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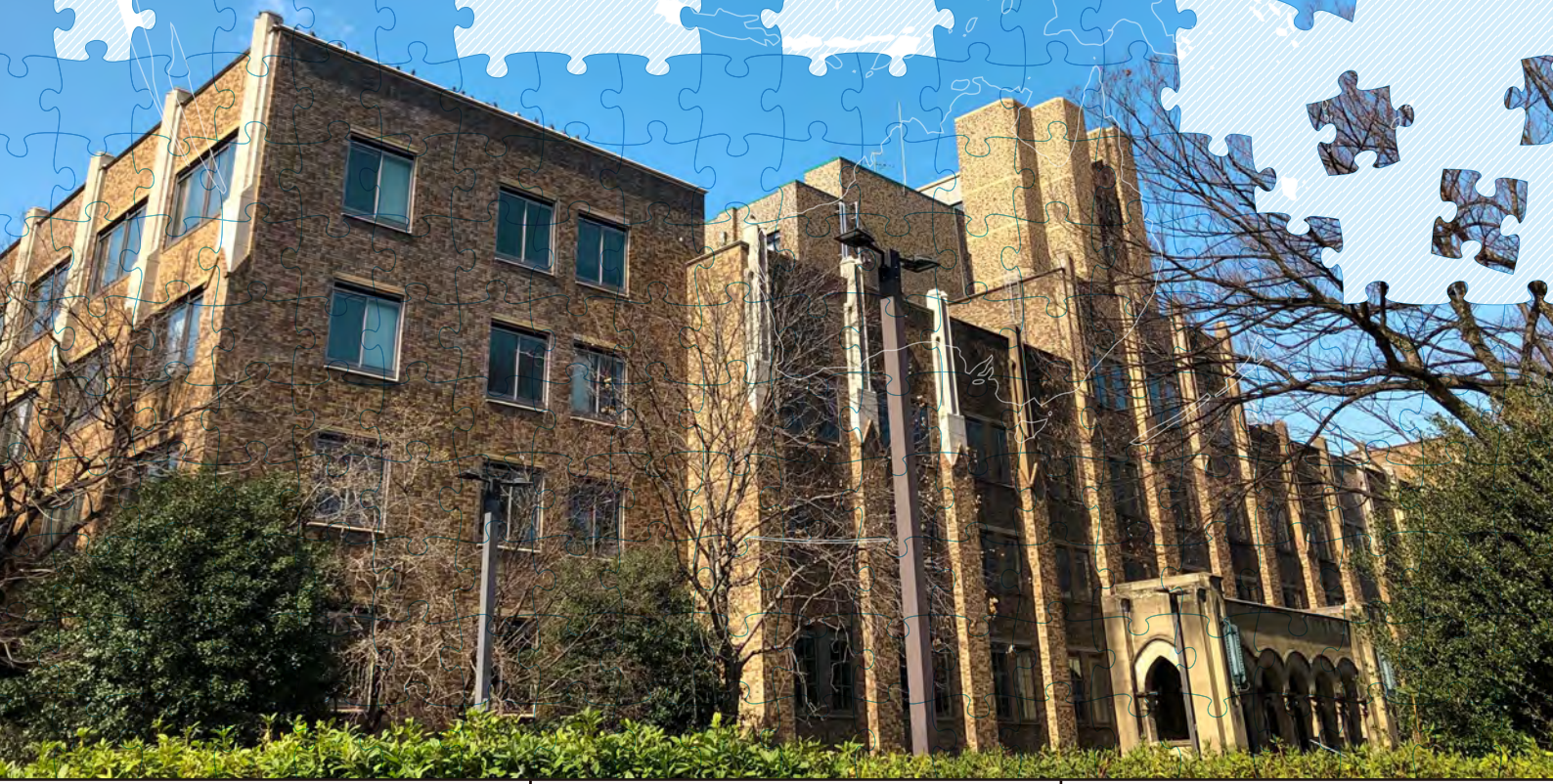
Different measures, different perceptions

A survey on measure sensitivity of inequality perception from Japan



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SDGs 1 NO POVERTY, 2 ZERO HUNGER, 10 REDUCED INEQUALITIES

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Different measures, different perceptions

A survey on measure sensitivity of inequality perception from Japan*

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Abstract

Understanding whether our perceptions of the world are influenced by the way in which statistics are presented is a critical issue for public policy discussions because policy debates are often based on our perceptions of the world through our interpretations of data, as in the case of issues pertaining to income inequality. In this study, we investigate the sensitivity of perceived inequality to different stratification measures. We randomly presented 15,000 Japanese adult respondents with either the stratification index proposed by Xiang Zhou or a series of household income percentiles, both of which were derived from the same data distribution spanning two periods in Japan. Our findings indicate that respondents perceived a more significant increase in inequality when they were presented with the income percentiles than when they were presented with Zhou's stratification index. Therefore, to ensure consistency in public policy making, we must observe not only the same fact but also the same measurement of that fact. Different measurements of one fact may lead to different perceived worlds in our minds.

Keywords perceived inequality; stratification index; percentiles.

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1 Introduction

Disparity has increasingly been the focus of policy and societal concern. Disparity can be measured in a variety of ways[1,2,3,4,5], and its trends can vary depending on the indicator used. There are various indicators of disparity, and the magnitude and direction of disparity can vary depending on the measure used[5]. This claim may be true not only in terms of actual objective income distributions but also with regard to people's subjective perceptions of disparity. That is, how people interpret objective income distributions is based on their subjective perceptions of various indicators, and the impacts of these various indicators on their subjective perceptions as well as the directions of those impacts may differ. For example, it is widely known that beliefs regarding intergenerational mobility affect redistribution preferences[6]. Recent research has indicated that while intergenerational income mobility has remained low and stable in the United States, the public tends to overestimate the persistence of income ranks, particularly by overestimating the prospects of children from rich families and underestimating the prospects of children from poor families[7]. This situation highlights the fact that objective disparities and people's subjective perceptions of disparity are different. This discrepancy is one of the reasons underlying misperceptions of objective disparities. Therefore, to share understanding of the overall picture of disparities, it is necessary to understand not only objective disparities but also subjective perceptions of disparities[4].

