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Self-centered and non-self-centered inequality aversion matter: Evidence from Uruguay based on an experimental survey

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Abstract
In this paper we provide evidence on the empirical relevance of two notions of inequality aversion that have been explored in the literature: *self-centered* and *non-self-centered* inequality aversion. We used a flexible model and designed an experimental survey that allowed us to address jointly both of these notions of inequality aversion and to distinguish their relevance. The survey was administered to a sample of first-year University students in Uruguay. The findings confirm the empirical relevance of both notions of aversion to inequality in a developing country. Most study participants exhibited *non-self-centered* inequality aversion, while a minority of the individuals in our sample appeared to favor inequality. In general the magnitude of aversion to inequality varied as a function of individuals' position in the income distribution. *self-centered* income aversion is influenced by many factors, which is manifested in the fact that the magnitude of its parameters is more heterogeneous in compression to non-self centered aversion. In a minority of individuals, self-centered aversion has zero effect, and they are more willing to pay to reduce *non-self-centered* inequality. Finally, considering both notions together may help prevent bias in the measurement of inequality aversion.

Keywords *Self-centered* inequality aversion · *Non-self-centered* inequality aversion · Relative income · Social preferences · Experimental survey

1 Introduction

Numerous studies in the field of economics have found that the performance of other individuals (e.g. relative income) affects one's own well-being. There is less agreement among

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economists, however, on how to explain these findings, as they are consistent with multiple hypotheses derived from different theoretical models. In addition, these models are generally successful at explaining some, but not all, of the relevant findings (Fehr and Schmidt 2003; Fehr and Gächter 2000; Heffetz and Frank 2011; Clark and D'Ambrosio 2014; Hopkins 2008; Alesina and Giuliano 2011; Charness and Rabin 2002). Previous authors have posited the notion of social preferences to explain why relative performance affects individual well-being. This paper aims to address a specific form of social preference, namely, inequality aversion.

Inequality aversion implies that an individual is willing to resign a material payoff to reduce aggregate inequality (Fehr and Schmidt 1999) and income inequality is generally understood or operationalized as the degree of dispersion between individuals' incomes. Unlike many other variables related to personal well-being, inequality is a characteristic of groups rather than of individuals (Clark and D'Ambrosio 2014). People's concern about inequality in a group may depend on their place in that group or their distance with respect to others (Fehr and Schmidt, 1999, 2003).

Explanations of why people are averse to inequality and value it as an undesirable outcome can be grouped into three categories. First, there is a normative explanation where the valuation of inequality depends on whether the resulting distribution is ethically justifiable. In this case, inequality matters "per se" (Fehr and Schmidt 2003; Clark and D'Ambrosio 2014; Alesina and Giuliano 2011; Sen 1985). The other two categories of explanation are more instrumental. The first is based on the idea that individuals associate greater dispersion of income with a greater risk of ending up with a low level of income. In this sense, preferences for more egalitarian societies could be motivated by risk aversion in the face of a possible drop in income (Harsanyi 1955; Schildberg-Hörisch 2010; Amiel et al. 2015). Finally, a third category of explanation is associated with the presence of externalities. On the one hand, income inequality could have a negative effect on social well-being, if it affects the quality of institutions or reduces the accumulation of human capital at an aggregate level (Laffont 2005; Alesina and Giuliano 2011; Alesina and Rodrik 1994; Ray 1998). Moreover, it could be argued that inequality generates violence (e.g. Fajnzylber et al. (2002) explored this relationship). On the other hand, inequality could have a positive externality if it induces higher levels of effort. In this case, people may value inequality as a good because it is useful in order to increase social efficiency (Alesina and Giuliano 2011).

These arguments can help explain why and how people value income inequality and their willingness (or not) to assume costs to reduce it. For example, several empirical papers have found that individuals dislike inequality or consider certain levels of inequality undesirable (For a review: Clark and D'Ambrosio 2014 or Fehr and Schmidt 2003). However, people may have different notions about what "inequality" means. In turn, these differing notions imply different ways of measuring inequality aversion and identifying its foundations. The theoretical and empirical literature distinguishes two general notions of inequality aversion. First, viewing inequality as bad regardless of one's relative income or position in the income distribution is called *non-self-centered* inequality aversion (Clark and D'Ambrosio 2014; Alesina and Giuliano 2011). In contrast, *self-centered* inequality aversion refers to instances where individuals base their preferences on the difference between their own income and that of others. In this latter case, one's willingness to pay to reduce inequality depends on the individual's situation in relation to others (Fehr and Schmidt 1999, 2003, Bolton and Ockenfels 2000). Although there is a broad theoretical debate on the foundations of inequality aversion, these two notions of the concept have been addressed separately in previous empirical research. Several questions arise from this conceptual distinction, which

include: "Which of these two notions guide people's valuations of inequality?";"How each concept affects inequality aversion?" ; "Are the two notions complementary or substitutes?". Based on a theoretical model that jointly considers the two notions of inequality aversion, we address this distinction empirically and briefly explore its implications.

We propose an individual utility function that distinguishes *non-self-centered* and *self-centered* inequality aversion; we call this function the "unrestricted model". Both notions are modeled by specific parameters, taking the main background as reference. The *non-self-centered* component is modeled using a measure of aggregate inequality that is independent of the position occupied by the individual. To give more flexibility to the *self-centered* component, two parameters are considered that separately capture the effect of relative affluence and relative deprivation (Fehr and Schmidt 1999; Ferrer-i-Carbonell 2005). Alternatively, to explore the sensitivity of *non-self-centered* inequality aversion to individual's position, we use a "restricted model" of this utility function which assumes that the *self-centered* component of inequality aversion is null.

To estimate these parameters, we adapt the experimental questionnaire used in Carlsson et al. (2005). Our strategy allows us to measure the parameters associated with both notions of inequality aversion and, at the same time, compare our findings with previous research. The survey questionnaire we administered asks participants to make a series of choices between pairs of hypothetical societies, choosing which hypothetical society they would prefer their grandchild to live in 60 years hence. Specifically, participants choose between 27 pairs of societies, where individuals sacrifice their income to reduce global inequality. As there is no uncertainty in the scenarios participants are asked to evaluate, respondents' choices reflect their preferences regarding inequality per-se. Additionally, by holding societies constant in terms of absolute income and global inequality, and varying individuals' position in the income distribution we incorporate a change in the magnitude of the *self-centered* inequality faced by a participants' grandchildren. As a consequence, the structure of the choices allows us to distinguish the two forms of aversion, which constitutes this paper's main contribution.

The experimental questionnaire was administered to a sample of first-year university students of the Faculty of Economic Sciences and Administration (FCEA) of the University of the Republic (Uruguay). The questionnaire includes a survey module, with which enabled we elicitated some individual attitudes and social preferences. Our analysis also incorporates information from the Faculty's administrative records.

Our results confirm that, on average the population we studied perceives inequality as a bad, although there is some heterogeneity in the magnitude of the effect. For a majority of participants, we found that their willingness to pay for a reduction of inequality is very sensitive to their position in the income distribution. In this case, the parameters of *self-centered* inequality aversion become relevant. In a minority of individuals, *self-centered* inequality aversion has no effect and these individuals are more willing to pay to reduce *non-self-centered* inequality (probably due to fairness concerns). Our results confirm the relevance of parameters associated with both notions of inequality aversion, *self-centered* and non-self-centered, although the magnitude of the parameters varies among individuals. Both notions should be considered together when measuring individual' concerns about inequality. These results suggest that the estimates of *non-self-centered* inequality aversion in previous works were biased because they do not distinguishes the *self-centered* component. Moreover, we found that our measures of inequality aversion are strongly correlated with a set of variables that have been used to approximate this concept.

Our paper contributes to two strands in the literature. First it contributes to the literature on inequality aversion (e.g. Clark and D'Ambrosio 2014, Fehr and Schmidt 1999, 2003, 2006; Charness and Rabin 2002) and, particularly, to the research based on experimental questionnaires (Johansson-Stenman et al. 2002; Carlsson et al. 2005; Pirttilä and Uusitalo 2007; Amiel et al. 2009; Traub et al. 2005; Traub et al. 2009). Our findings relate to those of Amiel et al. (2009) and Traub et al. (2005), which demonstrated that, under uncertainty about own income, respondents' degree of inequality aversion is motivated by ethical concerns and self-concerns. The present work relates most closely to that of Johansson-Stenman et al. (2002), who confirm the relevance of risk (or inequality) aversion and relative concern, but address them separately. We contribute new evidence regarding the empirical significance of *self-centered* and *non-self-centered* inequality aversion using a unified and coherent framework to distinguish them. Both notions of inequality aversion have been addressed in previous research, but have not been considered simultaneously. We provide a first exploration of the relationship between the two notions. In addition, there have been few quantitative studies of inequality aversion parameters for Latin American countries, one of the economically most unequal regions in the word. Because research has shown differences between countries in inequality aversion related to the cultural background of respondents (Gaertner and Schokkaert 2012), results for Latin American countries may differ from those found in Europe, North America, and elsewhere.

Second, this paper makes a potential methodological contribution regarding the use of experimental surveys (Gaertner and Schokkaert 2012) and (Beshears et al. 2008). Unlike in previous papers, our strategy affords greater flexibility to elicit the parameter, thus allowing a more accurate approach to, measuring inequality aversion. Our findings confirm that participants' views of inequality vary based on their relative economic position in various hypothetical scenarios and they suggest the importance of controlling for both notions of inequality aversion in order to measure (and interpret) their parameters with greater precision.

