but at a decreasing rate. As a result, at

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[5] Since models 1 and 2 suggest a strong correlation between monetary poverty and the variables included in the estimation, this needs to be taken into account when household consumption is included in regressions 5 and 6 as the correlates in the previous models may be instrumenting for household consumption. We thank Reviewer 2 for pointing this out.

the highest consumption level, where average consumption is more than ten times as high as in the lowest quintiles, nearly half remain multidimensionally poor.

5 Discussion

We hypothesized that poverty incidence measured by the multidimensional index will be higher than that captured through monetary poverty measure. Our findings generally confirm this hypothesis. However, while the difference in both kinds of estimated poverty rates was quite large in 2010/11 (25.18%), the contrast in 2013/2014 was significantly less pronounced (6.7%). A similar, but less strong convergence took place regarding extreme poverty rates. This convergence in poverty rates between years is the result of disproportionately large reduction of multidimensional poverty, compared to monetary poverty.

These findings are in line with results by Alkire et al. (2017), who find annualized reduction in multidimensional poverty in Rwanda between 2005 and 2010 of nearly 5 percentage points, compared to an annualized reduction in income poverty by only around 2.5 percentage points. Similarly, Housseini and Alkire (2014) observe a reduction in multidimensional poverty rates in Rwanda from 82.9% to 66.1% throughout the same period, more than twice as much as reductions in income poverty. Their lower estimate of multidimensional poverty in 2010 might be due to the use of data from the Demographic Health Survey instead of EICV, resulting in a different choice of indicators.

Significant improvements in terms of standard of living between 2010/11 and 2013/14 are captured more clearly through the multidimensional measure of poverty. In particular, improved access to education, health and basic services seem to have been the main drivers. A decomposition of the multidimensional measure by indicator reveals significant improvements in school attainment, health functioning, access to electricity and drinking water, in particular (Table 9, Supplementary Material]. A report by the National Institute of Statistics of Rwanda (2015) confirms: between 2010/11 and 2013/14, the proportion of households with access to electricity increased by 9%, and with access to both improved drinking water by approximately 10% (National Institute of Statistics of Rwanda 2015).

We also hypothesized the lack of overlap between both measures on who is identified as poor, which is confirmed by our analysis. There were significant disparities in identification in 2010/11. While a large proportion (82%) of the monetary poor were also identified as poor by the multidimensional measure, only about half (53%) of the multidimensionally poor individuals were identified as poor by the monetary measure. In 2010/11, using the multidimensional measure alone would thus have identified nearly all monetary poor, while using only the monetary measure would have left half of the multidimensionally poor unidentified.

In 2013/14, the proportions of unidentified poor, when using only one of the measures, were even larger. Only 60% of the monetary poor would have been identified by the multidimensional measure and only 51% of the multidimensional poor by the monetary measure. Thus, using only a multidimensional measure or only a monetary measure would have resulted in quite different parts of the population being identified as poor.

These findings corroborate results from previous studies, which also found significant disparities in other contexts (Baulch and Masset 2003; Klasen 2000; Kwadzo 2015; Laderchi et al. 2003; Suppa 2016; Tran et al. 2014). While the magnitude of the mismatch that we find in Rwanda in 2010/11 is less severe than the mismatch found by Levine et al. (2012) in Uganda in 2005/06 (only 23% of the population were identified as poor by both

measures, compared to 36.5% in Rwanda) the mismatch in Rwanda increased to an approximately equal level (to only 24% identified as poor by both measures), in 2013/14.

These findings are in line with the arguments that resources need not necessarily translate into well-being outcomes (Tran et al. 2014). Furthermore, they imply that measuring poverty using monetary indicators alone might not accurately account for the multidimensionality of poverty.

We also hypothesized significant variation between both measures with regard to assessing poverty risk factors. Our findings confirm this hypothesis partly. We find that both measures are associated with proximity to all-weather roads, hours worked, and educational attainment. In contrast, we find strong evidence for contrary effects of household size, and different strengths for rural location. However, evidence for the effect of having a woman as household head is inconclusive. According to the regression analysis, it increases the risk of monetary poverty, but decreases the risk of multidimensional poverty. But poverty rates among female-headed households are higher for both monetary and multidimensional poverty.

