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Individual's risk attitudes in sub-Saharan Africa: Determinants and reliability of self-reported risk in Burkina Faso

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Abstract

Understanding individual risk taking is an important topic in Africa, as access to financial institutions and social security is scarce, and where markets and government policies largely fail to understand investment decisions of poor households. Data on risk attitudes in Africa is limited and the available data collected might not be reliable. We investigate the determinants of risk attitudes in different domains and the reliability of survey data in a sub-Saharan African country, Burkina Faso, using a large representative panel survey of 31,677 individuals from 10,800 households. Our results show that determinants such as individual's sex and age are significantly associated with willingness to take risk. Reliability differs across determinants of risk taking and risk domains. Women, older individuals or those with high education have more reliable risk measures compared to men, younger individuals or people with low education. Risk taking in traffic has the highest test-retest reliability followed by willingness to take risk in general and financial matters.

Keywords: Risk attitudes; determinants of risk taking; test-retest reliability; Burkina Faso.

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1. Introduction

Willingness to take risk is an important factor in almost every economic decisionmaking, as individual risk attitudes are a core determinant of economic behavior. Individuals in sub-Sahara Africa are exposed to a countless of different negative events, such as the risk of climate change and drought, risk of diseases, or that they live in countries where institutions and government policies fail to protect them from such risk. Thus, risk taking is particularly an important topic in sub-Saharan Africa because access to financial institutions and social security is scarce or underdeveloped (e.g., Obeng-Odoom 2017; de Walque 2013). As the institutions are still underdeveloped, individual's unwillingness to take risk by not starting an entrepreneurial venture or seeking other occupation opportunities may make poverty more persistent in sub-Saharan African countries, such as Burkina Faso which is considered one of the most economically underdeveloped countries in the world. Thus, understanding and predicting individuals risk attitudes becomes important for understanding decisions of poor households, such as why individuals venture into new occupations (Bonin et al., 2007) or invest in new upcoming opportunities (Guiso and Paiella, 2005) which increase the mobility in the labor market. For instance, individuals with a lower willingness to take risk (in other words, those who are more risk-averse) are less likely to be self-employed and countries with higher aggregate risk aversion have a lower total factor productivity (Dohmen et al., 2011).

There is an emerging line of research focusing on providing information on individual's risk attitudes in sub-Sahara Africa, such as in Northern Ethiopia (Yesuf and Bluffstone, 2009), rural Uganda (Tanaka and Munro, 2013) and cattle farmer societies in Mali and Burkina Faso (Liebenehm and Waibel, 2014). However, the shortcoming of this emerging line of research is that the available data collected might not be reliable, due to small sample size, restricted geographic variation and or lack of panel structure.

In this study, we address all these shortcomings and discuss the main methodological requirements for an empirical research agenda on risk preferences: validated measures of risk preferences and a strict definition of what it means when preferences are stable. In economics, this definition implies that individual risk attitudes are constant over time.

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We have collected the same type of risk measurement, as used in previous research.¹ We capture risk attitudes in general, traffic and financial matters for a panel of 31,677 individuals from 10,800 households in Burkina Faso. The large sample size provides the necessary statistical power for analyzing the determinants and the test-retest reliability of risk attitudes by dividing the sample into different subgroups. The large sample size also has additional benefits by decreasing the probability of Type I and Type II errors, which is detrimental when making inference.

This paper contributes at multiple levels to the emerging line of research on individual's risk attitudes in sub-Saharan Africa. The first contribution of this study is to replicate the findings of previous literature, such as Dohmen *et al.* (2011) and Hardweg *et al.* (2013), but with a large nationally representative sample in a sub-Saharan African country, which increases the precision of our results. Our main results about the determinants of risk attitudes are in line with the previous studies both in developed and emerging countries (ibid), which increase the external validity of our results. Gender and age are important determinants for willingness to take risk in general, traffic and financial matters. Individuals own level of education tends to be much more important in financial matters, than in traffic and general risk attitudes. Parent's literacy determines risk taking in general and traffic. We also find that our risk measures predict risky behavior such as self-employment and smoking.²

Second, the findings of this study contribute to the recent integration of individual-difference psychology into economics (Borghans *et al.*, 2008; Almlund *et al.*, 2011), where the argument is that risk attitudes are domain-specific (e.g., Weber *et al.*, 2002). Women (and older individuals) are less willing than men (and younger individuals) to take risk in traffic compared to in general and financial matters.

Third, this study makes a unique contribution to the literature by analyzing the test-retest reliability of three self-reported risk questions in a large nationally representative panel survey in Burkina Faso. Although previous findings all indicate a high validity for survey measures concerning risk attitudes, there are no studies in developing countries focusing on the reliability of self-reported risk

¹ Such as in Dohmen *et al.*, 2011; Hardeweg *et al.*, 2013; Lönnqvist *et al.*, 2015; Vieider *et al.*, 2015; Beauchamp *et al.*, 2017; Jin *et al.*, 2017.

