# POLES APART? AN ANALYSIS OF THE MEANING OF POLARIZATION

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Starting from the axiomatization of polarization contained in Esteban and Ray (1994) and Chakravarty and Majumder (2001), we investigate whether people's perceptions of income polarization are consistent with the key axioms. This is carried out using a questionnaire–experimental approach that combines both paper questionnaires and on-line interactive techniques. The responses suggest that important axioms which serve to differentiate polarization from inequality—e.g. increased bipolarization—as well as other distinctive features of polarization, i.e. the non-monotonous behavior attributed to polarization, are not widely accepted.

## 1. INTRODUCTION

Income polarization has come to play a key role in the analysis of the evolution of income distribution, of the consequences of economic growth and of social conflict. But what is it? To use this concept in economic models the idea of polarization has to be transformed into a precise criterion that can be applied to income distributions. Normally a polarization measure is used; generally the measure is based on a specific axiom system such as those introduced by Esteban and Ray (1994) and others. But do the axiomatic structures that have been suggested capture the meaning of polarization as commonly understood by social commentators and lay people? Indeed, in popular discussion the terms polarization and inequality are often not clearly distinguished: for example, a BBC

summary of a recent empirical study of the UK income distribution noted ". . . during the 1980s and 1990s inequality had increased, as a polarization in British society had occurred."[1] Is this sort of thing just a careless slip, or is it really true that there is no clear concept of polarization "out there"?

We address this issue by investigating the way distributional comparisons are actually perceived by people who have not been primed as to the conventional interpretation of polarization. We focus on ordinal issues concerning the measurement of polarization rather than on this or that specific index and, as our point of reference, we take a fairly broad theoretical literature, not just the contribution of one or two particular authors. The paper is organized as follows: Section 2 examines the meaning that has been given to the concept of polarization in the recent literature; Section 3 explains the approach we have adopted in eliciting people's views and perceptions of polarization, and describes the samples used for our study; Sections 4 to 6 examine the results; Section 7 concludes.

## 2. The Meaning of Polarization

In other social science disciplines, polarization is often considered as a *process.* In politics, it is a process by which the public opinion divides and goes to the extremes. In communications and psychology, the process involves a social or political group dividing into two opposing sub-groups with fewer and fewer members of the group remaining neutral or holding an intermediate position. In the case of income polarization the accepted meaning is less clear cut, but no less interesting.

The concept of polarization assumes the existence of poles—normally two. It also assumes the agglomeration of members of the community at more than one pole. In the context of income polarization the poles arc simply income levels. Beyond this one needs to provide some kind of structure that gives meaning to the concept as well as the basis for deriving computable indices. This is the role played by the introduction of an explicit axiomatization as in the classic study by Esteban and Ray (1994) and the recent paper by Chakravarty and Majumder (2001).[2] The typical axiom systems and the meaning of individual axioms are discussed in Section 2.l.

Some of the axioms used to pin down the meaning of polarization comparisons have a similar flavor to those used in the literature on income inequality, social welfare, and poverty, and we will find that it is appropriate to analyze these in a manner that draws on the empirical literature concerning attitudes to distributional comparisons that have been developed in those related fields. However, not too much should be made of this similarity because polarization is a distinct concept and requires a distinct axiomatization.

In particular it is important to recognize the essential differences between inequality and polarization. Indeed it is arguable that one of the driving forces that led to the formulation of an explicit concept of income polarization in the 1990s was the recognition that inequality, as conventionally defined, misses out on some

[1]See http://news.bbc.co.uk/2/hi/business/6901147.stm.
[2]See also the contributions by Wang and Tsui (2000), Rodriguez and Salas (2003), Bossert and Schworm (2006), and Esteban *et al.* (2007).

key aspects of the evolution of income distributions over time that should be of concern to policy analysts and social commentators (Wolfson, 1994, 1997). The key to the conventional approach to inequality is the transfer principle, but it is not clear that respect for this principle is always appropriate for distributional comparisons in terms of polarization.

### 2.1. *Axioms*

In the literature there are several alternative axiom systems for polarization. Here we concentrate on two principal formulations of the problem within the same income-distribution framework. An income distribution is a pair $(\mathbf{p}, \mathbf{x})$ where $\mathbf{p} \in \mathbb{R}_+^n$, $\mathbf{x} \in \mathbb{R}_{++}^n$ and the set of all such pairs is denoted by $\mathcal{D}$; in other words we characterize a distribution as a vector of non-negative population masses $(p_1, p_2, \ldots, p_n)$ located on the "rungs" of an income ladder $(x_1, x_2, \ldots, x_n)$, where each rung is a strictly positive number. A polarization index is a function $P : \mathcal{D} \to \mathbb{R}_+$. Both formulations use the following two axioms to characterize $\mathcal{D}$:

**Axiom PP** (*Principle of Population*). For any $(\mathbf{p}, \mathbf{x}) \in \mathcal{D}$ and any positive integer $m$, $P(m\mathbf{p}, \mathbf{x}) = P(\mathbf{p}, \mathbf{x})$.

**Axiom SI** (*Scale Independence*). For any $(\mathbf{p}, \mathbf{x}) \in \mathcal{D}$ and any $\lambda > 0$, $P(\mathbf{p}, \lambda\mathbf{x}) = P(\mathbf{p}, \mathbf{x})$.

Counterparts of these properties appear in many contexts including poverty and inequality. Here they ensure that polarization remains unchanged if you replicate the population (PP) or if you rescale all the incomes together (SI).[3] Now to the two formulations:

**Formulation 1.** This is epitomized by Chakravarty and Majumder (2001) but finds its roots in the classic paper by Wolfson (1994) and in other recent contributions such as Wang and Tsui (2000). It uses median income $\hat{x} := \max\left\{ x_j : \sum_{i=1}^{j} p_i \le \frac{1}{2} \sum_{i=1}^{n} p_i \right\}$ to divide the population into two fundamental groups ("poorer," "richer"). One can then introduce:

**Axiom IS** (*Increased Spread*). Consider $(\mathbf{p}, \mathbf{x}')$, $(\mathbf{p}, \mathbf{x}) \in \mathcal{D}$ such that $x_h' = x_h$, $h \ne i$ and let $\delta > 0$. If either (a) $x_i < \hat{x}$ and $x_i' = x_i - \delta$ or (b) $x_i > \hat{x}$ and $x_i' = x_i + \delta$ then $P(\mathbf{p}, \mathbf{x}') > P(\mathbf{p}, \mathbf{x})$.

**Axiom IB** (*Increased Bipolarity*). Consider $(\mathbf{p}, \mathbf{x}')$, $(\mathbf{p}, \mathbf{x}) \in \mathcal{D}$ such that $x_i' = x_i + \delta$, $x_j' = x_j - \delta$, $x_h' = x_h$, $h \ne i, j$ where $x_i + 2\delta \le x_j$ and $\delta > 0$. If either (a) $x_i < x_j < \hat{x}$ or (b) $x_j > x_i > \hat{x}$ then $P(\mathbf{p}, \mathbf{x}') > P(\mathbf{p}, \mathbf{x})$.

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[3]Clearly it may also make sense to consider alternative assumptions about the effects of a general income change. For example, our empirical results below show that in the polarization context many consider translation independence to be appropriate rather than SI: this would imply, for any $(\mathbf{p}, \mathbf{x}) \in \mathcal{D}$ and any $\delta \in \mathbb{R}$, $P(\mathbf{p}, \mathbf{x} + \delta\mathbf{1}^n) = P(\mathbf{p}, \mathbf{x})$ (adding or subtracting the same absolute amount to all incomes leaves polarization unchanged). One could also consider an "intermediate" position between scale independence and translation independence, analogous to intermediate inequality measures (Bossert and Pfingsten, 1990). Other forms of systematic income dependence may also be relevant (Amiel and Cowell, 1999a).