Measuring inequality aversion in a way that distinguishes both notions is of interest for various reasons. First, inequality aversion is a key parameter for understanding the behavior of people. Camerer and Fehr (2006) found that inequality aversion is a key determinant in decision-making. However, it makes a difference which notion of inequality aversion one assumes because it affects the incentives individuals perceive and their potential behaviour responses. For example, when inequality aversion is non-self-centered, we expect that individuals in contexts of greater inequality will be more willing to assume some type of personal cost to reduce inequality, although this does not imply any direct return for themselves in terms of income, access to goods or services. This willingness to sacrifice does not happen with *self-centered* aversion, where the inclination to view inequality as a cost (or not) and potential incentives to reduce it depends on the place that the person occupies in the distribution. It may also have implications for understanding how workers' efforts respond to relative wages, considering the possible incentives which could be generated by horizontal or vertical wage inequality (Cohn et al. 2014; Breza et al. 2018; Cullen and Perez-Truglia 2018),). Finally, Aronsson and Johansson-Stenman (2016) argue that *self-centered* inequality aversion typically results in some negative externalities, while, *non-self-centered* inequality aversion may produce either positive or negative externalities.

Second, the magnitude of inequality aversion is a key parameter both in the measurement of inequality and in the analysis of social welfare and public policy design. Evidence concerning the existence of social preferences has renewed scholarly interest in analyzing the motivations behind support for redistributive policies and in advancing in knowledge of the

cultural determinants of this support (Luttmer and Singhal 2014; Kleven 2014). As an example, knowing individual parameters of inequality aversion, and their foundations, helps one to determine optimal marginal tax rates (Aronsson and Johansson-Stenman 2016). Finally, the degree to which society is willing to tolerate levels of inequality is linked to literature that has addressed preferences for redistribution.

The rest of the paper is organized as follows. In Section 2, the two concepts of inequality aversion are discussed (i.e. *self-centered* and *non-self-centered*) and we present our model and hypotheses. In Section 3 we describe the empirical strategy and the experimental design. Section 4 summarizes the main results, while Section 5 presents an analysis of robustness and validity. Finally, in Section 6, we offer some concluding comments.

2 Inequality aversion

Inequality aversion implies that individuals resist unequal results and are willing to renounce material benefits to reduce inequality (Fehr and Schmidt 1999). A variety of explanations have been put forth as to why people care about income inequality and why the willingness to pay to reduce it varies among individuals. In addition, individuals may differ in their understanding of what inequality means which would have significant implications for measuring aversion and understanding its foundations. We distinguish two notions of inequality aversion at individual level: *self-centered* and non-self-centered. To develop this distinction, we consider the following general equation:

$$U_i(X) = U\left[X_i, G(X_i, X^{-i}), \Phi\right] \tag{1}$$

where U_i is the utility of individual i, X_i is her income and X represents the income vector $(X_1, ..., X_N)$ of every individuals $(1, , i, ..N)$ in society. The second and third arguments represent, respectively, the *self-centered* and *non-self-centered* components of inequality aversion. The function $G\left(X_i, X^{-i}\right)$ is an attempt to formalize how *self-centered* income inequality (or relative concern) affects i's utility, which depends on the difference between one's own income (X_i) and the income of other individuals in society (the vector X^{-i}). Finally, Φ is a measure of inequality that does not depend directly on the income (or position) of individual i (for example, the Gini index or the variation coefficient).

Let U_{ij} denote the partial derivative with respect to argument j. It is trivial to show that all these arguments are related, namely a change in the individual's absolute income (X_i) may affect simultaneously the other two arguments of the utility function $(G(.)$ and $\Phi)$. However, these three arguments allow us to distinguish the direct effects of *self-centered* (U_{i2}) and *non-self-centered* inequality $(U_{i3}$). This equation reflects the idea that individual relative income (or position) may change without altering aggregate income inequality. At the same time the aggregate inequality in a society where individual i lives could change while the individual's relative income remains constant.

In order to link our experimental strategy to economic theory and to previous empirical papers, we use a specific form of the Eq. 1. For generality and flexibility purposes, our baseline model uses the following multiplicative equation:

$$U_i(X) = [X_i][RD]^{-\alpha}[RA]^{-\beta}[\Phi]^{-\gamma} \tag{2}$$

with:

$$RD = \begin{cases} \frac{\int_{X_i}^{X_{max}} (X - X_i) f(X) dX}{X_i} & if \quad X_i < X_{max} \\ 1 & if \quad X_i = X_{max} \end{cases} \quad RA = \begin{cases} \frac{\int_{X_{min}}^{X_i} (X_i - X) f(X) dX}{X_i} & if \quad X_i > X_{min} \\ 1 & if \quad X_i = X_{min} \end{cases}$$

where $f(X)$ represents the density function of income distribution. There are alternative possible functional forms with various properties, but this is attractive for its simplicity and comparability. Φ is an index of income inequality which does not depend directly on X_i (i.e: any index that satisfies the principle of anonymity) and γ measures the degree of *non-self-centered* inequality aversion. *Self-centered* inequality aversion depends on the aggregated distance between the individual's income and the income of others in society. This equation allows the evaluation of *self-centered* inequality to be asymmetric when distinguishing the effect on utility of those who are worse off than individual i in terms of income (RA: relative affluence if $X_j < X_i$) and of those who are better off (RD: relative deprivation if $X_j > X_i$).[1] As result, α is a parameter that measures the effect on utility of those who have more income than individual i, while β accounts for the effect of those who have less. Applying the logarithmic transformation to Eq. 2, we obtain:

$$\log(U_i) = \log(X_i) - \alpha \log(RD) - \beta \log(RA) - \gamma \log(\Phi) \quad \forall j \neq i \tag{3}$$

This general formulation includes well-known and much-studied cases of inequality aversion. On one hand, when $\gamma = 0$ we obtain a utility function analogous to the Fehr and Schmidt model, which is one of the main benchmarks of *self-centered* inequality aversion models. Fehr and Schmidt (1999) propose a model in which an individual's utility is affected by the distance between their income and that of others. As Fehr and Schmidt (2003) explain, this function is consistent with the observed evidence regarding the behavior of individuals in various experimental economics games, in which the number of participating individuals is generally limited. The authors point out that the incorporation of new agents makes it more complex to know which reference point individuals take into account when making their valuations. This aspect is trivial in the games analyzed by Fehr and Schmidt (1999), because in the majority of scenarios they analyze there are only two players.

Hopkins (2008) adapted Fehr and Schmidt's model for a population with a large number of individuals. He demonstrates that this model is very general and flexible, encompassing many of the models used in empirical research in the field of happiness or well being. This framework provides flexibility for interpreting various effects in terms of α and β: i) $\alpha > 0$ represents the envy effect, which postulates that the utility of an individual is reduced when the income (or distance) of people richer than themselves is increased; ii) $\beta < 0$ identifies a compassion effect, which suggests that the altruism of individual i only operates when it improves the situation of those who have a lower income, iii) $\beta > 0$ identifies a pride effect, indicating an increase in utility by observing that other individuals in society, who are in a relatively worse situation, have decreased their income.[2] iv) $\alpha < 0$ represents a tunnel effect, when the individual's utility is increased because those who are in a relatively better

[1] RD denotes relative deprivation defined as the normalized sum of the income of all who have a higher level of income than individual i, when indiviudual i's income is lower than the maximum in the society. On the other hand, RA denotes the relative affluence defined as the normalized sum of the income of all individuals who have a lower level of income than i, when i's income is higher than the minimum income in the society. Note that when $RD = 1$ or $RA = 1$ these terms are respectively neutral.

[2] Observe that, in the cases of pride and envy effects, the sign is opposite to the case of altruism.

situation improve their income, which leads to more favorable expectations about one's own future income (Hirschman and Rothschild 1973). Finally, the magnitude of these parameters could be mediated for reasons of efficiency (Charness and Rabin 2002; Fehr and Schmidt 2003).

On the other hand, when we assume $\alpha = 0$ and $\beta = 0$, we focus on *non-self-centered* inequality aversion. Furthermore, if we define Φ as the coefficient of variation, we arrive at Carlsson et al. (2005) model for measuring inequality aversion. Note that γ can be interpreted as a constant elasticity of absolute income in relation to *non-self-centered* inequality. [3] This utility function establishes a log linear relationship between individual well-being and aggregate income inequality, which has been used in the literature of happiness economics (see for example, Clark and D'Ambrosio 2014). This specification is also related to the literature on preferences for redistribution (see for example, Alesina and Giuliano (2011)). On one hand, γ_i could be negative if an individual thinks that inequality is unfair or brings negative externalities with potential consequences at the aggregate level of social well-being. On the other hand, γ_i could be positive if the individual thinks that inequality may improve social welfare due to "incentive effects" as noted by Alesina and Giuliano (2011).

These different micro foundations support the relevance of distinguishing between the two different notions of inequality aversion. While *non-self-centered* aversion could motivate individuals to reduce inequality even in societies to which themselves do not belong, *self-centered* income aversion is only affected by an individual's relative income. The basis of inequality aversion then, would affect willingness to pay to reduce inequality or support for re-distributive policies (Aronsson and Johansson-Stenman 2016; Clark and D'Ambrosio 2014). Note that both aspects of inequality aversion could coexist in the preferences of an individual. Furthermore, individuals may value one aspect of inequality aversion more than the other, which may explain heterogeneity in preferences for equality. We seek in this paper to elucidate this distinction as well as to show how the two are linked and can be considered simultaneously.