It is because, not the least, our decision-making behaviors in the context of public policy depend on our perceptions of society. Preferences for policies that address inequality and poverty rely on the ways in which we perceive disparity[8,9,10,11,12]. Thus, it follows that our preferences could depend on our cognitive capacity to perceive facts. If our capacity is sufficiently large compared to the measurement units with which we are presented to describe society, then such measurement units are irrelevant to our deci-

sions regarding public policy. However, if our cognitive capacity is limited with respect to the measurement units used to describe society, then our political decision-making actually begins with the choice of measurement unit that is to be used to describe reality prior to making decisions that are recognized to be sensitive to partisanship. Thus, it is critical to investigate in further detail whether measurement units based on the same fact affect our perceptions or impressions of reality, i .e., by going beyond the contexts of behavioral and experimental economics and psychology to encompass the social sciences in general and the field of policy-making .

Income inequality is a notable issue in both developed economies and relatively wealthy emerging economies. We must address this issue. Thus, understanding how people feel about inequality in light of different measurement units based on the same fact is critical to policy-making aimed at addressing this issue. To investigate how we perceive income inequality, we compare two measures of inequality, namely, Xiang Zhou's stratification index and percentiles. We use data regarding income distribution in Japan from 1985 and 2018, which were obtained from the National Livelihood Survey conducted by the Ministry of Health, Labour and Welfare of the government of Japan. Using these data, we calculate various percentile proportions alongside Zhou's stratification index.

Then, we implement a randomized conjoint experiment as part of a web survey. We show the household income distributions of households with a child and households with an elderly individual exhibited in two "societies"; the income distribution of one society from 1985 to 2018 is described in terms of to percentile proportions, and the income distribution of the other society from 1985 to 2018 is described according to Zhou's stratification index. Both measures actually describe the same referent, i.e., Japanese society between 1985 and 2018 . Then, we ask respondents which society seems to have become more unequal between 1985 and 2018.

If we find different evaluations between the description based on income percentiles and the description rooted in Zhou's stratification index, then our perception of inequality is susceptible to the way in which statistics regarding the very same distribution are presented. Otherwise, we would conclude that the human recognition of inequality does not differ significantly between the percentile measure and stratification index presentations and that more trials are needed to investigate whether the irrelevance of measurement units applies to a broader range of measures of inequality.

One policy implication of this study is that if the former result is obtained, it indicates that we essentially begin to make a public policy choice when we decide on a measurement of inequality and present this measurement to the public, which occurs far before citizens and their representatives begin to discuss such policies consciously. Otherwise, citizens who are exposed to different measurements are more likely to exhibit consistent perceptions of a certain issue and share a common recognition of the facts, thus establishing a better foundation for policy-making.

2 Literature review

2.1 Measures of inequality and stratification

Two primary indexes are used to measure disparity: inequality and stratification. Inequality and stratification have long been typical concepts in sociological research on the notion of disparity[13,14,15]. However, the formal distinction between these two indexes has rarely been discussed[5].

If we simplify what the two indexes indicate, inequality refers to the extent to which resources are distributed unevenly across classes, whereas stratification refers to the extent to which "people can be differentiated hierarchically on one or more criteria

into distinct layers"[16]. In other words, it could be said that inequality focuses on absolute levels of disparity, whereas stratification focuses on rank, i.e., relative levels of disparity. Because the distribution itself contains information about both inequality and stratification, we use the distribution to illustrate the differences between the two indexes.

In general, higher levels of within-group inequality and lower levels of between-group inequality tend to be associated with lower levels of stratification[17]. Figure 1 shows the related patterns for inequality and stratification by reference to the two example groups of men and women. Imagine two populations, one composed exclusively of men and the other composed exclusively of women. Among the populations shown in the upper left quadrant of Figure 1, the average income of a man is JPY 50,000, and the average income of a woman is JPY 45,000 with a difference of JPY 5,000. Among the populations shown in the upper right quadrant, the difference in average incomes between men and women is JPY 30,000. Because inequality focuses on changes and differences in absolute levels, a difference of JPY 5,000 (upper left) in absolute terms is less than a difference of JPY 30,000 (upper right); thus, the upper-left populations appear to exhibit less inequality. However, since the upper-left populations exhibit hardly any overlap in the income distributions of men and women and since men mostly have higher incomes than women, this context features advanced (high levels of) stratification. The populations shown in the upper right quadrant exhibit greater distribution overlap than the populations shown in the upper left quadrant; thus, stratification is relatively unadvanced (low). If we consider this relationship between inequality and stratification, we can see patterns such as those shown in the lower left and right of Figure 1, in which context the former expresses high inequality and low stratification, while the latter expresses high inequality and high stratification. The four patterns shown in Figure 1 all express disparities, but

it is possible to depict various patterns of disparities by taking into account the indexes of inequality and stratification.