Polarization must increase if you decrease the income of someone in the poorer group or if you increase the income of someone in the richer group (IS), or if you bunch incomes closer together within the poorer or the richer group (IB). IS part (a) corresponds to the monotonicity axiom in poverty analysis if the poverty line is below median income. In the statement of IB there is an implied transfer on one side of the median and it is clear that polarization must go up exactly where inequality must go down according to the well-known transfer principle (Dalton, 1920).

**Formulation 2**. This is rooted in Esteban and Ray (1994). The axioms are all stated in terms of an elementary "three-rung" income distribution: in the following four statements $\mathbf{p}$ and $\mathbf{x}$ have dimension 3, $\mathbf{p} > \mathbf{0}$ and $x_1 \leq x_2 \leq x_3$.[4]

**Axiom ER1.** Let $p_1 > p_2 = p_3$ and $x_1 < x_2 < x_3$. Then, for $p_2/p_1$ sufficiently small and $x_3/x_2$ sufficiently small: $P\big((p_1, 2p_2), (x_1, \sqrt{x_2 x_3})\big) > P(\mathbf{p}, \mathbf{x})$.

**Axiom ER2.** Let $p_1 > p_3$ and $x_2/x_1 > x_3/x_2 > 1$. Then there exists a small positive $\delta$ such that $P(\mathbf{p}, (x_1, x_2 + \delta, x_3)) > P(\mathbf{p}, \mathbf{x})$.

**Axiom ER3.** Let $x_3/x_2 = x_2/x_1 > 1$. Then for all $\delta \in \left(0, \frac{1}{2} p_2\right)$: $P((p_1 + \delta, p_2 - 2\delta, p_3 + \delta), \mathbf{x}) > P(\mathbf{p}, \mathbf{x})$.

**Axiom ER4.** Let $p_2 > p_3$ and $x_3 > x_2 > x_1$. Then, for $p_1$ and $p_2 - p_3$ sufficiently small and for $\delta \in (0, p_1)$: $P((p_1 - \delta, p_2, p_3 + \delta), \mathbf{x}) \geq P(\mathbf{p}, \mathbf{x})$.

So polarization is increased by pooling two small population masses on the upper income rungs at their geometric mean (ERl), by increasing intermediate income in a special three-income society (ER2), or by moving population mass from the middle outwards (ER3); migration from a very small population mass at a low income to a moderately-sized high income (ER4) will not reduce polarization. The income transformation implied in ER3 is consistent with an inequality change that respects the transfer principle: in this very special case polarization and inequality move in the same direction.

## 2.2. *Measures*

Corresponding to the two formulations in Section 2.1 we find specific classes of polarization measure. For example, Formulation 1 leads naturally to the following class of measures:

$$(1) \qquad P^I(\mathbf{p}, \mathbf{x}) := \phi\big(I(\mathbf{p}^-, \mathbf{x}), I(\mathbf{p}^+, \mathbf{x}), \hat{x}, \mu^-, \mu^+\big)$$

where $\phi$ is strictly decreasing in each of its first two arguments, $I$ is an inequality index satisfying the transfer principle, $\hat{x}$ is the median and

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[4]Esteban and Ray (1994) work with log incomes, which explains the use of the geometric mean (instead of the arithmetic mean) in ER1. In addition one could follow Esteban and Ray's practice and normalize $x_1 \equiv 1$, but this is not essential.

$$p_i^- := \begin{cases} p_i & \text{if } x_i < \hat{x} \\ 0 & \text{otherwise} \end{cases}, \quad p_i^+ := \begin{cases} p_i & \text{if } x_i > \hat{x} \\ 0 & \text{otherwise} \end{cases},$$

$$\mu^- := \frac{\sum_{i=1}^{n} p_i^- x_i}{\sum_{i=1}^{n} p_i^-}, \quad \mu^+ := \frac{\sum_{i=1}^{n} p_i^+ x_i}{\sum_{i=1}^{n} p_i^+}.$$

This is the approach of Chakravarty and Majumder (2001) and Wang and Tsui (2000).[5] By contrast, by invoking Axioms ER1–ER3 (Formulation 2) and assuming a quasi-additive structure for the polarization index, Esteban and Ray (1994) derived the index

(2)
$$P^{\alpha}(\mathbf{p}, \mathbf{x}) := \sum_{i=1}^{n} \sum_{j=1}^{n} p_i^{1+\alpha} p_j \left| \log\left(\frac{x_j}{x_i}\right) \right|,$$

where $\alpha$ is a positive parameter.[6]

Of course this still leaves the exact characterization of the polarization measure open-ended. For the measure $P^I$ one still has to specify the index $I$—Chakravarty and Majumder (2001) suggest the Atkinson index, Wang and Tsui (2000) suggest the Gini. For the measure $P^{\alpha}$ one still has to specify the parameter $\alpha$—Esteban and Ray (1994) provide an argument that it must be less than 1.6 (implicit in the proof of their Theorem 1) and, if ER4 is invoked, it must be greater than 1.[7] Clearly $P^{\alpha}$ satisfies SI. Whether $P^I$ satisfies SI or some other general principle of income levels (see footnote 3) will depend in part on the properties of the $I$ that has been specified.

### 2.3. *A Preliminary Comparison*

How do the two formulations compare? Let us mention three issues that will be important for the empirical analysis that follows. The second and third issues bring in additional points that Esteban and Ray make on the meaning of polarization but that they do not introduce as explicit assumptions.

#### IB and ER1

IB "explicitly demonstrates that polarization and inequality are two different concepts" (Chakravarty and Majumder, 2001, p. 6); furthermore it appears to capture a similar idea to ER1 as well as being related to Esteban and Ray's discussion of the behavior of $P^{\alpha}$ under progressive transfers (p. 844). An important issue is whether IB can be taken as just a more general form of ER1: this question is examined formally in Appendix A and its empirical implications in Section 5.2.

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[5]In addition to PP, SI, IS, and IB, Chakravarty and Majumder (2001) invoke three other properties, symmetry, normalization, and continuity, to derive their measure (see their Proposition 1).

[6]See Esteban and Ray (1994), Theorem l.

[7]See Esteban and Ray (1994), Theorem 3.

### Monotonicity in Polarization

IS can be seen as a simple monotonicity property (Chakravarty and Majumder, 200l). However, in discussing the "intermediate behavior" of their measure, Esteban and Ray (1994, pp. 828, 843) show that if initial polarization is relatively large, then as population moves away from two central masses, to the extremes—the sequence (a) to (c) in Figure 1—polarization as measured by $P^\alpha$ first decreases and then increases.

### Small Groups

Esteban and Ray (1994) present a puzzle for which there is no counterpart in Formulation 1. What is the impact on polarization of the shift in population mass in the two cases represented by panels (a) and (b) in Figure 2? They suggest that although case (a) may be ambiguous as to its effect, case (b) should definitely increase polarization.
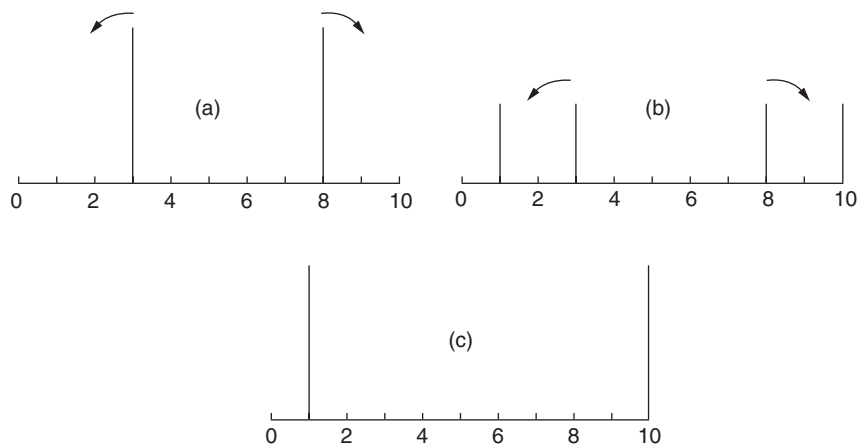


Figure 1.  Non-Monotonicity?