2.1 Identifying inequality aversion parameteres

Here we provide the intuition behind the procedure we followed to derive the values of the parameters α, β and γ. Panel (A) in Fig. 1 illustrates the decision of an individual who chooses between two societies A and B_s, which are identical in all respects, except for their income distribution (A is more unequal than B_s, i.e, $\Phi_A > \Phi_{B_s}$). Furthermore the individual's income varies between societies B_s, but all societies B_s exhibit the same level of aggregate income inequality ($\Phi_{B_s} = \Phi_{B_{s-1}}$). Any choice between Societies B_s and A implies a trade-off between income and equality. For example, income in Society B_1 is greater than in Society A. If we observe $A \succ B_1$, implies a preference for greater inequality. However, $B_s \succ A$ implies some degree of inequality aversion for $s = (3, 4, 5, 6)$, while $A \sim B_2$ implies that the individual has no preferences for (in)equality.

Let I_0 be the indifference curve for an individual indifferent between Societies A and B_4. The slope of the red line that joins A and B_4 represents a measure of inequality aversion: the increase in income required to hold the level of utility constant when inequality increases.

[3] Another *non-self-centered* model is found in Johansson-Stenman et al. (2002), who used an experiment to measure inequality aversion and risk aversion. In this case, they used a utility function suggested by Atkinson (1970) with constant relative risk aversion (CRRA). An alternative equation is used in the Leaky Bucket experiment by Pirttilä and Uusitalo (2007).

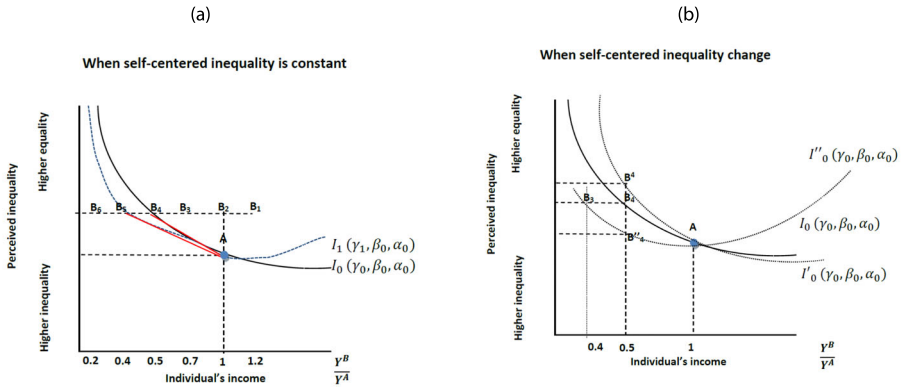

Fig. 1 Individual choice: Inequality vs income

If $B_4 \succ A$ the implied value of inequality aversion is greater than the value implied by I_0. It follows that if $B_4 \succ A$ and $A \succ B_5$, then the magnitude of inequality aversion is somewhere in between the slopes of the two indifference curves (the red lines in Panel A of Figure 1). This simple intuition is the key result we exploit in order to derive inequality aversion. However, at this point, we have not distinguished between *self-centered* and *non-self-centered* inequality aversion.

In Panel (B) of Fig. 1, the situation is analogous, but now let us introduce a change in *self-centered* inequality in all societies B_s. If preferences remain unchanged, the curve I_0 still represents the preferences of the individual, and the observed sequence of choices remains the same. However, if this change affects individuals' perceptions of inequality, the curve will move to I'_0 or I''_0 if *self-centered* inequality is perceived as a good or a bad, as will the decisions made between pairs of societies. This shift would imply *self-centered* inequality matters and that α and β in Eq. 3 are different from zero, which also affects the magnitude of γ.

Our experimental survey design was inspired by this analysis. Our treatment of information is designed to identify for an individual whether preferences are affected by a change in *self-centered* income inequality keeping constant *non-self-centered* inequality. We replicate the individual's choices under identical conditions while manipulating the information about the relative sizes of RD and RA. We use two additional assumptions: i) the income in societies follows a uniform distribution;[4] ii) Φ, the measure of *non-self-centered* inequality, is equal to the coefficient of variation.[5]

Equipped with a pair of societies (A and B) for which $A \sim B$, we have $U(A) = U(B)$. From Equation (3) we can derive the implicit parameters of inequality aversion, but we alternately use two versions: i) Restricted model; ii) Unrestricted model.

[4]This assumption is used in our experimental survey and in previous papers. It provides participants an intuitive sense of income inequality. We introduce it now because it also simplifies the mathematical derivations.

[5]This measure is used for the following reasons: the coefficient of variation as a measure of inequality in a distribution satisfies some desirable conditions such as the property of Anonymity, the property of Dalton-Pigou and the property of Invariance at Scale. The latter, in particular, is very useful for quantifying the inequality between societies with different income scales. It is also the measurement used in Carlsson et al. (2005), so using the same indicator allows for comparability with the literature.

Restricted model: in Eq. 2, if we assume α and β are zero, the same equation used by Carlsson et al. (2005) is obtained, where *self-centered* inequality is not modeled and individual only care about the magnitude of the coefficient of variation as a measure of *non-self-centered* inequality. This leads to the following expression:

$$\widehat{\gamma}_{i,P} = \frac{\log(x_{iB}^{P}/x_{iA}^{P})}{\log(\Phi_B/\Phi_A)} \quad With \quad P = (Minimum, Mean, Maximum) \tag{4}$$

Using this strategy allows us to estimate inequality aversion parameters from the individual's willingness to pay for lower income inequality based on Carlsson et al. (2005) equation. However, our experimental design allows us to elicit the parameters under three alternative individual positions in the income distribution to explore whether inequality aversion is affected by *self-centered* inequality aversion. To facilitate the exposition during the rest of the paper, let $\widehat{\gamma}_{mean}$, $\widehat{\gamma}_{max}$, $\widehat{\gamma}_{min}$ denote the estimation of γ based on (4) when individual i is located at the mean, maximum or minimum respectively. Observe that the restricted model allows an individual's *non-self-centered* inequality aversion to vary with position in the income distribution, which seems contradictory with the notion of *non-self-centered* inequality aversion. This issue will be exploited when we postulate our research hypotheses in next section.

Unrestricted model: if the restriction $\alpha = \beta = 0$ is not imposed in Eq. 3 we allow *self-centered* inequality aversion to be an argument in the utility function. We will refer to γ as the *non-self-centered* inequality aversion parameter of the unrestricted model. From Eq. 3, using the indifference condition and the same assumptions, we reach the following expressions:

$$\text{When } i \text{ is at the mean} \quad \gamma_i = \frac{\log(x_{\bar{i}B}/x_{\bar{i}A}) + (\alpha+\beta)\log\left(\frac{x_B^{max}-x_{\bar{i}B}}{x_{\bar{B}}} / \frac{x_A^{max}-x_{\bar{i}A}}{x_{\bar{A}}}\right)}{\log(\Phi_B/\Phi_A)} \tag{5}$$

$$\text{When } i \text{ is at the minimum} \quad \gamma_i = \frac{\log(x_{iB}^{min}/x_{iA}^{min}) + \alpha\log(\frac{x_B^{max}-x_B^{min}}{x_B^{min}} / \frac{x_A^{max}-x_A^{min}}{x_A^{min}})}{\log(\Phi_B/\Phi_A)} \tag{6}$$

$$\text{When } i \text{ is at the maximum} \quad \gamma_i = \frac{\log(x_{iB}^{max}/x_{iA}^{max}) + \beta\log(\frac{x_B^{max}-x_B^{min}}{x_B^{max}} / \frac{x_A^{max}-x_A^{min}}{x_A^{max}})}{\log(\Phi_B/\Phi_A)} \tag{7}$$

Expressions (5), (6), (7) form a system of non-linear equations. If we know a pair of societies A and B for which $U_A = U_B$ when the individual is located at the minimum, another pair for the same individual located at the mean and a third pair for the same individual located at the maximum, then the equation system is compatible, which allows us to identify α, β and γ for each individual i. This strategy allows us to identify a combination of parameters that is consistent with the individual decision.[6]

[6]Note that this strategy assumes that the partial derivatives U_{i_j} do not change their sign. Note also that we identify a unique value of the parameters solving the equation system generated by the thee indifference curves, which is a simplification. We can identify a combination of intervals that are compatible with an individual's decision, because a non-unique combination of parameter values could be possible. However, this simplifying assumption does not have strong implications for the measurement of inequality aversion parameters. Our 729 potential combinations of parameter values imply that the parameters have a practically "continuous" distribution in the range of interest as is described in Section 3.1. It implies that the assumption is not so demanding. This assumption facilitates the interpretation and does not affect the results, as we discuss in more detail in Section 5.1.

2.2 Hypothesis

To provide evidence on the empirical relevance of both notions of inequality aversion, we propose two hypotheses.

Hypothesis 1 *Non-self-entered inequality aversion (γ) is insensitive to a change in an individual's position in the income distribution.*

The evidence regarding the first hypothesis is now presented in the section 4.1 "Sensitivity of *non-self-centered* inequality aversion to the position in the distribution"

To advance in this direction, expression (4) is estimated for the same individual using her choices when she is located at the bottom, mean and top of the distribution. Evidence supporting $\widehat{\gamma}_{min} \neq \widehat{\gamma}_{mean} \neq \widehat{\gamma}_{max}$ implies rejection of Hypothesis 1.

It is worth mentioning that, by definition, the parameter of inequality aversion based on a *non-self-centered* concept should not be sensitive to position. Therefore, rejection of Hypothesis 1 implies that the assumption $\alpha = \beta = 0$ is very restrictive. Confirmation of this result leads to our second research hypothesis.

Hypothesis 2 *At the individual level, two concepts of inequality aversion coexist, one explained by a self-centered component and the other by a non-self-centered component.*

To test this hypothesis, the statistical and economic relevance of the parameters associated with both concepts of inequality aversion (Eq. 2) will be addressed. In other words, our aim is to evaluate empirically whether α, β and γ are different from zero when considered together.

