The Journal of Economic Inequality
https://doi.org/10.1007/s10888-025-09703-7

RESEARCH

Specific egalitarianism? Inequality aversion across domains

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Received: 26 June 2025 / Accepted: 8 July 2025

Abstract
An individual's inequality aversion (IA) is a central preference parameter that captures the welfare sacrifice from exposure to inequality. However, it is far from trivial how best to elicit IA estimates. Also, little is known about the behavioural determinants of IA and how they differ across domains such as income and health. Using representative surveys from England, this paper elicits comparable estimates of IA in the health and income domains using two alternative elicitation techniques: a direct trade-off and an indirect "imaginary-grandchild" approach that results from the choices between hypothetical lotteries. We make three distinct contributions to the literature. First, we show that IA systematically differs between income and health domains. Average estimates are around 0.8 for health IA and range from 0.8 to 1.5 for income IA. Second, we find that risk aversion and locus of control are central determinants of IA in both income and health domains. Finally, we present evidence suggesting that the distribution and comparison of IA vary depending on the elicitation method employed.

Keywords Inequality aversion · Income inequality aversion · Health inequality aversion · Imaginary grandchild · Inequality and efficiency trade-offs · Risk attitudes · Locus of control

1 Introduction

Individual inequality preferences are informative about the way people perceive the existence of inequality in their communities. Accordingly, a complete analysis of the welfare effects of programs that influence inequality requires consideration of the sacrifice or welfare loss resulting from inequality. Atkinson (1970) defined inequality aversion (IA) as "the amount society is willing to give up to achieve a more egalitarian distribution." That is, an individual's degree of IA represents their judgement about how far society should forgo increases in total outcomes to achieve a more egalitarian distribution of outcomes. For instance, in the income domain, it measures the supposed willingness to sacrifice an individual's income to live in a more equal society (Fehr and Schmidt 1999). However, we still know little about what individual IA looks like and how it compares across welfare domains. Empirical research on inequality preferences is fundamental to eliciting robust estimates of such trade-offs, which helps in measuring the welfare effects of policy interventions. There is only limited

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Published online: 14 August 2025

consensus on how best to elicit estimates of such IA parameters, whether in terms of the way the marginal utility of income varies with the position of income in the income distribution, as a social preference, or more simply, as an extension of individual risk aversion.

The elicitation of IA is far from trivial, given that it is typically inferred from choices under some hypothetical decision-making tasks. Ideally, for individuals to reveal their true and non-distorted IA, inequality preferences should be elicited under the assumption of a "veil of ignorance", behind which individuals seek to agree on appropriate social choice rules without knowing what position they will hold in society (Rawls 1971). This ensures that their own circumstances do not influence their expressed preferences (Bosmans and Schokkaert 2004; Harsanyi 1955). However, as people do know their position in the social hierarchy, the "veil of ignorance" approach is in practice tricky to implement in lottery-type choice decisions. Alternatively, one can elicit self-reported, non-personalised preferences to inequality-efficiency trade-offs using surveys,[1] even though they are also affected by individuals' status quo and self-interested preferences.

The first contribution of this paper lies in using a preference elicitation technique that approximates the veil of ignorance, in both income and health domains. We elicit IA by asking respondents to choose between hypothetical societies on behalf of their (imaginary) grandchild to live in, without knowing the exact status of their grandchild in the hypothetical future society (Carroll et al. 2017; Carroll and Samwick 1995; Carlsson et al. 2005).[2] Our contribution is to design it in a way that can be compared to similar estimates in the income and health domains. We use an experimental questionnaire method with quasi-randomized information treatments, and IA is recovered from each respondent's set of choices under the assumption of a general utility function. Furthermore, we use two formats: a simple lottery format and a lottery with follow-up questions, where, upon answering the simple lottery, individuals respond to a more bounded lottery based on the previous lottery responses. This second method provides greater precision on the inequality aversion estimates. The importance of comparing simple and more complex lotteries lies in the fact that "detailed or precise" inequality preferences might be constructed at the time of elicitation. We check the extent to which this is the case.[3]

A second contribution of this paper is to compare IA parameters across two domains. One could argue that individuals' aversion to inequality depends on the origin of inequality, for example, whether the inequality is effort-induced or perceived to result from luck (Lippert-Rasmussen 2001; Segall 2009). This hypothesis is also known as "specific egalitarianism" (Tobin 1970), whereby attitudes toward inequality are domain-specific. The fact that one might hold egalitarian views in one domain does not guarantee that such views extend to other domains in life where individuals might have more choice and information or where the consequences of individuals' actions might be less critical for their welfare. We examine the extent to which health and income IA measures follow similar patterns. This is important

[1] This kind of trade-offs are employed in the literature of economic evaluation of health programs based on established methodological principles for valuing trade-offs between different dimensions of health (Williams and Cookson 2006).

[2] Here, survey respondents are expected to abstract from their circumstances and make a sequence of discrete choices between imagined societies characterized by varying levels of average welfare (in terms of income and health) and inequality in such domains. Questions from this approach tend to be framed in a way to overcome status quo biases (and hence come closer to 'veil of ignorance approaches) and elicit the sacrifice individuals would be willing to undergo to reduce inequality. For example, Johanneson and Johansson (1997) estimates preferences for inequality in health care under the veil of ignorance.

[3] Throughout the paper, we use the terms "lottery approach/estimates" and "imaginary grandchild approach/estimates" inter-changeably. We distinguish one-round with two-round elicitations using the words "simple lottery" and "follow-up lottery" throughout the paper.

given that income inequalities might be at the root of health inequalities.[4] While income can result from labour market effort, health production might well be the result of health investments, including efforts to follow healthy behaviours such as refraining from smoking, drinking and having a healthy diet (Grossman 1972). Health might be perceived as the result of effort, much like income, which would lead one to theorize that IA should be similar in the two domains. Despite the theoretical controversy, so far, the empirical evidence of the prominence of income vs. health IA is limited. The present paper contributes to this argument.

Finally, we contribute to the examination of the potential behavioural explanations for inequality preferences in both income and health domains.[5] Together with testing the influence of risk and time preferences, we examine the effect of "locus of control", that is, whether individuals attribute to themselves the control over events in their lives as opposed to outside factors.[6] In theory, locus of control should be an important determinant of people's degree of aversion to income and health inequality. If people feel that their financial conditions and health are strongly influenced by external factors (such as chance, luck, powerful others), then they may attribute less responsibility to themselves when it comes to managing their finances and health. They do not think their future income and health is predictable, and due to this uncertainty, they would be averse to income and health inequalities. In contrast, those who feel strong internal control tend to anticipate their future income and health and act upon them. Such ex-ante effort results in smaller ex-post inequality aversion. However, whether the locus of control affects inequality preferences is an empirical question. Budria et al. (2012) show evidence supporting the idea that "external" individuals are more inequality-averse than "internal" individuals. In contrast, Andor et al. (2022) show that individuals with an internal locus of control tend to be more prosocial. They are more likely to contribute to climate change mitigation, donate money and in-kind gifts to charitable causes, share money with others, cast a vote in parliamentary elections, and donate blood. Here, we measure risk preferences and locus of control both with and without distinguishing between the health and financial domains, and we use further survey evidence to test this idea.

We show that there are significant differences in the elicited values of inequality preferences depending on the method employed, whereby lotteries reveal higher, although consistent, inequality aversion. The estimates are consistent with the presence of inequality-averse preferences. Second, we find evidence that IA differs by domain. Average estimates for health inequality are around 0.8, and range from 0.8 to 1.5 for income inequality. This result suggests that, on average, participants are willing to sacrifice 8-15% of their income and health to reduce corresponding inequality in society by 10%. Furthermore, both risk preferences and locus of control play a domain-specific role in explaining IA, and that domain-specific risk preferences and locus of control exert an influence on the estimates.

The rest of the paper is organised as follows. In Section 2, we provide the background to the present study, focusing on the diverse evidence from IA studies and attitude studies. Section 3 describes the data and the empirical strategy followed. Section 4 reports and analyses the

[4] Indeed, income inequality can explain access to healthy inputs (e.g., nutritious food), preventative actions and health care, though this is not always the case when health is the result of individual choices that are unrelated to income or due to genetic endowments.

[5] In the social-science literature, it is usually assumed that social norms determine what a society regards as an "acceptable inequality" and that such norms are shaped by common history and past institutions (Lübker 2007). Inequality aversion can result from the process of social learning by observing others' payoffs (which may diminish the value of one's payoffs).