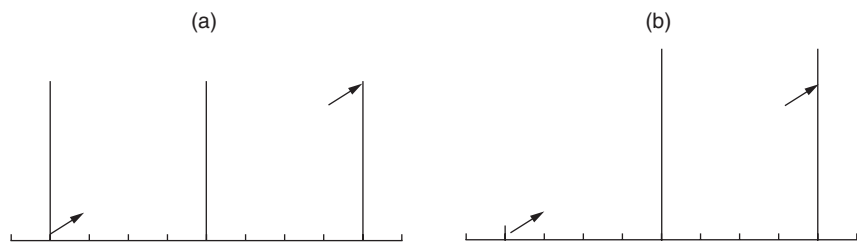*Source*:  Esteban and Ray (1994, figure 5).



Figure 2.  Significance of Small Groups?

*Source*:  Esteban and Ray (1994, figure 3).

## 3. The Approach

We used a standard technique to investigate whether this formulation of polarization is "appropriate" in that it corresponds with individuals' views. The method follows that of earlier work on inequality, poverty, and social welfare (Amiel and Cowell, 1992, 1999b). The basic idea is to set up a number of income-distribution comparisons and to invite respondents to state which of the two distributions represents greater polarization. So the approach is purely ordinal and, given an appropriate collection of income-distribution pairs, it is possible to get some insight on whether the structures imposed by the axiomatization are consistent with the principles that underlie people's perceptions of polarization.

### 3.1. *Questionnaires*

There are three features of this investigation that contrast with other studies of attitudes. First, there is no question of incentives being involved, so that monetary reward has no role to play in our study.[8] Second, it is unlikely that there is a role for personal involvement as there would be had we focused on social welfare, inequality, or poverty (your viewpoint could depend on whether or not you are poor). Third, it does not touch on the issue of what people prefer or what they want, in contrast to, say, a study of redistribution: what we are seeking here is just an opinion on a specific distributional characteristic.

Of course, as in other types of study, we also need to check on whether respondents are influenced by the way questions are presented. In the present case this takes two forms:

- Within a questionnaire we pose questions both in the form of specific numerical problems and, later, also in terms of principles expressed verbally.
- We used a variety of formats for the questionnaire concurrently. Since the initial contributions to the polarization literature appealed strongly to individual intuition in establishing the concept, it is clearly important to use alternative representations in order to appeal to our respondents' intuition. Some respondents completed the questionnaire on-line in an interactive environment, VLAB, established at the Distributional Analysis Research Programme, of STICERD, LSE. Others completed the questionnaire in the corresponding hardcopy form. Both versions were prepared in three forms of questionnaire that presented the numerical representation in different ways:
  1. *With hints.* The two distributions are presented as simple vectors, written out in full. Where components differ between the two income vectors, these are highlighted in bold to emphasize to the respondent what particular implied change in the distribution he or she ought to be looking at.

[8]Compare Amiel and Cowell (1999b, p. 26). "we may reasonably assume that strategic decisions are not going to have a significant role to play in the pattern of responses; and because no decision is consequent upon the responses to the questions—or upon other related questions as in the cases of voting-intention opinion polls—there is reason to believe that the responses are relatively uncontaminated by people's desire to impress or mislead."

TABLE 1

Axioms and Questions

| Axiom | Answers Consistent with Axiom |
|---|---|
| PP | 3AB, 15C |
| SI | 4AB, 5A, 16A, 17A |
| IB | 2A, 14B |
| IS | 1A, 9A, 7B, 10A, 13aC, 13bB, 21A |
| ER1 | 11B, 12B, 22B |
| ER2 | 6B, 18A |
| ER3 | 7B, 19A |
| ER4 | 8B, 20A |
| Non-monotonicity | 1B, 9B, 10A, 21D |
| Relevance of small groups | 1AB, 13aB, 13bC |

2. *No hints.* As above, but without putting particular vector components in bold.

3. *Pictures.* We use a simple graphic (based on Amiel and Cowell, 1999b) to represent the two distributions on an income line.

A number of variants of the questionnaires were used in order to examine specific hypotheses—how these questionnaires differed from one another is explained in Section 5. The questionnaires themselves are available at http://darp.lse.ac.uk/polarisation/ and the master version used for reference in this paper is reproduced in Appendix D.[9]

Many of the questions to be addressed concern the extent to which respondents' views correspond to individual axioms or principles employed in the polarization literature. The relationship between the question used in our study, the Axioms set out in Section 2.1, and other properties highlighted in Esteban and Ray (1994) are given in Table 1. If a substantial proportion of respondents answer questions in a way that is systematically different from the entry on the right-hand side of the table, there is *prima facie* reason to call into question the corresponding axiom or principle.

We can do more than examine individual principles using the questionnaire–experimental approach. The proportion of the sample who simultaneously give the responses listed in rows ER1–ER3 of Table 1 can be taken as an indication of the extent to which individuals intuit polarization in a manner consistent with Esteban and Ray's (1994) polarization index, $P^\alpha$ given in equation (2). Likewise the proportion of the sample who, in addition to the above, also give the responses of row ER4 can be taken as an indication of the extent to which polarization is perceived in the narrower form of $P^\alpha$ with $\alpha \geq 1$.[10] In addition, the proportion of the sample

[9]This master version was not the one used for the bulk of our respondents: the versions used in the initial phase with our main sample (reported in Section 4) were slightly shorter, omitting Questions 11, 12, and 22.

There was one further important change to the master version for some respondents. It may also be thought that the arguments given in the options of the verbal questions could drive individuals toward the "right" answer. To check that, we ran some questionnaires with bare verbal answers, i.e. increase, decrease, remain the same.

[10]This means that the sensitivity parameter is sufficiently large that $P^\alpha$ is not close to an inequality index (Gini defined on log incomes)—see Esteban and Ray (1994), Theorem 3.

who respond in line with rows IS, IB, and PP of Table 1 can be taken as an indication of the extent of "support" for the $P^I$ index (1) suggested by Chakravarty and Majumder (2001).

### 3.2. *The Samples*

The questionnaire–experiments reported here consisted of a main study and two follow-up investigations.

### Main Study

Our main sample consisted of 1521 students from 11 universities spread amongst six countries (1427 paper questionnaires, 94 internet), which we use for the main study, and two smaller samples that we use to test several hypotheses or conjectures which arose from the analysis of the main sample. The three samples are shown in Table 2. Average age in the main sample is 22, and the gender composition is fairly equally balanced. Most are economics and business students but we also sampled students from other social sciences, and to a lesser extent from other disciplines. Notice that the distribution of the type of questionnaire is also balanced, with the pictorial version being slightly more used than the other two. Average political views lay near the mid-point of the support and, on average, respondents expect to be financially better off in ten years' time than were their families ten years ago.

### Follow-Up Studies

To address specific issues that arose from the analysis of the main sample, we implemented two follow-up studies with smaller samples. The first of these uses two subsamples of 131 and 128 individuals who responded to two parallel questionnaires, on inequality and polarization, with the aim of finding out whether respondents answer polarization questions as though they are being presented with inequality questions—the differences between these two questionnaires and the relationship to the one used in the main study are explained in Section 5.1. The second follow-up study samples 191 individuals to check whether the Increased Bipolarity property is an adequate proxy for the ER1 axiom. The strategy of running two parallel questionnaires is also used in this follow-up study, obtaining balanced subsamples.

The composition of the follow-up samples is very similar to the main sample; however, they come from only one university (UAB), and the second follow-up study uses only the picture-type questionnaire.