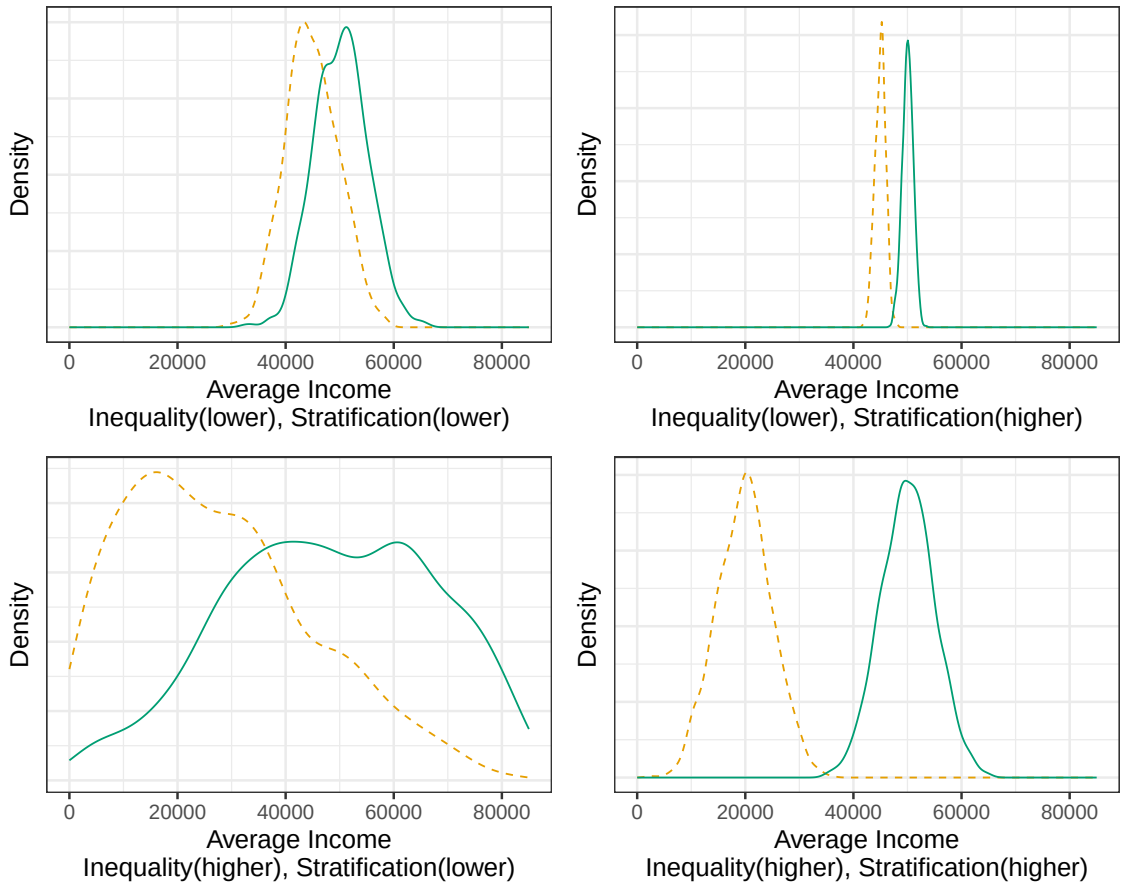

Figure 1: Relationship between inequality and social stratification.

2.2 Nonparametric stratification index

Let us summarize the formal definition of stratification is given by Xiang Zhou[5]. First split the sample into group 1 and group 2. Then, Zhou's stratification index is

$$S = \frac{\sum_{i=1}^{n_1} \sum_{j=1}^{n_2} \left[f_1 \left(r_i^1 > r_j^2 \right) - f_2 \left(r_i^1 < r_j^2 \right) \right]}{n_1 n_2}, \tag{1}$$

where n_1 and n_2 denote the number constituents of group 1 and group 2, respectively, r_i^1 and r_j^2 denote the rank of constituent i of group 1 and that of constituent j of group 2 in the entire sample, and f_1 and f_2 are binary step functions such that

$$f_1 = \begin{cases} 1 & \text{if} \quad r_i^1 > r_j^2, \\ 0 & \text{otherwise} \end{cases}$$

and

$$f_2 = \begin{cases} 1 & \text{if} \quad r_i^1 < r_j^2, \\ 0 & \text{otherwise.} \end{cases}$$

Again, the more overlap is observed in the distributions of the two groups, the more Zhou's stratification index decreases, and vice versa. In other words, if both groups are segregated such that the distributions of the two groups never overlap, Zhou's stratification indicates that the entire sample is the most stratified between group 1 and group 2.

3 Research design

3.1 Online survey

In March 2020, we conducted a nonprobability online survey of 15,000 Japanese adult respondents living in Japan, who were recruited by Rakuten Insight, one of the largest online survey companies in Japan. Table A1 presents the descriptive statistics of our sample. Table A2 presents a demographic summary of the national census of 2020, which was administered by the Ministry of Internal Affairs and Communications of the government of Japan, for comparison with our sample. To compare the income levels of our respondents, Table A3 shows the household income distribution surveyed by the

Ministry of Health, Labour and Welfare. As Table A1 shows, our sample respondents are slightly more educated.

3.2 Intervention

We create two measures of household income inequality using the same distribution of household income data obtained from the National Livelihood Survey, which was conducted by the Ministry of Health, Labour and Welfare of the government of Japan in 1985 and 2018. The measures are percentiles and Zhou's stratification index. We randomly cite one point from each measure for 1985 and 2018 and show these points to respondents. We do not indicate that the measures are drawn from the same distribution but rather explain that each point measures the inequality of "a" society. For the purposes of randomization, we employ a randomized conjoint experimental design. Considering the two descriptions based on the percentiles and stratification index that are generated by the randomized conjoint design, the respondents are then asked to identify which "society" became more unequal between households with a child and household with an elderly individual from 1985 to 2018. Our intervention is a combination of two samples, each of which is based on the percentiles and Zhou's stratification index taken from the same household income distribution. Thus, our intervention is based on a factorial design.

3.3 Experimental design

We show respondents income distributions of households with a child and households with an elderly individual in two hypothetical societies S_A and S_B as of 1986 and 2018 and ask them which society seems to have become more unequal between 1986 and 2018. Both S_A and S_B are Japan, and the income distributions are drawn from the National

Livelihood Survey, which was conducted by the Ministry of Health and Welfare in 1986 and the Ministry of Health, Labour and Welfare in 2018.[1]

We take families with a child or an elderly individual as the sample and split the sample into families with a child and those with an elderly individual. Then, we ask respondents to identify the society in which inequality between households with a child and households with an elderly individual increased between 1986 and 2018 . To describe inequality, we show respondents descriptions pertaining to Zhou's stratification index as presented in equation (1) and percentiles of household income. Thus, we create 6 descriptions of household income distributions in Japan in 1986 and 2018, l_A and l_B, as follows:

1. Description of distribution based on the stratification index suggested by Xiang Zhou[5].
2. Description of distributions at the 5th percentile.
3. Description of distributions at the 25th percentile.
4. Description of distributions at the 50th percentile.
5. Description of distributions at the 75th percentile.
6. Description of distributions at the 95th percentile.

English translations of the descriptions are presented in Table 1. One each of levels $L_A, L_B = 1, 2, ...6$ is randomly assigned to S_A and S_B such that the same descriptions are not assigned simultaneously, $l_A \neq l_B$ where l_A and l_B are levels shown to respondents.

[1] A description of the survey in Japanese is available at the website of the Ministry of Health, Labour and Welfare: https://www.mhlw.go.jp/toukei/list/20-21.html Accessed on June 7, 2022.

