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Inequality, envy and personality in public goods: An experimental study*

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Abstract: This paper examines the impact of inequality on contributions to public goods focusing on the mediating role of personality using an inequality aversion model as a theoretical framework and experimental data from rural Rwanda. As predicted by the theoretical model, low-income players contribute less. We examine the predictive power of two personality approaches. The first is a person-centred approach using latent class analysis (LCA) to identify types of individuals with specific constellation of Big Five dimensions. The second focuses on individual dimensions of Big Five. While the person-centred approach has no explanatory power, one dimension of Big Five, Extraversion, is a significant and robust determinant; low-income players with higher Extraversion significantly reduce their contribution. Further exploratory analyses focusing on two dimensions of Big Five reveal that it does not provide any additional explanation compared to when each dimension is considered.

Keywords: public goods games; personality; inequality; envy; Rwanda

JEL Classification Codes: C93, H41, D63, O12, O55

1. Introduction

The cross-fertilisation between economics and psychology has a long history. Pioneers of marginalist/neoclassical economics were interested in the psychological basis of economic decisions. But the rise of revealed preference theory and formalisation of economics significantly reduced the psychological content of economics (Bruni & Sugden, 2007; Lewin, 1996). In the later part of the 20th Century, interest in psychology within economics revived and one strand incorporated insights from psychology into models of economic decisions and led to the birth of behavioural economics (Daniel Kahneman & Tversky, 1979; D. Kahneman

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& Tversky, 1992). A second strand, which gained real momentum only recently, uses personality psychology to better understand individual heterogeneity in economic decisions; Bowles & Gintis (1976) is an early example and Almlund, et al. (2011) is a recent comprehensive review of this literature. In the latter, the term ‘non-cognitive skills’ is widely used to mainly capture personality characteristics. While traditional economics emphasised the role of cognitive capability, the literature on ‘non-cognitive skills’ highlights the importance of personality in human development, health, education and labour market outcomes. A growing empirical literature provides support for this. For example, early acquisition of ‘non-cognitive’ capabilities among children is crucial for adult welfare in addition to cognitive skills (Cunha & Heckman, 2007; Cunha & Heckman, 2009). Improvements in personality skills in an early childhood intervention programme for low IQ African American children aged three to four in the US – the Perry Preschool Programme – has more lasting effects than cognitive skills (Heckman, Pinto, & Savelyev, 2013). The impact of ‘non-cognitive’ skills on inter-generational transmission of earnings can be as significant as cognitive skills (Bowles, Gintis, & Osborne, 2001a). Personality also predicts many educational outcomes; for instance, while Conscientiousness predicts overall achievement and college grades, Openness is a good indicator of educational attainment such as attendance and course difficulty (Almlund, et al., 2011). Personality has strong explanatory power also in labour market outcomes. Conscientiousness predicts performance and wages in a range of occupations and Neuroticism is a good indicator of job search effort (Almlund, et al., 2011). Incentive enhancing preferences at work are influenced by personality resulting in different levels of effort by employees at every wage rate (Bowles, Gintis, & Osborne, 2001b). Personality is also a good predictor of health-related behaviour; for example, Conscientiousness has better predictive power on longevity compared to intelligence or family background (Almlund, et al., 2011).

Apart from the above research on education, labour market and health outcomes, a small but growing literature looks at the role of personality in experimental games in general and public goods games in particular. Agreeableness relate to cooperative preferences in prisoners' dilemma and public goods games (Pothos, et al., 2011; Volk, Thöni, & Ruigrok, 2011; Volk, Thöni, & Ruigrok, 2012). Personality does not relate to altruism in dictator games played with kin but it becomes significant when subjects play with non-kin; the highest level of altruism is exhibited by players high on Neuroticism and Extraversion and low on Conscientiousness and Agreeableness (Ben-Ner & Kramer, 2011). Cooperation in prisoners' dilemma game is stronger among individuals that scored high on the withdrawal aspects of Neuroticism and the enthusiasm aspect of Extraversion (Hirsh & Peterson, 2009). There is also some evidence that incentives mediate the effect of personality. For instance, Lönnqvist, Verkasalo, & Walkowitz (2011) found that personality predicted decisions only in incentivised games where low Neuroticism and high Openness predict stronger cooperation. Müller & Schwieren (2012) provide evidence that Neuroticism is the likely reason for women's low level of interest to engage in competitive situations. The above findings highlight the importance of personality in experimental games.¹ The studies cited here are few examples from a growing literature.

The current paper contributes to this literature particularly focusing on how personality mediates the impact of inequality in public goods. The impact of inequality on social welfare is extensively studied. Experimental and non-experimental studies show that the relative position of people in an income distribution is an important determinant of welfare in addition to absolute income. The weight of empirical evidence suggests that inequality reduces growth (e.g., Banerjee & Duflo, 2003), among other factors, by reducing the quality of institutions and education (Easterly, 2007). Inequality can also exacerbate other social problems such as conflict (e.g., Esteban & Ray, 2011) and environmental degradation (Boyce, 2003).

While the weight of evidence indicates the negative impact of inequality on economic growth and welfare, its impact on contributions in public goods games is not clear. The inequality aversion model of Fehr and Schmidt (1999) predicts that low-income players decrease while high-income players increase contributions, the former due to envy and the latter due to guilt. The model predicts a fall in overall contributions with inequality because the decrease in contribution by low-income players will likely be larger than the increase in contribution by high-income players since envy is a stronger motive than guilt. Earlier work by Rapoport & Suleiman (1993) similarly suggest that heterogeneous groups are less successful in providing public goods. The model of Bolton & Ockenfels (2000) predicts similar behaviour by low and high-income players like Fehr and Schmidt (1999) without specifying the strength of the corresponding changes and hence is quiet on how overall contribution changes. In contrast, the theoretical work of Bergstrom, Blume, & Varian (1986) predicts that voluntary contribution to the public good will increase with inequality. Chan, et al. (1996) tested this and found that even though mean group behaviour conforms to the prediction of the model, individual behaviour does not; the increase in total contribution is due to low-income players over-contributing even though high-income players under-contribute. Similarly, players with high endowments contributed less in Cherry, Kroll, & Shogren (2005). Low-income subjects give the same absolute amount (hence more as a proportion of endowment) as the high-income players in Buckley & Croson (2006). In Anderson, Mellor, & Milyo (2008), when each individual's standing within the group is made public, inequality reduces contributions for all group members showing the importance of information and the relative ranks of individuals. As can be seen from this short review, the theoretical and empirical work has not yet arrived at a clear consensus on the impact of inequality on contribution to public goods.