## 4. Results

Let us examine the extent to which individuals' perceptions of polarization issues accord with principles commonly used in the economics literature and outlined in Section 2. We begin with an overview of the responses to the issues summarized in Table l, starting with the structural properties (PP and SI) and then the two formulations of polarization introduced in Section 2.1. However, as we

TABLE 2

DESCRIPTIVE STATISTICS OF OUR SAMPLE

| Variable | Main Study | | Follow-Up Study 1 | | | | Follow-Up Study 2 | |
| | | | Polarization | | Inequality | | | |
| | $N$ | Val* | $N$ | Val* | $N$ | Val* | $N$ | Val* |
|---|---|---|---|---|---|---|---|---|
| Age | 1,445 | 22.11 | 128 | 20.45 | 118 | 19.94 | 183 | 22.45 |
| Political views | 1,392 | 3.61 | 123 | 3.06 | 108 | 3.17 | 178 | 2.86 |
| Family income in 1995 | 1,425 | 4.09 | 125 | 3.89 | 112 | 4.03 | 181 | 4.02 |
| Income prospects in 2015 | 1,422 | 4.68 | 126 | 4.90 | 111 | 5.17 | 181 | 4.65 |
| Gender | 1,449 | | 128 | | 116 | | 183 | |
|   Female | 757 | 52.24 | 79 | 61.72 | 68 | 58.62 | 99 | 54.1 |
|   Male | 692 | 47.76 | 49 | 38.28 | 48 | 41.38 | 84 | 45.9 |
| Employed before university | 1,403 | | 127 | | 117 | | 180 | |
|   No | 733 | 52.25 | 37 | 29.13 | 42 | 35.90 | 52 | 28.9 |
|   Yes | 670 | 47.75 | 90 | 70.87 | 75 | 64.10 | 128 | 71.1 |
| Subject of study | 1,478 | | 131 | | 128 | | 191 | |
|   Economics | 632 | 42.76 | 51 | 38.93 | 48 | 37.5 | 46 | 25.6 |
|   Business | 591 | 39.99 | 41 | 31.30 | 40 | 31.25 | 49 | 24.1 |
|   Social Sciences | 175 | 11.84 | 39 | 29.77 | 40 | 31.25 | 96 | 50.3 |
|   Other | 80 | 5.41 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Language of questionnaire | | | | | | | | |
|   Catalan | 550 | 36.16 | 131 | 100.00 | 128 | 100.00 | 191 | 100.00 |
|   English | 363 | 23.87 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
|   Spanish | 608 | 39.97 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| University** | | | | | | | | |
|   LSE | 83 | 5.46 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
|   UAB | 343 | 23 | 131 | 100.00 | 128 | 100.00 | 191 | 100.00 |
|   UB | 145 | 9.53 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
|   UEC | 87 | 5.72 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
|   UHOB | 60 | 3.94 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
|   UI | 64 | 4.21 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
|   UMON | 69 | 4.54 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
|   UOC | 94 | 6.18 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
|   UR | 185 | 12.16 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
|   URJC1 | 210 | 13.81 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
|   UV | 181 | 11.9 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Type of questionnaire | | | | | | | | |
|   Hints | 426 | 28.01 | 46 | 35.11 | 44 | 34.38 | 0 | 0.00 |
|   No hints | 454 | 29.85 | 45 | 34.35 | 42 | 32.81 | 0 | 0.00 |
|   Pictures | 641 | 42.14 | 40 | 30.53 | 42 | 32.81 | 191 | 100.00 |

*Notes*: *"Val" gives mean of relevant variable or percentage with specified characteristic.
**London School of Economics. Universitat Autònoma de Barcelona, Universitat de Barcelona. East Carolina University, University of Tasmania, University of Istanbul, Monash University, Universitat Oberta de Catalunya. Universidad de la República, Universidad Rey Juan Carlos I, Universidad de Vigo.

will see, axioms IB and ER1 raise special questions that deserve separate attention—we return to these in Section 5.

### 4.1. *The Structure of Distributional Comparisons*

A majority of the sample gives responses in line with the population principle—see Table 3. But Table 4 reveals that the evidence for scale independence is less strong and a substantial number of respondents' views are consistent with translation invariance (see footnote 3). Interestingly, a significant share of

TABLE 3

POPULATION PRINCIPLE

|  | Question 3 | Question 15 |
| --- | --- | --- |
| Increases | 29.3 | 12.8 |
| Same | *57.1* | *82.9* |
| Decreases | 13.6 | 4.3 |
| N | 1,496 | 1,468 |

*Note*: "Orthodox" answers in italics.

TABLE 4

SCALE OR TRANSLATION INVARIANCE?

|  | Question 4 | Question 5 | Question 16 | Question 17 |
| --- | --- | --- | --- | --- |
| Increases | **61.5** | 18.0 | **30.3** | 6.7 |
| Same | *28.2* | **50.2** | *53.9* | **64.9** |
| Decreases | 10.3 | *31.8* | 10.8 | *20.7* |
| Depends |  |  | 5.0 | 7.6 |
| N | 1,507 | 1,497 | 1,468 | 1,466 |

*Note*: "Orthodox" answers in italics; answers consistent with translation invariance in bold.

TABLE 5

INCREASED SPREAD

|  | Question 1 | Question 13a | Question 13b | Question 10 |
| --- | --- | --- | --- | --- |
| Increases | *59.5* | *68.8* | *70.5* | *75.8* |
| Same | 6.1 | 12.0 | 11.0 | 8.9 |
| Decreases | 34.4 | 13.2 | 12.2 | 15.3 |
| Depends |  | 6.0 | 6.3 |  |
| N | 1,507 | 1,497 | 1,486 | 1,506 |

*Note*: "Orthodox" answers in italics.

respondents answer in line with the principle being tested by each question, thus providing incoherent answers (not shown, but see Amiel *et al.*, 2007, for further details).

In the case of both principles, the verbal questions seem more persuasive than the numerical ones (for example, 69 percent of those who did not answer in line with the PP in the numerical question did so in the verbal one). One might wonder whether the short argument provided in the different options drives individuals toward the orthodox answers. However, the analysis of our "bare-verbal-questions" sample reveals this to be an unfounded suspicion.

### 4.2. *The Meaning of Polarization—Formulation 1*

Table 5 shows that there is a substantial majority that supports Increased Spread, whether the issue is presented in numerical or verbal form. It is interesting to note that parts (a) and (b) of Question 13 show that there is symmetry in the evaluation of changes when occurring in the two halves of the distribution: no

TABLE 6

INCREASED BIPOLARIZATION

|  | Question 2 | Question 14 |
|---|---|---|
| Increases | *30.1* | *19.7* |
| Same | 16.2 | 47.8 |
| Decreases | 53.7 | 32.5 |
| N | 1,497 | 1,441 |

*Note*: "Orthodox" answers in italics.

more importance is given to a "gap" at the lower rather than the upper half of the distribution.[11]

By contrast Increased Bipolarity enjoys little support, in whatever form the issue is posed. This result is remarkable—perhaps unfortunate—because the property provides a clear distinction between polarization and inequality. As shown in Table 6, only 30 percent of the sample provides an answer to Question 2 that is consistent with the axiom. This percentage falls to 20 percent in the verbal Question 14. Perhaps respondents consider that the implied income changes are too small to make any difference; 16 and 48 percent view the changes proposed in Question 2 and Question 14, respectively, as having no effect on polarization. As outlined above, IB involves equalizing transfers: so it is possible that respondents are heavily influenced by the notion of inequality when assessing the implicit transfer which takes place from distribution B to A in Question 2 or when deciding about the effect of the explicit income transfer of Question 14. We examine this issue in Section 5.l.

### 4.3. *Formulation 2—ER*

As we have previously noted, it appears that IB might be taken as a generalization of ER1 and so it might seem that the negative findings reported in the preceding paragraph might be considered as fatal for ER1. We return to this below.

For now, let us examine the other axioms used in the ER formulation. Both ER2 and ER3 receive overwhelming support from our sample respondents: more than 65 percent of the respondents answer in line with the axiom being tested (Table 7); more than half of the whole sample provides consistent answers to the numerical and verbal questions. However, ER4 receives somewhat less support in that fewer than 40 percent of the sample ever respond in line with this axiom (Table 8), and only one sixth agrees with the axiom in both questions simultaneously.[12]

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[11]The evidence in favor of IS remains when other questions 7, 9, 10 are used.