Our question about changes in household income inequality between households with a child and households with an elderly individual in "Society A" and "Society B" was as follows.

> **Question** In society A and society B, the income distributions of households with a child and households with an elderly individual changed from 1986 to 2018 as follows. Between society A and society B, in which society do you think income inequality between households with a child and households with an elderly individual increased?

Society A	Society B
Description text of household Income distribution L_A	Description text of household Income distribution L_B

Each respondent was asked to identify the society that the respondent felt began to exhibit greater inequality between households with a child and households with an elderly individual. We assigned this choice-based task to each respondent over five rounds.

Therefore, by showing household income distributions in Japan over two periods using percentile points and the Zhou stratification index, we aim to determine whether respondents perceive the changes in inequality of the same society between two periods differently depending on the measure shown to them.

3.4 Identification

Consider the outcome of respondent i, $Y_j^{i,r}\left(l_j^{i,r}, l_{\neg j}^{i,r}\right)$, where $j \in \{A, B\}$, $l_j^{i,r} \neq l_{\neg j}^{i,r}$ denote levels described in Table 1 that are randomly chosen and shown to respondent i in round

Table 1: The hypothetical "two societies" generated by the same income distribution in Japan.

Attribute	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
Society A	In 1985, when comparing households with a child with households with an elderly individual, the probability that a household with a child is wealthier than a household with an elderly individual was 89 percent. In 2018, the probability was 86 percent.	In 1985, the income of households with a child at the 5 percentile point was 4 million yen, and the income of households with an elderly individual at the 5 percentile point was 1 million yen. In 2018, the income of households with a child at the 5 percentile point was 4 million yen, and the income of households with an elderly individual was 2 million yen.	In 1985, the income of households with a child at the 25 percentile point was 7 million yen, and the income of households with an elderly individual at the 25 percentile point was 2 million yen. In 2018, the income of households with a child at the 25th percentile point was 4 million yen, and the income of households with an elderly individual at the 25th percentile point was 4 million yen.	In 1985, the income of households with a child at the 50th percentile point was 10 million yen, and the income of households with an elderly individual at the 50th percentile point was 3 million yen. In 2018, the income of households with a child at the 50th percentile point was 14 million yen, and the income of households with an elderly individual at the 50th percentile point was 6 million yen.	In 1985, the income of households with a child at the 75th percentile point was 14 million yen, and the income of households with an elderly individual at the 75th percentile point was 5 million yen. In 2018, the income of households with a child at the 75th percentile point was 19 million yen, and the income of households with an elderly individual at the 75th percentile point was 8 million yen.	In 1985, the income of households with a child at the 95th percentile point was 21 million yen, and the income of households with an elderly individual at the 95th percentile point was 13.05 million yen. In 2018, the income of households with a child at the 95 percentile point was 23.05 million yen, and the income of households with an elderly individual at the 95 percentile point was 15.05 million yen.
Society B						

r such that

$$Y_j^{i,r}\left(l_j, l_{\neg j}\right) = \begin{cases} 1 & \text{if } i \text{ answered that } S_j \text{ became more unequal than } S_{\neg j}, \\ 0 & \text{otherwise,} \end{cases} \tag{2}$$

in round r. Since we randomly assign the level of description L_j and $L_{\neg j}$, $\boldsymbol{L} \equiv (L_j, L_{\neg j})$, $L_j \neq L_{\neg j}$, satisfies the unconfounded assumption

$$\boldsymbol{L} \perp\!\!\!\perp Y_j\left(l_j, l_{\neg j}\right),$$

and

$$\boldsymbol{L} \perp\!\!\!\perp Y_j\left(l_j, l_{\neg j}\right) | \boldsymbol{X}_i,$$

where $\boldsymbol{X}_i$ denotes the background characteristics of respondent i we survey. Therefore, we identify Y_j as a causal effect of treatment $\boldsymbol{L}$.

3.5 Estimation

Our baseline estimates are marginal mean

$$\tau\left(l_j^{i,r}, l_{\neg j}^{i,r}\right) = E\left[Y_j^{i,r}\left(l_j^{i,r}, l_{\neg j}^{i,r}\right)\right] \tag{3}$$

for $l_j = 1, \ldots, 6$, which is the marginalized probability that S_j is considered to have become more unequal than $S_{\neg j}$ when l_j is shown to respondent i in round r.

Next, we estimate the augmented inverse propensity weight (AIPW) and then regress the AIPW scores on several background characteristic variables to investigate the possible heterogeneity of the effects of treatment $l_j = 1, \ldots, 6$ across respondents.

4 Results

Figure 2 presents the marginal mean of the probability of respondents perceiving a steeper increase in inequality between households with a child and households with an elderly individual between different descriptions of the same income distribution as characterized by equation (3). When the descriptions of either the 50th percentile or the 25th percentile of the same income distributions of households with a child and households with an elderly individual were shown, respondents were more likely to perceive that the income inequality between households with an elderly individual and households with a child had increased. In contrast, when the stratification index suggested by Xiang Zhou was shown, respondents were less likely to perceive that the income inequality between households with an elderly individual and households with a child had increased. Additionally, when the 5th percentiles were shown, respondents were more likely to perceive that the income inequality between households with an elderly individual and households with a child had not increased.

Since the income distributions of households with an elderly individual and those with a child from which descriptions were drawn were identical distributions pertaining to Japan according to a survey conducted by the Ministry of Welfare, Health, Labour and Welfare, the government of Japan, perceived differences in the increase in inequality were caused by the different impressions conveyed by descriptions of the same distribution. Figure 2 indicates that descriptions of the middle and lower-middle percentiles are more likely to trigger a sense of inequality, while Zhou's stratification index and the bottom percentile are unlikely to do so.