Apart from the literature on experimental games referred above, another strand of research from personality psychology on equity sensitivity² is relevant here. Note this

literature mainly uses questionnaires in contrast to experimental games that rely on incentivised decisions. Overall, there is extensive evidence for a strong relationship between personality and equity sensitivity. For example, Friehe, Mechtel, & Pannenberg (2014) found that agreeable people are less concerned about income comparisons but conscientious individuals tend to compare more intensively their position at work but less in private domains. Attitude towards global inequality is significantly affected by personality characteristics; social conformity (a combination of low Openness and high Conscientiousness) and tough-mindedness (low Agreeableness) are important determinants of attitudes towards global inequality (Reese, Proch, & Cohrs, 2014). The predictive power of Big Five on ideological orientations influencing attitudes towards inequality is as large as that of education or income (Gerber, et al., 2010). Hirsh, et al. (2010) found that one aspect of Agreeableness (Compassion) is associated with liberalism and egalitarianism while another aspect (Politeness) with conservatism and traditionalism. In addition, conservatism/moral traditionalism is positively associated to Orderliness (an aspect of Conscientiousness) while the opposite is true for Intellect (a facet of Openness).

This paper examines the impact of inequality on contributions to public goods focusing on the mediating role of personality. The paper examines the effect of inequality, particularly that of envy, using the Fehr & Schmidt (1999) model as a theoretical framework and experimental data from rural Rwanda. A short Big Five questionnaire (Rammstedt & John, 2007) captures personality. As predicted by the theoretical model, low-income players contribute less. The paper then tests the predictive power of two approaches to understand how personality mediates the effect of inequality. First, the predictive power of a person-centred approach (e.g., Asendorpf, 2006) using latent class analysis (Lanza, et al., 2007; Lanza, et al., 2015) is examined. Second, an approach focusing on individual dimensions of Big Five is used. While the person-centred approach has no predictive power, one dimension of Big Five,

Extraversion, is a significant and robust determinant. As hypothesised, low-income players with higher levels of Extraversion significantly reduce their contribution. On the other hand, the results do not support the hypothesis that Neuroticism mediates the contribution behaviour of low-income players. Further exploratory analyses focusing on two dimensions of Big Five reveal that it does not provide any additional explanation compared to when each dimension is considered.

The next section describes the conceptual framework and hypotheses. Sections 3 presents the experimental design and data collection. While Section 4 summarises the main results, Section 5 provides conclusion.

2. Conceptual framework and hypotheses

Recent theoretical work has improved our understanding of the impact of inequality on individual behaviour (e.g., Charness & Rabin, 2002; Fehr & Schmidt, 1999). The inequality aversion (also known as the “guilt/envy” (Wilkinson, 2008)) model of Fehr and Schmidt (1999) is used here as a conceptual framework. Using insights from social psychology, Fehr and Schmidt (1999) argue that relative incomes affect individual behaviour and in particular, comparison with the income of a reference group is important. In the model, people dislike inequality whether it is advantageous or disadvantageous to them. Richer people feel guilt while poorer people suffer from envy. Being richer is better than being poorer implying envy from being poorer decreases utility more than the guilt from being richer. The following utility function captures this:

$$U_i(x) = x_i - \alpha_i \frac{1}{n-1} \sum_{j \neq i} \max\{x_j - x_i, 0\} - \beta_i \frac{1}{n-1} \sum_{j \neq i} \max\{x_i - x_j, 0\}$$

Here x_i denotes monetary payoff of player i and n represents the number of players. The second term in the utility function measures the loss of utility from disadvantageous

inequality (envy) and the third from advantageous inequality (guilt). The assumption that the former is stronger than the latter implies $\beta_i \leq \alpha_i$ ($0 \leq \beta_i < 1$). As described in the next section, the current study looks at only envy because we did not implement the treatment required to identify guilt due to resource constraints. The inequality aversion model predicts that low-income players reduce their contribution due to envy. Hence, our first hypothesis:

Hypothesis 1: Low-income players contribute less compared to the control group.

The main and novel aspect of this research is identifying how personality mediates the effect of inequality, particularly on how personality affects the contribution behaviour of low-income players. In particular, the focus is on *dispositional envy*, i.e., what type of personality is predisposed towards envy. How the experiment induces inequality, is crucial to identify dispositional envy. If a mechanism perceived grossly ‘unfair’ by most players induces inequality, almost everyone is likely to be upset and hence we expect reduction in contribution to public goods across the board irrespective of personality differences; identifying dispositional envy becomes difficult in this instance. For example, if initial endowment is determined by real effort and inequality is induced by taking away from those who produced more (making them low-income players) and giving it to those who put in little effort (making them high-income players) that will likely upset all low-income players leading to across the board reduction in contribution. This is a form of *episodic envy* (Cohen-Charash, 2009). Episodic envy likely affects even people who are not predisposed to envy because it has a strong situation-specific impact. Inequality in the current experiment is induced randomly and as a mechanism based on chance it is less likely to trigger episodic envy that upsets all low-income players providing a better design to identify dispositional envy.

Low-income subjects in the experimental games will get the same level of income as in the control group, with the only difference being half of the players in their group will get more (look at next section for details). Those low-income players who are more sensitive to

comparison with others will be disposed towards envy. From the Big Five personality dimensions – Openness, Conscientiousness, Extraversion, Agreeableness and Neuroticism – Extraversion is the one closely related to sensitivity to comparison with others. Extraversion is mainly turning outward of psychic energy and extraverts are more influenced by their surroundings (Feist & Feist, 2002). Apart from this general feature of Extraversion, there is also some evolutionary evidence. A study by Brosnan et al. (2015) find that chimpanzees with higher Extraversion are more responsive to inter-individual comparisons resulting in more sensitivity to inequitable outcomes. Further, research using brain activity shows that reward reactivity is higher among extraverts (Cooper, et al., 2014; Smillie, 2013). From these observations, we get our second hypothesis.

Hypothesis 2: Higher Extraversion among low-income players decreases contribution.

We also hypothesise that Neuroticism affects the sensitivity of people to income inequality due to the emotional aspect of envy. Given other factors, the generated inequality is likely to be more upsetting for people with higher Neuroticism leading to higher reduction in contribution. There is some supporting empirical evidence from the equity sensitivity literature in psychology (note questionnaires, not incentivised experimental games, are used to measure equity sensitivity in this literature). Scott & Colquitt (2007) find that equity sensitivity (greater entitledness) and higher scores of Neuroticism are related. Similarly, Stouten, Kuppens, & Decoster (2013) find that feelings of anger in response to inequality relate to Neuroticism. This leads us to our third hypothesis.