[12]In fact, when cross-checking the responses from the numerical and the verbal questions, consistent rejection of the axiom is the option that gathers the largest support (44 percent). A possible explanation is that the level of income of the poorest individual has a large impact on a person's polarization assessment. Note that in the verbal Question 20 our "justification" or "explanation" for a decrease (option b) is that the lowest income group disappears; and when explanations are dropped from the answers, the "decrease" response loses strength: 15 percentage points that could be attributed to the "importance-of-the-income-of-the-poorest-individual" effect.

TABLE 7

AXIOMS ER2 AND ER3

| | ER2 | | ER3 | |
|---|---|---|---|---|
| | Question 6 | Question 18 | Question 7 | Question 19 |
| Increases | *71.8* | *65.8* | *76.9* | *67.4* |
| Same | 8.3 | 10.3 | 5.8 | 15.2 |
| Decreases | 19.9 | 15.1 | 17.3 | 8.6 |
| Depends | | 8.9 | | 8.7 |
| N | 1,506 | 1,460 | 1,506 | 1,458 |

*Note*: "Orthodox" answers in italics.

TABLE 8

AXIOM ER4

| | Question 8 | Question 20 |
|---|---|---|
| Increases | *38.9* | *27.4* |
| Same | 3.1 | 9.6 |
| Decreases | 58.1 | 63.0 |
| N | 1,507 | 1,439 |

*Note*: "Orthodox" answers in italics.

TABLE 9

NON-MONOTONICITY IN FIGURE 5

| Question 9 | | Question 21 | |
|---|---|---|---|
| Increases | 56.2 | Increases always | 42.5 |
| Same | 6.7 | Decreases always | 8.5 |
| Decreases | *37.1* | Increases first, then decreases | *12.1* |
| | | Decreases first, then increases | *20.3* |
| | | Same | 9.5 |
| | | None | 7.1 |
| N | 1,498 | N | 1,415 |

*Note*: "Orthodox" answers in italics.

Finally, consider the two properties mentioned in Section 2.3 but not presented as formal axioms. First, the substantial support for IS suggests that Esteban and Ray's (1994) *non-monotonicity* argument is rather weak. Indeed this is what we find in Table 9. Since there is no ground to allow for polarization to decrease in the transition from panels (b) to (c) of Figure 1, non-monotonicity implies that people should perceive a decrease in polarization in the transformation going from panels (a) to (b)—the gist of our Question 9. However, Table 9 shows that the responses in favor of non-monotonicity amount to only about a third of the sample regardless of whether the issue is presented numerically (Question 9) or verbally (Question 21). Cross-checking the responses to Questions 9 and 21 shows complete consistency between the numerical and the verbal questions. Second, are *small groups* significant in terms of polarization (Figure 2)? The message that comes out of the answers to Questions 1, 13a, and 13b (Table 5) is clear-cut: few individuals do make a difference.

TABLE 10

COMBINATIONS OF ACTUAL AND EXPECTED ANSWERS IN THE
POLARIZATION AND INEQUALITY QUESTIONNAIRES

| Responses in both questionnaires . . . | | |
|---|---|---|
| | . . . actually | |
| . . . ought to | Coincide | Differ |
| Coincide | *I* | *II* |
| Differ | *III* | *IV* |

## 5. POLARIZATION AND INEQUALITY

Our findings suggest that important axioms which serve to differentiate polarization from inequality—such as Increased Bipolarity—are not widely accepted. This is an issue that cannot be lightly set aside. There are two main questions arising from this result: (a) Do people respond to polarization questions as though they were being presented with issues in inequality? (b) Is it inappropriate to see IB as a proxy for ER1? To address these questions we carried out two follow-up studies, discussed in Sections 5.1 and 5.2.

### 5.1. *Do Respondents Think in Terms of Inequality?*

In the standard theory a central difference between inequality and polarization is what happens if an income transfer is made between two individuals on the same side of the median: inequality and polarization should move in opposite directions. It is possible that some of the apparently heterodox answers discussed earlier may indicate that respondents were actually thinking in terms of *inequality* when answering our questionnaire about *polarization.* We investigated whether this is so by running a small follow-up experiment, consisting of two parallel questionnaires, one on polarization and one on inequality. The latter results from replacing the word polarization with inequality in a "bare-verbal questions" version of the polarization questionnaire (and adapting the introductory text).

To assess whether respondents think in terms of inequality when answering the polarization questionnaire, we compare responses between the two samples; full details of the comparative study can be found in Amiel *et al.* (2007); Appendix B shows only the results which are discussed below. Actual and expected responses can either coincide or differ between questionnaires. When disagreement between expectations and realizations occurs (cells *II* and *III* in Table 10) because polarization responses are not in line with the relevant axiom but inequality responses are, we will consider that respondents think in terms of inequality when answering the polarization questionnaire.[13] Responses that fall in cell *IV*, however, suggest that individuals are indeed thinking differently in

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[13]Note that disagreement between expected and actual responses may also arise because inequality responses are not in line with the axiom and polarization responses, or because both inequality and polarization responses are not in line with the respective relevant axioms. These two instances however do not provide any relevant information.

TABLE 11

EXPECTED ANSWERS IN THE POLARIZATION AND INEQUALITY QUESTIONNAIRES

| | | Expected Answer in . . . | | | |
|---|---|---|---|---|---|
| Q | Polarization | Inequality | Q | Polarization | Inequality |
| 1 | A | A | 13a | C | C |
| 2 | A | B | 13b | B | B |
| 3 | AB | AB | 14 | B | A |
| 4 | AB | AB | 15 | C | C |
| 5 | AB | AB | 16 | A | A |
| 6 | B | A | 17 | B | B |
| 7 | B | B | 18 | A | B |
| 8 | B | A | 19 | A | A |
| 9 | B | A | 20 | A | B |
| 10 | A | A | 21 | D | A |

each questionnaire.[14] Finally, notice that no information can be elicited from cell *I,* which describes the situation where responses coincide in both questionnaires.

As shown in Table 11,[15] expected answers differ in 40 percent of the questions, and most notably in those referring to IB (Questions 2 and 14) and to the non-monotonic behavior of polarization (Questions 9 and 21). The answers obtained in Question 2 may suggest that individuals think in terms of inequality when answering the polarization questionnaire. Answers to this question ought to be different but, as shown in Table B1 (Appendix B), they are actually very similar: in both questionnaires more than half of the respondents choose distribution B as the most polarized or unequal. Nevertheless, responses to the companion verbal Question 14 do not go in the same direction, and thus cast doubt on the robustness of conclusions from the numerical responses alone.

The responses to Questions 9 and 21 also provide inconclusive evidence. Answers to Question 9 should differ between both questionnaires.[16] Respondents to the inequality questionnaire do answer in line with the principle of transfers, but on the polarization side both distributions gather similar support though the difference in Table B2 (Appendix B) are statistically significant ($z = 4.2$; $p < 0.001$)—and support for distribution A is not as strong as it is among inequality respondents. Answers to the companion verbal Question 21 give support to the possibility that polarization questionnaire respondents think in terms of inequality: irrespective of the questionnaire type the option that receives most support is that of a monotonic increase, consistent with inequality postulates but not with the

[14]That is, if answers differ because they are in line with the axiom. The case where answers happen to differ, but only because some of the responses do not accord with the relevant axiom, does not provide any relevant information.

[15]In most cases the expected answer comes from adapting the polarization axiom which is being tested to the case of inequality. Scale and translation invariance of Questions 4, 16, 5, and 17 are good examples of this. When this does not apply, the expected answer uses the transfer principle. Only in the case of four questions have we appealed to stochastic dominance. In Questions 6 and 18, distribution B generalized-Lorenz dominates distribution A, while in Questions 8 and 20 distribution B Lorenz dominates distribution A.

[16]According to the principle of transfers, distribution A should be more unequal, while the non-monotonic behavior of polarization would require distribution B to show more polarization.