In Vietnam, Tran et al. (2014) also find a convex relationship between household size and the risk of monetary and multidimensional poverty, respectively. They explain that monetary poor families tend to have more children and tend to live together to share limited resources. However, small households are often composed of elderly singles or couples, which tend to be more deprived in terms of health, education and other living standards, increasing their risk of being multidimensionally poor.

The estimated effects of rural location contradict expectations voiced by some experts, including from ILO (2008, pp. 12–13) and the World Bank (2008). Multidimensional poverty rates should be lower in urban areas, due, for example, to better access to basic services, investment in enterprises, and infrastructure development. Conversely, rural location should have a stronger effect on the risk of multidimensional poverty than on the monetary poverty risk, due to the relatively stronger effect of a lack of basic services and infrastructure on multidimensional poverty. However, controlling for other factors, we find multidimensional poverty rates in urban areas to be higher than monetary poverty rates. In addition, the increase in the risk of poverty through rural location is smaller for multidimensional poverty than for monetary poverty. A possible explanation could be the negative impact of rural-to-urban migration on living standards in urban areas, reinforcing urban multidimensional poverty (Levine et al. 2012).

Our analysis confirms that resources might or might not be converted into well-being outcomes and that the link between consumption and multidimensional poverty is weak. We find only a minimal mitigating effect of consumption on being multidimensionally poor. Furthermore, the effect seems to become less strong as consumption levels increase. Estimated multidimensional poverty rates remain high among individuals at highest consumption levels.

In his comparison of monetary and multidimensional poverty measures in Germany, Suppa (2016) finds a decreasing effect of income on multidimensional poverty with increasing income levels. However, he also finds multidimensional poverty rates to be near zero in the highest income quintiles. This is likely because his study takes place in a high-income country, thus underlining a difference between such countries and low-income countries, such as Rwanda.

We conclude that while monetary resources seem to contribute to reducing multidimensional poverty to some extent, their effect is rather small and becomes increasingly smaller as resources increase. This supports the argument that monetary resources are only one variable among many others that are relevant for well-being. Furthermore, it supports the

argument that increased consumption capacity does not necessarily lead to improved well-being outcomes. Therefore, monetary indicators such as income or consumption should not be the only measures of well-being.

5.1 Robustness Checks

In order to test the robustness of our results, we performed three robustness checks [see Supplementary Material 7–20]. We re-estimated the above analyses, implementing three MPI modifications suggested by Dotter and Klasen (2017). First, instead of employing all six household living conditions indicators, we only used *Floor Material*, *Drinking Water*, and *Assets*. Second, we modified the *School Attainment*-deprivation-threshold, by considering a household as non-deprived in *School Attainment*, only if less than half of household members have completed at least primary school. Lastly, we used a different method to determine extreme multidimensional poverty. Instead of simply raising the cross-dimensional poverty threshold to 50%, we used higher deprivation thresholds for each intra-dimensional indicator.

A reduced number of living standard indicators results in slight reduction in estimated multidimensional poverty rates in both 2010/11 and 2013/14 and larger reduction in estimated extreme multidimensional poverty rates. However, overall, multidimensional poverty rates remain significantly higher than monetary poverty rates in both years. In addition, there is even larger disagreement between both measures in terms of identifying the poor in 2010/11, while the extent of disagreement in 2013/14 remains fairly similar. The estimated marginal effects of the different determinants on the risk of multidimensional poverty also remain virtually the same. The estimated marginal effect of consumption, in contrast, increases slightly, by approximately two percentage points. However, in substantive terms, the link between consumption and the risk of being multidimensionally poor remains similarly weak as before.

Using a lower S*chool Attainment*-deprivation threshold results in significantly higher multidimensional poverty estimates, increasing the disparity between estimated monetary and multidimensional poverty rates. Extreme monetary poverty rates only differ slightly, being slightly lower in 2010/11 and slightly higher in 2013/14. The extent of agreement on poverty identification remains virtually equal in 2010/11 and becomes slightly weaker when it comes to identifying the extremely poor. In 2013/14, agreement increases slightly, but remains virtually equal for extreme poverty. Overall, the disagreement between both measures remains similarly large.

The fit of the models used to estimate marginal effects on the risk of poverty of a range of poverty determinants, according to percentage of correctly predicted, increases significantly. The disparity between estimated effects of rural location on monetary and multidimensional poverty becomes even stronger, while the mitigating effect of household size on the risk of multidimensional poverty becomes negligible. Also, the effects of the household head having completed primary school, secondary school, or more than secondary school significantly loses in strength. The estimated effect of unemployment of the household head, in contrast, becomes statistically significant and positive with a strength of 3–5%. Lastly, the estimated mitigating effect of consumption decreases by nearly 5%.