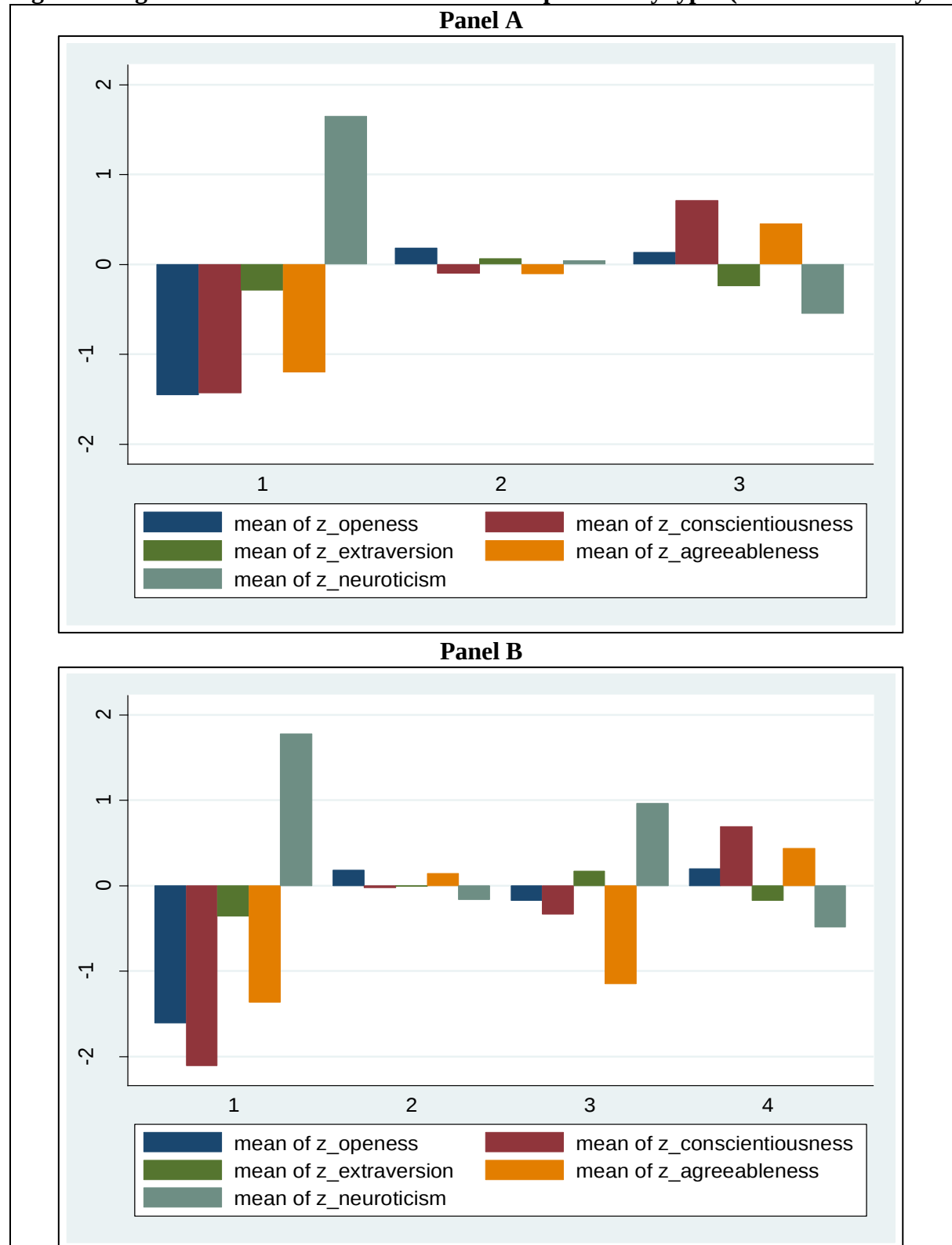
Hypothesis 3: Higher Neuroticism among low-income players decreases contribution.

Hypotheses 2 and 3 consider individual dimensions of Big Five. We also explore the explanatory power of another approach, a person-based approach, which considers personality *types* with certain constellation of Big Five dimensions. The person-centred approach focuses

on patterns and organisation of traits within a person (Robins, et al., 1996) and uses combinations of Big Five dimensions to identify personality types rather than considering each dimension separately. This is a typological approach and the identification of personality types is data-driven. In this paper, latent class analysis (LCA) (Lanza et al., 2007; Lanza et al., 2015) is used to divide the sample into different personality types. Traditionally, LCA uses a likelihood ratio chi-squared statistics denoted by G^2 (G-squared) to assess model fit. With increasing interest in information statistics, additional statistics like Akaike and Bayesian information criteria, with their adjusted variants, are now widely used (Lanza et al., 2007; Lanza et al., 2015). Table A1 in the appendix reports these statistics for 3 to 10 groups/classes. While four out of five statistics support three groups, Akaike information criteria supports classification of our subjects into four groups. In most empirical analyses, as in our case, the statistics do not provide an unambiguous selection. Due to this uncertainty, considering all groupings with at least some statistical support is recommended. Figure 1 presents the mean z-score of Big Five dimensions for each personality type when the sample is divided into three (Panel A) and four (Panel B) classes.

The personality profile of the first and last classes in both classifications are remarkably similar. The first groups of both classifications contain people with very high Neuroticism and low levels of the remaining four dimensions. The last groups (group 3 in Panel A and group 4 in Panel B) are characterised by low level of Neuroticism and more than average values of the remaining dimensions except Extraversion. Group 2 in both have people with scores very close to the sample mean for all five dimensions. Group 3 in Panel B is characterised by high Neuroticism and Extraversion while the other dimensions are below the average.

Figure 1: Big 5 mean z-scores for 3 and 4 classes of personality types (Latent class analysis)



In most studies, three personality types – Resilient, Overcontrolled and Undercontrolled – are identified but Herzberg & Roth (2006) argue that the constellation of Big Five dimensions that characterise each is not consistent across studies. In spite of this inconsistency, the three personality types are usually characterised in the following way (Specht, Luhmann, & Geiser, 2014). Resilients have low scores in Neuroticism but high scores in all the other four dimensions. Undercontrollers are low on Conscientiousness and Agreeableness. Overcontrollers score low on Extraversion and Openness and high on Neuroticism. In our classification, the closest group to Resilients are groups 3 in Panel A and group 4 in Panel B. In both classifications, group 1 coincides with Overcontrollers. Group 3 in Panel B is closest to Undercontrollers.

Note two of our hypotheses in relation to individual dimensions of Big Five predict that higher Extraversion and higher Neuroticism amplify the decrease in contribution of the poor. The only group with higher than average Extraversion and Neuroticism is group 3 in Panel B (the Undercontrollers). In contrast, the only group with lower than average Extraversion and Neuroticism are the last groups (group 3 in Panel A and group 4 in Panel B). The following two hypotheses follow from these observations.

Hypothesis 4: Undercontrolled low-income players with higher than average Extraversion and Neuroticism decrease their contribution.

Hypothesis 5: Resilient low-income players with lower than average Extraversion and Neuroticism increase their contribution.

The empirical analysis in Section 4 pursues these five hypotheses. Before that, the next section presents the experimental design and data collection.

3. Experimental design and data collection

This research is part of a larger European Union funded project named ReDirect that focused on the feasibility of payments for environmental services (PES) around the Nyungwe National Park in south-west Rwanda. The project implemented an experimental PES by collectively paying money to villages commensurate with how well they conserved the natural resources of the park (e.g., by not cutting trees, not setting snares, not mining in the park, etc.). The project pays villages collectively but individuals in the villages can secretly exploit the park's resources and hence the PES faces the classic public goods dilemma, the tension between individual and collective interest with an opportunity to freeride. Furthermore, existing socio-economic inequalities in the study area are expected to have an impact on the implementation of PES. The desire to understand the impact of inequality on the implementation of PES, which is a public good, is one of the motivations for this research³. For more on ReDirect project see (Gross-Camp, et al., 2012; Martin, et al., 2014).