[6] The concept of locus of control was first developed by Rotter (1966), who proposed a uni-dimensional scale to measure the degree to which one thinks certain relevant outcomes are contingent on their behaviour. Though born as a psychological concept, locus of control has later been widely used in economics, in particular health economics (Furnham 1986; Wallston 1978).

results. Section 5 examines the robustness of our descriptive and inferential results. Section 6 concludes.

2 Background

2.1 Inequality aversion

A classic study by Loewenstein et al. (1989) estimates the shape of an individual utility function that takes both one's own and others' utility into account and shows that the shape of their utility function depends on the "nature of the dispute" (for example, a personal or business matter). In a similar fashion, Fehr and Schmidt (1999) and Bolton and Ockenfels (2000) employ dictator, ultimatum, and gift exchange games to measure IA parameters. The former proposes a share and envy model, where aversion to inequality arises from either leading or lagging behind others in terms of payoffs, while in the latter's model, inequality aversion depends on one's payoff as a share of players' summed payoffs. Amiel and Cowell (1999a) provide evidence of income IA using questionnaire experiments. The evidence suggests that experiment participants would be willing to sacrifice some of their income to reduce income inequality in society.

Inequalities in health are important independently of income inequalities because health is instrumental for individuals' economic performance and productivity, as well as being one of the basic freedoms and opportunities of individuals (Anand 2002). Only under exceptional circumstances could one identify clear cases of "legitimate" inequalities in health (e.g., individuals refusing to exercise, or taking unhealthy diets out of the pursuit of other competing goals). This idea is consistent with specific egalitarianism (Tobin 1970). Furthermore, individuals might exhibit a different form of rationality when they are making decisions in public and private realms, as in the latter realm they are observed citizens in a public (as opposed to private) realm[7] (Harsanyi 1955).

More recently, some contributions elicit health IA parameters to guide welfare evaluation in the health domain. Robson et al. (2017) examines health IA parameters that can be used to represent alternative normative policy concerns for reducing health inequality versus improving total health. Using data from a small-scale survey of the general public in England to elicit health IA parameters, they found that 81% of the population interviewed does exhibit inequality concerns of some kind.[8]

Cookson et al. (2018) develop and test two e-learning interventions designed to help respondents understand this question more completely. The interventions contained a video animation, exposing respondents to rival points of view, and a spreadsheet-based questionnaire that provided feedback on implied trade-offs, from which IA parameters were elicited.[9]

There are two principal problems with the bulk of the previous studies on inequality preference. First, most of the evidence on innate preference for equality comes from laboratory

[7] Ubel and Loewenstein (1996) find that people prefer an egalitarian equilibrium of giving everyone the chance of having a transplant even though the possibility of failure might be higher for certain groups, hence reducing overall health.

[8] And there is evidence suggesting a substantial concern for health inequality among the English general public, which, at current levels of quality-adjusted life expectancy, implies weighting health gains to the poorest fifth of people in society six to seven times as highly as health gains to the richest fifth.

[9] After the e-learning intervention, a marginal health gain is still valued much more highly for the poorest fifth than the richest fifth, by multiples of 2.6 and 7.0, respectively (for details of these calculations, see Robson et al. (2017).

or classroom settings rather than representative-sample surveys. Many previous studies are small scale, and have limited external validity. Second, the studies usually examine inequality preferences only on a single domain. Recently, Attema et al. (2023) studied risk and inequality preferences in both income and health domains. Our paper attempts to further contribute to both issues.

2.2 Domains of inequality

People's inequality preferences differ across domains for economic reasons. For example, income might be perceived as resulting from work effort, while health might be perceived as influenced by genetic endowments. If people find effort-induced inequality more acceptable than endowment-induced inequality, then they would be more averse to health than to income inequality.[10] However, a component of people's health is behavioural, which means the result of preventable conditions might reflect in inequality judgment (Spring et al. 2013). Also, marginal changes in effort might not be reflected in changes in income.

An alternative argument underpinning the differences in inequality preferences across domains is that income can be accumulated over time (Cruces et al. 2013). By contrast, health is harder to accumulate in a similar way. Health capital has more dimensions than income and is relatively harder to measure with precision than income. Individuals might reveal a higher IA in those domains where the outcome variable can be more easily stocked.

One of the more difficult issues to address is that health and income are related. A higher income is likely to result in better overall health (Grossman 1972), and healthier individuals are more likely to be productive and earn more. Evidence suggests that individuals distinguish pure and income-related health inequalities in experiments when they are reminded of their difference (Robson et al. 2024a). Our paper treats the two domains as separate, without incurring an impression on survey participants of the relation between income and health.

Hurley et al. (2020) estimate IA in Ontario using a representative online survey and find that mean income IA is greater than mean health IA. Furthermore, aversion to income-related health inequality is greater than aversion to income or health alone, which suggests that the public is more concerned about inequalities that are systematically related to a person's socio-economic status (Hosseinpoor et al. 2012; Hurley et al. 2020; Robson et al. 2024a). Leibler et al. (2009) find support for a Pigou-Dalton transfer being stronger in the context of income rather than health. Abasolo and Tsuchiya (2020) compared losses in income and health from an ex-ante or social risk perspective, as opposed to an ex-post or outcome perspective: people might be more averse to the dimension of wellbeing that can be measured — which would make them more averse to income inequality.[11]

Overall, aversion to health inequality has been less intensively studied than individual aversion to income inequality. Typical studies include Abásolo and Tsuchiya (2013), Abasolo and Tsuchiya (2020), Hurley et al. (2020), Hosseinpoor et al. (2012), and Leibler et al. (2009) who treat health IA and income IA as distinct concepts. In particular, Pinho and Botelho (2018) emphasized the sensitivity of inequality preference to the elicitation procedure used. However, most evidence comes from small-scale experiments that have limited external

[10] This is an example of luck egalitarianism, which argues that inequalities resulting from arbitrary factors (luck) should be first compensated. And even within a domain, nudges that stress the importance of luck in determining individual income raise inequality aversion as Bergolo et al. (2022) found.

[11] They found that outcome and social risk perspectives deliver different estimates, and in an outcome framework, income IA is stronger than health IA. It is worth noting that Abasolo and Tsuchiya (2020) did not find the aversion estimates to vary with individual characteristics, which might suggest the presence of strong unobserved driving factors.

validity. Studies looking at inequality aversion in a specific domain or inequality aversion, in general, are subject to a similar problem. Examples of such research drawing upon small-scale experiments include Amiel and Cowell (1999a), Bolton and Ockenfels (2000), Bosmans and Schokkaert (2004), Carlsson et al. (2005), Cowell and Schokkaert (2001), and Fehr and Schmidt (1999). The use of wide-scale survey evidence can advance the understanding of the sources of IA preferences.

2.3 Elicitation of IA

Previous studies on IA either do not use the same methodology for income and health (Cropper et al. 2016), or they do not engage with the veil of ignorance hypothesis, which makes estimates sensitive to strategic responses (Buckley et al. 2012). Typically, the elicitation task used requires an individual to choose between two hypothetical societies that are made different by a policy and, hence, are subject to heuristics and biases, as well as the participant's reference points, which are specific to the society they currently live in. Schildberg and Hörisch (2010) studied the importance of the veil of ignorance in making choices and show that, behind the veil of ignorance, subjects choose more equal distributions, not only for insurance purposes but also because of a genuine social preference for equality.

To mimic the "veil of ignorance" condition, we consider two different elicitation methodologies. To make sure respondents understand the question, we use a simple description of scenarios that have been piloted. One elicitation method is to directly elicit individuals' trade-off preferences between the level of an outcome and the inequality of the outcome. The other elicitation method is the "imaginary grandchild" approach, followed by a choice of lottery scenarios that request individuals make a choice of society for their (hypothetical) grandchild.[12] Respondents can be randomly assigned to a choice scenario with different income or life expectancy means and distributions. In follow-up responses, one can vary the questions offered to respondents to test for order effects and their sensitivity to various parameters.[13] Bergolo et al. (2022) is the closest to our paper in methodology that focuses on university students in Uruguay studying income inequality aversion.