 $^{^{2}}$ Our results are in line with previous research using the same self-reported risk questions (e.g., Dohmen *et al.*, 2011) and show that these risk measures have a behavioral validity. Results available upon request.

attitudes.³ The importance of understanding how reliable a survey measurement is has to do with the overall consistency of the instrument: does it produce similar results under consistently applied conditions? Or are the obtained scores due to randomly occurring factors like seasonality or current event, and measurement error (Marczyk *et al.*, 2005)? Hence, reliability of risk preferences is an important empirical question, that economist have only recently begun to address. To the best of our knowledge, there are only three studies that examine whether self-reported willingness to take risk are reliable (Lönnqvist *et al.*, 2015; Dohmen *et al.*, 2016; Beauchamp *et al.*, 2017).⁴ Our results show that women (older individuals and high educated) have more reliable risk measures than men (younger individuals and low educated). Reliability differs across domains; risk taking in traffic has the highest test-retest reliability followed by willingness to take risk in general and financial matters.

Fourth, there are two important implications for measuring risk attitudes in a sub-Saharan African country. First, risk, in general, could be used as a proxy for other risk domains, but it is less precise in predicting risk taking in other domains. We recommend having a domain-specific risk question if the research question depends on it. Second, this study provides an important pathway for researchers who would like to focus on individual's risk attitudes but have scare resources to collect an incentivized risk measurement. Self-reported risk not only have a high validity, as previous research have showed, but as this study shows the reliability is also satisfactory. This is in particular important for sub-Saharan African countries, as it becomes possible to capture individual's economic behavior through surveys, instead of investing great resources in designing and collecting incentivized risk measurements.

All in all, this illustrates the importance of reliability and reproducibility of scientific findings (Dreber *et al.*, 2015; Camerer *et al.*, 2016) by using and analyzing the same measures as previous literature.

³ The validity of the same self-reported risk measures that we use has been proven to capture individuals risk preferences by comparing them to incentivized lottery type field experiments, in developed countries (e.g., Dohmen *et al.*, 2011; Lönnqvist *et al.*, 2015), emerging countries (e.g., Hardeweg *et al.*, 2013), developing countries and comparatively for 30 countries (Vieider *et al.*, 2015).

⁴ The are other studies that have also attempted to address the reliability of risk question over time with different risk measurements than ours, such as a typical multiple price list (Andersen *et al.*, 2008 [n=97]), gain/loss lotteries (Zeisberger *et al.*, 2012 [n=86]), hypothetical income gambles (Barsky *et al.*, 1997 and Kimball *et al.*, 2008 [n=693]) and different types of self-reported risk question than ours (1-5 scale, with different random ordering of scales) over time (Weber *et al.*, 2002 [n=121]). However, the studies that found reliability results that are more than only moderately stable over time, are those that use the same self-reported willingness to take risk question as in this paper. These findings support the use of this observed risk measure for the underlying objectively measurable risk attitudes.

2. Validity and stability of risk preferences

In recent years, with the emerging interest in risk taking, economists have started to examine the validity of their measures of risk preferences. This implies that economists no more assume but instead investigate if the commonly used measures of risk preferences are internally valid and have an external or behavioral validity. Risk measurements aiming to capture risk preferences have a behavioral validity if they capture actual risky behaviors. For instance, Dohmen et al. (2011) indicate that their self-reported risk preferences predict risk taking behavior (e.g., self-employment and smoking). Other studies also show that these same types of risk measurements are reliable predictors of actual risk taking in incentivized lottery experiments across the world (e.g., Dohmen et al., 2011; Hardeweg et al., 2013; Lönnqvist et al., 2015; Vieider et al., 2015). Measured risk preferences are internally valid if different ways of measuring risk preferences have the same underlying risk preferences and offer a coherent explanation of the same individual. For instance, recent studies about developed (Dohmen et al., 2011) and developing (Yesuf and Bluffstone, 2009) countries indicate that individual characteristics such as gender, parental education, own education, and age are important determinants of risk attitudes, irrespective of ways of measuring risk preferences, such as self-report measures or experimental measures.

In economics, stability of (risk) preferences is defined as the fact that individual risk preferences are constant over time, as opposed to stability of the distribution of preferences, in a given population. This definition implies that the same willingness to take risk should be observed when measuring an individual's risk preferences repeatedly over time, given that there is no measurement error. Therefore, if one were to observe changes in risk measures over time, the standard approach in economics has been to assume that this is due to measurement error, hence it considers these changes to be nothing more than noise. The common method to test the definition of preference stability is by analyzing the test-retest reliability of the measured risk preferences. If reliability is low, the risk measure does not provide an accurate assessment about the risk preferences we want to capture, which implies that measurement error might be high.

However, with insight from behavioral economics and psychology (Almlund *et al.*, 2011; Borghans *et al.*, 2008), recent empirical economic studies have suggested that individuals' risk preferences are domain-specific (e.g., Weber *et al.*, 2002).

3. Data description

Our study is based on a multipurpose Household Budget Survey (HBS). The HBS is a face-to-face, nationally representative panel survey covering 10,800 households spread across the 13 regions of Burkina Faso. The main purpose of the HBS is to evaluate whether Burkina Faso has achieved the UN millennium goals, which is why each household is interviewed in four rounds during 2014. The HBS surveys the head of each household in the sample. It also surveys all other members present in the household at the time of the interview and collects demographic information for the remaining non-present members at the time of the interview. The HBS has an overall household response rate of approximately 95 per cent for the third and fourth round respectively, which gives us a low level of attrition.