We implemented two between-subjects one-shot public goods games in 13 study villages/cells⁴ in October 2009⁵. In each cell, we randomly allocate 24 subjects equally between the two treatments – simple and inequality - with the total number of players adding up to 312. The simple version is the control treatment where players with *equal* endowments of Rwandan Franc (RWF) 1,000⁶ contribute to a common pool and get an equal share of the public good. We increase the total contribution of the group by three-fold hence the marginal per capita return (MPCR) is 0.25. In addition, players get RWF 500 as show-up/participation fee. In the inequality treatment, randomly selected six players out of twelve get RWF 1,000 as show-up fee while the remaining get the same as the simple version (RWF 500). Inequality is induced through the show-up fee rather than the initial endowment in order to avoid a potential contamination of contribution behaviour by an income effect (Anderson et al., 2008)). Except the difference in show-up fee, the inequality version is the same as the control treatment.

Subjects played the games mostly in schools but in some cases in other public buildings. We provided sufficient space between players to avoid communication and the threat of expulsion was very effective to impose this rule. Research assistants competent in the local language, Kinyarwanda, and English translated the instructions with the support of the main researchers⁷. After reading the instructions, we privately answered questions, instead of in a general discussion, to avoid players influencing each other. Furthermore, players took a short test to check their understanding and we provided additional explanation to those who did not answer correctly. The instructions in the local language, the question and answer session and the test guaranteed a high level of understanding among the players. We trained research assistants intensively and conducted a pilot game. Players made their decisions in private by going out of the rooms with only one research assistant collecting their contributions; privacy of contribution decisions avoided peer and social pressures. Three of the authors personally managed the training of the research assistants, the pilot and initial games.

The next section summarises the main empirical results.

4. Results

This section summarises the main empirical results addressing the hypotheses outlined before. Before discussing the main results, let us first examine the balance/similarity between the control and treatment groups. As described before, strict implementation of random assignment between control and treatment groups ascertain there are no systematic observable and unobservable differences between the two groups. As a further check, we test for balance between the two groups in terms of the observable characteristics of subjects using both parametric and non-parametric statistics. Table A2 in the appendix provides the results. None of the variables is significantly different between the control and treatment groups. The random assignment with the balance test reassure us that the empirical results based on the comparison

of treatment and control groups is not confounded by systematic differences between the two groups.

The upper part of Table 1 presents the means, medians and standard deviations of contribution rates and the lower part reports parametric and non-parametric tests. Contribution rates in the inequality treatment are lower than in the control treatment but the difference is significant only at 10% level. When we compare the mean contribution rate of the control treatment specifically with that of low-income players in the inequality treatment, the difference is highly significant (at 1%). While subjects in the control group contributed on average 72% of their endowment, the figure for low-income players is only 58%; similarly, the median contribution falls from 100% to 50%. This provides strong evidence that lower income players on average significantly reduce contribution as predicted by the Fehr and Schmidt (1999) model; envy seems a potent motivating factor for reduction of contribution with inequality.⁸

Table 1: Contribution rates and significance tests

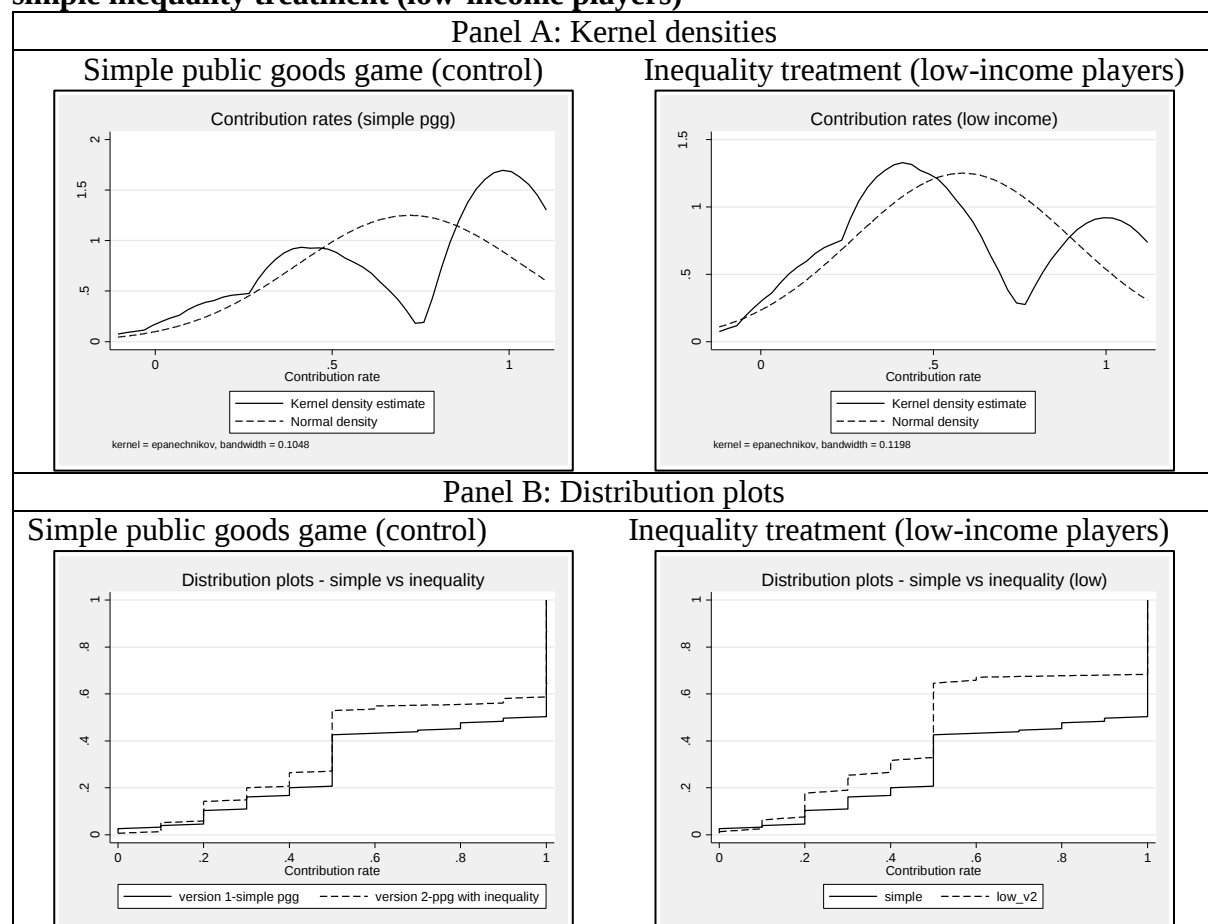
Game	N	Mean	p50	SD
Total	309	0.69	0.80	0.32
Control	155	0.72	1.00	0.32
Inequality	154	0.66	0.50	0.32
Inequality - low-income	78	0.58	0.50	0.32
Inequality - high-income	76	0.73	1.00	0.32
	T-tests		Mann-Whitney	
	t-value	p-value	z-value	p-value
Control-inequality	1.6926	0.0915	1.69	0.091
Control-inequality (low-income)	3.0488	0.0026	2.87	0.0041
Control-inequality (high-income)	-0.304	0.7614	-0.165	0.8689

Note: N = number of observations; p50 = 50th percentile (median); SD = standard deviation

The statistics in Table 1 provide strong evidence that on the average low-income players reduce their contribution. In addition to mean figures, exploring the whole distribution of contribution rates is advisable. To address that, Figure 2 first presents kernel densities (Panel A) and then distribution plots (Panel B) of contribution rates for the control and low-income

players. The kernel densities clearly show a significant shift in distribution between control and low-income players; for the control group a significant mass of the distribution is found around 1 (100% contribution) but the mass is shifted towards 0.5 (50% contribution) for low-income players in the inequality treatment. Similarly, the distribution plots in Panel B show that the plot of low-income players dominates that of the control group for almost the whole range of contribution rates. The tests at the mean and the pattern of overall distributions demonstrate that low-income players contribute significantly less than the control group. Hence, these tests support Hypothesis 1; low-income players contribute less compared to the control group.