There are alternative methods to elicit inequality preferences. For instance, a decision-maker method may result in preferences influenced by their awareness of their own social status, which might not reflect their "true preferences". Alternatively, it may be beneficial to acknowledge the complexity of disentangling preferences and interests by considering a preference for income distribution in scenarios like an imaginary trade union negotiation (e.g., salary bargaining), although this approach may exclude groups such as the self-employed, and it only applies to the employment income domain. Similarly, one can rely on experimental methods and use leaky-bucket or dictator games, where imaginary transfers of resources involves trade-offs between reducing inequality and improving efficiency or increasing their own income (Amiel and Cowell 1999b; Fehr and Schmidt 1999; Fong 2001; Pirttilä and Uusitalo 2010). However, this does not apply to the health domain. In fact, for health, ideal methods are more limited, as health measurements often involve greater error and are influenced by self-reporting biases (Costa-Font and Cowell 2019).

Our paper adopts the method of Carlsson et al. (2005) an approximation to the concept of a veil of ignorance. When comparing income and health, using the perspective of an

12 This is more realistic considering that most people have children and that our analysis by age groups and household size heterogeneity shows that the effect is not affected by relevant demographic characteristics.

13 The discrete choice experiment questions we propose allow eliciting a consistent measure of IA at the individual level for both income and health, which has already been piloted and tested in small samples.

imaginary grandchild is more realistic, as policymakers often prioritize their own preferences over those of their constituents and may not act as benevolent decision-makers. By contrast, individuals may reveal preferences more aligned with their true values when they think about an imaginary family member. The approach also facilitates a direct comparison of income and health outcomes. These are the advantages of the imaginary-grandchild approach over indirect elicitation methods, such as life-satisfaction surveys or revealed preferences.

2.4 Determinants of inequality preferences

2.4.1 Risk attitudes

IA is related to the risk attitude behind a veil of ignorance. This is because a person's ranking of income distributions under uncertainty of their exact position in each distribution depends on their risk preferences. Amiel and Cowell (1999a) use an experimental method to elicit IA; similarly, Cowell and Schokkaert (2001) and Amiel et al. (2001) discuss evidence of the potential link between attitudes towards risk and how individuals trade off inequality and outcomes in a society. Johansson-Stenman et al. (2002) develop experiments where they make participants make choices behind the veil of ignorance to elicit trade-offs between income and inequality. Using a well-being measure, Ferrer-i-Carbonell and Ramos (2010) show that the relationship between risk attitudes and IA survives the inclusion of individual characteristics (e.g., income, education, and gender). Other methods include Bellemare et al. (2008) estimate IA for a representative sample of the Dutch population using an ultimatum game with subjective probabilities and Koch et al. (2018) employs binary lotteries to show a clear sensitivity to risk preferences.

However, some research demonstrates the presence of IA independent of risk aversion. Carlsson et al. (2005) estimate risk aversion and IA separately, since people may value equality per se, that is, they value the fact itself of living in a relatively equal society, irrespective of the level of uncertainty regarding their position in the social ladder. In a laboratory experiment, Kroll and Davidovitz (2003) studied children's inequality preferences while holding the risk level constant. Attema et al. (2023) find that, while aversion to risk and inequality is the mean preference for outcomes in health and wealth, attitudes toward individual risk are moderated in the loss domain for health and wealth. In our survey, we measure risk preferences drawing on Dohmen et al. (2011) rather than using lotteries, and we investigate whether IA is still present when we control for risk aversion.

2.4.2 Locus of control

A key behavioural determinant that has received limited attention is locus of control (LOC), which measures the degree to which people feel they can control their lives, both in the health and financial domains. Intuitively, one might think that those who think they have more internal control tend to be less inequality-averse, as they attribute one's well-being to one's actions. However, Andor et al. (2022) find that individuals with more internal LOC are more likely to believe that social problems can be solved through action and that the subjective benefits of acting in a prosocial manner outweigh the costs of doing so.[14] Our paper tests whether a feeling of more control leads to greater or less inequality aversion.

[14] While the authors focus on the case of public goods provision, their finding can also be extended to inequality reduction: those with more internal LOC is more willing to reduce outcome inequalities, even if the cost is a decrease in the mean level of that outcome.

2.4.3 Other behavioural explanations

Health status and health-related experience also explain inequality preferences. Tsuchiya and Dolan (2007) find differences between members of the public and those working for the National Health Service: ordinary people are more averse to inequality than clinicians. Another important determinant of inequality attitudes is an individual's health severity and its distribution. Nord (1993) argues that the priority given to the worse-off should increase with the severity of their illness, and more attention should be paid to the worse-off the more inequality there is in society. There is evidence that younger and more educated people tend to be less averse to inequalities, while women and left-wing voters tend to be more inequality averse (Bellemare et al. 2008; Carlsson et al. 2005; Hardardottir et al. 2021; Lindholm et al. 1997).[15] Abásolo and Tsuchiya (2013) show that blood donors are more likely to be egalitarians. Dolan and Robinson (2001) invoke loss aversion as an explanation for differences in levels of IA across different experiments. This evidence suggests that there is a need to investigate further the behavioural foundations of health-inequality preferences.

A role may also be played by individual attitudes toward luck and effort. Health status may be only to a limited extent the result of individual choice: there is an important role for luck (Fleurbaey and Schokkaert 2009). Luck can play a larger role in influencing health than in other areas of behaviour. If one thinks income and health outcomes are more determined by luck rather than individual effort, then intuitively one should be more supportive of government redistribution and favour lower inequality against higher average outcome levels. Hardardottir et al. (2021) examined individual belief on the source of health, wealth and success, but found no significant effects. Edlin et al. (2012) posed more specific questions, distinguishing between "blameworthy" groups (those whose illness is perceived as their own fault) and "trustworthy" groups. They found that while respondents tended to devalue the lives of the blameworthy group, they also assigned higher priority to them if they faced worse health prospects. This reflects a greater weighting of the severity of health outcomes over moral judgments irrespectively of the cause of a health shock. Robson et al. (2024b) found that health disadvantaged individuals (such as smokers and the poor) tend to be assigned a greater welfare weight.But as beliefs about responsibility for income and smoking strengthen, weights on the poor decrease and weights on non-smokers significantly increase. Our paper will provide a detailed examination of how a range of behavioural variables mentioned above influence inequality preferences.

3 Data and methods

For this study we designed and conducted two survey experiments collecting information on behavioural parameters, socio-economic status, demographic characteristics, as well as different measures of inequality preferences in the income and health domains. Our survey was carried out in two consecutive years–2016 and 2017–so the evidence is comparable and composed of questions that were previously piloted. The sample size is about 2000 each year. Each survey included an experiment where individuals were asked to choose a hypothetical society for their grandchildren in the domain of income and health. We use the respondent's choice of (hypothetical) society to estimate their level of IA. These estimates were used

[15] Nevertheless, Abásolo and Tsuchiya (2008) found that attitudes to egalitarianism in health care depend on the question framed, and gender and income have no effect on attitudes. Meanwhile, age has a non-monotonic effect on IA, where younger and older people are less inequality averse than middle-aged people.

to estimate the implied confidence intervals of IA parameters, and regression analysis was employed to study the behavioural determinants of IA.

3.1 Model: standard form

Using the model developed by Carlsson et al. (2005), individual utility is given by $u(y, \Phi, \gamma)$, where y is their income and Φ is an inequality index. Here, γ is a parameter of individual IA which can be interpreted as the inequality elasticity, reflecting the percentage point change in income that would hold utility constant under a 1% increase in inequality. $\gamma = 0$ corresponds to the conventional case where utility is independent of the income distribution, $\gamma < 0$ reflects inequality-prone preferences, and $\gamma > 0$ reflects inequality-averse preferences. $\gamma = 1$ implies that a 1% increase in own income gives as much utility as a 1% decrease in the inequality measure, whereas $\gamma > 1$ implies that a 1% decrease in the inequality gives more utility than a 1% increase in own income. The utility function is assumed to take the form:

$$u = h(y\Phi^{-\gamma}) \tag{1}$$

where $h(\cdot)$ is any monotonically increasing transformation. If we adopt the coefficient of variation $\frac{\sigma}{\mu}$ as the inequality index Φ, then Eq. 1 can be written as the following, where μ_y is mean income and σ_y is standard deviation of societal income distribution:

$$u = h\left(y\left(\frac{\mu_y}{\sigma_y}\right)^{\gamma}\right) \tag{2}$$

If societies A and B are regarded as equally good, then Eq. 2 can be re-arranged into:

$$y_A\Phi_A^{-\gamma} = y_B\Phi_B^{-\gamma} \tag{3}$$

Equation 3 enables us to pin down the value of γ:

$$\gamma = \frac{\ln(y_A/y_B)}{\ln(\Phi_A/\Phi_B)} = \frac{\ln(y_A/y_B)}{\ln(\sigma_A/\sigma_B) - \ln(\mu_A/\mu_B)} \tag{4}$$

The model can be extended into the health domain, where income y is replaced by life expectancy h. Støstad and Cowell (2024) provides further theoretical justification for this approach, in contrast to a social welfare function approach.