Finally, it is worth mentioning that finding unfavorable evidence about H1 and favorable evidence about H2 has practical implications for measuring inequality aversion. First, Eq. 1 provides a more flexible utility function than has been used in previous papers. Therefore, indirectly, our strategy provides a robustness check regarding the implications of an individual's utility function assumed to elicit the inequality aversion parameter. Second, evidence concerning our hypothesis would indicate that, in order to measure and interpret inequality aversion parameters, both concepts of inequality aversion must be considered. It follows as a corollary that estimations which only focus on one concept could be biased; the interpretation at least should be discussed. For example, Carlsson et al. (2005) terms it individual inequality aversion when "individuals are willing to pay to live in a more equal society per se" (p1). However, the magnitude of their measure combines the effects of *non-self-centered* and *self-centered* inequality aversion. It could be argued that in Carlsson et al. (2005) the parameter was elicited when individuals are located at the mean of the distribution. In this context, $RD = RA$ and the effect of *self-centered* inequality aversion could be compensated, resulting in an aggregate null *self-centered* inequality aversion.[7] However, this only occurs when $\alpha + \beta = 0$, and only under this assumption could the estimation of γ be interpreted as *non-self-centered* inequality aversion. Note that there are no a priori reasons to assume that an individual is equally affected by RD and RA. For example, if the envy effect dominates over the compassion effect (in the proposed model, this implies finding the

[7]Note that when the income distribution is symmetric, as in the case of a uniform distribution, the aggregate income of those above the individual is exactly equal to the aggregate income of those who are below in the distribution.

$\alpha > \beta$ result suggested by Fehr and Schmidt, 1999), ignoring the *self-centered* effect leads to a bias in the *non-self-centered* inequality aversion estimate.[8] Likewise, if $\gamma \neq 0$, in a context of many agents, *non-self-centered* inequality aversion could be relevant, and ignoring it could lead to problems in the estimation of *self-centered* inequality aversion (α and β). Fehr and Schmidt (1999) warn that their model is only adequate to explain social preferences in certain games, most of which involve a reduced number of individuals (two players). In this context, the distinction between the *self-centered* and *non-self-centered* components of inequality aversion loses all meaning.

3 Empirical strategy

Accurately measuring inequality aversion and identifying the concepts implicit in it pose a significant challenge. In this study, in order to elicit the parameters of inequality aversion at the individual level, we administer an experimental questionnaire where participants must make a set of choices about hypothetical situations. The use of experimental questionnaires allows us to control various relevant factors that are unmanageable in social surveys on values and opinions (for a review of the use of experimental questionnaires, see Gaertner and Schokkaert (2012)). The effectiveness of the strategy requires the assumption that all participants interpret the task well and respond seriously (for a discussion, see Beshears et al., 2008). This strategy is sometimes criticised because the individuals' choices are not associated with financial prizes, so people may not be motivated to respond with their true preferences. Amiel et al. (2015, p. 238) point out it is not clear what role financial incentives play in studies that focus on normative aspects or ethical preferences, or whether incentives could even be distortive. Kahneman and Tversky (1979, p.265) argue that choices between hypothetical payments may reveal useful information that is difficult to obtain in experiments that involve real payments, because respondents have no reason to disguise their true preferences. However, economic incentives could drive participants to make a greater effort to understand the tasks, particularly if the tasks are difficult. In order to mitigate this last potential problem, we simplified the task as much as possible. Moreover, in our experimental task, random or inconsistent responses are easily identifiable.

The survey was designed to be administered to a sample of first-year students from the Faculty of Economics and Administration of the University of the Republic in Uruguay. The survey was administered at either the beginning or the end of a lecture, during September 2017. Participation was voluntary with no financial payoff. Our sample comprised first-year students in order to minimise the effect that university study (in particular the study of economics) may have on the answers. The time used by each participant to complete the survey form varied between 15 and 25 minutes. Instructions were read aloud to all the participants and each part was explained. We stressed the need for each individual to answer the questionnaire on their own based on their own personal preferences and we emphasized that there were no correct or incorrect answers.

It is worth mentioning that while working with university students may weaken the external validity of the results obtained, it has some important advantages: first, students have a relative advantage in terms of understanding the questionnaire; second, they are willing to participate, demonstrating interest and seriousness even though there is no remuneration for participating. On the other hand, researchers have compared the results obtained from

[8] Analytic demonstration is available on request.

administering experimental questionnaires to university students to the results obtained from representative samples of the general population, and the results are comparable (Pirttilä and Uusitalo 2007; Amiel et al. 2015).

Our survey questionnaire contains two parts. The first part contains the experimental component (which is an adaptation of Amiel et al. (1999) and Carlsson et al. (2005)) and the second part contains a set of questions to measure the participants' opinions and attitudes.[9]

3.1 Experimental design

In our experimental task, participants are asked to imagine 60 years have passed (they themselves are no longer living) and to choose between pairs of hypothetical societies (Societies A and B_i) based on what they believe would provide the best situation for their hypothetical grandchild.[10] The respondents were provided with general background information about the hypothetical societies, similar to that used in Carlsson et al. (2005).[11] Participants know their grandchildren's income and there is no uncertainty.

Each participant makes three series of choices between pairs of hypothetical societies. For every choice a sign highlights the grandchild's income/position, the maximum, minimum and mean income in each society, and a simple drawing that uses coins and buildings to represent income distribution, which is uniform but differs in levels (see image A.1 in the Appendix).[12] In each choice task, the respondent selects either: Society A (which remains unchanged) or Society B_s. Society A is always twice as unequal as society B_s (measured by the coefficient of variation). In each of the three tasks, participants choose 9 times between the pair of Societies A and B_s with $s = (1, ..., 9)$. Grandchild's income in society B_s is decreasing with s, implying an increasing trade-off between income and inequality.

In the first set of choices, the grandchild is always located at the mean of the income distribution, while in the second and third sets the grandchild is located at the minimum and maximum of the income distribution, respectively. The choice tasks were structured in such a way that the difference in *non-self-centered* inequality always remains constant between each pair of societies, and only *self-centered* inequality aversion varies. Varying income position at the individual level constitutes, an innovation of our approach, allows us to analytically separate the two aspects of inequality aversion (self-centered and non-self-centered) and derive the 3 parameters of interest. Table A.1 in the Appendix describes in detail the information about societies A and B_s shown to participants and also the

[9] Digital version of the questionnaire used can be viewed using the following link: https://docs.google.com/forms/d/e/1FAIpQLSdwXIrBZ0-srrK8vsLtYPFqnsrNeenhUH-JfBln_jK2_p-EoA/viewform?usp=sf_link

[10] The objective is for the participants to abstract from their current context in the income distribution, and thus elicit a more intrinsic notion of their preferences. Carlsson et al. (2005) argue that by asking about the grandchild instead of the individual, the potential problems of self-perception that individuals may have about themselves are minimised. The responses of the individuals could be guided by strategic behaviour or the search for moral satisfaction through the image they transmit about themselves with their responses. However, the way in which the data was collected was impersonal (without interactions or recognition) so this effect is not expected to be relevant.

[11] E.g: no welfare state, no poverty, identical quality of goods and services between both societies.

[12] The design was chosen in an attempt to avoid the effect of fatigue or inattention. Every building has the same number of floors, equal number of people on each floor, and distribution of income is represented by coins following a uniform distribution. Besides making the exercise more understandable, the trade-off between income and inequality is made explicit. In addition, the buildings allow us to reflect in a graphic way what the change of position for the grandchild in the income distribution implies. A pre-test was implemented with students to evaluate if individuals identified which society was more unequal and the results indicated a high degree of comprehension.

implicit parameters of inequality aversion when the participant is indifferent between the two societies.

In the first choice task (Society A vs Society B_1), the grandchild has a higher level of income in Society B_1, therefore if the participant chooses society A, they would be sacrificing income for greater inequality, so it would be clear that they are not averse to inequality and, on the contrary, are willing to pay for greater inequality. As the participant progresses in the series of choices, the grandchild's income in the following societies (B_s) falls in absolute terms. For example, in (B_2), the grandchild has the same income in both societies, so if the respondent were indifferent, it would imply that inequality aversion is 0. From $s \geq 3$ the grandchild's income is lower in society B_s with respect to society A, so choices implying a succession of preferences for society B at least until $s \geq 3$ imply some degree of inequality aversion. This situation reflects the decision discussed in Panel (a) of Fig. 1. When an individual only cares about *non-self-centered* inequality, her sequence of choices is the same in the three hypothetical situations, when her grandchild is at the mean, at the minimum and at the maximum. For example, a respondent who chooses $\{B_1, B_2, B_3, B_4, A, A, A, A, A\}$ in the three positions, implies that always $B_4 \succeq A$ and $A \succeq B_z \; \forall z > 4$. From the reveled preference relation and the indifference condition defined in the restricted model (Eq. 4), we know that: $0.09 < \widehat{\gamma}_{max} = \widehat{\gamma}_{min} = \widehat{\gamma}_{mean} \leq 0.015$. Note that when the identification of the parameter is based on the unrestricted model, using the corresponding indifference conditions (5, 6 and 7), if we observe in the three sets of choices ($B_4 \succeq A$ and $A \succeq B_z \; \forall z > 4$), then γ =0.152, $\beta = 0$ and $\alpha = 0$. The situation illustrated in Panel (B) of Fig. 1 showed that the sequence of choices may change when *self-centered* inequality changes. For instance, assume a series of choices $\{B_1, B_2, B_3, B_4, A, A, A, A, A\}$, $\{B_1, B_2, B_3, A, A, A, A, A, A\}$, $\{B_1, B_2, B_3, A, A, A, A, A, A\}$ at the mean, the minimum and the maximum, respectively. Under the restricted model, this set of choices implies: $0.09 \leq \widehat{\gamma}_{mean} \leq 0.15$, and $0.05 \leq \widehat{\gamma}_{min} = \widehat{\gamma}_{max} \leq 0.09$. This scenario indicates that *self-centered* inequality matters and, based on the restricted model, we obtain γ =0.012, β = 0.057 and $\alpha = 0.019$. For instance, in this case, the individual exhibits *non-self-centered* inequality aversion as well as envy and pride effects.