Figure 2: Kernel densities (Panel A) and distribution plots (Panel B) of contributions in simple inequality treatment (low-income players)



Instead of discussing our empirical results following the exact sequence of our hypotheses let us first address those related to person-based approach; Hypothesis 4 Undercontrolled (with higher than average Extraversion and Neuroticism) low-income players reduce contribution and Hypothesis 5 Resilient (with lower than average Extraversion and Neuroticism) low-income players increase contribution.

As indicated before, because of the inconclusive statistical tests in LCA to select between three or four groups, we explore whether the person-based approach has explanatory power by considering both classifications (given earlier in Figure 1). To do that, contribution rates are regressed on interactive terms between dummy variables representing the personality types (which could be three or four groups) with dummy variables for the control game, low-income and high-income players in the inequality version. We use interval regressions to handle the censoring problem, particularly on the right-hand side, with many subjects contributing 100%. To control for additional confounding effects and examine the robustness of our results, we run three versions of these regressions: with no additional variables, with demographic variables and with demographic variables plus cell/village fixed effects. This helps to control for unobserved village level features as well as observable demographic characteristics of subjects. The demographic variables included in the regressions are sex, age (in log), never married, no education and whether the subject is protestant, the dominant religion in the study area. The computation of standard errors is clustered at the session level and since the number of clusters is low (24) the p-values are corrected using the score bootstrap (Kline and Santos, 2012). We used the Stata programme, Boottest, written by (Roodman, 2015) to get the corrected p-values. Table 2 presents estimation results from these regressions, Panel A for three personality groups and Panel B for four.

The coefficients of interest in our case are the interactive terms with low-income players in the inequality treatment (the second portion of the table); none of these interactive terms is

significant at conventional levels. Hence, we find no support for both hypotheses related to person-based approach. The results imply that the explanatory power of the person-based approach using LCA is poor in our case.

Table 2: Personality types and inequality after LCA: Three (Panel A) and four (Panel B) groups

	Panel A			Panel B		
	1	2	3	1	2	3
Simple public goods game						
x group 2	-0.215	-0.191	-0.0842	-0.122	-0.103	0.00941
x group 3	-0.206	-0.185	-0.0356	-0.123	-0.0934	-0.0399
x group 4				-0.162	-0.147	0.0195
Inequality low-income						
x group 1	-0.537	-0.462	-0.299	-0.332	-0.198	-0.0593
x group 2	-0.457	-0.419	-0.303	-0.389	-0.353	-0.252
x group 3	-0.334	-0.344	-0.275	-0.361	-0.353	-0.194
x group 4				-0.273	-0.266	-0.204
Inequality high-income						
x group 1	-0.150	-0.134	-0.0288	-0.148	-0.111	-0.0594
x group 2	-0.204	-0.177	-0.0394	-0.161	-0.136	-0.00347
x group 3	-0.0916	-0.0477	-0.0522	0.0245	0.0319	0.114
x group 4				0.0931	0.131	0.205
Constant	1.124***	1.381***	1.373***	1.043***	1.282***	1.280***
Observations	310	308	308	310	308	308
Demographic vars.	No	Yes	Yes	No	Yes	Yes
Cell fixed effects	No	No	Yes	No	No	Yes

Note: p-values computed using score bootstrap (Kline and Santos, 2012) clustered at session level

Now let us go back to our remaining two hypotheses based on individual dimensions of Big Five: Hypothesis 2, higher Extraversion among low-income players decreases contribution and Hypothesis 3, higher Neuroticism among low-income players decreases contribution. To test for the two hypotheses we follow a similar procedure as before. Contribution rates are regressed, using interval regressions, on interactive terms between each of the Big Five dimensions and dummy variables for control treatment, low-income and high-income players in the inequality treatment. Similar to the previous case, we run four versions of these regressions to ascertain robustness of coefficients to inclusion and exclusion of other

confounding variables: without any additional variable, controlling for other Big Five dimensions, demographic variables and village fixed effects all added cumulatively. As before, score bootstrap (Kline and Santos, 2012) corrects for the p-values.

The only coefficient consistently negative and significant (at least at 10% level) in all the four regressions is the interactive term between Extraversion and low-income players. The coefficients indicate that a one score increase in Extraversion (which ranges between 2 and 10) reduces the contribution of low-income players by between 8% and 9%; these results support our Hypothesis 2. In contrast, all the interactive terms with Neuroticism are not significant implying that there is no support for Hypothesis 3. The only other Big Five dimension that is significant, in two cases at least at 10% level, is Openness; note, in addition to being significant only twice, the magnitude of the coefficients are low compared to those for Extraversion.

Overall, while the person-based approach to personality using LCA has no explanatory power, there is significant and robust negative correlation between Extraversion and the contribution of low-income players. There is also some weak evidence that Openness has a similar but weaker and less robust effect. Hence, the individual dimensions of Big Five seem to have a better explanatory power than the person-based approach considered here.

In the final part of this empirical section, we explore an intermediate position where we consider combinations of two Big Five personality dimensions. Instead of using groups of people with certain constellation of all Big Five dimensions classified by latent class analysis (LCA), as done in person-based approach, we can legitimately ask if combinations of Big Five dimensions have explanatory power. For example, our empirical results have shown that Extraversion and to a certain extent Openness are correlated to contribution of low-income players. Do low-income players with high Extraversion and high Openness reduce contribution more than subjects each separately? Do we get more explanatory power by combining the Big Five dimensions as compared to considering each dimension separately?