This study focuses on three different risk questions in the HBS that directly ask the respondent to assess his or her willingness to take risks in traffic, in financial matters and in general. We have adopted the same self-reported risk questions from the German Socio-Economic Panel (SOEP), which has been used extensively in previous studies and have also been empirically validated through field experiments as being a fruitful way of eliciting a reliable measurement of risk preferences. The risk attitudes have been collected in the third and fourth rounds of 2014 as a separate module for all household members who were 18 years and older. The exact English wording of the questions is as follows: "How do you see yourself: Are you a person who is fully prepared to take risks or do you try to avoid taking risks? On a scale from 1 to 10, where 1 = not at all willing to take risk and 10 = very willing to take risk. A. In traffic (driving a car, motorcycle, bike, etc.), B. In financial matters, C. In general?"

4. Descriptive statistics and contribution factors concerning risk attitudes

Figure 1 shows the distribution of risk attitudes in traffic, financial matters and in general for our sample. The black bars in the histograms show the responses for the third round of the survey, while the grey bars show the responses for the fourth round on an ordinal scale from 1 to 10. Figure 1 shows a reassuring fact: unlike most ordinal scale question responses, the three risk questions are not centered in the middle,⁵ which suggests that the respondents have understood the question and are not indifferent to the scaling. Recent empirical literature

⁵ Similar studies on risk attitudes have around 22 per cent of respondent's responses centered in the middle for developed countries (Dohmen *et al.*, 2011) and 40 per cent for emerging country (Hardeweg *et al.*, 2013).

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suggests that (poor) households in developing countries are reluctant to invest in new technologies due to their risk aversion (Tanaka et al., 2010), and indicate that individuals from sub-Sahara Africa are on average less willing to take risk (Yesuf and Bluffstone, 2009) compared to developed countries (Dohmen et al., 2011). However, there exist previous research that also predicts the reverse, that individuals from sub-Sahara Africa are not more risk-averse (e.g., Wik et al., 2004) compared to developed countries (e.g., Holt and Laury, 2002). The reason for this inconclusiveness has been due to lack of statistical power, and only focusing on the financial risk domain. Figure 1 shows considerable heterogeneity in risk attitudes across the three risk domains. We see that the respondents are much more risk-averse in their attitudes toward traffic than financial matters or in general, as indicated by the fact that the bars are much higher to the left side of the diagram. One reason could be that taking risk in traffic has more severe consequences than taking risk in financial matters. This interpretation is supported by a mean value of 3.32 (3.31) in traffic for the third round (fourth round), while the mean values for financial and general are higher: 4.65 (4.70) and 4.06 (4.02). Moreover, in the figure we see that the responses between the third and the fourth round have a similar distribution.



FIGURE 1: WILLINGNESS TO TAKE RISKS AT TWO TIME PERIODS

Note: On the x-axes, we have the response to the risk questions on a scale from 1 to 10, where 1 = not at all willing to take risk and 10 = very willing to take risk in the third and fourth round. On the y-axes, we see the fractions.

4.1. Descriptive statistics of self-responses concerning risk

We now turn to a first descriptive look on self-assessments of risk attitudes and different individual characteristics, as illustrated in Table 1.⁶ We classify these characteristics into six different groups, influenced by Hardeweg *et al.* (2013): demographic characteristics and parental background, economic status, family structure, employment status, subjective attitudes and, finally, health status. In the risk literature, most of these characteristics are considered endogenous with respect to risk attitudes, although it has been argued that the demographic characteristics are largely exogenous (e.g., Dohmen *et al.*, 2011; Hardeweg *et al.*, 2013). Nevertheless, the focus of this study is not to causally estimate risk attitudes, it is rather to analyze whether associations of risk attitudes with regard to individual characteristics have the same expected sign as in previous studies. limitations of the study is that we did not verify whether multiple entrepreneurs owned the business.



FIGURE 2: DIFFERENCES BETWEEN RISK ATTITUDES IN TIME

Note: On the x-axes, we have the difference between round 3 and 4 for individual responses to each risk question. The y-axes represent the response rate in per cent.

The demographic characteristics are age and sex of respondents. Willingness to take risk has been shown to decrease with age (Tanaka *et al.*, 2010). However, there are few representative surveys large enough to break down risk attitudes by age groups. In the HBS, risk attitudes in the two time periods on average have a negative association with age, implying that, on average, the older the

⁶ For a more detailed description of the variables in Table 1 and for the risk domains of traffic and financial matters see Sepahvand and Shahbazian (2017), where the relationship with regard to willingness to take risk is on average similar to general risk taking.

individual, the lower the values of self-reported risk preferences. Most previous literature indicates that women are more risk-averse than men (Donkers *et al.*, 2001; Weber *et al.*, 2002; Croson and Gneezy 2009; Dohmen *el al.*, 2011; Hardeweg *et al.*, 2013; Beauchamp *et al.*, 2017), whereas others do not find any difference (Kruse and Thompson 2003; Harrison *et al.*, 2007). The descriptive statistics in Table 1 show sex heterogeneity when it comes to self-assessment of risk attitudes: women's willingness to take risk seems to be lower than that of men. Dohmen *et al.* (2011) find a positive relationship between parental education and willingness to take risks. Approximately 18.5 per cent of the cases in the sample have a father who is literate.⁷ Having (or having had) a literate father, compared to having an illiterate father, seems to be positively related to a willingness to take risk.