Let us call m^{sup} the order number of choice task in which the individual chooses society A from the series of choices at the mean, j^{sup} its equivalent for the series of choices at the minimum and k^{sup} at the maximum. Therefore (m^{sup}, j^{sup}, k^{sup}) is a combination of choices that represents the three switch points for each of the three positions on the income distribution. Given that the questionnaire provide us with a combination (m^{sup}, j^{sup}, k^{sup}) for each participant, we have all the information required to solve the system given by Eqs. 5, 6 and 7 if we assume that $U_A = U_B$ at this point. This is a simplifying assumption to avoid working with indifference regions in three-dimensional space. However, this assumption is not strong and does not affect the results, as we discuss in Section 5.1. Note that the three series of choices establish 729 (i.e. 9^3) possible combinations of γ, β and α. The implied parameters based on each possible decision are presented in the Fig. A.2 of the Appendix. Observe that the distribution is almost continuous in the relevant range of values and $\gamma > 0$, $\beta = 0$ and $\alpha = 0$ are only 9 of the possibles cases included in the figure.

3.2 Non-experimental component

Our questionnaire includes a set of attitudinal survey questions. A first set of questions measure directly or indirectly inequality aversion through subjective responses and attitudes. Most of these questions were taken from previous papers (Kuziemko et al. (2015); Alesina et al. (2017); Cruces et al. (2013) and the study "European Social Survey"). The survey

questions elicit opinions about the seriousness of poverty as a problem for society, opinions about the seriousness of inequality as a social problem, trust in the national government, preferences for redistribution, the role participants attribute to luck vs. effort in determining income, the State vs. Market valuation, among others. This allows us to explore the consistency of our measure of inequality aversion based on our experimental design.

Also, we include a series of questions that were designed to explore possible mechanisms by which inequality can be considered a problem. These questions were designed for this research and assess the role of fairness, the role of meritocratic views, negative externalities related to the provision of public services, insecurity and crime, and positive externalities related with incentive effects. Finally, some questions were also included to reveal socioeconomic characteristics at the time of completing the survey, such as educational level of the participant's parents, income, family composition and employment status. Responses to the questionnaire were merged with administrative records of the University, thus providing us with socioeconomic data about the participants and their schooling as a student.

3.3 Sample analysis and consistency of responses

358 students participated in the study. As expected, the sample is balanced in observable characteristics to the population of first-year students from University's Faculty of Economic Sciences and Administration (FCEA) as shown in Table A.2 in the Appendix. Participants were able to make any combination of choices between pairs of societies. Some combinations violate the principle of transitivity.[13] We are aware of the growing evidence challenging the assumption of transitivity (Kahneman 2003, Fehr and Schmidt 2006), but discussion of this topic is beyond the scope of this work. We therefore considered these cases as "inconsistent" and discarded them from our main analysis yielding a sample of 214 participants for the analysis.[14] We did, however, analyze the inconsistent responses and found no evidence[15] of any particular demographic characteristic differentiating consistent and inconsistent groups. They did not differ in years of schooling, general academic performance or performance specifically in quantitative methods courses.[16] Could be argued that transitivity of preferences is a strong assumption, but we will keep conservative in this sense and request transitivity to our answers for being included in the analysis. We did, however find evidence that participants who provided inconsistent answers spent less time completing the questionnaire. Given that the questionnaire was demanding in terms of attention and concentration, we attribute inconsistent responding to participants not paying enough attention to the task. Because consistent responding was not found to be correlated with observable participant characteristics, restricting the sample to consistent responders should not lead to biased estimations.

[13] Under the framework of the experiment, for a set of choices $(A; B_1, ..., B_9)$, if $A \succeq B_i$ and $B_j \succeq A$ for any $j > i$, it implies preferences are not transitive.

[14] If inconsistencies in the other sets of choices are not taken into account for defining consistency, the number of consistent answers is: 268 only considering the set of choices at the mean, 310 only considering the set of choices at the minimum and 298 only considering the set of choices at the maximum.

[15] Available upon request from the authors, although main results are presented in Table A.2.

[16] We analyze schooling and general performance as well as performance specifically in quantitative methods courses.

4 Results

The main results are organized in two sections. First, in Section 4.1, we focus on evidence related to Hypothesis I. Then, in Section 4.2, we present evidence regarding hypothesis II.

4.1 Sensitivity of *non-self-centered* inequality aversion to the position in the distribution

As a starting point, we analyze $\widehat{\gamma}_{mean}$, which was estimated based on the restricted model (4) and participants' decision when in the hypothetical situation of their grandchild being located at the mean. This establishes a first benchmark for the analysis. Given that this estimation is directly comparable to Carlsson et al. (2005), a natural question is whether our results are similar to theirs. Table A.3 in the Appendix summarizes this comparison. Indeed, results for Uruguayan students are consistent with the evidence for Swedish students obtained by Carlsson et al. (2005) (i.e, distributions of responses are similar on average[17]). Under these assumptions results for Uruguay exhibit a positive degree of inequality aversion on average ($\widehat{\gamma}_{mean}$=0.3053). Furthermore, 52% of participants are willing to pay to reduce inequality, and only 13% favor inequality.[18] This indicates that, when the individual is located at the mean and the effects of *self-centered* inequality aversion are ignored, the experiment yields results consistent with previous research that employed the same strategy. This comparison validates our execution of the experiment and allows us to proceed to present evidence regarding **Hypothesis I**.

We compare $\widehat{\gamma_{med}}$, $\widehat{\gamma_{min}}$, $\widehat{\gamma_{max}}$ using the responses to each set of choices. A first result arises from Fig. 2. The observable differences in the estimated density of responses in each set of choices indicates how an individual's *non-self-centered* inequality aversion depends on position in the income distribution. Statistical tests were performed to assess whether inequality aversion varies when individuals choose at different positions. Mean tests are presented in Table A.4 of Section A.4 in the Appendix. The null hypotheses $\widehat{\gamma}_{med} = \widehat{\gamma}_{min}$, $\widehat{\gamma}_{min} = \widehat{\gamma}_{max}$, and $\widehat{\gamma}_{med} = \widehat{\gamma}_{max}$, are rejected at 95% confidence. Kolmogorov-Smirnov tests were also performed to assess whether the distributions differ from each other, one by one. In all cases, the null hypothesis (Ho: the distributions are statistically equal) is rejected at the 95% confidence level (in all cases the p-value is less than 0.025).

Within the framework of our experimental survey, and given the information about the hypothetical societies, an individual's sequence of choices should remain the same when he varies position if *self-centered* inequality does not matter. However, only 14.95% of respondents change from B_s to A at the same point in the three sets of choices (i.e., $m^{sup} = j^{sup} = k^{sup}$). We know that, for this minority group, *self-centered* inequality aversion is zero and the concept of *non-self-centered* inequality aversion dominates. In other words, their degree of inequality aversion is insensitive to their hypothetical grandchild's position in the income distribution, which would be consistent with (α and $\beta = 0$). An important aspect is that this group of participants, whose decisions are insensitive to the position of their grandchild, generally have a relatively high γ. Their insensitivity to position is surely associated with their disinterested concern about inequality.

[17] Because the intervals represented by the societies in the two questionnaires are not exactly the same (in particular there is an overlap for some intervals), kernel-density estimations were computed. The results are presented in Fig. A.3 of the Appendix.

[18] Under a conservative assumption where the range that includes zero is excluded.

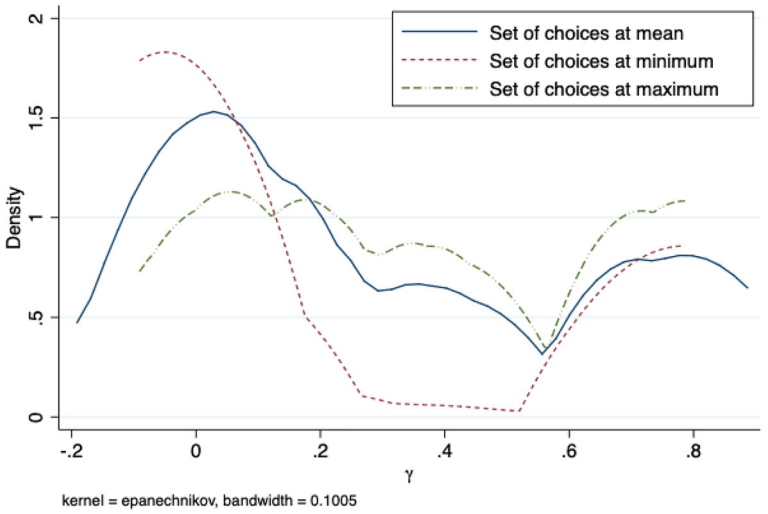

Fig. 2 Kernel estimation of the density of the distribution of $\widehat{\gamma}$. Source: authors, using data from the administered questionnaire. Based on the 214 students who made consistent responses in the three experiments. The lines represent the distribution of $\hat{\gamma}_{med}$, $\hat{\gamma}_{min}$ and $\hat{\gamma}_{max}$ based on the restricted model