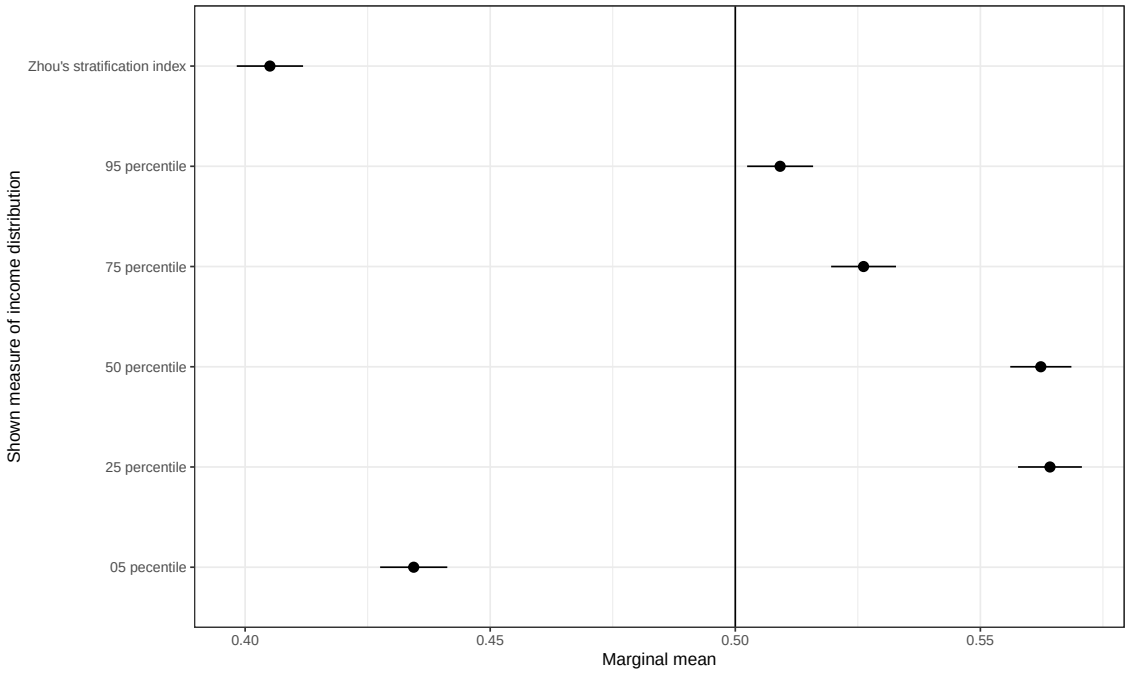

Figure 2: Perceived increase in inequality by description levels.

To investigate the possibly heterogeneous perceptions of the increase in inequality across various background characteristics, Figure 3 presents the results of applying the linear ordinary least squares approach to the augmented inverse propensity weight scores of the outcome characterized by equation (2) for description levels ranging from the 5th percentile to Zhou's stratification index on household income, self-perceived social status, self-perceived degree of right-leaning personal politics, highest degree of education, sex, and age . While age, sex, and subjective social status have significant coefficients for one to two description levels, the associations between the impacts of description levels of inequality and background characteristics are largely weak. A clear difference between Zhou's stratification index and the middle and lower-middle percentiles was observed across primary background characteristics.

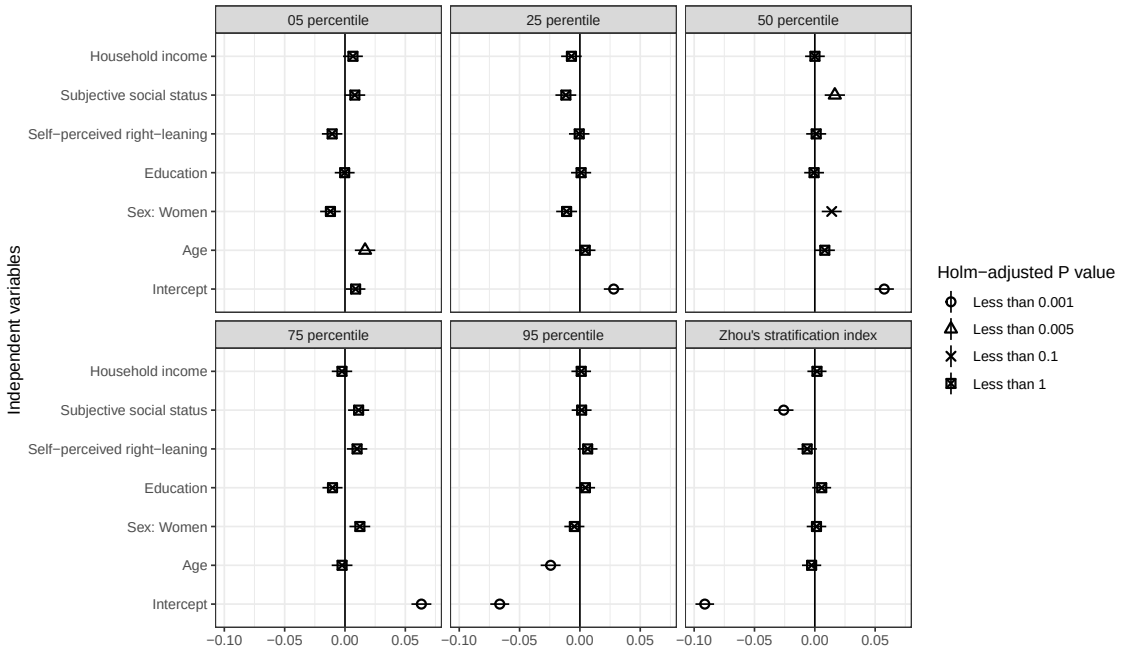

Figure 3: Regression of the perceived rise in inequality by description levels on socioeconomic status and political positions.

5 Concluding remarks

Xiang Zhou presented an index to measure social stratification. Zhou's stratification index is a summarized amount that aims to describe a distribution, thus resembling the Gini coefficient or the Theil index. A notable feature of Zhou's stratification index, however, is that it uniquely corresponds to a distribution. In contrast, the Gini coefficient and the Theil index are used to compare the overall disparity exhibited by different distributions; hence, infinite distributions are able to correspond to a Gini coefficient or a Theil index.

Another measure of disparity that uniquely corresponds to distribution is percentiles, which have indeed been widely used to describe disparity in terms of income distribu-

tions. With regard to a given society, we could use either percentiles or Zhou's stratification index to make policy decisions. While Zhou's stratification index was suggested as an objective measure of the state of distribution, the manner in which it is perceived can be critical when this index is deployed for practical purposes. We were interested in the ways in which percentiles, a widely used measure of disparity, and Zhou's index are perceived and whether the perceptions that they could evoke are different.