Economic status may confound some of the associations of age, gender and parental background, which have been said to be largely exogenous. This is due to the fact that economic status might influence life expectancy, sex composition and parents' socio-economic background. We use several indicators for economic status: household consumption, human capital, having experienced food shortage and having access to a bank account. Table 1 shows that human capital, having experienced food shortage and having a bank account are important indicators for risk attitudes. Individuals with the highest level of education (university) compared to low/no education, seems to be more willing to take risks; this is also noticeable with regard to having a bank account. Having experienced food shortage during the last 12 months seems to be negatively related to a willingness to take risk.

Family structures have been hypothesized to impact risk attitudes; being married, for instance, is associated with risk aversion (Liebenehm *et al.*, 2015).⁸ We include one factor within family structure: individuals' civil status. Being a widower seems to decrease respondents' risk attitudes.⁹

There is no doubt that certain occupations are riskier than others. Occupational risks may be measured in different ways, such as the type of health hazards and in terms of economic risks (Bonin *et al.*, 2007). In this study, we use occupational information. However, since a large majority of the respondents

⁷ In those instances where there is a missing value on father's literacy (which is more common for the older respondents), we have coded them as having a father who is (was) illiterate.

⁸ Miyata (2003) finds co-residence (i.e., in our case being married) being important for risk aversion as it is considered a type of security blanket.

⁹ Sepahvand and Shahbazian (2017) show that singles take more risk in traffic.

work in agriculture, we also include the number of hours worked in the last seven days. Those who work more hours seem to report a higher willingness to take risk.

	Obs.	%		
			Gener	al risk
			Ro	und
			3	4
General	31,677	100	4.06	4.02
Sex				
Female	18,210	57.5	3.63	3.53
Male	13,467	42.5	4.64	4.70
Age				
18–29	11,907	37.6	4.16	4.19
30–39	7,294	23.0	4.31	4.27
40–49	4,932	15.6	4.18	4.15
50-59	3,515	11.1	3.91	3.83
60+	4,029	12.7	3.29	3.09
Father's literacy				
Literate	5,859	18.5	4.78	4.92
Illiterate	25,818	81.5	3.91	3.82
Education level				
Low/no	24,281	76.7	3.96	3.89
Primary	3,344	10.6	4.48	4.51
Secondary	3,624	11.4	4.32	4.39
University	428	1.4	4.46	4.55
Food shortage				
Yes	18,049	57.0	3.98	3.85
No	13,628	43.0	4.16	4.26
Bank account				
Yes	3,468	11.0	4.62	4.67
No	28,209	89.0	3.99	3.95
Family structure				
Single	5,705	18.0	4.37	4.43
Married	23,326	73.6	4.09	4.03
Divorced	363	1.1	3.79	3.94
Widowed	2,283	7.2	3.05	2.93

TABLE 1: DESCRIPTIVE STATISTICS

Employment sector				
Food Farming	21,080	66.5	4.06	4.00
Export & Ind. Farming	715	2.3	4.64	4.75
Breeding	313	1.0	4.31	4.38
Industry	653	2.1	4.13	4.12
Commerce	2,257	7.1	4.17	4.22
Manufacturing	308	1.0	4.34	4.54
Other occupation	2,736	8.6	4.54	4.62
No occupation	3,615	11.4	3.42	3.35
Hours worked during past week				
0 hours	3,647	11.5	3.43	3.37
1–20 hours	1,809	5.7	3.91	3.87
21–30 hours	4,176	13.2	3.87	3.91
31–40 hours	6,633	20.9	4.04	4.00
41–50 hours	8,563	27	4.18	4.18
50+ hours	6,849	21.7	4.41	4.32
Subjectively poor				
Yes	19,298	61.0	3.98	3.94
No	12,379	39.1	4.19	4.15
Sick				
Yes	6,368	20.1	3.97	-
No	25,309	79.9	4.08	-

Note: Shows number of observations, share of total observations and mean for general risk attitude and individual characteristics for rounds 3 and 4. The variable Sick has not been collected for the fourth round. In addition to these descriptive statistics, the Spearman rank correlation between the variable and the general risk attitude shows that coefficient for all of these variables are statistically significant (results available upon request).

4.0

96.0

3.51

4.08

3.48

4.05

1,269

30,408

We also consider subjective attitudes toward own poverty. Table 1, on average shows a seemingly negative relationship with regard to willingness to take risk throughout all risk attitudes and among those who consider themselves as poor. Last, we have indicators on health status. The first indicator is whether or not the individual has been sick during the past 15 days. The second indicator is whether or not the individual has a disability of any sort (such as being blind, deaf or having reduced physical ability, mental disability, etc.). We see that both health indicators constitute a small part of the sample. Those who are sick or have a disability report a lower willingness to take risk.