In contrast, the vast majority of participants (85%) exhibit choices that are sensitive to position. It could be argued that participants change their decision (i.e., their "switch point") between the three sets of choices by mistake or neglect. Nevertheless, if that were so, a small difference should be observed between (m, j, k). Contrary to that expectation, 62% of responses exhibit a difference greater than two.[19] In addition, we used transaction matrices, which allows us to describe the degree of variability in the choices made by participants when they switch from one position in the distribution to another. This analysis shows that behaviours tend to vary greatly in most cases for the same individual when his position changes.[20] Furthermore, it confirms that participants insensitive to position accumulate at high levels of γ and exhibit strong aversion to inequality in their expressed attitudes and opinions (i.e., they endorse the statement that inequality is a problem for the society to a greater degree than do other participants).[21] From Fig. 2 we learn that if only *non-self-centered* inequality aversion is considered, when individuals face the set of choices at the minimum they are less willing to pay to reduce inequality. The greatest willingness to pay for less inequality is observed for the set of choices at the maximum. In other words, the greater one's financial constraints in relation to the rest of society, the more self-interested one's behavior and the less willing one is to sacrifice one's income for an improvement in

[19] I.e. $|m - j| > 2$ or $|m - k| > 2$ or $|k - j| > 2$. This information is presented in Table A.6

[20] Available upon request from the authors

[21] Compared to the rest of the participants, a greater proportion of these individuals consider 1) that income to be mainly determined by luck rather than by effort (35% vs 27%); 2) that inequality is a serious problem in Uruguay (25% vs 17%); 3) that it is a problem for the whole society (37.5% vs 29.65%); and 4) generally agree that inequality is a problem when asked for underlying justice reasons.

Table 1 Main estimation of inequality aversion. Unrestricted model

	Obs.	Mean	Min	25%	Median	75%	Max
γ	214	0.387	−0.990	0.088	0.349	0.679	1.539
γ*	195	0.320	−0.541	0.078	0.329	0.569	0.986
α	214	−0.088	−0.663	−0.229	−0.098	0.000	0.663
α*	195	−0.069	−0.539	−0.214	−0.069	0.000	0.663
β	214	−0.006	−1.111	−0.179	0.000	0.184	1.326
β*	195	0.048	−0.771	−0.108	0.000	0.194	0.868

Source: authors, using data from the administered questionnaire

Notes: Based on the 214 students who made consistent responses in the three experiments. *Estimates when *outliers* are excluded (the three parameters in range the (-1; 1)

terms of equality (i.e., greater concern for the individual's own situation). Intuitively, when individuals are located in the highest positions of the income distribution, their own income level allows them to "afford" to assume an individual cost (relatively cheap) for living in a less unequal society. It is important to highlight that the grandchild's income is fixed, so participants sacrifice their grandchildren's income to reduce inequality without expecting a return for it. Likewise, this implies reducing the income not only of the grandchild, but also of all the individuals in society least advantaged. This result suggests that, for most participants, given their individual characteristics, a better position in the distribution increases their willingness to pay for greater equality. Nor should it be concluded that people with low incomes stop identifying inequality as a cost. The relevance of relative income in this exercise surely indicates that they expect this cost to be assumed by others who are in a better position.

This result provides evidence to reject **Hypothesis 1** (i.e., individual inequality aversion is sensitive to position), suggesting that the strategy we used for measuring *self-centered* inequality incorporates a concept of *non-self-centered* inequality aversion. In other words, the income position matters when measuring inequality aversion and not considering it would bias the estimation. A joint estimation of both concepts of inequality aversion will be discussed in the following section (4.2), which addresses Hypothesis II.

4.2 Identification of *self-centered* and *non-self-centered* inequality aversion

Results presented in previous section suggest that inequality aversion depends on position, which seems inconsistent with a *non-self-centered* aversion concept. In this section, we use the unrestricted model, which allows to distinguish between *self-centered* inequality aversion (captured by α and β) and *non-self-centered* inequality aversion (captured by γ).

Table 1 summarizes the main results and presents descriptive statistics for the three elicitated parameters.[22] In addition, Fig. A.4 of the Appendix presents the kernel estimations for the three parameters of an inequality aversion and describes the complete distribution. On the one hand, the distribution of γ confirms the relevance of *non-self-centered* inequality aversion regardless of an individual's position. Its mean and median values are +0.32 and

[22] Statistics excluding outliers were also computed. Note that values out of range (-1; 1) represent a few cases of extreme behaviours.

+0.329. Furthermore, γ density shows positive asymmetry, with low frequency in the negative range of values. On the other hand, α accumulates a significant density around zero and accumulates a relatively high frequency of negative values. Its mean and median are -0.069 and -0.069 respectively. β shows a quite symmetric distribution around zero, with most of its density around very low values (its mean and median are -0.006 and +0.048, respectively).

The joint null hypothesis $\alpha = \beta = \gamma = 0$ is rejected for the average participants. The mean test for significance of γ and α rejects the hypothesis that these parameters are equal to zero with 99% confidence. However, for β we only reject at 95% confidence that the parameter is equal zero at the mean when excluding outliers. If we test the significance of the median of these parameters, similar results are obtained (see Table A.7 in the Appendix). We also computed confidence intervals by bootstrap method (see Table A.8 in the Appendix) and obtained the same conclusions.

In addition, the *self-centered* and *non-self-centered* inequality parameters have a negative and significant correlation (Table A.9 in the Appendix). The higher the value of the parameter (γ), the lower the degree of comparative concern about inequality (α and β), with the correlation coefficients of γ with α and β being -0.6003 and -0.6292, respectively. Then, if we look at the correlation between the parameters for *self-centered* inequality aversion ($\rho = 0.3142$), we see that α is positively related to β, which suggests complementarity. For instance, the greater the sensitivity of participants' utility to the incomes of those who are in a better position, the greater the sensitivity to those who are in a worse position. That is, those who assign greater weight to the comparative or *self-centered* component of inequality aversion show, at the same time, greater magnitudes of α and β.

These results suggest that both concepts of inequality aversion matter and compete with each other. Furthermore, they confirm the economic relevance of both concepts of inequality aversion and provide supportive evidence for **Hypothesis II** *inequality aversion is explained simultaneously by a self-centered component and a non-self-centered component*. This result constitutes novel evidence and argues for the need to distinguish both concepts to accurately measure inequality aversion.

Second, the parameters associated with the *non-self-centered* concept exhibits a significantly larger magnitude than *self-centered* parameters and generally have a positive effect. Namely, most participants are averse to *non-self-centered* inequality. We find that *non-self-centered* inequality aversion is significantly different from zero but, as expected, there is greater heterogeneity. Let us now discuss the interpretation of the parameters in more detail, focusing first on the *non-self-centered* concept and then on the *self-centered* concept.

4.2.1 Non-self-centered component

Our results based on the un-restricted model confirm the existence of *non-self-centered* inequality aversion measured by γ. The average individual is willing to pay to reduce inequality, regardless of position and the role of *self-centered* inequality. The estimate of γ has a mean value of 0.39 (0.32 if we exclude outliers), which is consistent with our expectation and with prior research.

The degree of *non-self-centered* inequality aversion obtained with this approach is higher than our previous estimation when the restricted model was applied $\gamma_{mean} = 0.294$. That is, when the *self-centered* channel is not considered, the estimation of $\widehat{\gamma}$ presents a bias that the measure based on the restricted model tends to underestimate. The restricted model provides an estimation of $\widehat{\gamma}$ in each set of choices for each individual, so in order to quantify the bias, some criterion is needed. Two alternatives were tested: first, the estimate that arises using only the set of choices at the mean $\widehat{\gamma}_{med}$ (which is used by previous authors);

second, the estimate of $\tilde{\gamma}$ resulting from the average of the estimates obtained in the three positions when the restricted model is applied ($\tilde{\gamma} = \frac{1}{n}\frac{\sum(\widehat{\gamma}_{min}+\widehat{\gamma}_{med}+\widehat{\gamma}_{max})}{3}$). As mentioned, the average value of $\widehat{\gamma}$ is 0.39, while the average value of $\tilde{\gamma}$ is 0.296 and the average value of γ_{med} is 0.294. A means test was carried out to check whether the differences are statistically significant, and the null hypothesis was rejected with 99% confidence (this information is presented in Table A.5 of the Appendix). An identical analysis was performed excluding extreme values, in this case $\gamma = 0.32$ and $\tilde{\gamma} = 0,28$ and the null hypothesis was again rejected with 95% confidence. Note that a few individuals (14% of participants) have a negative *non-self-centered* inequality aversion (i.e: $\gamma < 0$), which implies some participants are willing to sacrifice income to live in a society with greater inequality. This behavior is surely associated with motivations for efficiency (see for example Fehr and Schmidt (2003) or Alesina and Giuliano (2011)). To summarize, not accounting for *self-centered* inequality aversion (i.e, applying the restricted model) leads to an underestimation of *non-self-centered* inequality aversion of 23.5% with respect to $\tilde{\gamma}$ and 24.4% if we compare to γ_{med}, a significant magnitude given the range of variation for the parameter. These results confirm the importance of considering both components of inequality aversion in order to accurately measure it.

4.2.2 Self-centered component

The interpretation of the parameters associated with the *self-centered* component poses a greater challenge, as there are different effects simultaneously, which could move in opposite directions. The sign that we will obtain depends on which of the effects dominates. Recall that the unrestricted model α captures the effect on individual utility for those with higher incomes, $\alpha < 0$ if the individual obtains utility when others have more income (tunnel or efficiency effect), while $\alpha > 0$ implies the opposite (envy effect). β captures the effect on utility of other individuals having lower incomes. A positive value of β could be interpreted as altruism, while a negative value could be interpreted as pride. It should be noted that the parameters associated with *self-centered* inequality aversion exhibit a larger dispersion; they are, on average, significantly different from zero, although their magnitude is lower than γ.[23]

On average, α exhibits negative values (-0.087), meaning the presence of other individuals with higher income levels has a positive effect on utility, although its magnitude is small. This effect can be interpreted economically as a tunnel effect or efficiency effect. However, in 17.76% of the participants the envy effect dominates ($\alpha > 0$).