Our results show that respondents perceived changes in disparity in Japanese society differently depending on whether they were shown percentiles or Zhou's index, despite the fact that these measures described the same change in the income distribution of Japanese household income between 1985 and 2018. A general tendency was that the respondents who were shown Zhou's stratification index were less likely to perceive that inequality between households with a child and households with an elderly individual increased than the respondents who were shown percentiles. Meanwhile, different percentiles also evoked different perceptions of change in income distribution. Respondents strongly perceived an increase in disparity when they were shown the 25th and 50th percentiles, weakly perceived an increase in disparity when they were shown the 75th percentile, barely perceived an increase in disparity when they were shown the 95th percentile, and perceived a decrease in disparity when they were shown the bottom 5th percentile. Our respondents were particularly sensitive to changes in the neighborhood of the median income group.

In other words, our results indicate that when percentiles are used as an indicator of disparity, they lead to unstable perceptions. In this regard, we may tentatively conclude that Zhou's index is more reliable than percentiles as an indicator that uniquely corresponds to a distribution.

Additionally, our results contribute to our understanding of polarization in advanced

democracies, including Japan. As in other advanced democracies, the question of whether income inequality has increased since the 1980s has been the subject of debate. Much debate regarding and studies on this topic have focused, by their nature, on subjective evaluation[18,19,20]. We suggest another facet of research. We must treat subjective perceptions of the measures developed to summarize disparity objectively, including percentiles and Zhou's index. Based on reading such measures, which are expected to summarize disparity objectively, we form our subjective perceptions of disparity and make decisions to address those perceptions. However, we must know how subjectively we perceive disparity based on different measures that have been constructed to measure disparity objectively.

Nonetheless, we acknowledge one limitation of our research. Namely, we did not compare Zhou's index with other summarized measures of disparity. Although Zhou's index was developed to replace the index suggested by Yitzhaki and Lerman[21], we did not compare these two indexes. The task of specifying the characteristics of Zhou's index in comparison with those of the index by Yitzhaki and Lerman and others is left for future research.

Methods

Preregistration

The research design, survey method, and analytical strategy of this study were preregistered with the AEA RCT Registry of the American Economic Association before the survey was conducted on October 15, 2021 (AEARCTR-0008317, https://doi.org/10.1257/rct.8317).

Outline of the study

Our decision-making behaviors with regard to public policy depend on our perceptions of society. Preferences for policies that address inequality and poverty rely on the ways in which we perceive inequality. If our cognitive capacity is limited with respect to the measurement units used to describe society, then our political decision-making actually begins with the choice of measurement unit that is to be used to describe reality prior to making decisions that are recognized to be sensitive to partisanship. Therefore, it is essential to investigate whether measurement units based on the same fact affect our perceptions or impressions of reality.

Income inequality is considered a notable issue in both developed economies and relatively wealthy emerging economies. Given our possibly limited cognitive capacity, understanding how people feel about inequality in light of different measurement units based on the same fact is critical to policy-making aimed at addressing this issue. To investigate how differently we perceive income inequality, we compare two measures of inequality, namely, Zhou's stratification index and percentiles.

We use data regarding income distribution in Japan from 1985 and 2018, which were obtained from the National Livelihood Survey conducted by the Ministry of Health, Labour and Welfare of the government of Japan. Using these data, we calculate percentile proportions and Zhou's stratification index.

Then, we perform a randomized conjoint experiment via the internet. We show the household income distribution of households with a child and households with an elderly individual exhibited in two "societies"; the income distribution of one society from 1985 to 2018 is described in terms of percentile proportions, and the income distribution of the other society from 1985 to 2018 is described according to Zhou's stratification index. Both measures actually describe the same referent, i.e., Japanese society in 1985 and

2018. Then, we ask respondents which society seems to have become more unequal between 1985 and 2018.

If we find different evaluations between the description based on income percentiles and the description rooted in Zhou's stratification index, then our perception of inequality is susceptible to the way in which statistics regarding the very same distribution are presented. It indicates that we essentially begin to make a public policy choice when we decide on a measurement of inequality and present this measurement to the public, which occurs far before citizens and their representatives begin to discuss such policies consciously. Otherwise, we would conclude that the human recognition of inequality does not differ significantly between the percentile measure and stratification index presentations and that more trials are needed to investigate whether the irrelevance of measurement units applies to a broader range of measures of inequality.

Intervention

We create two measures of household income inequality using the same distribution of household income data obtained from the National Livelihood Survey, which was conducted by the Ministry of Health, Labour and Welfare of the government of Japan in 1985 and 2018. The measures are percentiles and Zhou's stratification index. We randomly cite one point from each measure for 1985 and 2018 and show these points to respondents. We do not indicate that the measures are drawn from the same distribution but rather explain that each point measures the inequality of "a" society. For the purposes of randomization, we employ a randomized conjoint experimental design. Considering the two descriptions based on the percentiles and stratification index that are generated by the randomized conjoint design, the respondents are then asked to identify which "society" became more unequal between 1985 and 2018. Our interven-

tion is a combination of two samples, each of which is based on the percentiles and Zhou's stratification index taken from the same household income distribution. Thus, our intervention is based on a factorial design.

Expected primary outcomes

Depending on human cognitive capacity, we predict that different measurement units based on the same fact affect human recognition of that fact. Our experiment aims to investigate whether percentiles of income and Zhou's stratification of income cause respondents to exhibit different levels of recognition of the same fact.

In our experiment, we describe changes in household income distribution between 1985 and 2018 based on both household income percentiles and Zhou's stratification index; then, we ask the respondents whether either "society" seems to have become more unequal than the other. If either society is evaluated to have become more or less unequal than the other, we interpret this outcome as indicating that human recognition of the inequality is sensitive to the measures used.

Otherwise, we conclude that our experiment remains within the scope of rational human recognition and that further investigation is needed to judge the extent to which it is possible to ensure that the measurement unit is not relevant to human recognition of inequality in the context of inequality measurements .