Disability Yes

No

4.2 Association between risk attitudes and individual characteristics

We estimate our regressions using ordinary least squares (OLS) models and report robust standard errors that allow for clustering at the household level. These panel data regressions are based on 31,677 individuals from 10,800 households that we follow during the two survey rounds. The results of our regressions confirm the relationships from our descriptive statistics in Section 4.1 and allow us to see if the interpretation of these regression estimates is in accordance with previous literature.¹⁰

Table 2 show the coefficient estimates for general, traffic and financial risk attitudes as the dependent variables. The four model specifications, as shown by models (1) to (4), use the average risk attitudes for the two survey rounds. Models (1) and (2) in Table 2 use sex and age as exogenous explanatory dummy variables with respect to risk attitude. The estimates show that the results remain robust across model specifications. Women are significantly less willing to take risks in general, and when breaking down risk attitudes by age groups, the results show that the older the individual, the more risk-averse. The same trends are also shown for willingness to take risk in traffic and financial matters for models (1) and (2) in Table 2. Moreover, model (3) includes a binary variable for whether or not the respondent's father is (was) literate. Having a literate father increases individuals' willingness to take risks in general, traffic and financial matters compared to having a father who is not literate. As shown in Table 2, the effect is significant. Model (4) show the result when including all other control variables in order to check the robustness of our estimations. The result shows that individuals' own level of education (binary variable) does not seem to be an important predictor for risk attitudes in traffic and in general. However, there is a negative association between educational level and financial risk attitudes: individuals with higher levels of education tend to be less risk taking than those with no education ¹¹

To summarize: we see that women are significantly less willing to take risk in all three risk domains compared to men, with somewhat less risk taking attitude in traffic. Furthermore, higher age results in a lower willingness to take risk. Literate fathers in Burkina Faso have a positive and significant impact on willingness to take risk with a stronger effect in traffic. Previous literature

¹⁰ Interval, binary and Ordered Probit regression gives similar results, available upon request.

¹¹ Sepahvand and Shahbazian (2017, 2020) show that it exist a domain dependent variation. The correlations are between 0.5 and 0.7 across the three risk domains.

		Gen	eral			Tra	ffic			Fina	incial	
	M1	M2	M3	M4	M1	M2	M3	M4	M1	M2	M3	M4
Female	-1.09***	-1.12***	-1.02***	+**/0-0-	-1.31***	-1.35***	-1.23***	-1.20***	-1.08***	-1.11***	-1.06***	***0-0-
Ref: 18–29 years	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
30–39 years		0.09^{**} (0.03)	0.10^{**} (0.03)	0.06^{**} (0.03)		-0.16*** (0.03)	-0.15^{**} (0.03)	-0.07*** (0.03)		0.30^{***} (0.03)	0.30^{***} (0.03)	0.15^{**} (0.03)
40-49 years		-0.04 (0.03)	-0.02 (0.03)	-0.04 (0.03)		-0.41*** (0.03)	-0.38*** (0.03)	-0.28*** (0.03)		0.19^{***} (0.03)	0.20^{***} (0.03)	0.06 (0.03)
50-59 years		-0.36*** (0.03)	-0.34*** (0.03)	-0.32*** (0.04)		-0.72*** (0.03)	-0.69*** (0.03)	-0.57*** (0.04)		-0.25*** (0.04)	-0.23*** (0.04)	-0.32*** (0.04)
60+ years		-1.06*** (0.03)	-1.02*** (0.03)	-0.86*** (0.04)		-1.34*** (0.03)	-1.30*** (0.03)	-1.12*** (0.04)		-1.19*** (0.04)	-1.17*** (0.04)	-0.99*** (0.05)
Ref: Illiterate, Father			0.25***	0.17***			0.29***	0.17^{***}			0.14^{***}	0.06
Literate, Father			(0.04)	(0.04)			(0.04)	(0.04)			(0.04)	(0.04)
Ref: Low/no education Primary level				0.11^{***} (0.04)				0.10^{**} (0.04)				0.11** (0.04)
Secondary level				-0.08* (0.05)				0.00 (0.05)				-0.15*** (0.05)
University level				-0.16 (0.13)				0.05 (0.14)				-0.31** (0.13)
Additional controls	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes
Constant	4.67*** (0.02)	4.84^{**} (0.03)	4.73*** (0.03)	3.83*** (0.51)	4.06*** (0.02)	4.44** (0.03)	4.30^{**} (0.03)	7.19^{***} (0.49)	5.30*** (0.02)	5.40*** (0.03)	5.33*** (0.03)	4.09^{***} (0.51)
Observations	31,677	31,677	31,677	31,620	31,677	31,677	31,677	31,620	31,677	31,677	31,677	31,620
R-squared	0.084	0.123	0.125	0.143	0.124	0.182	0.185	0.212	0.076	0.130	0.131	0.168
Note: Shows coeffi	cient estin	nates (OL	S) for risk	attitudes	in general	, traffic a	nd financi	al matters.	Models ((1) to (4)	use the av	erage risk

TABLE 2: PRIMARY DETERMINANTS OF RISK ATTITUDES IN GENERAL, TRAFFIC AND FINANCIAL MATTERS

attitude between round 3 and 4 as the dependent variable. The dependent variable is measured on a scale from 1 to 10. Additional controls include indicator variables on economic status, family structure, employment status, subjective attitudes, health status, and weekly time dummy variables. The Consumption controls (within economic status) are in logs. For more information about the controls, such as coefficient and significance see Sepahvand and Shahbazian (2017) Tables A1-A3. Robust standard errors in parentheses are clustered at the household level. *p < .10, **p < .05, ***p < .01. Not