The results are more ambiguous with respect to the sign of β. For instance, 38.78% of the participants have a value of $\beta > 0$ and 46.26% have a value of $\beta < 0$. For the total of the sample the average is also negative but of low magnitude (-0.006). However, this statistic is sensitive to the presence of extreme values; when these are excluded, its sign changes and its magnitude is 0.048 (see Table 1). In turn, for the majority (and the average participant), observing others in society with lower income levels would have a weak positive effect on utility, which could be interpreted as a pride effect. However, these results conceal a high degree of heterogeneity at the individual level.

[23] A hypothesis test was performed for each of the parameters with and without atypical values. In all cases, the null hypothesis is rejected (Ho: the parameter is equal to zero) with 99% confidence, except in the case of β where the evidence allows us to reject the null hypothesis at 95% confidence only when atypical values are not considered. The results of the hypothesis contrasts are presented in Table A.7 in the Appendix.

In sum, we find a relatively smaller magnitude of the average parameters associated with *self-centered* inequality aversion. In addition, we find a higher degree of heterogeneity among individuals. Both results could be explained by the fact that effects operate in opposite directions and that they manifest with different intensity between individuals.

5 Robustness analysis and validation

In this section, the robustness and consistency of the results presented in the previous sections is analyzed. First, implications of the simplifying assumption introduced in Section 2.1 to elicit inequality aversion parameters are evaluated. Secondly, we incorporate alternative utility function forms and we explore only *self-centered* inequality aversion. Then, we analyze whether the estimated inequality aversion parameters correlate with the participants' responses to a set of attitude questions about inequality. Finally we discuss the importance of the distention between *self-centered* and *non-self-centered* inequality aversion.

5.1 Sensitivity analysis of the assumptions

As mentioned in Section 2.1, to estimate the values of α, β and γ a simplifying assumption is made. We elicit the parameters from $U_A = U_{Bs}$, when strictly we observe $\{U_A < U_{Bs-1}; U_A \geq U_{Bs}; U_A > U_{Bs+1}\}$, in order to avoid working with indifference regions in a three-dimensional space. As we previously discussed, potential problems associated with this assumption are mitigated by the number of choices that participants make in the questionnaire, with 729 potential combinations. To measure the magnitude of the error associated with this simplification, we ran a simulation analysis.

Let $\widehat{\Omega_{m,j,k}}$ denote the estimation of α, β and γ for a given combination of $(m^{sup}, j^{sup}, k^{sup})$. 200 hypothetical combinations of α, β and γ were generated by a random process. Assuming the same utility function presented in Eq. 2 we used the parameters generated and simulated choices made by 200 hypothetical individuals. Following the strategy carried out in the paper, we obtain for each simulated choice a estimation of $\widehat{\Omega_{m,j,k}}$. The error implicit in our simplifying assumption is computed from the difference between the true (and known) parameters of inequality aversion simulated and those obtained by our estimation strategy $\widehat{\Omega_{m,j,k}}$. The average difference between the estimated value of γ and the true value is less than 0.01. In the case of α, this difference is only 0.0038. Finally, the difference we observe for parameter β is less than 0.0077.

The simulation exercise confirms that the strategy we adopted yields an adequate approximation and so supports the simplifying assumption. In addition, as mentioned before, using this assumption greatly simplifies the interpretation of results.

5.2 Alternative modeling: *self-centered* aversion

The proposed model allows us to simultaneously consider the effect of two concepts of inequality aversion, incorporating the possibility that both channels compete. However, it is of interest to evaluate whether our strategy allows us to capture effects similar to those found by previous authors, when functional forms already explored in the literature are assumed. We already showed at the beginning of Section 4 that our results are similar to those of Carlsson et al. (2005) if same functional form is assumed to measure *non-self-centered* inequality aversion. What if only *self-centered* inequality aversion is modeled? As

a robustness check, α and β are estimated assuming ($\gamma = 0$), that is, only the effects of the sum of the income of those in society who are better off and worse off in society operate. This is analogous to applying the original model of Fehr and Schmidt (1999) in the context of more than two players.

The results confirm the existence of social preferences characterized by envy and altruism.[24] Both α and β exhibit positive values for most participants and, on average, reach 0.07 and 0.10, respectively, and they are statistically significant (available upon request from the authors). These results support the existence of envy and compassion effects.[25] Furthermore, this test supports the use of the experimental questionnaire to capture these effects despite the absence of economic incentives. More important, this result indirectly suggests the need to consider both channels simultaneously to measure inequality aversion. Note that modeling only the *self-centered* effect could introduce a bias, because the evidence of this paper suggests that the explanatory capacity of both concepts of inequality aversion compete with each other (we address this issue in Section 5.4).

5.3 Variables associated with inequality aversion

To explore whether the estimated parameters measure inequality aversion, multivariate linear regression models were used to analyze the relationship between the parameter of *non-self-centered* inequality aversion γ and participants' socioeconomic characteristics and attitudes toward inequality. The intention is not to explore a causal relationship, but, rather, to validate our measure of inequality aversion and explore its association with some potential explanatory channels. Considering the path of γ (the dependent variable), the models were estimated using the Ordinary Least Squares method with standard errors robust to heteroscedasticity.

We analyze whether our measure of *non-self-centered* inequality aversion is correlated with a set of variables concerning participants' attitudes toward inequality and their opinions about the economic implications of inequality, both in terms of fairness and efficiency. We focus on the association with the following attitudinal variables: (i) **Inequality is a problem**, i.e., whether if participants think inequality is a problem; (ii) **Poverty is a problem**, i.e., whether participants agree that poverty is a problem; (iii) **Luck** identifies those participants who think income is mainly determined by luck rather than effort; (iv) **Ideology**, which measures participants' ideological self-identification (right vs. left scale). Finally, we consider a set of variables which captures whether inequality is viewed as a "bad" or a good" due to fairness or instrumental considerations: (v) **reduces opportunity**, i.e., the degree of agreement with the statement that inequality is a problem because it reduces opportunities

[24] In order to estimate α and β, only two of the three sets of choices need to be used. Mean and minimum were used in this case.

[25] As an additional sensitivity analysis, we used an alternative model which considers efficiency effects. One notable result is the proportion of participants who show negative inequality aversion in Table A.3, which could be guided by an efficiency effect. To explore this hypothesis, an alternative analysis was performed considering a model where the efficiency effect is captured by prioritizing the income of those who are located at the maximum. This involved considering three effects (no more than 3 parameters can be modeled): *non-self-centered* inequality aversion; *self-centered* inequality aversion towards those with more income; and the effect of the maximum income of society (envy / efficiency effect). The algebraic solution and results are not presented for reasons of space and are available upon request. Comparable estimations of *non-self-centered* inequality aversion were obtained. In addition, the sign of α is negative and the magnitude is similar to that obtained with the unrestricted model. Finally, β has a high range of variation, and most participants were found to have an envy effect towards the richest while a minority seems to prioritize an efficiency effect.

for young people; and (vi) **only if it is unfair**, i.e., the degree to which participants agree that inequality is only a problem if its origin is unfair; (vii) **instrumental**, i.e., the degree to which participants agree that inequality is a problem because it decreases the quality of public services or because it generates insecurity and violence (resulting from the simple sum of individual responses; and, (viii) **Inequality is good**, which assess the degree to which participants agree that inequality is a not a problem, when it is explained by differential merit or because it generates incentives.

As control variables, we included a set of items concerning participants' individual characteristics (i.e., demographic and socioeconomic background): their course of study (which is also included in Carlsson et al. (2005)); the average grade obtained at the university and a dummy variable that identify those participants who passed at least two quantitative methods courses.[26] In all cases, we controlled for the amount of time participants it took to complete the questionnaire and a fixed effect by the group where the experiment was carried out. The definition of the variables and the main descriptive statistics are included in Table A.2 of the Appendix. Results of the estimates are summarized in Fig. 3.

A first comment is that, with exceptions, the demographic and socioeconomic background variables do not exhibit statistically significant correlations with inequity aversion, which is probably associated with the number of observations. However, the sign of the correlation is systematically consistent with what would be expected. Variables associated with greater availability of income, such as having attended a private secondary school, father's education or employment status, have a negative association with *non-self-centered* inequality aversion. However, only private secondary education is statistically significantly different from zero (P-value=0.081) and its coefficient is -0.132. This could be associated with belonging to a household that has greater resources available to it. An alternative interpretation is that this group exhibits different social preferences than does the group whose members attended public secondary school. This could be the case, for example, if private institutions are associated with more competitive environments. However, this is only an hypothesis based on correlations between variables and the responses to these questions should be addressed in future research.

We found a strong positive association between the magnitude of γ and endorsements of the statement that inequality is a problem (the coefficient is 0.086 and the P-value 0.011). The magnitude of the inequality aversion parameter is not significantly associated with instrumental considerations (prevention of violence and insecurity and the provision of public goods) or normative considerations (coefficients of "reduces opportunity" and "only if it is unfair" are near to zero). On the other hand, participants who agree that inequality is not a problem due to efficiency considerations (because it generates better incentives or because inequality is explained by individual effort, i.e., a meritocratic view) exhibit a negative and significant correlation with inequality aversion parameters (the coefficient is -0.041 and the P-value 0.061). Participants who think that poverty is a serious problem in Uruguay exhibit a positive association with inequality aversion parameters (0.052), but it is not significantly different from zero (P-value 0.135). Ideology and beliefs about the role of luck exhibit a very weak association. In sum, our measure of inequality aversion is significantly correlated with attitudes and opinions toward inequality. The importance of inequality and poverty as

[26]These variables are a proxy for cognitive abilities. The inclusion of credits obtained in mathematics, in addition to giving an approximation of the student's progress toward the degree, are subjects that, due to their content, could contribute to a better understanding of the distribution indicators that were used in the experimental questionnaire.