Table 3: Big 5 personality dimensions and contribution behaviour with inequality

VARIABLES	Coefficients	Coefficients	Coefficients	Coefficients
Openness				
x simple public goods game	-0.006	-0.001	-0.001	-0.004
x inequality low-income	-0.036*	-0.033	-0.034	-0.039**
x inequality high-income	-0.003	0.002	0.002	-0.001
Constant	0.952***	1.028***	1.445**	1.660**
Observations	307	297	295	295
Conscientiousness				
x simple public goods game	0.015	0.032	0.024	0.014
x inequality low-income	-0.008	0.009	0.002	-0.010
x inequality high-income	0.020	0.036	0.029	0.017
Constant	0.782***	1.006***	1.411**	1.616**
Observations	309	297	295	295
Extraversion				
x simple public goods game	-0.052	-0.046	-0.057	-0.050
x inequality low-income	-0.089**	-0.081*	-0.091**	-0.086**
x inequality high-income	-0.0462	-0.041	-0.052	-0.045
Constant	1.239***	1.032***	1.418**	1.608**
Observations	309	297	295	295
Agreeableness				
x simple public goods game	0.000353	0.000	0.001	0.006
x inequality low-income	-0.028	-0.029	-0.027	-0.025
x inequality high-income	-0.001	-0.002	0.001	0.004
Constant	0.924***	1.012***	1.441**	1.659**
Observations	306	297	295	295
Neuroticism				
x simple public goods game	0.041**	0.033	0.027	0.023
x inequality low-income	-0.013	-0.022	-0.028	-0.029
x inequality high-income	0.033	0.025	0.019	0.019
Constant	0.767***	1.027***	1.475**	1.625**
Observations	306	297	295	295
Other personality dimensions?	No	Yes	Yes	Yes
Demographic variable?	No	No	Yes	Yes
Cell fixed effects?	No	No	No	Yes

Note: p-values computed using score bootstrap (Kline and Santos, 2012) clustered at session level

To address the above questions, we did the following exploratory empirical analysis. To keep the scale of personality dimensions within the same range, we computed averages of the relevant two Big Five dimensions.⁹ For example, the score for measuring subjects with

high Extraversion and high Openness is computed as the simple average of the two, i.e., (score of Extraversion + score of Openness)/2. Note, to capture subjects with high Extraversion *and* low Openness we require another composite score, where the Openness score is reversed, i.e., (score of Extraversion + (12 - score of Openness))/2¹⁰. Overall, all such type of composite indices provide 30 different combinations of Big Five dimensions and their reversed scales.

Using the composite scores for the 30 combinations, we run four versions of regressions with interactive terms similar to those reported in Table 3 (without additional variables, with other personality dimensions, demographic variables and cell/village fixed effects). Table 4 presents the statistically significant and robust results and Table A3 in the appendix reports the non-significant results.

Table 4: Composite dimensions of Big 5 and contribution behaviour with inequality

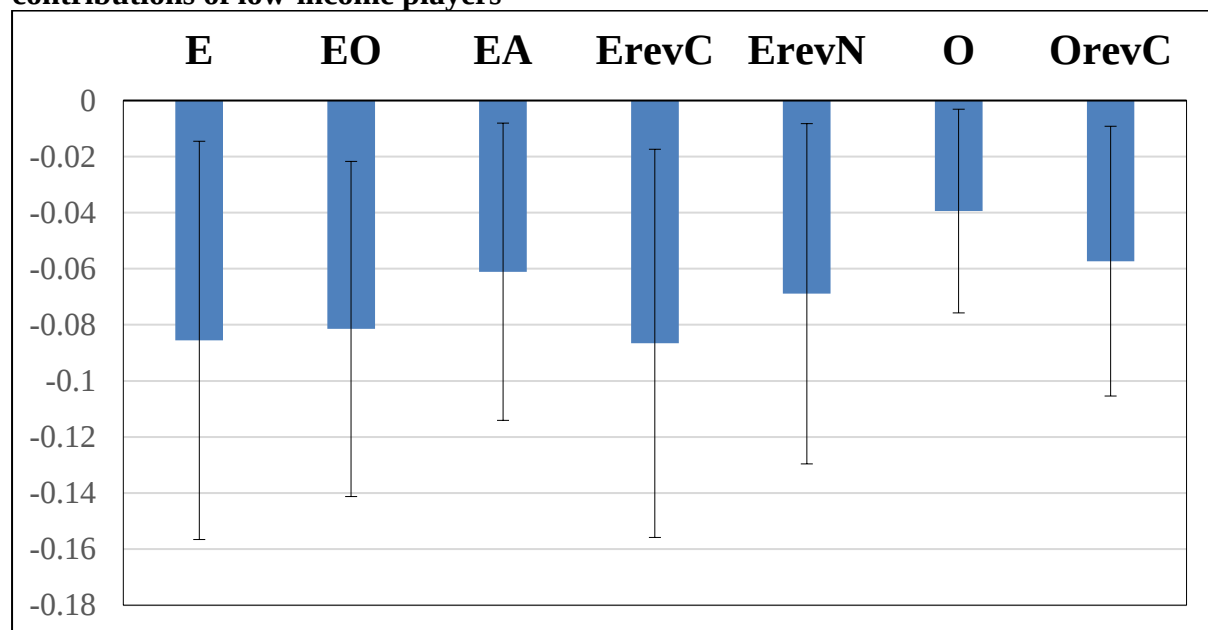
VARIABLES	Coefficients	Coefficients	Coefficients	Coefficients
Extraversion-Openness				
x simple public goods game	-0.0429	-0.038	-0.046	-0.046
x inequality low-income	-0.077**	-0.072*	-0.079**	-0.082***
x inequality high-income	-0.038	-0.034	-0.042	-0.042
Constant	1.188***	0.910**	1.250**	1.485**
Observations	306	297	295	295
Extraversion-Agreeableness				
x simple public goods game	-0.029	-0.030	-0.035	-0.027
x inequality low-income	-0.062*	-0.062	-0.066*	-0.061**
x inequality high-income	-0.0275	-0.029	-0.032	-0.025
Constant	1.125***	0.884**	1.196**	1.390**
Observations	305	297	295	295
Extraversion-reverse Conscientiousness				
x simple public goods game	-0.034	-0.057	-0.056	-0.038
x inequality low-income	-0.084**	-0.106**	-0.103**	-0.087**
x inequality high-income	-0.029	-0.055	-0.054	-0.034
Constant	1.084***	1.275***	1.472***	1.505***
Observations	308	297	295	295
Extraversion-reverse Neuroticism				
x simple public goods game	-0.048	-0.048	-0.048	-0.039
x inequality low-income	-0.079***	-0.077**	-0.076**	-0.069**
x inequality high-income	-0.044	-0.043	-0.043	-0.034
Constant	1.255***	1.099***	1.312**	1.480***
Observations	305	297	295	295
Openness-reverse Conscientiousness				
x simple public goods game	-0.018	-0.020	-0.014	-0.007
x inequality low-income	-0.061**	-0.068**	-0.061*	-0.057**
x inequality high-income	-0.015	-0.022	-0.016	-0.006
Constant	1.005***	1.370***	1.710***	1.747***
Observations	306	297	295	295
Other personality dimensions?				
Demographic variables?	No	Yes	Yes	Yes
Cell fixed effects?	No	No	No	Yes

Note: p-values computed using score bootstrap (Kline and Santos, 2012) clustered at session level

As expected, the significant five combinations contain Extraversion (four) and Openness (one): Extraversion-Openness, Extraversion-Agreeableness, Extraversion-reverse Conscientiousness, Extraversion-reverse Neuroticism and Openness-reverse

Conscientiousness. We compare the two sets of coefficients to test whether these results provide additional explanatory power over and above the previous results using Extraversion and Openness individually (reported in Table 3). Figure 3 gives the magnitude of coefficients with their 95% confidence interval. The coefficients on combinations containing Extraversion (EO, EA, ErevC and ErevN) are statistically not significantly different from that with only Extraversion (E). Similarly, the coefficient on Openness-reverse Conscientiousness also is not statistically different from that on only Openness. These results indicate that combinations of Big Five dimensions do not provide additional explanatory power. The significant effects of Extraversion and Openness essentially drive the significant results of higher combinations in Table 4. The above results indicate that it is unlikely to find more explanatory power by combining even more dimension of Big Five.