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finds a less consistent relationship between German father's education and risk attitudes across domains (e.g., Dohmen *et al.*, 2011), which could be related to that risk domains are gendered in Burkina Faso. The relationship between the level of education and risk attitudes in financial matters shows a pattern toward a lesser willingness to take risk as the level of education increases. Previous studies from rural areas (Hardeweg *et al.*, 2013) and other sub-Saharan African countries with smaller samples sizes (Yesuf and Bluffstone, 2009) do not find statistically significant relationships between years of education and literacy related to risk taking. However, using nationally representative German data, Dohmen *et al.* (2011) find the same pattern like ours, the higher education the individuals are enrolled in, the lesser willingness to take risk in financial matters. Thus, we see that these factors are important in determining willingness to take risk, also when we add all of the controls.

5. Reliability of risk measurements

Reliability is defined as the consistency of individual's answers to an instrument across measurement occasions (e.g., Beauchamp et al., 2017). It is typically assumed that experiment and survey measures capturing risk preferences are reliable, i.e. that their results are reproducible and measurement error is small. Previous findings on self-reported risk question have been able to find important insights about individual's risk attitudes¹², but they have lacked the sample size, geographic variation and or panel structure to test and analyze the reliability of risk attitudes. This implies that the actual reliability of risk measurements is largely unknown. Knowledge about reliability is important. Whether or not a measurement is reliable is a crucial element in any sort of inference, as we as researchers want to be able to suggest that our findings constitute evidence of a relationship between two phenomena. One common approach of measuring reliability is by asking the same individual the same question repeatedly within a set time period and then analyze the difference between his or her responses, which is also known as a test-retest analysis. If reliability within a given domain is low, elicited risk preferences through one measurement cannot be expected to provide us with accurate assessments about the risk preferences we want to capture (Wölbert and Riedl, 2013).

In this study, we present two different measurements of the test-retest reliability. First, a Pearson correlation, which assumes that the risk measurements are

¹² Such as Weber *et al.*, 2002; Caliendo *et al.*, 2009; Bonin *et al.*, 2007; Ding *et al.*, 2010; Hanoch and Gummerum, 2010; Liebenehm *et al.*, 2015; Vieider *et al.*, 2015; Highhouse *et al.*, 2016; Jin *et al.*, 2017.

continuous and has been used previously by Dohmen *et al.* (2016) and Lönnqvist *et al.* (2015). Second, a test-retest measurement obtained through deriving the polychoric correlation.¹³ Since our risk variables are measured on an ordinal scale, the polychoric correlation is preferred over the Pearson correlation, the former has also been used previously by Beauchamp *et al.* (2017). If the correlation is high, then the measurement has a high level of reliability.

5.1. Test-retest reliability results

Panel A in Table 3 shows the estimates for our two test-retest reliability measurements and their corresponding 95 % confidence intervals in the domain of general, traffic and financial matters. First, we see that the values for the Pearson and polychoric correlations are quite close. Second, both correlation measurements show the same pattern: the highest correlation is obtained for traffic, then in general and finally in financial matters. We also observe the preciseness of our estimates indicated by the 95% confidence intervals. As a robustness check, we drop observations with an extreme difference between their answers in round 3 and 4 (i.e., the responses that differ more than five scale points in absolute values¹⁴), as shown in Panel B in Table 3. We see that our test-retest reliability measures increase in magnitude even though the pattern is the same, where taking risk in traffic or in general give the highest scores.¹⁵

We have only been able to find three previous studies performing test-retest reliability analysis for similar risk measurements: i.) Dohmen *et al.* (2016) use the German Socio-Economic panel data with a test-rest sample size of 300 individuals, ii.) Beauchamp *et al.* (2017) use the Swedish Twin Panel Survey with approximately 494 individuals, which is also the only previous study so far to use polychoric correlation for our kind of risk measurements, and iii.) Lönnqvist *et al.* (2015) which uses a panel survey from laboratory experiments with a sample size of 44 individuals. The results of these three studies are illustrated in Table 4.¹⁶ To begin with, Beauchamp *et al.* (2017) report a correlation of 0.63 for the willingness to take risk in general for a sample of Swedish twins,

¹³ The term polychoric correlation refers to all correlations based on ordinal variables that measure an (assumable) continuous underlying variable. In our case, we asked respondents to self-assess their risk attitudes on a scale from 1 to 10. However, risk attitudes may be considered continuous in nature.

¹⁴ Correspondence to approximately 5.8 per cent of the sample size.

¹⁵ We delve deeper into the characteristics of these observations with extreme differences in round 3 and 4 as a robustness check in order to understand the stability of our test-retest results. Results available upon request.

¹⁶ There are studies that look at the stability of incentivized risk preferences, such as lottery and/or experiments (for a literature overview, see Chuang and Schechter, 2015). However, since the focus of this study is on self-reported risk attitudes, we only include studies with an approach similar to ours.

whereas we obtain a correlation of 0.53. The test-retest coefficient obtained by Dohmen *et al.* (2016) for the willingness to take risk, in general, is 0.61. Lönnqvist *et al.*, (2015) obtained a much higher value: 0.77. When comparing our result for willingness to take risk in traffic with that of Lönnqvist *et al.* (2015), there is no difference for the polychoric correlation; whereas we get a Pearson correlation of 0.51. Our result for willingness to take risk in financial matters is 0.48 (Pearson corr. 0.45), 0.55 for Lönnqvist *et al.* (2015) and 0.67 for Beauchamp *et al.* (2017).