3.2 Model: assumptions

The model rests on the following assumptions (Bergolo et al. 2022). First, inequality affects individual utility only in the consequential sense, i.e., people care about the level of societal inequality but not the mechanisms generating inequality. Nevertheless, our paper also tests whether perception on the importance of luck versus effort in personal success affects inequality aversion.

Second, the model captures non-self-centered inequality aversion, in which individuals like or dislike inequality depending on the parameters of the outcome distribution, but not how their own income compares to that of others (self-centred inequality aversion). This motivates an elicitation approach that abstracts from personal circumstances, as we explained already.

Third, preferences assume a form where inequality aversion remains unchanged under equal proportionate changes in Φ_A and Φ_B, rather than equal absolute changes in Φ_A and Φ_B.

The coefficient of variation satisfies this criterion as it is scale invariant and scale independent. It is worth noting that the coefficient of variation is also translation invariant but not translation independent. In the robustness check section, we will further discuss the possibility of using alternative measures of inequality as Φ.

3.3 Measuring IA

In the 2016 survey, we measure IA via two different techniques: direct elicitation through trade-off questions, and lottery-based elicitation. That is, each participant answers questions from both methods. In the 2017 survey, the (two-round) lottery-based technique is used.

3.3.1 Direct trade-offs

We measure IA directly from the following trade-off questions: "Reducing health inequality is more important than improving total health" and "Improving total health is more important than reducing health inequality". We ask participants, on a scale of 1 to 10, to what extent they agree with the above claims. These simple questions have been used in previous studies (Asaria et al. 2023). The presumption is that people are able to abstract from their personal circumstances, and we transform answers x_i^j of individual i in domain j, thus $\gamma^j = \frac{10-x_i^j}{9}$.

3.3.2 Lottery-based elicitation on income

Respondents are asked what kind of world they would like their (imaginary) grandchild to live in, without knowing ex ante the status of their grandchild in the income and health hierarchy. This mimics the veil of ignorance condition that is crucial in measuring IA under the model specified earlier. We ask respondents to make a choice between two scenarios A and B which differ in terms of the range of incomes in society (incomes are in £ per year; in every other respect A and B are the same). There are four possible answers: "A is better", "B is better", "A and B are equally good", and "Cannot say". Scenario A's incomes ranges from £20,000 to £100,000 with an average of £60,000.

To obtain greater benefit from the survey we quasi-randomise the specific numbers presented in scenario B in each case (scenario A remains unchanged). Hence, scenario B would be randomly chosen from four versions, B1 to B4, as shown in Table 1. In addition to the above questions, the 2017 survey includes a follow-up round of elicitation: depending on respondent choice in the baseline round explained above, lottery B, B1 to B4 are replaced by new lotteries correspondingly. The new lotteries are summarised in Table 2. Supplementary Information A presents the survey questions in detail.

3.3.3 Lottery-based elicitation on health

The questions are framed as described above. We ask respondents to make a choice for their (imaginary) grandchild between two scenarios A and B which differ in terms of the range of life expectancy in society (life expectancy is measured at birth; in every other respect A and B are the same). Again, there are four possible answers: "A is better", "B is better", "A and B are equally good", and "cannot say".

Scenario A is: Life expectancy is between 40 and 80, with an average of 60. Scenario B would be randomly chosen from four versions in the baseline round. Depending on their

Table 1 Imaginary Grandchild: Baseline Scenarios

	Income				Health				2016		2017	
	Min	Mean	Max	γ	Min	Mean	Max	γ	No.	Freq.	No.	Freq.
Lottery A	20,000	60,000	100,000		40	60	80					
Lottery B1	30,000	50,000	70,000	0.36	60	65	70	–0.05	494	0.25	501	0.24
Lottery B2	40,000	60,000	80,000	0.00	30	60	90	0.00	501	0.25	513	0.25
Lottery B3	20,000	35,000	50,000	1.22	45	60	75	0.00	506	0.25	519	0.25
Lottery B4	30,000	65,000	100,000	–0.37	50	67.5	85	–0.54	507	0.25	516	0.25
									2,008	1.00	2,049	1.00

Table 2 Imaginary Grandchild: Follow-up Scenarios

	Income						Health					
	Min.	Mean	Max.	γ	No.	Frequency	Min	Mean	Max	γ	No.	Frequency
Lottery A	20,000	60,000	100,000				40	60	80			
					**If chose A in original lottery*							
Lottery B	10,000	65,000	120,000	0.34	588	0.45	30	60	90	0.00	571	0.38
					**If chose B(#) in original lottery*							
Lottery B1	40,000	50,000	60,000	0.15	140	0.11	65	68	71	–0.06	304	0.20
Lottery B2	30,000	50,000	70,000	0.36	233	0.18	46	58	70	0.07	112	0.07
Lottery B3	25,000	40,000	55,000	0.70	80	0.06	50	60	70	0.00	98	0.07
Lottery B4	40,000	65,000	90,000	–0.15	253	0.20	56	68	80	–0.20	415	0.28
					1,294	1.00					1,500	1.00

answers, respondents will be asked to compare lottery A with a new lottery in the follow-up round. The procedure is similar to the income IA elicitation design, summarised in Tables 1 and 2. Supplementary Information A presents the survey questions in detail.

3.3.4 Computation of IA

Responses to the lottery-based questions are used to calculate IA parameters. The boundary values, also presented in Tables 1 and 2, are obtained by the following method. Assuming uniform distributions, we can calculate the mean, standard deviation and coefficient of variation of each income and healthy life expectancy distribution. For example, if a society's income is uniformly distributed over $[a, b]$, then $\mu = \frac{a+b}{2}$, $\sigma^2 = \frac{(b-a)^2}{12}$, and Φ is then σ/μ. Although a Pareto distribution might be considered a more appropriate depiction of income distributions in reality, it is more reasonable to assume that participants intuitively assess their imaginary grandchild's (uncertain) position in the hypothetical societies using a uniform distribution. We also assume that behind the veil of ignorance, expected income or health is equal to the mean of their respective distributions.

When presented with two versions of an imaginary society to choose from, respondents could state that they are indifferent between the two choices, and then γ can directly be calculated using the model in 3.1. If respondents expressed a strict preference, then we can infer the range of their IA parameters. To illustrate with an example: suppose an individual is given the choice between two societies, where in society A the coefficient of variation $\Phi_A = 0.3$, and the individual's monthly income $y_A = £24,000$, while in the more equal society B $\Phi_B = 0.2$ and $y_B = £20,000$. A respondent who is indifferent between A and B has an IA parameter of $\gamma = 0.45$. A respondent who prefers the more equal society B has $\gamma > 0.45$, and a strict preference for society A gives $\gamma < 0.45$. A rule of thumb here is that the greater is a person's γ, the more IA there is. Tables 1 and 2 summarise the indifference-level γ values that individuals face for each pair of lotteries in each survey year.

3.4 Empirical strategy

Given that our estimates follow from individual choices about lotteries where individuals are presented with different levels of relevant average well-being outcomes (income or health), and inequalities in such outcomes are defined in an upward and downward outcome range, we estimate a series of interval regression models. The general equation is:

$$\gamma_i^j = L(x'_{b,i}\beta_1 + x'_{s,i}\beta_2 + x'_{d,i}\beta_3 + \varepsilon_i) \tag{5}$$

where γ_i^j is the IA parameter (interval estimates) for individual i in domain $j \in \{y, h\}$ with y for income and h for health; γ_i^j could be distributed as point data, left-censored, right-censored or interval data; $x'_{b,i}$ represents an array behavioural variables; $x'_{s,i}$ is a vector of socioeconomic control variables; $x'_{d,i}$ is the demographic control variables; ε_i is idiosyncratic error. $L(\cdot)$ is a function that transforms the linear combination of independent variables into γ. The regression coefficients are estimated by the maximum likelihood method.