Figure 3: Coefficients and 95% confidence intervals of combinations of Big Five on contributions of low-income players



Note: E = Extraversion; EO = Extraversion-Openness; EA = Extraversion-Agreeableness; ErevN = Extraversion-reverse Neuroticism; O = Openness; OrevC = Openness-reverses Conscientiousness

The next section summarises the main results and provides conclusions.

5. Conclusion

We started from a number of hypotheses about the impact of inequality on the provision of public goods and how that is mediated by personality, measured by Big Five, using the theoretical framework of the inequality aversion model of Fehr and Schmidt (1999). We find that inequality significantly decreases contribution by low-income players as predicted by Fehr and Schmidt (1999). As a novel part of this research, we further analysed the mediating effect of personality first by considering person-centred approaches that focus on constellation of all Big Five dimensions and second considering individual dimensions of Big Five. The person-centred approach based on latent class analysis (LCA) has no explanatory power. From the individual dimensions of Big Five, Extraversion significantly and negatively affects the contribution of low-income players. A one score increase in Extraversion (which ranges between 2 and 10) reduces the contribution of low-income players by between 8% and 9%; this is a robust result. In addition, we find Openness has a similar effect like Extraversion, but the magnitude of the effect is smaller and the results less robust. We further did some exploratory work to assess whether scores on two dimensions of Big Five (e.g., subjects with higher Extraversion and higher Openness) provide additional explanatory power compared to considering only each dimension. The results show first in the overwhelming majority of cases the results are not statistically significant and second when they are significant they do not provide additional explanatory power compared when each dimension is considered, i.e., the significant results are driven by Extraversion and to certain extent Openness. Hence, the main highlight of the empirical analysis is that Extraversion is a robust determinant of reduced contributions by low-income players. There is some evidence that Openness has the same but weaker effect than Extraversion.

The findings of this research would help us understand the potential effects of inequality in the provision of public goods. The design and provisioning of public goods should seriously

consider issues of existing and emerging inequalities, otherwise, as the results from this research imply, those negatively affected are likely to be less cooperative. Knowledge about what type of people are more sensitive to inequality can be a crucial information to policy makers and practitioners to minimise the negative impact of inequality.

We believe replicating similar types of experiments as done in this research can help to examine how robust the results are in different contexts. Future research can improve on what we have done here. For example, the current research used a short Big Five questionnaire (Rammstedt & John, 2007). Using comprehensive questionnaires reflecting current developments in personality psychology is advisable. For example, one good option is the personality questionnaire developed by DeYoung, Quilty, & Peterson (2007) looking at 10 aspects of the Big Five and their relations to genetics. Apart from Big Five, it is also advisable to consider other approaches to personality. Questionnaires based on Reinforcement Sensitivity Theory (RST)(Corr & Cooper, 2012; McNaughton & Corr, 2008) and on emotional foundations of personality (Davis & Panksepp, 2018) are other potentially useful instruments.

We believe personality psychology has a great potential for understanding individual heterogeneity in microeconomic analysis; the current paper is a contribution towards that. More work in both experimental and non-experimental research is required to explore this potential.

Endnotes

¹ In contrast, Swope et al. (2008) find only limited support for the role of personality in a study that included dictator, ultimatum, trust and prisoners' dilemma games.

² While the term 'inequality aversion' is widely used in economics, the psychology literature uses 'equity sensitivity' – conceptually the two terms are equivalent.

³ Even though this is one of the initial motivations for the research, the current paper does not deal on the implication of the experimental results on the implementation of PES.

⁴ Cells are the lowest administrative sub-divisions in Rwanda roughly coinciding with villages.

⁵ In addition, we played two other treatments with low and high contribution thresholds; this paper does not use the data from the additional treatments.

⁶ One RWF is worth around £1.50 at the time of the fieldwork.

⁷ See the Appendix for the script of instructions for the simple and inequality treatments.

⁸ The contribution of high-income players in the inequality treatment is not significantly different from that of the control treatment. Note, since we do not have a treatment with all players getting the higher show-up fee, this is not evidence for lack of guilt among high-income players.

⁹ The other alternative is to use interactions between Big Five dimensions. We opted for average scores than interactions because the latter will generate variables with a different range and undermine comparability. Note the Big Five scores range between 2 and 12 but interactions between two dimensions will range between 4 and 144.

¹⁰ Note the score for each dimension of Big Five range between 2 and 10 and reversing the scores for a dimension requires deducting the scores from 12.

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Appendix

Scripts of instructions

Version 1: Simple public goods game

Thank you very much for coming to participate in this research.

This game is about your own individual decision. There is no right or wrong answer. You have to make the decisions by yourself. For this reason, should not talk to each other during the game; those talking to each other will be excluded from the game. Depending on your decision and the decisions of others, you will get different amounts of money; at the end of the game, you'll take this money home. Since the amount of money you get can be substantial, you should make your decisions carefully.

The money used in these games comes from a European organisation and is used for the purpose of research; the research has nothing to do with the government or with aid organisations. All information gathered here will be used for research and no other purpose and the identity of individuals will be not be revealed.

In this group there are twelve people. At the beginning of the game, we'll give each one of you 1,000 RWF. Then each of you will be asked to contribute privately to a common pool of money that belongs to all twelve of you. You can contribute any amount of the 1,000 RWF you are given. You can contribute all of it (1,000 RWF) or nothing (zero) or any amount in-between (100, 200, 300, 400, 500, 600, 700, 800 or 900 RWF). The decision is your own and other members of the group will not know how much you contributed.

After collecting all your contributions, we'll increase the total amount of the pooled money three-fold (i.e., the total amount is multiplied three times). This pooled money will then be divided equally among all twelve people.

For example, if all twelve people contribute all their 1,000 RWF, the total contribution will be 12,000 RWF and this will be increased to 36,000 RWF (12,000 times three). Then the 36,000 RWF will be equally divided, each one of you getting 3,000 RWF (36,000 divided by 12).

Let's give you a second example. If you didn't contribute anything at all but all the other eleven contribute all of their 1,000 RWF, then total contribution to the pool will be 11,000 RWF (1,000 times 11). Increasing the total contribution three-fold, it becomes 33,000 RWF (11,000 times three) and dividing it among the twelve participants equally each will get 2,750 RWF. Remember, you haven't contributed anything and still have the first 1,000 RWF and hence with the 2,750 RWF you get from the common money, you will have 3,750 RWF (2,750 plus 1,000) at the end.

Here is a third example: If all contribute 500 RWF, the total contribution will be 6,000 RWF (500 multiplied by 12) and when this is multiplied by three it increases to 18,000 RWF. This total common money will be divided among all the twelve each getting 1,500 RWF. With the 500 RWF that was not contributed to the common money, each individual will have 2,000 RWF (1,500 plus 500).