Overall, as indicated in Table 4, our results are somewhat lower than the previous studies, but we do not detect any large differences between the test-retest analyses for our sample compared to the previous results. There are several reasons as to why the results of the previous studies are somewhat higher than ours. Our sample is a representative sample of the population, while the previous studies have used samples that may be more homogeneous, such as twin studies, students or pilot studies. This is also evident when comparing a more homogenous part of our sample (Panel B, Table 3) with previous studies. The fact that we examine a developing country (which has a lower level of education) may also affect the results.

	Polychoric	Pearson	Observations			
	Panel A. All responses					
General	0.53	0.50	31,677			
95% C.I.	0.52–0.53	0.49–0.50				
Traffic	0.57	0.51	31,677			
95% C.I.	0.56–0.57	0.50–0.52				
Financial	0.48	0.45	31,677			
95% C.I.	0.47–0.49	0.44–0.46				
	Panel B	. Responses within 5 sca	ale points			
General	0.60	0.56	31,050			
95% C.I.	0.59–0.60	0.55–0.57				
Traffic	0.64	0.59	30,961			
95% C.I.	0.63–0.64	0.58–0.59				
Financial	0.58	0.55	30,666			
95% C.I.	0.57–0.58	0.54–0.55				

TABLE 3: ESTIMATES OF TEST-RETEST RELIABILITIES FOR RISK ATTITUDES

Note: Shows test-retest reliability estimates and their corresponding 95% confidence interval for risk taking in general, traffic and financial matters. Panel A shows the test-retest estimates for the whole sample and Panel B shows the restricted sample where we have removed the extreme values within each risk domain and only look at those individuals that have an absolute difference of 5 scale points between round 3 and 4.

	General	Traffic	Financial	n	Method	
Burkina Faso	0.53	0.57	0.48	31,677	Polychoric	
Burkina Faso	0.50	0.51	0.45	31,677	Pearson	
Beauchamp <i>et al.</i> (2017)	0.63		0.67	494	Polychoric	
Dohmen <i>et al.</i> (2016)	0.61			300	Pearson	
Lönnqvist <i>et</i> al. (2015)	0.77	0.57	0.55	44	Pearson	

TABLE 4: TEST-RETEST RELIABILITIES FOR RISK ATTITUDES, COMPARISON WITH PREVIOUS STUDIES

Note: Shows the test-retest reliability estimates from previous studies compared to our results from the whole sample for risk attitudes in general, traffic and financial matters.

5.2. Test-retest reliability analysis across subgroups

As mentioned earlier, a strength of this study is its large sample size. Therefore, we are able to break down the sample into different subgroups in order to detect how the test-retest reliability is affected by the factors described in Section 4.1. Figure 3 and 4 visually illustrate the results of the test-retest reliability analysis.¹⁷

Figure 3 shows the test-retest analysis for women and men. We see that there is a significant difference (i.e., the 95 % confidence intervals do not overlap) between women and men for all three risk attitudes: the polychoric correlations are higher for women.

Figure 3 shows that there is no significant age-cohort effect on the test-retest estimates, which also do not exhibit any large differences for the polychoric correlations.

Figure 3 shows the test-retest analysis of the literacy of the respondents' father. Respondents with a literate father tend to have lower polychoric correlations than those with an illiterate father. However, the pattern is reverse when it comes to the individuals' own level of education; as shown in Figure 3, the correlation increases with the level of education. But as the confidence intervals overlap, we only see a significant difference in financial matters between those with low and the highest levels of education. Figure 3 shows a significant difference between those experiencing food shortage and those who do not: the polychoric correlations are higher for those with food shortage.

¹⁷ Detailed results about each figure is available upon request.

As shown in Figure 4, with regard to risk taking in general and traffic, having a bank account affects the test-retest estimates significantly compared to not having access to a bank account. Figure 4 shows a significant difference in the test-retest estimates between those not working and those working the most, above 50 hours per week.

To summarize: our results show that the reliability of risk measures are higher among women compared to men. Access to a bank account results in higher reliability compared to those without one. Level of education seems to also matter for the reliability of risk measures, as individuals with university degrees are more consistent in their responses across time compared to those with less education. This allows us to understand more about how reliability of risk measurements differ among subgroups, which could be an important input for future research when analyzing different type of subgroups risk taking.

Figure 3: Estimates of Test-retest Reliabilities for Risk Attitudes (polychoric correlation)









Note: Shows test-retest reliability estimates (polychoric) and their corresponding 95% confidence interval for risk taking in traffic (\blacksquare), general (\bullet) and financial matters (\blacktriangle) for the whole sample and different subgroups.

Figure 4: Estimates of Test-retest Reliabilities for Risk Attitudes (polychoric correlation)

















Note: Shows test-retest reliability estimates (polychoric) and their corresponding 9% confidencinterval for risk taking in traffic (\blacksquare), general (\bullet) and financial matters (\blacktriangle) for different subgroups.