TABLE 12

RESPONSES ON QUESTIONS DEALING WITH AXIOM ER1

| | Polarization | | |
| | Question 11 | Question 12 | Question 22 |
|---|---|---|---|
| *Increases* | *46.9* | *48.5* | *33.3* |
| Same | 17.4 | 23.7 | 34.4 |
| Decreases | 35.7 | 27.8 | 32.3 |
| N | 98 | 97 | 93 |
| | Inequality | | |
| | Question 11 | Question 12 | Question 22 |
| Increases | 15.0 | 23.7 | 24.1 |
| Same | 26.9 | 34.4 | 37.9 |
| *Decreases* | *58.1* | *41.9* | *38.0* |
| N | 93 | 93 | 87 |

*Note*: "Orthodox" answers in italics.

non-monotonicity feature of polarization. But the difference between monotonicity and non-monotonicity is much smaller in the polarization sample than in the inequality sample.[17]

Questions 6 and 18 are an interesting case, which suggests that respondents do not think in terms of inequality when confronted with the polarization questions. Responses in both questionnaires are in line with ER2, thus being clearly at odds with the (demanding) set of axioms required by the generalized Lorenz dominance criteria. However, responses to Questions 8 and 20 are consistent with the hypothesis that individuals do think in terms of inequality.[18]

### 5.2. *Increased Bipolarity—A Closer Look*

Our second response to the problem raised by the lack of support for the key Increased Bipolarity principle is to distinguish more sharply between ER1 and IB. This was done by presenting a sample of 191 students with the inequality and polarization versions of the questionnaire in Appendix D and comparing the results of Questions 2 and 14 on the one hand with those of Questions 11, 12, and 22 on the other.

About half of the polarization subsample (ca. 100 new respondents) answer Questions 11 and 12 in accordance with ER1—nearly 50 percent of the respondents report that the pooling of the two small population masses increases polarization—see Table 12. Moreover, the symmetry in the answers to Questions 11 and 12 reveals support for a possible extension of ER1 to include pooling on the lower income rungs, since strictly speaking, only Question 11 provides a faithful representation of ER1—i.e. pooling of the masses on the upper income rungs.[19] While providing some evidence in support of ER1 this follow-up sample also

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[17]This difference is statistically significant ($z = 14.1$; $p < 0.001$).

[18]Test statistics show that, for all four questions (i.e. Questions 8 and 20 in the two questionnaires), differences in responses are statistically significant.

[19]Though ER1 gathers reasonable support for each of the two Questions 11 and 12 separately, only 36 percent of respondents provide a consistent answer for both questions.

confirms the weak support for IB that was obtained in the previous samples.[20] People seem to appreciate the differences between the two axioms.

As pointed out above, IB and ER1 are key principles that distinguish the concepts of polarization and inequality—their characterization of a change in income distribution is, in a sense, in direct opposition to that of the principle of transfers. Hence, it is worth noting that the respondents to the inequality questionnaire provide answers to Questions 11 and 12 that are consistent with the principle of transfers.

However, the message coming from the answers to Question 22 is less clear-cut since the three choices obtain roughly speaking the same (one third) support, irrespective of the type of questionnaire (polarization or inequality).

### 5.3. *Axioms Required by Polarization Indices*

Only a minor proportion of the sample seem to endorse all the axioms required to build the most popular indices in the literature. The three axioms used in theorem 1 in Esteban and Ray (1994) (Questions 11, 6, and 7) gather 39 percent of support. When ER4 is also considered—having thus the four axioms required to arrive at the preferred measure in Esteban and Ray (1994, theorem 3)—support goes down to 23 percent. As far as Chakravarty and Majumder (2001) is concerned, IS and IB jointly (as required for their proposition 1) command very little support.

## 6. What Affects Polarization Perceptions?

Are individual characteristics or circumstances, such as the country of residence or parental income, important in understanding the perception people have of polarization? Or is this perception related to choices such as someone's field of study? Maybe it is the elicitation method itself that drives perceptions—the way questions are put or whether they are presented as paper questionnaires or using the internet. We investigated these issues using multinomial regression—see the results in Tables C1 to C4 in Appendix C.[21] Let us focus on two main categories of explanation: elicitation mode and cultural background.

### 6.1. *Elicitation Mode*

Recall that (i) each respondent was presented with both numerical and verbal questions on each of the main polarization axioms, and (ii) there were three separate types of questionnaire distinguished by the way the numerical questions were presented—with hints, without hints, or pictorially. The discrepancies in the proportion of orthodox responses between the corresponding numerical and verbal questions do not usually affect the qualitative conclusion on each of the axioms.

The questionnaire type certainly has a significant impact on the answers to the questions related to polarization axioms that receive the least support, i.e. Questions 2 (IB), 4 (SI), 8 (ER4), and 9 (non-monotonicity feature) and, in some cases,

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[20]The new follow-up sample provides answers to Questions 2 and 14 which are very similar to those obtained with the other two samples—see Section 4.2.

[21]Estimates are obtained using the main sample only.

also on the corresponding verbal question. For example, in the case of IB, respondents answering the pictorial type are twice as likely to agree with the axiom than those who answered either of the types (but even for the pictorial type, only 37 percent responded in accordance with IB). However, the type of questionnaire affects also the answer to questions that test axioms which gather large support. For instance, respondents with the pictorial type are also more likely to agree with ER2 than those who used the questionnaire with visual hints.

In contrast, those with the pictorial type are also more than twice as likely to reject scale invariance in favor of reporting larger polarization, as the gap between two poles increases in absolute terms but stays constant in relative terms (Question 4). The regression estimates on Question 5 reveal that those with the pictorial-type questionnaire are twice as likely to give a response in line with translation invariance axiom rather than scale invariance.

Finally it is reassuring to note that the internet variable is only significant for a few cases. Responding through Virtual Lab rather than on paper does not seem to matter.

### 6.2. *Cultural Background*

We capture cultural differences by the subject of study and the country and language in which the questionnaire was run. Instruction in economics matters for one of the important axioms that gathered little support, Increased Bipolarity. As compared to individuals being taught other social sciences, economics students are far more inclined to think in accordance with IB, instead of reporting that an equalizing transfer decreases polarization. Students from other disciplines are also more inclined than economics students to give answers that are not consistent with the other main polarization axioms (Questions 1, 3, 6, 9, 10) and they are less likely to respond in line with scale invariance (Question 16).

In order to examine the influence of societies and the common features of their culture on individual perceptions of polarization we have used a variable that combines the language used and the place the questionnaire was run—that identifies Catalan, Spanish, Anglo-Saxon (in England, the U.S. and Australia), Uruguayan, and Turkish. Our key finding is that cultural background has no role to reply in the case of polarization principles that appear to have little support (for example, Questions 2, 4, 8, and 9).

## 7. A Brief Conclusion

Do people view polarization in the same way that economists do? In many respects, yes. But in one vital respect—the issue of Increased Bipolarity—they certainly do not. This undermines some of the standard approaches to polarization that have been developed in the literature. What is more the conclusion is robust under alternative representations of the questionnaire (pictorial, numerical, or verbal; with or without hints). However, the point should be qualified if one distinguishes between Increased Bipolarity and the related, but more narrowly focused, ER1 axiom of Esteban and Ray: it emerges that ER1 can claim greater support among our respondents than Increased Bipolarity, but it is still only a

minority whose views on polarization are consistent with ER1. Moreover, the most popular indices in the literature do not enjoy much support since only a small proportion of people endorse all the axioms that these measures require.

Do people view polarization in the same way that they view inequality? Here the evidence is mixed. The responses to some questions suggest that individuals do think in terms of inequality while some others point to the opposite conclusion. Either way it suggests that there may be room for new thinking on the meaning of polarization.