The behavioural determinants are risk aversion and LOC for the 2017 survey, where we identify the domain of the behavioural determinants, namely financial and health locus of control, as well as financial and health risk attitude. In the 2016 survey, this distinction is not made, although, on top of risk aversion and locus of control, we have patience and attitude toward luck as behavioural variables. In our baseline estimates, we include age, gender and region as demographic controls, with income and education as socio-economic controls. In the robustness check section, we add employment status, marital status and number of children as additional controls.

For IA estimates from the trade-off approach, we use a simple linear model. Our empirical specification is:

$$\gamma_{i,trade}^{j} = x_{b,i}'\beta_1 + x_{s,i}'\beta_2 + x_{d,i}'\beta_3 + \varepsilon_i \tag{6}$$

where $\gamma_{i,trade}^{j}$ is the trade-off IA parameter (point estimates) for individual i in domain $j \in \{y, h\}$ with y for income and h for health, $x_{b,i}'$ are behavioural variables; $x_{s,i}'$ are socioeconomic controls; $x_{d,i}'$ are demographic controls; ε_i is idiosyncratic error as before.

The coding of the covariates is summarised in Supplementary Information C. Note that in some cases control variables take values such as "don't know" or "prefer not to say", which complicates the interpretation of the coefficients. In response, we include dummy variables that take value one for each of these categories for each control variables.

4 Descriptive statistics

4.1 Distribution of IA estimates

Following the method explained above, for each pair of scenarios of the "imaginary-grandchild" questions, we estimate the boundary values of the IA parameters. For example, when asked to choose between Scenario A: incomes range from £20,000 to £100,000 with an average of £60,000, and Scenario B: incomes range from £30,000 to £70,000 with an average of £50,000, if respondent j answers that they are indifferent between the two, then they reveal their income IA parameter is $\gamma_i^y = 0.36$. If they prefer A, then we can infer that $\gamma_i^y < 0.36$; and if they prefer B, then $\gamma_i^y > 0.36$. γ_i^y and γ_i^h are defined in Section 3.3, taking values of $[-10, 10]$ for the imaginary-grandchild approach, and discrete values of 1 to 10 for the trade-off approach. We later re-scale the trade-off response to interval [0, 1] as in Section 3.3.1, so that estimates across approaches are comparable.

In the 2016 survey, participants were only asked one question per domain. However, in the 2017 survey, we used follow-up questions to help us further narrow down the possible range of IA parameters for each individual. Additionally, in the 2017 survey experiment, it is possible to identify inconsistencies from the follow-up questions.[16] Figure 1 below summarises interval estimates of income and health IA from the 2016 and 2017 surveys respectively.

The comparisons of distributions of IA depends on the relevant domains and elicitation techniques. In the first two panels of Fig. 1, the trade-off responses for both income and health IA exhibit a focus point at the median value 5. This corresponds to a value of 0.6 after re-scaling to the support [0, 1]. Extreme responses tend to be rarer as they depart from the median, but also the distribution is skewed for health IA where a larger share of responses that put greater importance on improving total health than reducing health inequality. This suggests that there is greater aversion to income inequality than health inequality, which we will formally test in the next subsection.

16 For example, if a person strictly prefers income scenario A to B3, but then says that they prefer A to the replaced B3 in the second round, then we label their response as inconsistent, as the first response suggests a parameter range smaller than 1.22, whereas the second suggests a range larger than 0.70, i.e., the two responses are contradictory. Around 10% of respondents give inconsistent responses.

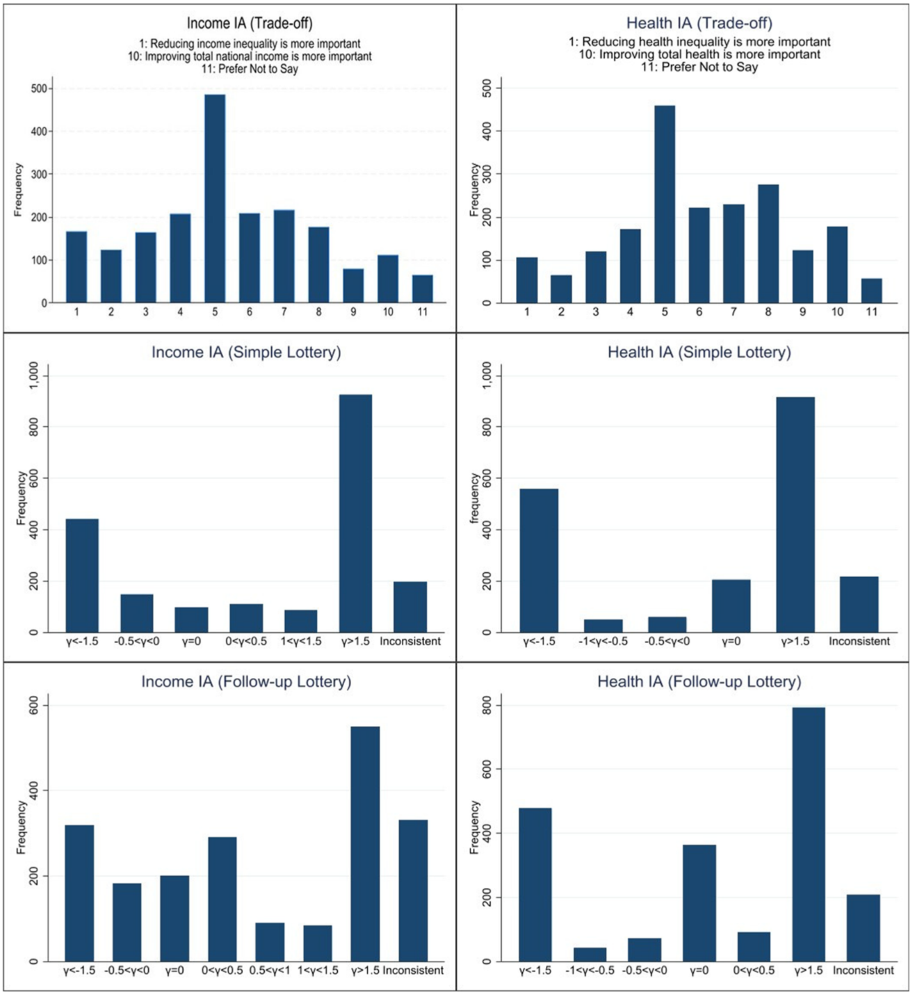

Fig. 1 Distribution of IA Estimates. Note: This figure plots the distribution of IA estimates from our surveys, from the trade-off, simple and follow-up lottery approaches respectively

As for the raw estimates from the lottery approach, both income and health IA estimates reveal similar bimodal distributions. From the bottom four panels of Fig. 1, the two most common categories for the income and health IA estimates are $\gamma > 1.5$ and $\gamma < -1.5$. In the case of income IA in 2017, the point estimates $\gamma = 5.18$ and $\gamma = -4.83$ are the modal responses. As for health IA, $\gamma = 4.73$ and $\gamma = -5$ are the modal point estimates. This bimodality is consistent with the findings in Hurley et al. (2020) and Cropper et al. (2016), that respondents are either very averse or not at all averse to health inequality, with only a small proportion of people having moderate level of IA. In Cropper et al. (2016), 30% of respondents always preferred the more equal distribution of health risks in all questions, suggesting strong inequality aversion. Hurley et al. (2020) elicit preference for inequality in actual income and health rather than risks: their design has the same set of boundary values of γ for income and health, whereas in our design the boundary values differ in some places. While this makes our parameters non-perfectly comparable across domains, the use of a wider range of boundary values, namely negative values, enable us to locate inequality-prone preferences. The modal responses at positive and negative values of γ imply that respondents are either highly averse to or highly prone to inequalities in both the income and health domain. Furthermore, while there is a large share of positive IA estimates in the health domain, there is a large number of even larger positive estimates in the income domain. The most popular point estimates in the positive range in 2016 is $\gamma = 4.9$ for health IA and $\gamma = 5.18$ for income IA. This further suggests that the strength of aversion to income inequality is higher than to health inequality.

Overall, the lottery estimates conform more closely to a bimodal than bell-shaped distribution. Raw estimates reveal a larger share of extreme answers.[17] This suggests that they might perceive the imaginary-grandchild and trade-off questions differently: the imaginary grandchild approach is less explicit about the sacrifice to aggregate outcomes by improving equality, as γ is not immediately clear after participants express their preferences between versions of societies, whereas in the trade-off questions, people directly give out their views by choosing a number on a scale of 1 to 10. Despite this difference in perception, a higher share of respondents agree more with the statement that reducing inequality is more important than improving the total outcome in the income domain than in the health domain. This corroborates the observation that aversion to income inequality is on average higher than health inequality.