Remember, the above three are specific examples. You are free to contribute any amount or, if you don't want, you might not contribute anything at all. The decision is yours and other players will not know about your decision.

After the common pool of money is equally distributed among the participants the game will be finished. Before you go home the researchers will ask you a few questions. Then you will be given an additional 500 RWF to thank you for your participation.

Before the game starts, research assistants will ask you some questions to be sure that you've understood these instructions. If you've any questions you can individually ask the research assistants.

Thank you.

Version 2: Public goods game with inequality

Thank you very much for coming to participate in this research.

This game is about your own individual decision. There is no right or wrong answer. You have to make the decisions by yourself. For this reason, should not talk to each other during the game; those talking to each other will be excluded from the game. Depending on your decision and the decisions of others, you will get different amounts of money; at the end of the game, you'll take this money home. Since the amount of money you get can be substantial, you should make your decisions carefully.

The money used in these games comes from a European organisation and is used for the purpose of research; the research has nothing to do with the government or with aid organisations. All information gathered here will be used for research and no other purpose and the identity of individuals will be not be revealed.

In this group there are twelve people. At the beginning you will pick one piece of paper from here *[research assistants should show a bowl (or similar) from which the lots are to be drawn]* and those who get 1s will receive 1,000 RWF while those who get 2s will receive 500 RWF at the end of the game.

We'll then give each one of you 1,000 RWF. You will be asked to contribute privately to a common pool of money that belongs to all twelve of you. You can contribute any amount of the 1,000 RWF. You can contribute all of it (1,000 RWF) or nothing (zero) or any amount in-between (100, 200, 300, 400, 500, 600, 700, 800 or 900 RWF). The decision is your own and other members of the group will not know how much you contributed.

After collecting all your contributions, we'll increase the total amount of the pooled money three-fold (i.e., the total amount is multiplied by three). This pooled money will then be divided equally among all twelve people.

For example, if all twelve people contribute all their 1,000 RWF, the total contribution will be 12,000 RWF and this will be increased to 36,000 RWF (12,000 times three). Then the 36,000 RWF will be equally divided, each one of you getting 3,000 RWF (36,000 divided by 12).

Let's give you a second example. If you didn't contribute anything at all but all the other eleven contribute all of their 1,000 RWF, then total contribution to the pool will be 11,000 RWF (1,000 times 11). Increasing the total contribution three-fold, it becomes 33,000 RWF (11,000 times three) and dividing it among the twelve participants equally each will get 2,750 RWF. Remember, you haven't contributed anything and still have the first 1,000 RWF and hence with the 2,750 RWF you get from the common money, you will have 3,750 RWF (2,750 plus 1,000) at the end.

Here is a third example: If all contribute 500 RWF, the total contribution will be 6,000 RWF (500 multiplied by 12) and when this is multiplied by three it increases to 18,000 RWF. This total common money will be divided among all the twelve each getting 1,500 RWF. With

the 500 RWF that was not contributed to the common money, each individual will have 2,000 RWF (1,500 plus 500).

Remember, the above three are specific examples. You are free to contribute any amount or, if you don't want, you might not contribute anything at all. The decision is yours and other players will not know about your decision.

After the common pool of money is equally distributed among the participants the game will be finished. Before you go home the researchers will ask you a few questions.

Before the game starts, research assistants will ask you some questions to be sure that you've understood these instructions. If you've any questions you can individually ask the research assistants.

Thank you.

Appendix Tables

Table A1: Latent class analysis (LCA) model selection statistics

Classes	BIC	AIC	AdBIC	CAIC	G
3	3082.9185	2542.0998	2695.5875	3204.9185	2298.0998
4	3260.5746	2538.0054	2743.0751	3423.5746	2212.0054
5	3450.7504	2546.4306	2803.0823	3654.7504	2138.4306
6	3652.5871	2566.5168	2874.7504	3897.5871	2076.5168
7	3863.5619	2595.7410	2955.5566	4149.5619	2023.7410
8	4077.1517	2627.5803	3038.9779	4404.1517	1973.5803
9	4287.7662	2656.4443	3119.4238	4655.7662	1920.4443
10	4503.3101	2690.2376	3204.7990	4912.3101	1872.2376

Key: BIC = Bayesian Information Criterion; AIC = Akaike Information Criterion; AdBIC = Adjusted BIC; CAIC = corrected AIC; G = G-squared

Note: Statistics computed using the Stata plugin by Lanza et al, 2015

Table A2: Testing balance between control and treatment groups

	T-tests		Mann-Whitney	
	t-value	p-value	z-value	p-value
Male	0.6939	0.4883	0.6945	0.4874
Age (log)	1.2747	0.2034	1.3153	0.1884
Never marry	1.3870	0.1665	1.3849	0.1661
No education	-1.1581	0.2477	-1.1575	0.2471
Protestant	0.5789	0.5631	0.5795	0.5622
Openness	0.5693	0.5696	0.5795	0.5623
Conscientiousness	1.0991	0.2726	0.0353	0.9718
Extraversion	0.1534	0.8782	0.6074	0.5436
Agreeableness	0.0846	0.9327	0.0020	0.9984
Neuroticism	-0.6005	0.5486	-0.4651	0.6419

Table A3: Couples of Big 5 personality dimensions and contribution behaviour with inequality (coefficients on interaction with dummy of low-income players)

	Coefficient	Coefficient	Coefficient	Coefficient
OC	-0.019	-0.005	-0.013	-0.029
OA	-0.037	-0.040	-0.038	-0.041
ON	-0.015	-0.025	-0.032	-0.039
OrevE	-0.016	-0.008	-0.002	-0.013
OrevA	-0.032	-0.030	-0.034	-0.041*
OrevN	-0.050**	-0.045	-0.046	-0.054*
CE	-0.041	-0.019	-0.036	-0.047
CA	-0.016	-0.003	-0.007	-0.015
CN	0.021	0.016	0.003	-0.011
CrevO	0.010	0.013	0.007	0.000
CrevE	0.023	0.045	0.043	0.023
CrevN	-0.027	0.038	0.026	0.002
CrevA	-0.001	0.005	-0.003	-0.017
EN	-0.038	-0.039	-0.054	-0.055*
ErevO	-0.036	-0.044	-0.048	-0.040
ErevA	-0.050	-0.049	-0.059	-0.060
AN	-0.014	-0.023	-0.026	-0.026
ArevO	-0.019	-0.025	-0.020	-0.014
ArevE	-0.008	0.087	0.106	0.091
ArevN	-0.041*	-0.062*	-0.052	-0.043
ArevC	-0.057	-0.064	-0.054	-0.044
NrevO	-0.002	-0.008	-0.012	-0.011
NrevC	-0.030	-0.050	-0.048	-0.041*
NrevE	0.018	0.018	0.018	0.008
NrevA	-0.014	-0.015	-0.023	-0.028
Other personality dimensions?	No	Yes	Yes	Yes
Demographic variables?	No	No	Yes	Yes
Cell fixed effects?	No	No	No	Yes

Note: O, C, E, A and N stand for Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism respectively. ‘rev’ stands for reverse scale.