Experimental design

We create two measures of household income inequality using the data obtained from the National Livelihood Survey, which was conducted by the Ministry of Health, Labour and Welfare in 1985 and 2018; these two measures are the percentiles and Zhou's stratification index. We randomly pair one point from each measure, show them to each respondent

(who is not informed that these measures pertain to the same society), and then ask the respondent which "society" seems to have become more unequal between 1985 and 2018. For the randomization involved in pairing the measures, we employ a randomized conjoint experimental design as a factorial design. We assign each respondent five tasks that involve choosing between the randomly matched pairs of inequality measures.

Alongside the experiment, we collect information about the respondents' background characteristics, such as their age, gender, prefecture, working status, employers' size, job title, education, income, household income, political preferences, partisanship, whether they read a newspaper, internet news, or books, and self-perception of their social class. Considering the possible heterogeneity of intervention effects across these background characteristics, we employ a generalized random forest algorithm for R[22,23].

Randomization method

The pairing of the two inequality measures is to be conducted by a survey company using a computer.

Experiment characteristics

- Sample size: Planned number of clusters
  - 15,000 individuals.
- Sample size: Planned number of observations
  - 15,000 individuals X 5 tasks X 2 outcomes (more/less unequal) = 150,000 observations.
- Sample size by treatment arms

– The use of 15,000 individuals as our design is a factorial design.

Ethical declarations

5.1 Ethical approval and consent to participate

The Ethical Review Board, Institute of Social Science, The University of Tokyo approved this study (Approval number: 73).

The authors, namely, Sho Fujihara, Keisuke Kawata, Masaki Nakabayashi, and Shoki Okubo, obtained informed consent from all participants in the survey by designing the survey in such a manner that, on the opening page, the survey was described, informed consent was requested, and respondents were not allowed to advance to the actual survey unless they provided informed consent.

Competing interests

The authors, namely, Sho Fujihara, Keisuke Kawata, Masaki Nakabayashi, and Shoki Okubo, declare that they have no relevant or material financial interests related to the research described in this paper.

Availability of data

The datasets generated as part of the survey research and analyzed during the current study as well as the original questionnaire for the survey will be made publicly available after cleaning at the Center for Social Research and Data Archives, Institute of Social Science, The University of Tokyo (https://csrda.iss.u-tokyo.ac.jp/english/). Until

these data become publicly available at the institution, they are available from the corresponding author, Masaki Nakabayashi, upon request.

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Appendix: Descriptive statistics

Table A1 presents descriptive statistics of our sample.

Table A1: Descriptive statistics of background characteristics.

Characteristic	**Female**, N = 7,376[1]	**Male**, N = 7,624[1]
Age	44 (34, 54)	51 (42, 61)
Prefecture		
Prefecture: Tokyo	1,061 (14%)	1,102 (14%)
Prefecture: Kanagawa	638 (8.6%)	666 (8.7%)
Prefecture: Chiba	353 (4.8%)	433 (5.7%)
Prefecture: Saitama	413 (5.6%)	460 (6.0%)
Prefecture: Aichi	501 (6.8%)	514 (6.7%)
Prefecture: Osaka	642 (8.7%)	575 (7.5%)
Prefecture: Other	3,768 (51%)	3,874 (51%)
Marital status		
Unmarried	2,230 (30%)	2,141 (28%)
Married	4,353 (59%)	4,967 (65%)
Divorced/bereaved	781 (11%)	505 (6.6%)
Did not respond	12	11
Children		
0	3,384 (46%)	3,158 (42%)
1	1,356 (18%)	1,124 (15%)
2	1,869 (25%)	2,364 (31%)
3	645 (8.8%)	834 (11%)
4	71 (1.0%)	93 (1.2%)
5 or more	24 (0.3%)	34 (0.4%)
Did not respond	27	17
Whether at work: Yes	4,862 (66%)	6,151 (81%)
Did not respond	43	35
Working arrangement		
Regular employee	2,329 (48%)	4,321 (70%)
Part-time employee	1,275 (26%)	181 (2.9%)
Casual staff	280 (5.8%)	194 (3.2%)
Contract employee	537 (11%)	527 (8.6%)
Board member	24 (0.5%)	212 (3.5%)
Self-employed	244 (5.0%)	601 (9.8%)
Help with family business	90 (1.9%)	35 (0.6%)
Other	77 (1.6%)	73 (1.2%)
Did not respond	2,520	1,480
Job title		
Employee with no title	3,707 (85%)	2,751 (53%)
Foreperson	125 (2.9%)	286 (5.5%)
Assistant manager	176 (4.0%)	680 (13%)
Section manager	91 (2.1%)	705 (14%)
Department manager	46 (1.0%)	482 (9.3%)
Other	180 (4.1%)	260 (5.0%)
Do not know	60 (1.4%)	36 (0.7%)

Did not respond	2,991	2,424
Size of employer		
1–4 employees	229 (5.2%)	148 (2.8%)
100–499 employees	868 (20%)	1,135 (22%)
30–99 employees	756 (17%)	755 (14%)
5–29 employees	871 (20%)	589 (11%)
500 or more employees	1,450 (33%)	2,136 (41%)
Government	217 (4.9%)	444 (8.5%)
Did not respond	2,985	2,417
Income		
Less than 0.50 million yen	1,879 (26%)	480 (6.3%)
0.50–0.99 million yen	934 (13%)	191 (2.5%)
1.00–1.49 million yen	843 (11%)	254 (3.3%)
1.50–1.99 million yen	511 (6.9%)	304 (4.0%)
2.00–2.49 million yen	665 (9.0%)	557 (7.3%)
2.50–2.99 million yen	468 (6.4%)	484 (6.4%)
3.00–3.99 million yen	875 (12%)	949 (12%)
4.00–4.99 million yen	613 (8.3%)	3,351 (44%)
5.00 million yen or higher	571 (7.8%)	1,035 (14%)
Did not respond	17	19
Household income		
Less than 0.50 million yen	226 (3.1%)	244 (3.2%)
0.50–0.99 million yen	101 (1.4%)	86 (1.1%)
1.00–1.49 million yen	222 (3.0%)	143 (1.9%)
1.50–1.99 million yen	258 (3.5%)	199 (2.6%)
2.00–2.49 million yen	437 (5.9%)	350 (4.6%)
2.50–2.99 million yen	374 (5.1%)	331 (4.3%)
3.00–3.99 million yen	898 (12%)	763 (10%)
4.00–4.99 million yen	913 (12%)	896 (12%)
5.00–5.99 million yen	851 (12%)	897 (12%)
6.00–6.99 million yen	664 (9.0%)	693 (9.1%)
7.00–7.99 million yen	617 (8.4%)	730 (9.6%)
8.00–8.99 million yen	474 (6.4%)	549 (7.2%)
9.00–9.99 million yen	351 (4.8%)	476 (6.2%)
10.00 million yen or higher	983 (13%)	1,261 (17%)
Did not respond	7	6
Highest degree of education		
Junior high school	78 (1.1%)	135 (1.8%)
High school	1,758 (24%)	1,658 (22%)
Vocational college	1,158 (16%)	702 (9.2%)
2-year college	1,201 (16%)	129 (1.7%)
Technical college	66 (0.9%)	115 (1.5%)
4-year college	2,847 (39%)	4,170 (55%)
Graduate education	256 (3.5%)	705 (9.3%)
Did not respond	12	10
Party support		
Party support: Liberal Democratic Party (Ruling)	1,295 (18%)	2,190 (29%)
Party support: Constitutional Democratic Pary	377 (5.1%)	577 (7.6%)
Party support: Democratic Party for the People	120 (1.6%)	198 (2.6%)
Party support: Clean Government Party (Ruling)	188 (2.6%)	152 (2.0%)