4.2 IA Heterogeneity across domains and groups

Beyond the overall distributions of our IA estimates, we compare their summary statistics across domains and groups, detailed in Tables B9 and B10 in the Supplementary Information, while grpahical comparisons in Fig. 2 below. From Tables B9 and B10 we observe that the sample mean of income IA is greater than that of health IA in all elicitation methods. In the lottery approach, the difference in sample means across domains is significant at the 5% level in the 2016 (but not 2017) survey. The greater aversion to income IA is attributable to the previously noted fact that the modal response in the positive ranges for income IA bear higher magnitudes than the positive modal response for health IA. Income IA is also significantly greater than health IA on average when elicited via trade-off questions, despite taking a distribution form different than the distribution of the imaginary-grandchild responses. In other words, regardless of the elicitation approach, respondents express greater aversion to income inequality than to health inequality on average. This supports (Tobin 1970's) original hypothesis that IA is domain-specific, as well as subsequent findings from e.g., Leibler et al. (2009), Abasolo and Tsuchiya (2020) Hurley et al. (2020), and more recently Hardardottir et al. (2021) that health IA is lower than income IA. Comparing estimates across methods, we observe that the second round of elicitation reduces the sample means of both income and health IA. The standard errors have also decreased, which means the follow-up lottery questions lead to greater precision of estimates as expected. Re-scaled estimates from the trade-off approach have the lowest sample means and the least spread, which is attributable to the fact previously noted that trade-off responses are concentrated at the neutral preference.

We also group the estimates by age and gender. Figures 2 visualises the point estimates along age from Table B10, with one standard error confidence. The 2017 survey gives a 'hump shape' of IA estimates by age. Young and old people in the sample are on average

[17] Predicted values of IA using socio-demographic characteristics tend to follow a bell-shaped distribution, although this result is now removed from our discussion.

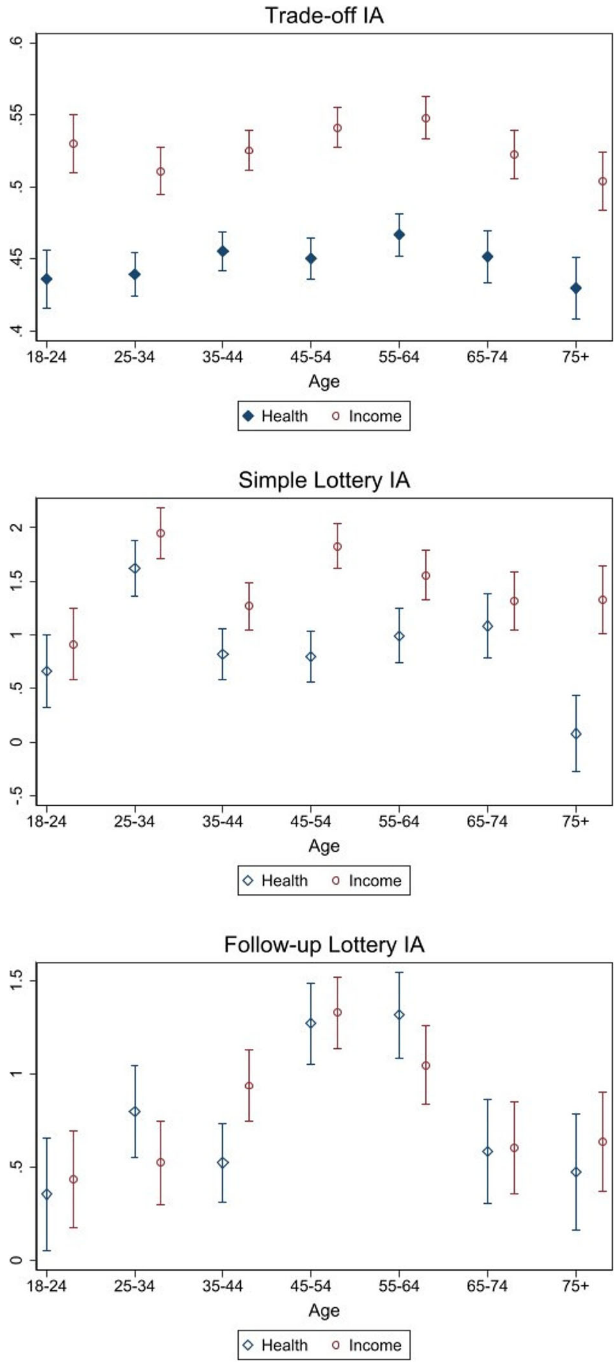

Fig. 2 IA Heterogeneity Across Domains and Groups. Note: This figure plots the point IA estimates from the trade-off, simple and follow-up lottery approaches respectively. The confidence intervals are of one standard error length. We group the income and health IA estimates by age and gender

less averse to income and health inequality than middle-aged respondents, consistent with Abásolo and Tsuchiya (2008). People aged 18-24 have health and income IA of 0.3 to 0.4, while people aged 45-54 have inequality aversion of as high as 1.3, indicating that they are willing to reduce inequality by 10% at the cost of a 13% reduction in total outcomes. While our estimates are on average greater than (Bergolo et al. 2022's) baseline IA estimates of 0.2 for university students, we consistently identify that the younger population are much less averse to income and health inequalities than the middle-age group. This hump-shape across age groups is also observable from the trade-off responses, although less clear in the simple lottery responses, where the estimates are less accurate than in the follow-up lottery.

As for differences across genders, from Table B9, we observe no robust difference in the IA estimates between male and female participants, in income and health domains likewise. It is also worth noting that income IA is greater than health IA in almost all age groups and across genders, suggesting that the domain-specificity is not driven by a particular sub-group, but is a more general pattern.[18] We found northern regions to be more averse to income and health inequality than the midlands overall, with Scotland as the most averse, followed by the East of England and London being the least averse to health inequality. Further details on regional heterogeneity are available in Costa-Font and Cowell (2025).

5 Behavioural determinants of IA

In this section, we examine the role of behavioural determinants of inequality aversion. To this end, we regress the IA estimates on risk attitude, locus of control, patience, and luck, controlling for socio-economic and demographic characteristics. As explained above, we use interval regression technique with maximum likelihood estimation for interval IA estimates as in Eq. 5, and we use linear regression with ordinary least squares estimation for point IA estimates and trade-off responses as in Eq. 6. Note that in the 2017 survey, we used domain-specific risk attitude and locus of control. We have patience and perception of the role of luck as an additional behavioural variable in the 2016 survey. Tables 3 and 4 present the main results, and in Supplementary Information B we include Tables B11 to B14 for additional specifications. Summary statistics of these variables are provided in Tables B7 and B8 also in Supplementary Information B. The coding of covariates used is summarised in Supplementary Information C.

5.1 Trade-off approach

Columns (1) and (2) in Table 3 use re-scaled trade-off responses as dependent variables, with support from 0 to 1. We identify risk aversion, locus of control, and luck as significant determinants of IA elicited via the trade-off approach. Respondents assign greater importance to reducing inequality in both income and health domains than improving the corresponding total outcome when they are more risk-averse, feel more internal control, and feel luck is more important in determining personal success. We interpret the coefficient estimates in columns (1) and (2) as follows. Initially, we compare a person who is very unwilling to take risks to a person who is very willing to take risks; the former is on average 0.15 more averse to income inequality and 0.09 more averse to health inequality on a scale of 0 to 1, holding the

[18] The only exceptions are the 25-34 age group, plus the follow-up lottery estimates across genders.

other covariates constant.[19] Referring to Table B9, these are around half a standard deviation of the increase in inequality aversion.

In comparison, the effect of attitudes toward luck are much stronger than risk aversion on IA. Those who believe that success is solely dependent on effort have an inequality aversion parameter 0.28 lower than those who believe that success is solely dependent on luck. This result supports the luck-egalitarianism hypothesis.[20] It is also consistent with recent findings such as Edlin et al. (2012) and Robson et al. (2024b), where aversion to health disadvantages becomes weaker if they are due to irresponsibility. Locus of control has a weaker effect of about half the strength of risk aversion. Besides the difference in magnitude, the coefficient estimates for all three behavioural determinants are significant at the 1% level.