6. Conclusion

In this paper, we have investigated individual's risk attitude in sub-Saharan Africa. We examined a large nationally representative sample of 31,677 individuals from 10,800 Burkinabe households with data collected on risk attitudes. We have made multiple contributions about the determinants of risk taking and the reliability of self-reported risk measures, in an effort to learn more about individual's risk attitudes in sub-Saharan Africa.

Our findings are in line with previous research about the determinants of risk attitudes (e.g., Dohmen *et al.*, 2011; Hardeweg *et al.*, 2013; Vieider *et al.*, 2015). We find that willingness to take risk is significantly associated with sex and age. Women tend to report to be less risk taking than men. Older respondents respond that they are less risk taking than younger respondents are. While other determinants, such as parents' (and own) level of education, economic status, health and/or marital status are also significantly associated with individuals' risk taking, their contribution as a determinant of risk attitudes are not as large as sex and age.

We find support for the argument that risk attitudes are domain-specific, which is in line with previous literature in economics and psychology (Weber *et al.*, 2002; Vlaev *et al.*, 2010; Highhouse *et al.*, 2016). For instance, women (and older individuals) are less willing than men (and younger individuals) to take risk in traffic than both in general and financial matters.

Estimating the test-retest reliability of 31,677 individuals self-reported risk measurements in general, traffic and financial matters, we find that the reliability

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of our measures is quite stable. Comparing our results to previous homogenous small-scaled studies from developed countries, we conclude that our results are somewhat lower than those found in Sweden (Beauchamp et al., 2017) and Germany (Dohmen et al., 2016; Lönnqvist et al., 2015). There are several reasons as to why our results are somewhat lower than previous studies. First previous studies have used more homogenous samples than our sample (such as twin studies, lab experiments with students and pilot studies). When restricting our sample to a more homogenous sub-sample, our results become similar, and in some instances have higher reliability scores than previous results (ibid). Another reason could be that we focus on a sub-Saharan African developing country, which has on average lower educational level than Sweden and Germany. Our large sample size makes this study unique, as it provides the statistical power necessary to analyze the reliability of risk measures for different sub-groups, such as sex, literacy, family structure and subjective attitudes but also economic, employment and health status. Our results show a higher level of reliability for women compared to men, university graduates than individuals with other educational attainments and those who have a bank account compared to those without one. Our findings do not exhibit any significant difference of reliability for subgroups such as different age groups, family structure, been sick during the last 15 days, having a disability of any sort or for different working hours.

Understanding how and why risk attitudes evolve over time will be a valuable input to the desirable properties of the reliability of risk attitudes. For instance, even though individuals' responses to risk questions are stable over time, there might exist changes in risk attitudes across measurement occasions that are not due to measurement error but rather other events, such as an exogenous shock.

Why is all this important? Well, almost every economic decision-making involves some degree of risk taking, yet it is only in recent years that economists have started to analyze the nature of individual's risk attitudes and how it should be measured. There are many different ways to eliciting risk preferences (for an overview see Charness *et al.*, 2013). There are those who argue that risk preferences should be elicited by incentive methods (e.g., Holt and Laury, 2002), since otherwise there is no incentive for individuals to reveal their true risk preferences. Self-reported risk question in surveys have been proven to capture individuals risk preference in developed countries (e.g., Dohmen *et al.*, 2011; Lönnqvist *et al.*, 2015), emerging countries (e.g., Hardeweg *et al.*, 2013), developing countries and comparatively for 30 countries (Vieider *et al.*, 2015). However, to the best of our knowledge, there are no studies in sub-

Saharan African countries focusing on the reliability of different self-reported risk attitudes. This study reduces the gap in the literature about the reliability of self-reported risk questions. Thus, there are two main suggestions for those interested in measuring risk attitudes in sub-Saharan Africa. First, the results of this study indicate that having a self-reported question about willingness to take risk, in general, could be a good proxy for other risk domains. But if the research question depends on it, then domain-specific risk measurements should be included. Second and most importantly, those researchers who would like to focus on individual's risk attitudes but have limited resources to collect an incentivized risk measurement could capture economic behavior through self-reported survey questions concerning risk. Self-reported risk not only has high validity, as previous research has shown, but as this study shows the reliability is also satisfactory.

From a policy perspective, understanding what determines risk attitudes could be important in sub-Saharan African countries for understanding the patterns of choices and investment decisions of households living in societies with underdeveloped institutions. For instance, our results about the correlation between father's literacy and their children's risk attitudes could help in designing education policies. Previous research indicates that education seems to make people in West Africa to be more open towards taking up risky opportunities (Liebenehm and Waibel, 2014). However, more understanding is need about the existence of intergenerational transmission of risk attitudes. Moreover, in a sub-Saharan African country like Burkina Faso with a large share of its population being below 20 years old, will lead to a more liberal group of voters, wanting more reforms and being in favor of more risky policy decisions which could potentially make poverty less persistent, compared to older individuals that are more risk-averse and thus conservative. It would be of high interest to investigate the impact of how an exogenous shock affecting the political climate induce a change in risk attitudes for different age groups.

Disclosure statement

Conflict of Interest: The authors declare that they have no conflict of interest. Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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