## Appendix A: The Increased Bipolarity Axiom

Consider the possible relationship between the apparently similar IB and ER1. We begin by noting two differences that make it difficult to compare the two axioms simply. First Chakravarty and Majumder (2001) impose a "one-sidedness" condition in IB in that the implied transfers must take place on one side or other of the median. If $\frac{1}{2}p_1 > p_2$ in Esteban and Ray's discussion,[22] then clearly the income change implied in ER1 would take place above the median. But if $\frac{1}{2}p_1 < p_2 < p_1$ then the "one-sidedness" condition is violated. Second Esteban and Ray always work in terms of log-incomes while Chakravarty and Majumder work only in terms of incomes. So the income change in ER1 is not a pure transfer as it is in IB (in ER1 the point masses are moved to the geometric mean of the two incomes, not the arithmetic mean). However, it is interesting to note Esteban and Ray's remark that "any other scalar can be used as the basic perceptual variable" (p. 829). So it may be reasonable to consider a form of the principle in Esteban and Ray (1994) in terms of income rather than log-income. In the light of these two points, suppose we consider a modified form of ER1 that imposes a stricter condition on $p_1$ and $p_2$ and that permits use of the arithmetic mean:

**Axiom ER1\***. Let $\frac{1}{2}p_1 > p_2 = p_3$ and $x_1 < x_2 < x_3$. Then, for $p_2/p_1$ sufficiently small and $x_3/x_2$ sufficiently small: $P\left((p_1, 2p_2), \left(x_1, \frac{1}{2}[x_2 + x_3]\right)\right) > P(\mathbf{p}, \mathbf{x})$.

Then it is clear that the conditions for ER1\* are a special case of Increased Bipolarity. In other words if $P$ satisfies Increased Bipolarity then it must satisfy ER1\*, but not vice versa. So it is clear that IB implies ER1\* but that neither ER1 nor ER1\* implies IB.

## Appendix B: Comparison of Polarization and Inequality

Tables B1 and B2 summarize results for Follow-up study 1 (FU1) that explicitly compared results from almost-identical polarization and inequality questionnaires. In each case the "Orthodox" position is in italics.

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[22]Note that in the diagram that they use to illustrate the meaning of their Axiom 1 (p. 832) it is clear that $p_1 > 2p_2$.

TABLE B1

IB, ER2, AND ER4 IN FU1

| | IB | | ER2 | | ER4 | |
|---|---|---|---|---|---|---|
| | Question 2 | Question 14 | Question 6 | Question 18 | Question 8 | Question 20 |
| | | | *Polarization* | | | |
| *Increases* | *33.6* | *18.5* | *67.5* | *53.2* | *40.7* | *32.5* |
| Same | 14.7 | 63.1 | 9.7 | 12.7 | 6.8 | 19.8 |
| Decreases | 51.7 | 18.5 | 22.8 | 19.1 | 52.5 | 47.6 |
| Depends | | | | 15.1 | | |
| N | 116 | 130 | 114 | 126 | 118 | 126 |
| | | | *Inequality* | | | |
| Increases | 31.8 | 9.5 | 62.7 | 48.4 | 18.9 | 15.7 |
| Same | 14.6 | 52.4 | 12.7 | 15.1 | 9.0 | 24.0 |
| *Decreases* | *53.6* | *38.1* | *24.6* | *21.4* | *72.1* | *60.3* |
| Depends | | | | 15.1 | | |
| N | 110 | 126 | 110 | 126 | 111 | 121 |

*Note*: "Orthodox" position in italics.

TABLE B2

NON-MONOTONICITY IN FU1

| Question 9 | | Question 21 | |
|---|---|---|---|
| | | *Polarization* | |
| Increases | 49.6 | Increases always | 31.0 |
| Same | 7.8 | Decreases always | 8.7 |
| *Decreases* | *42.6* | Increases first, then decreases | 13.5 |
| | | *Decreases first, then increases* | *18.3* |
| | | Same | 18.3 |
| | | None | 10.3 |
| N | 115 | N | 126 |
| | | *Inequality* | |
| *Increases* | *62.4* | *Increases always* | *38.7* |
| Same | 5.5 | Decreases always | 9.2 |
| Decreases | 32.1 | Increases first, then decreases | 9.2 |
| | | Decreases first, then increases | 11.8 |
| | | Same | 25.2 |
| | | None | 5.9 |
| N | 109 | N | 119 |

*Note*: "Orthodox" position in italics.

## APPENDIX C: REGRESSION MODEL TABLES

Tables C1 to C4 show the Relative Risk Ratios (RRR) and corresponding p-values of the coefficients in the regression model for responses on key questions. In each case multinomial logit was used and the reference group was "female, not employed, studies economics, answers Catalan questionnaire with hints on paper, politically left, with low income parents and expecting to do worse than them." The comparison answer is always the most frequent one.

## APPENDIX D: THE QUESTIONNAIRES

An example of the pictorial version of the questionnaire used in the present study is available online at www3.interscience.wiley.com. All the variants used in the study can be found at http://darp.lse.ac.uk/polarisation/.

TABLE C1

EFFECT OF INDIVIDUAL CHARACTERISTICS ON ANSWERS TO QUESTIONS 1 to 3

| Question | 1 | | | | 2 | | | | 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| "Orthodox" Answer | A | | | | A | | | | AB | | | |
| Comparison Answer | A | | | | B | | | | AB | | | |
| | AB | | B | | A | | AB | | A | | B | |
| | RRR | p-value | RRR | p-value | RRR | p-value | RRR | p-value | RRR | p-value | RRR | p-value |
| Age | 1.07 | 0.02 | 1.04 | 0.03 | 1.02 | 0.30 | 1.02 | 0.32 | 0.97 | 0.29 | 0.96 | 0.04 |
| Male | 0.68 | 0.13 | 0.98 | 0.86 | 1.13 | 0.37 | 1.09 | 0.59 | 1.15 | 0.45 | 1.02 | 0.86 |
| Employed | 0.73 | 0.25 | 0.82 | 0.14 | 1.28 | 0.08 | 1.20 | 0.30 | 1.69 | 0.01 | 1.35 | 0.04 |
| Subject of study | | | | | | | | | | | | |
| Business | 1.39 | 0.31 | 1.54 | 0.01 | 0.97 | 0.84 | 1.23 | 0.34 | 1.55 | 0.07 | 1.30 | 0.14 |
| Social Sciences | 0.91 | 0.83 | 1.45 | 0.08 | 0.58 | 0.02 | 0.70 | 0.21 | 1.50 | 0.20 | 1.55 | 0.05 |
| Other | 0.76 | 0.74 | 3.85 | 0.00 | 0.58 | 0.11 | 0.29 | 0.02 | 2.98 | 0.01 | 2.61 | 0.01 |
| Language | | | | | | | | | | | | |
| English | 1.43 | 0.38 | 1.20 | 0.41 | 1.39 | 0.14 | 1.17 | 0.56 | 4.26 | 0.00 | 4.04 | 0.00 |
| Spanish | 1.03 | 0.93 | 1.40 | 0.06 | 1.41 | 0.07 | 0.79 | 0.34 | 1.14 | 0.62 | 1.66 | 0.01 |
| Uruguayan | 0.97 | 0.95 | 1.38 | 0.15 | 1.32 | 0.24 | 1.23 | 0.47 | 1.61 | 0.17 | 1.82 | 0.01 |
| English (Turkey) | 0.41 | 0.41 | 2.54 | 0.00 | 0.95 | 0.88 | 0.67 | 0.40 | 5.48 | 0.00 | 6.24 | 0.00 |
| Version | | | | | | | | | | | | |
| No hints | 1.01 | 0.97 | 1.25 | 0.19 | 1.09 | 0.63 | 0.73 | 0.17 | 1.28 | 0.30 | 1.20 | 0.34 |
| Pictures | 2.34 | 0.01 | 1.41 | 0.03 | 1.85 | 0.00 | 1.17 | 0.44 | 1.16 | 0.52 | 1.37 | 0.06 |
| Internet | 0.86 | 0.82 | 0.70 | 0.33 | 1.03 | 0.94 | 1.24 | 0.62 | 1.06 | 0.91 | 1.12 | 0.77 |
| Political view | | | | | | | | | | | | |
| Center | 1.11 | 0.75 | 1.42 | 0.05 | 0.98 | 0.93 | 1.24 | 0.35 | 1.07 | 0.78 | 1.10 | 0.60 |
| Right | 1.08 | 0.85 | 1.41 | 0.11 | 1.08 | 0.72 | 1.40 | 0.23 | 1.12 | 0.71 | 0.96 | 0.87 |
| Income parents | | | | | | | | | | | | |
| Middle | 0.94 | 0.85 | 1.10 | 0.55 | 1.30 | 0.13 | 0.91 | 0.68 | 1.39 | 0.17 | 1.01 | 0.98 |
| High | 1.13 | 0.75 | 0.96 | 0.86 | 1.39 | 0.11 | 1.02 | 0.95 | 1.09 | 0.77 | 0.98 | 0.93 |
| Mobility prospects | | | | | | | | | | | | |
| Same as parents | 1.14 | 0.73 | 1.09 | 0.66 | 1.10 | 0.63 | 1.13 | 0.63 | 0.78 | 0.36 | 0.74 | 0.13 |
| Better than parents | 1.07 | 0.86 | 1.06 | 0.76 | 1.37 | 0.13 | 1.05 | 0.86 | 0.88 | 0.64 | 0.74 | 0.15 |