Party support: Japan Innovation Party	714 (9.7%)	914 (12%)
Party support: Japanese Communist Party	202 (2.7%)	216 (2.8%)
Party support: Independent	4,231 (57%)	3,048 (40%)
Party support: Other	241 (3.3%)	321 (4.2%)
Did not respond	8	8
Degree of dissatisfaction with politics		
(satisfied = 1 to dissatisfied =5)		
1	56 (0.8%)	137 (1.8%)
2	526 (7.2%)	930 (12%)
3	2,509 (34%)	1,976 (26%)
4	2,089 (28%)	2,012 (26%)
5	2,176 (30%)	2,562 (34%)
Did not respond	20	7
Public or individual interest		
(public=1, neither=2, individual=3)		
1	4,082 (56%)	4,552 (60%)
2	1,155 (16%)	863 (11%)
3	2,113 (29%)	2,191 (29%)
Did not respond	26	18
Preferred size of government		
(small=1, neither=2, large=3)		
1	1,347 (18%)	2,497 (33%)
2	1,171 (16%)	840 (11%)
3	4,770 (65%)	4,239 (56%)
Did not respond	88	48
Self-perceived degree of right-leaning personal politics		
(most left-leaning=0, most right-leaning=10	5.00 (5.00, 5.00)	5.00 (5.00, 6.00)
Did not respond	223	165
Subjective social status		
(highest=1, lowest=10	5.00 (5.00, 7.00)	5.00 (4.00, 7.00)
Did not respond	110	96
Elder siblings	0.00 (0.00, 1.00)	0.00 (0.00, 1.00)
Did not respond	3,222	2,908
Younger siblings	1.00 (0.00, 1.00)	1.00 (0.00, 1.00)
Did not respond	3,183	2,953

[1]Median (Interquartile range); n (%)

Table A2 presents a demographic summary of the national census of 2020, which was administered by the Ministry of Internal Affairs and Communications of the government of Japan, for comparison with our sample. As Table A1 shows, our sample respondents are slightly more educated.

Table A2: Demographic summary of the national census of 2020.

Population		Total	Men	Women
		126,146,099	61,349,581	64,796,518
		100.0%	48.6%	51.4%
Age	Median		47.1	50
	Mean		46.0	49.2
Labor participation and marital status: 15–64 years old			Men	Women
Population: 15–64 years old	a		36,753,516	36,169,248
Labor market participants	b		27,609,467	23,343,225
Population at work	c		26,396,754	22,521,997
Unknown	d		4,950,783	4,129,413
Labor participation rate: 15–64 years old	$b/(b-d)$		86.8%	72.9%
Marital status	Unmarried		14,827,517	11,790,437
	Married		18,411,345	20,211,842
	Bereaved/divorced		1,516,734	2,892,487
Education			Men	Women
Population: 24–64 years old	e		33,873,487	33,431,837
Highest degree: Elementary	f		11,428	12,435
Highest degree: Junior high school	g		1,769,706	1,182,121
Highest degree: High school	h		11,378,052	11,367,250
Highest degree: 2-year college	i		3,238,808	7,922,954
Highest degree: 4-year college	j		9,480,016	6,380,243
Highest degree: Graduate education	k		1,364,980	458,009
In school	l		1,231,413	1,075,824
Tertiary education	$(i+j+k)/e$		41.6%	44.2%

Source: 2020 population census administered by the Ministry of Internal Affairs and Communications of the government of Japan (https://www.e-stat.go.jp/en/stat-search/files?page=1&toukei=00200521&tstat=000001136464. Last accessed on June 30, 2022).

To facilitate comparison of the income levels of our respondents, Table A3 shows the household income distribution according to the Ministry of Health, Labour and Welfare.

Table A3: Distribution of household income according to the National Livelihood Survey

Income level	N	Share
Total	10,000	100.00%
Less than 0.5 million yen	120	1.20%
0.5–1 million yen	519	5.19%
1–1.5 million yen	631	6.31%
1.5–2 million yen	632	6.32%
2–2.5 million yen	689	6.89%
2.5–3 million yen	666	6.66%
3–3.5 million yen	711	7.11%
3.5–4 million yen	574	5.74%
4–4.5 million yen	555	5.55%
4.5–5 million yen	491	4.91%
5–5.5 million yen	488	4.88%
5.5–6 million yen	380	3.80%
6–6.5 million yen	463	4.63%
6.5–7 million yen	344	3.44%
7–7.5 million yen	329	3.29%
7.5–8 million yen	288	2.88%
8–8.5 million yen	260	2.60%
8.5–9 million yen	232	2.32%
9–9.5 million yen	216	2.16%
9.5–10 million yen	185	1.85%
10 million or over	1,225	12.25%

Source: National Livelihood Survey 2019 administered by the Ministry of Health, Labour and Welfare, the government of Japan https://www.e-stat.go.jp/stat-search/file-download?statInfId=000031957851&fileKind=1 (Accessed on September 10, 2021).