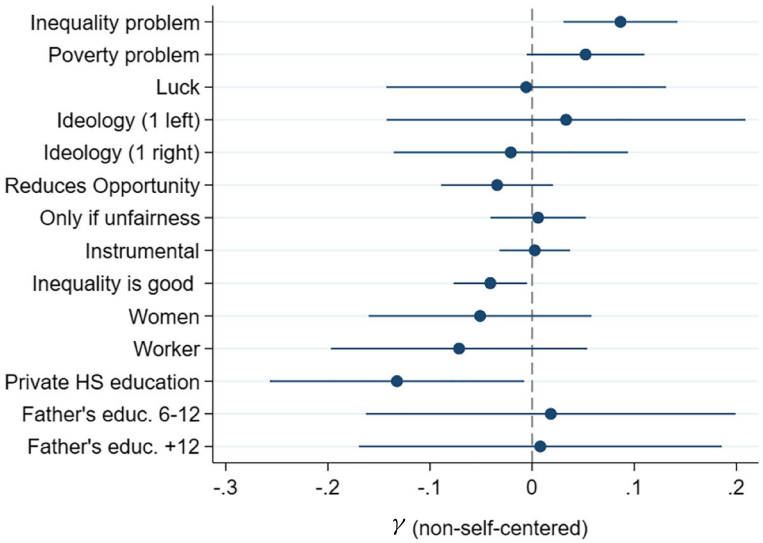

Fig. 3 Summary coefficients from OLS regression for γ. Notes: coefficients were estimated by OLS based on 182 observations with complete information about covariables. The dependent variable is γ based on the unrestricted model. "Inequality problem" ranges between 1 and 5 (5 is strongly agree), "Poverty problem" ranges between 1 and 5 (5 is strongly agree), "Luck" is a dummy variable (1=luck determines income); "Ideology" ranges between 1 and 3, (1=left-wing : 0 to 4; 2=centre: 5; 3: right-wing: 6 to 10) and omitted variable centre; "Reduces opportunities" ranges between 1 and 5 (5 is strongly agree), "Only if unfairness" ranges between 1 and 5 (5 is strongly agree); "Instrumental" ranges between 1 and 10 (10 high instrumental value); "Inequality is good" ranges between 1 and 10 (10=greater agree); "Woman" is a dummy variable (1 if female); "worker" is a dummy variable (1 if employed); "Private HS education" is a dummy variable (1 if assisted to private high school education); "Father's education" ranges between 1 and 3 (1=less 6 years, 2=between 6 and 12, 3=more than 12 year or technical education, omitted category 1=less 6 years). Control variables include: course of study; the average grade obtained in the university and a dummy variable that identifies those participants who passed at least two quantitative methods course of study; the time the participant took to complete the questionnaire and a fixed effect by the group where the experiment was carried out. The full estimates are not presented due to space restrictions and are available upon request. 90% Confidence Interval is included

a problem, meritocratic views and efficiency considerations suggest that inequality aversion is based on both instrumental and fairness considerations.

5.4 Does this distinction matter?

To address this question we incorporate two additional analyses. First, we replicate the estimates of the determinants of the inequality aversion parameter presented in previous section, but we iteratively use as dependent variable $\widehat{\gamma}_{med}$, $\widehat{\gamma}_{min}$ and $\widehat{\gamma}_{max}$ as the dependent variable. The coefficients obtained in the previous section for γ are included in the graph for easy comparison (results are presented in Fig. A.5 in the Appendix). As expected, in all cases, inequality aversion parameters are positively associated with beliefs that inequality is a problem, and the coefficients exhibit a lower magnitude with weaker significance (the coefficients are 0.048, 0.047 and 0.074 when the dependent variable is respectively $\widehat{\gamma}_{med}$, $\widehat{\gamma}_{min}$ and $\widehat{\gamma}_{max}$. Their P-values are: 0.078, 0.192, 0.007). However, we identify some differences

regarding the coefficients associated with "Inequality is good", which is very sensitive to position in the income distribution. For instance, $\widehat{\gamma}_{med}$ is significantly and positively associated with this variable, which seems contradictory (0.037 and P-value 0.02). Unlike the case of γ, the correlations between "luck" and $\widehat{\gamma}_{med}$ and between "luck" and $\widehat{\gamma}_{min}$ are a bit larger. This suggests that the participants' willingness to compensate for inequality due to luck is sensitive to their position in the income distribution. Finally, the correlation with "poverty is a problem" and with "Private high school education" is weaker in these estimates.

Secondly, we replicate the same estimates but we alternatively use α and β as the dependent variable. The results (Fig. A.6 in the Appendix) support the idea that both concepts of inequality aversion are substitutes. It is interesting to note how the coefficients change the sign regarding the estimates with γ as dependent variable.

6 Discussions

We focused on distinguishing the empirical significance of two concepts of inequality aversion with different micro-foundations: *non-self-centered* and *self-centered*. Previous research has generally focused on estimating inequality aversion by taking only one of these concepts into account, which precludes exploring their joint relevance and may lead to biases in measurement.

Two strategies were applied. The first was based on a restricted model, which replicated the procedure applied in Carlsson et al. (2005). Our results confirm that inequality aversion is sensitive to position occupied in the income distribution. A minority group of individuals did not modify their sequences of choices when their position changed. For this group of participants, the valuation of inequality is strongly dominated by *non-self-centered* inequality aversion. Furthermore, we found that they have attitudes and opinions extremely averse to inequality.

For most of the participants, we found that the willingness of participants to sacrifice income to reduce inequality is sensitive to position, which in itself contradicts the notion of *non-self-centered* inequality aversion. When individuals are at the top of the distribution, they seem to be willing to pay more, while when they are at the bottom individuals reduce their inequality aversion. Note that, in this case, the cost of reducing inequality for these people is relatively high for these people in terms of income, and respondents could demand that better-off people assume the cost. This evidence supports the relevance of considering position to quantify inequality aversion more precisely. Furthermore, it raises the question of whether willingness to pay is an adequate definition of inequality aversion. For instance, poor people could prefer a more equal society but, due to their relative deprivation, they cannot pay to achieve it.

In order to explore the empirical relevance of both concepts, our unrestricted model allowed us to differentiate the *self-centered* and *non-self-centered* effects. The results show that both notions are relevant. The evidence suggests that most individuals are averse to *non-self-centered* inequality. The distribution of the parameters of *self-centered* inequality aversion is more heterogeneous. Our findings suggests the existence of a bias in previous measurements of *non-self-centered* inequality aversion. In our case, not considering *self-centered* aversion leads to an underestimation of the parameter of *non-self-centered* inequality aversion of approximately 23%. Furthermore, the *self-centered* and *non-self-centered* inequality aversion parameters have a negative correlation, suggesting that they are substitutes.

Finally, information about individual attitudes toward inequality was used in our analysis to validate our measures of inequality aversion (although the relationship is statistically significant for only a few variables, probably due to the small number of observations).

This paper provides a measurement of inequality aversion for a sample of university students from Uruguay. This sample offers some advantages for our research design and to understand the behavioral aspects of inequality aversion. Our sample is not representative of the general Uruguayan population. However, previous papers (see Pirttilä and Uusitalo (2007)) found that the administration of experimental questionnaires to students yields results similar to those obtained from applying them to samples which are economically more representative of the population economically.[27] Further research using other functional forms that allow for interaction between both concepts of inequality aversion seems both promising and necessary.

A deeper understanding of inequality aversion and how to measure this concept is useful for evaluating and designing public policies, particularly redistributive policies. It would advance understanding of the fundamentals that lead people pay taxes, contribute charitable donations or finance public goods. The importance of being able to distinguish both concepts of inequality aversion to design tax schemes is highlighted in the literature of optimal tax design. Previous research has related inequality aversion to tax rates, finding that the optimal marginal tax rates are substantially greater when the implied externalities are internalized by assuming functions affected by inequality aversion (see Aronsson and Johansson-Stenman (2016)). The authors found significant differences when using estimates of inequality aversion that assume a *self-centered* or *non-self-centered* concept. Future research should explore on the implications for the design of tax schemes of differentiating the concepts of inequality aversion.

This work confirms the empirical relevance of both concepts of income inequality aversion, which are expressed with different intensity among individuals. This seems to be a key aspect to understand the micro-foundations of inequality aversion. An interesting and promising avenue to guide future research is the analysis of how individuals' willingness to reduce inequality (and their position sensitivity) vary depending on the dimension considered (e.g. wealth, health, education). Gaertner and Schokkaert (2012) summarized evidence about health inequality aversion. In addition, the results that arise from the multivariate analysis, while they do not allow us to establish causality relations, give us some clues about which mechanisms can explain the differences in inequality aversion. However, this question remains open and advancing understanding of this issue is a challenge for future research. Finally, the relatively low inequality aversion found when one's grandchild is at the bottom of the income distribution raises a question about the relationship between individuals' intentions and their actions. This could be interesting to explore in future research and represents a major challenge for the use of experimental questionnaires.

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[27] To improve the external validity of results, it would be interesting to replicate the questionnaire in other populations. However, more representative samples may have difficulty understanding the questionnaire.

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