Thus, using a different *School Attainment*-deprivation threshold seems to make a difference when it comes to examining poverty risk factors. However, the finding of a relatively large disparity between the effect of rural location on the risk of being monetary poor

and multidimensionally poor, respectively, as well as the finding of a relatively weak link between consumption and the risk of multidimensional poverty seem to be more robust.

Finally, employing different extreme multidimensional deprivation thresholds leads to significantly higher extreme poverty estimates in 2010/11, but only a minimal increase in 2013/14. In all cases, extreme multidimensional poverty rates remain significantly higher than monetary poverty rates, confirming the findings from the original analysis. Agreement on identifying the extremely poor slightly increases in 2010/11, but this seems to be mainly due to the overall higher extreme multidimensional poverty estimates. In 2013/14, the extent of agreement barely differs. Thus, the original findings of large disagreement on identifying the extremely poor seem to be robust to using different extreme multidimensional poverty thresholds.

Overall, with the exception of the magnitude of the estimated marginal effects of some poverty risk factors, our results seem to be robust to a variety of measurement modifications.

6 Conclusion and Implications

What do our findings imply for policy-makers and future research on poverty? Exclusively using monetary indicators for poverty measurement in the context of a low-income country like Rwanda has a serious risk of underestimating the multi-faceted poverty and its change over time. In Rwanda, using a monetary measure alone would not have been sufficient to adequately capture the high incidence of multidimensional poverty in both 2010/11 and 2013/14. It would also not have recognized significant progress made in the reduction of multidimensional poverty over time, thus sending inaccurate signals to policymakers regarding the optimal design of social policies as well as monitoring their effectiveness. Finally, exclusive reliance on monetary measures risks placing emphasis on factors dealing with which may not move us beyond temporarily boosting the incomes or consumption of poor households.

This study has several limitations. First, while disparities found in Rwanda may allow for cautious generalizations in the East African context, generalizations beyond this region should not be made unless the context is verified to be similar. Second, we assigned equal poverty status to all household members. Even though this might be justified for the reasons stated above, it might be problematic because it does not account for potential intra-household inequalities (Levine et al. 2012; Alkire and Santos 2014). For instance, there can be gender disparities within households regarding access to resources or access to education. Furthermore, in foster families orphaned children might be treated differently than biological children. Finally, domestic workers in Rwanda often live in their employer's household and are thus considered to be household members in EICV, but they might not enjoy the same standard of living.

Third, we replaced original MPI indicators in the health dimensions—child mortality and malnutrition—with *Disability* and *Health Functioning*. This choice was largely motivated by data availability. Disability does represent a health deprivation with negative consequences for capabilities, not only for affected individuals themselves, but also for their relatives. However, it can represent a rather uncommon form of deprivation. Also, our dataset does not allow to account for more common forms of health deprivation such as malnutrition. Furthermore, deprivation in health functioning, as measured in this study, might not be a form of deprivation disproportionately affecting the poor. In addition, neither indicator

accounts for total health functioning failure in the way child mortality does (Alkire and Santos 2014).

Finally, we mainly examined poverty in the form of headcounts, but these may not necessarily account for the depth of poverty, its intensity, or distributional inequalities among the poor. In addition, given the limitations of our data in terms of the time dimension we were able to examine only aggregate poverty trends, yet this does not yield much information about transitions of households in and out of poverty. Comparing the volatility of monetary and multidimensional poverty measures over time was thus not possible and the argument that multidimensional poverty measures more reliably account for the duration of poverty could not be tested.

Areas for future research include improving methods to account for intra-household disparities, expanding the scope of multidimensional poverty measures beyond basic capability dimensions, refining the choice of intra-dimensional indicators and providing data necessary for constructing more valid indicators. Finally, more research is needed on measuring and accounting for the duration of poverty and poverty dynamics over time.

Despite remaining challenges to measuring poverty, multidimensional poverty measures should soon end the global dominance of standard monetary measures, such as the global poverty line of $1.90 a day. Multidimensional measures are at least as practical and comparable across countries, but more solid in terms of accurately accounting for the nature of poverty.

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