Collectively the explanatory variables have an R^2 of 0.096 and 0.065 in columns (1) and (2). The direction and size of the above-mentioned effects remain robust in alternative specifications listed in Table B11 in the Supplementary Information. Comparing columns (1) with (3) and then (3) with (6), we notice that the inclusion of control variables amplifies the effect of risk aversion and locus of control while lowering the magnitude of the effect of luck. Comparing columns (1) with (2) and then (4) with (5), we notice that the inclusion of locus of control does not absorb the effect of other behavioural determinants nor the other control variables.

5.2 Lottery approach

Columns (3) and (4) of Table 3 use interval IA estimates from the 2016 lotteries as dependent variables. Here, both risk aversion and attitudes toward luck have much smaller effects on IA compared with previous columns (1) and (2) when adjusted to the same scale, and the estimates are statistically insignificant. In contrast, locus of control remains a significant determinant of IA. Using interval estimates, we find that individual who strongly agrees that they have little control over what happens to them is on average expected to be 0.34 less averse to income inequality and 0.08 less averse to health inequality, compared with one who strongly disagrees with the statement. This effect is small in magnitude, given that the standard deviations for income and health IA are 4.1 and 4.4, respectively. In Table B12 we include alternative specifications. Comparing columns (1) with (2) and then (4) with (5), we again notice that the inclusion of locus of control mildly changes the coefficients on the other covariates in terms of magnitude, but not statistical significance.

As for the 2017 interval IA estimates, Table 4 uses interval IA estimates in the income domain as the dependent variable. Consistent with the results from the trade-off and simple lottery methods, estimates suggest that higher risk aversion and weaker feelings of internal control are associated with a higher aversion to income inequality. Furthermore, financial risk aversion and health locus of control are among the most significant behavioural determinants of IA. In column (1) where financial and health locus of control are included, we see that risk aversion becomes insignificant. The health locus of control is significant across specifications. An individual who feels that they have little control over their health is, on average, 0.21 less averse to income inequality than one who strongly disagrees with the statement. It is worth noting that financial risk aversion bears a significant negative coefficient in the incomplete specification (2), but the intercept is positive with strong statistical significance, further

[19] See Supplementary Information C for the coding of variables. For risk aversion, 1 stands for very unwilling to take risks, and 10 for very willing.

[20] See Lippert-Rasmussen (2001), Segall (2009), Bergolo et al. (2022) and footnote 10.

Table 3 Determinants of IA: 2016 Survey

	(1) γ^{y}_{trade}	(2) γ^{h}_{trade}	(3) γ^{y}_{simple}	(4) γ^{h}_{simple}
Risk Aversion	−0.0152***	−0.00933***	−0.0114	0.00263
	(0.00293)	(0.00296)	(0.0104)	(0.00308)
Locus of Control	−0.00895***	−0.00964***	−0.0338***	−0.00846**
	(0.00307)	(0.00312)	(0.0109)	(0.00334)
Patience	0.00233	−0.00320	0.00279	−0.00555*
	(0.00298)	(0.00308)	(0.0106)	(0.00322)
Luck	−0.0284***	−0.0214***	−0.0113	−0.00242
	(0.00385)	(0.00411)	(0.0136)	(0.00402)
Age	−0.00154	0.000331	−0.0177	−0.00392
	(0.00384)	(0.00392)	(0.0154)	(0.00432)
Gender	−0.0180	−0.0384***	0.0566	−0.00120
	(0.0128)	(0.0129)	(0.0504)	(0.0150)
Income	−0.00132***	−0.000751**	−0.00195	−0.000456
	(0.000346)	(0.000348)	(0.00132)	(0.000385)
Education	0.0299***	0.0325***	0.0204	−0.00584
	(0.00973)	(0.00962)	(0.0385)	(0.0114)
Constant	0.902***	0.775***	0.952***	0.0937
	(0.0569)	(0.0591)	(0.216)	(0.0642)
N	1770	1774	1656	1638

Robust standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Note: this table uses IA estimates from the trade-off and simple lottery approaches. γ^{y} denotes income IA, γ^{h} denotes health IA, and the subscripts denote the approach used. The behavioural variables of interest are risk aversion, locus of control, patience and luck. Control variables include: age, gender, household income, education, and region fixed-effect (omitted from table)

supporting the finding above that risk aversion alone cannot explain inequality aversion, and the locus of control is another key determinant.

Consistent with results in the income domain, we identify health-LOC as a key behavioural determinant of health IA. However, the magnitude of effect on health IA is about one-third of the effect on income IA, as suggested in columns (3) and (4) of Table 4. Also, financial risk aversion becomes strongly significant. While financial risk aversion only explains part of the health inequality aversion, the inclusion of locus of control only reduces the magnitude of the coefficients on financial risk aversion but not their statistical significance. Considering other specifications in Tables B13 and B14, we find that dropping the control variables in columns (4)-(6) does not change the coefficients on risk aversion and locus of control, suggesting that biases from omitted socio-economic and demographic variables largely cancel out with each other.

These results have the following implications. First, different domains of risk aversion and locus of control have different effects on IA, which was masked in the 2016 survey. Second, financial risk aversion is a key determinant of IA such that greater aversion to risk translates into greater aversion to inequality, but it can only explain a small portion of inequality aversion. There must be reasons beyond uncertainty about one's position in the social ladder

Table 4 Determinants of IA: 2017 Survey

	(1) γ^{y}_{follow}	(2) γ^{y}_{follow}	(3) γ^{h}_{follow}	(4) γ^{h}_{follow}
Financial Risk	−0.0110	−0.0129*	−0.00769***	−0.00778***
	(0.00805)	(0.00730)	(0.00228)	(0.00209)
Health Risk	−0.00391		−0.000391	
	(0.00741)		(0.00212)	
Financial LOC	−0.00146		0.00240	
	(0.00694)		(0.00211)	
Health LOC	−0.0211***	−0.0226***	−0.00762***	−0.00649***
	(0.00749)	(0.00674)	(0.00237)	(0.00207)
Age	−0.00184*	−0.00173*	−0.000133	−0.000175
	(0.00101)	(0.000995)	(0.000287)	(0.000282)
Gender	−0.0832**	−0.0823**	−0.00838	−0.00839
	(0.0334)	(0.0334)	(0.00920)	(0.00915)
Income	−0.00786	−0.00759	0.00303*	0.00272*
	(0.00612)	(0.00605)	(0.00168)	(0.00164)
Education	0.00273	0.00328	−0.00147	−0.00106
	(0.0239)	(0.0239)	(0.00703)	(0.00704)
Constant	0.675***	0.658***	0.0447	0.0512
	(0.126)	(0.123)	(0.0344)	(0.0324)
N	1718	1718	1841	1841

Robust standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Note: this table uses IA estimates from the follow-up lottery approach. γ^{y} denotes income IA, γ^{h} denotes health IA, and the subscript denotes the approach used. The behavioural variables of interest are risk aversion, locus of control, patience and luck. Control variables include: age, gender, household income, education, and region fixed-effect

that motivates them to choose a more equal society at the cost of average outcomes. Third, health locus of control is a significant determinant of IA. The feeling of internal control in the health domain is associated with higher aversion to both income and health inequalities. This confirms (Andor et al. 2022)'s finding that greater internal control encourages pro-social behaviour. When one feels in control of their own finance and health, they have greater mental capacity to care for the distribution of outcomes. Last but not least, inequality preferences in the income and health domain are connected: risk attitude in the income domain affects IA in the health domain; health locus of control can impact income inequality aversion.

6 Robustness checks

6.1 From bimodal to unimodal distribution

As previously pointed out, the income and health IA parameters estimated from the imaginary-grandchild approach tend to be bimodally distributed. However, when comparing the IA estimates by domains and groups, and when calculating the confidence intervals, it would be natural to assume that the mean γ is normally distributed. In order to test whether this assumption distorts the comparison, we smooth the distributions of estimates by using predicted values of γ from Table 3 and columns (1) and (3) of Table 4.

Our descriptive conclusion is robust, as shown in Fig. 1 and Table 5: respondents are on average more averse to income inequality than to health inequality. In both years, income IA is greater than health IA on average, and the difference is significant at the 1% level. It is worth noting that the predicted IA averages are smaller than their corresponding original data. For income IA, the predicted values are about 1/3 of the raw estimates, and for health IA, the predicted values are even negative on average.

6.2 Exclusion of focal responses

To further test for the robustness of our results, we exclude focal responses (i.e. neutral answers that equal 5) to the risk attitude and locus of control questions. The remaining data are used in the same way as before. Supplementary Information Tables B16 and B17 report the results. In Table B16 columns (1) and (2) where the dependent variables are the imaginary grandchild IA estimates, we observe that locus of control remains significant with a negative sign, meaning that those who feel more internal control are more averse to income and health inequalities. Also, the magnitude of the coefficients become larger compared with estimates from columns (1) and (2) of Table B12. The results are similar when we include variables indicating whether the respondent has experienced any financial or health shocks recently. Table B15 uses estimates from the trade-off approach. Locus of control is a significant regressor with negative signs for both income and health IA, although luck is significant only for income IA.

In Table B17 columns (1) and (2), health locus of control is consistently a significant regressor to income and health IA, and financial risk aversion to health IA in addition. It is worth noting that the exclusion of focal responses does not change the magnitude of the coefficients from those in Tables B13 and B14. This suggests that neutral responses follow similar pattern to the other responses: those who are neither risk averse or loving with neither strong or weak internal control also tend to be neutral in terms of inequality aversion.

Table 5 Predicted IA

	N	Mean	Std.Err.
		Trade-off	
$\widehat{\gamma^i}$	1809	0.5267	0.0020
$\widehat{\gamma^h}$	1809	0.4469	0.0016
		Simple Lottery	
$\widehat{\gamma^i}$	1809	0.5529	0.0033
$\widehat{\gamma^h}$	1809	–0.0522	0.0011
		Follow-up Lottery	
$\widehat{\gamma^i}$	2049	0.3252	0.0025
$\widehat{\gamma^h}$	2049	–0.0354	0.0008

6.3 Inclusion of additional controls

In columns (3) and (4) of Supplementary Information Tables B15-B17, we include additional demographic controls, namely whether the respondent has children, their marital status, employment status, tenure, and health status. This helps us test whether our elicitation technique successfully mimics the veil of ignorance condition, such that demographic characteristics do not influence the coefficients on the behavioural variables of interest. Here, we use a weighted least squares instead of ordinary least squares with robust standard errors, to address heteroskedasticity with greater efficiency. We observe results similar to those presented above. The significant behavioural determinants are locus of control in the 2016 sample, and health locus of control (plus financial risk aversion) in the 2017 sample. The sign and magnitude of the coefficients on the behavioural variables are same as in the main results. The control variables are mostly statistically insignificant, suggesting that the imaginary-grandchild approach mimics well the veil of ignorance condition.[21]

6.4 Alternative measures of inequality

As mentioned already, the coefficient of variation (CV) inequality is scale invariant and scale independent, meaning both ordinal and cardinal inequality are unchanged by proportional transformations of income and health. The coefficient of variation is also translation invariant, but not translation independent, which means additive transformations do not change ordinal inequality, but change cardinal inequality. The violation of translation independence is a natural consequence of using both mean and standard deviation. A simple standard deviation is translation independent, but loses information about the distribution.

Another scale independent measure of inequality is the Gini coefficient. Keeping the assumption of uniform income distribution, that is, $y \sim U[a, b]$, the Lorenz curve takes the following parabolic shape:

$$L(F(y)) = \frac{x^2 - a^2}{b^2 - a^2} \tag{7}$$

where $F(y)$ is the C.D.F. of y. Using Eq. 7, the Gini coefficient of each hypothetical income lottery can be computed as follows:

$$\begin{aligned} Gini &= 1 - 2\int_0^1 L(F(y))dF(y) \\ &= 1 - 2\int_a^b L(F(y))f(y)dy \\ &= 1 - 2\int_a^b \frac{x^2 - a^2}{(b+a)(b^2 - a^2)}dy \end{aligned}$$

Computation of the Gini coefficients in the health domains follows a similar procedure. Table 6 below summarises the inequality indices Φ and the corresponding IA boundary values γ when the CV and the Gini coefficient is used respectively.

[21] In the 2016 survey, we also ask respondents whether they or their family members have suffered a financial shock or medical emergency in the last 12 months. When including these two variables empirical specification, the sign, magnitude, and significance of the behavioural determinants from the main section remains robust, and the two shock variables are statistically insignificant, further verifying the 'veil of ignorance' condition.

Table 6 Alternative measures of inequality

	Income				Health			
	Φ_{CV}	γ_{CV}	Φ_{Gini}	γ_{Gini}	Φ_{CV}	γ_{CV}	Φ_{Gini}	γ_{Gini}
A	0.39		0.22		0.19		0.11	
B1	0.23	0.36	0.13	0.36	0.04	–0.05	0.03	–0.06
B2	0.19	0.00	0.11	0.00	0.29	0.00	0.17	0.00
B3	0.25	1.22	0.14	1.23	0.14	0.00	0.08	0.00
B4	0.31	–0.37	0.18	–0.37	0.15	–0.54	0.09	–1.54
B'	0.49	0.34	0.28	0.33	0.29	0.00	0.17	0.00
B1'	0.12	0.15	0.07	0.15	0.03	–0.06	0.02	–0.06
B2'	0.23	0.36	0.13	0.36	0.12	0.07	0.07	0.07
B3'	0.22	0.70	0.13	0.71	0.10	0.00	0.06	0.00
B4'	0.22	–0.15	0.13	–0.15	0.10	–0.20	0.06	–0.20

We can see the boundary IA parameter values γ are very similar when the Gini coefficient rather than CV is used. A closer examination of Φ reveals that the values of $\frac{\Phi^A_{CV}}{\Phi^B_{CV}}$ across questions are very close to the values of $\frac{\Phi^A_{Gini}}{\Phi^B_{Gini}}$. Given that γ is computed according to Eq. 3, this explains the similarity in boundary values. Our conclusions on IA heterogeneity and the determinants of IA are confirmed when an alternative (scale independent) measure of inequality is used.

7 Conclusion

The elicitation of IA is important in understanding the welfare loss of inequality across populations. However, IA differs across domains, and identification of the underlying behavioural parameters requires careful use of elicitation procedures. Inequality preferences are likely to be different when they are presented as contemporary self-interested trade-off with other outcomes, in contrast to selection among hypothetical lotteries that mimic the veil of ignorance. To better understand the role of the veil of ignorance, one needs to examine the behavioural drivers of IA parameters, such as risk aversion and locus of control.

The first contribution of this paper is that the "veil of ignorance" perspective does play a role in influencing inequality preferences. For the trade-off approach, the distribution of IA is close to unimodal, with more people choosing neutral or close-to-neutral responses than extreme responses. However, IA parameters elicited through the imaginary grandchild approach tend to be bimodally distributed. People are more likely to give less extreme responses when they are directly asked to choose on an explicit scale of 1-10, whereas if the elicitation technique is less straightforward they may be more willing to reveal their true opinions, which could be more extreme.

The second contribution is that income IA is greater than health IA on average. The difference is significant in the 2016 survey in both methods, suggesting that the elicitation technique does not affect the first moment of the IA distribution. We also find a hump-shaped relationship between age and income IA. The 2017 survey is the more reliable of the two surveys since it employed two rounds of elicitation questions to narrow down the range of IA estimates as well as identifying irrational responses. Hence, we are more inclined to conclude that people have comparable degrees of aversion to income and health inequalities, although income IA could be slightly greater than health IA.

The third contribution concerns the forces underlying IA. We find robust evidence that risk aversion, locus of control and attitude on luck are consistently strong predictors of IA. Those who are more risk averse, feel more internal control, and believe more in luck than effort tend to be more averse to health and income inequalities. When specifying risk aversion and locus of control by domains, we further find that financial risk aversion and health locus of control are the main drivers of IA. This supports the intuition that IA is partly an aversion to risk and uncertainty–when choosing society behind a veil of ignorance, people do not know where they may end up in the income hierarchy. Those who dislike risk would choose a more equal society where the chance of ending up at the bottom is minimised. We conjecture that those who feel that they are in control of their own financial and health conditions have greater mental capacity to care for others' wellbeing. This result highlights the importance of behavioural factors in determining inequality preferences.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10888-025-09703-7.

Acknowledgements We are grateful to James Zuo for his brilliant research assistance and the International Inequality Institute for their support in the collection of the data.

Author Contributions Both authors contributed to the manuscript

Data Availability No datasets were generated or analysed during the current study.

Declarations

Competing Interests The authors declare no competing interests.

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