TABLE C2

EFFECT OF INDIVIDUAL CHARACTERISTICS ON ANSWERS TO QUESTIONS 4 TO 6

| Question | 4 AB B | | | | 5 AB AB | | | | 6 B B | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| "Orthodox" Answer / Comparison Answer | A | | AB | | A | | B | | A | | AB | |
|  | RRR | p-value | RRR | p-value | RRR | p-value | RRR | p-value | RRR | p-value | RRR | p-value |
| Age | 0.99 | 0.63 | 0.99 | 0.65 | 1.03 | 0.07 | 1.02 | 0.30 | 0.90 | 0.00 | 0.96 | 0.17 |
| Male | 0.90 | 0.63 | 1.16 | 0.26 | 1.80 | 0.00 | 0.97 | 0.86 | 0.79 | 0.12 | 0.90 | 0.63 |
| Employed | 1.80 | 0.01 | 0.89 | 0.44 | 1.08 | 0.60 | 1.35 | 0.08 | 1.14 | 0.39 | 1.24 | 0.36 |
| Subject of study |  |  |  |  |  |  |  |  |  |  |  |  |
| Business | 1.39 | 0.22 | 0.56 | 0.00 | 1.21 | 0.28 | 1.26 | 0.26 | 1.27 | 0.22 | 1.12 | 0.71 |
| Social Sciences | 0.83 | 0.65 | 0.71 | 0.13 | 1.23 | 0.36 | 1.02 | 0.94 | 1.69 | 0.04 | 0.76 | 0.53 |
| Other | 2.88 | 0.01 | 0.94 | 0.87 | 1.12 | 0.76 | 1.64 | 0.19 | 1.43 | 0.34 | 4.11 | 0.01 |
| Language |  |  |  |  |  |  |  |  |  |  |  |  |
| English | 2.02 | 0.02 | 0.79 | 0.30 | 1.84 | 0.01 | 2.78 | 0.00 | 1.18 | 0.51 | 0.75 | 0.49 |
| Spanish | 0.76 | 0.39 | 1.11 | 0.58 | 0.90 | 0.60 | 1.51 | 0.07 | 1.62 | 0.02 | 1.02 | 0.95 |
| Uruguayan | 0.92 | 0.85 | 0.77 | 0.28 | 1.67 | 0.03 | 1.21 | 0.55 | 0.72 | 0.29 | 1.33 | 0.48 |
| English (Turkey) | 0.37 | 0.35 | 1.19 | 0.59 | 1.77 | 0.99 | 0.99 | 0.98 | 3.10 | 0.00 | 2.16 | 0.16 |
| Version |  |  |  |  |  |  |  |  |  |  |  |  |
| No hints | 1.82 | 0.03 | 1.25 | 0.18 | 1.09 | 0.61 | 1.09 | 0.68 | 0.70 | 0.06 | 0.90 | 0.72 |
| Pictures | 1.31 | 0.31 | 0.49 | 0.00 | 0.46 | 0.00 | 0.77 | 0.19 | 0.66 | 0.02 | 0.76 | 0.31 |
| Internet | 1.32 | 0.62 | 1.32 | 0.47 | 0.59 | 0.18 | 0.83 | 0.68 | 3.34 | 0.01 | 4.92 | 0.00 |
| Political view |  |  |  |  |  |  |  |  |  |  |  |  |
| Center | 1.37 | 0.29 | 1.12 | 0.52 | 0.88 | 0.46 | 1.00 | 0.99 | 1.35 | 0.14 | 1.48 | 0.22 |
| Right | 0.99 | 0.99 | 1.04 | 0.88 | 0.88 | 0.55 | 1.06 | 0.84 | 0.91 | 0.70 | 1.00 | 0.99 |
| Income parents |  |  |  |  |  |  |  |  |  |  |  |  |
| Middle | 1.02 | 0.95 | 1.25 | 0.19 | 0.98 | 0.91 | 0.75 | 0.16 | 0.82 | 0.28 | 1.18 | 0.58 |
| High | 1.22 | 0.54 | 1.07 | 0.75 | 0.98 | 0.92 | 0.78 | 0.31 | 0.79 | 0.31 | 1.17 | 0.66 |
| Mobility prospects |  |  |  |  |  |  |  |  |  |  |  |  |
| Same as parents | 1.50 | 0.18 | 1.49 | 0.05 | 0.91 | 0.64 | 1.34 | 0.26 | 1.16 | 0.53 | 1.39 | 0.29 |
| Better than parents | 1.10 | 0.77 | 1.39 | 0.11 | 0.77 | 0.20 | 1.05 | 0.86 | 1.19 | 0.45 | 0.95 | 0.89 |

TABLE C3

EFFECT OF INDIVIDUAL CHARACTERISTICS ON ANSWERS TO QUESTIONS 8 TO 10

| Question | 8 | | | | 9 | | | | 10 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| "Orthodox" Answer | B | | | | B | | | | A | | | |
| Comparison Answer | AB | | | | A | | | | A | | | |
| | A | | B | | AB | | B | | AB | | B | |
| | RRR | p-value | RRR | p-value | RRR | p-value | RRR | p-value | RRR | p-value | RRR | p-value |
| Age | 1.05 | 0.22 | 1.04 | 0.01 | 1.00 | 0.88 | 1.03 | 0.04 | 1.01 | 0.76 | 0.97 | 0.24 |
| Male | 1.14 | 0.70 | 0.81 | 0.08 | 0.79 | 0.33 | 0.69 | 0.00 | 0.92 | 0.69 | 0.92 | 0.60 |
| Employed | 0.70 | 0.34 | 0.81 | 0.10 | 1.91 | 0.01 | 0.92 | 0.54 | 1.14 | 0.57 | 1.34 | 0.10 |
| Subject of study | | | | | | | | | | | | |
| Business | 0.77 | 0.55 | 1.02 | 0.88 | 1.21 | 0.55 | 1.15 | 0.39 | 0.80 | 0.44 | 1.56 | 0.04 |
| Social Sciences | 1.04 | 0.95 | 0.97 | 0.87 | 0.90 | 0.82 | 1.43 | 0.08 | 1.12 | 0.76 | 1.25 | 0.48 |
| Other | 0.65 | 0.62 | 2.40 | 0.00 | 1.34 | 0.62 | 1.85 | 0.05 | 4.89 | 0.00 | 3.85 | 0.00 |
| Language | | | | | | | | | | | | |
| English | 1.97 | 0.17 | 1.09 | 0.67 | 1.71 | 0.16 | 1.30 | 0.21 | 0.94 | 0.87 | 1.97 | 0.01 |
| Spanish | 0.81 | 0.67 | 1.27 | 0.17 | 1.56 | 0.19 | 1.14 | 0.45 | 1.71 | 0.07 | 1.49 | 0.09 |
| Uruguayan | 0.46 | 0.29 | 0.99 | 0.95 | 0.90 | 0.82 | 1.09 | 0.70 | 0.66 | 0.32 | 0.80 | 0.54 |
| English (Turkey) | 1.79 | 0.42 | 1.33 | 0.37 | 1.62 | 0.47 | 1.70 | 0.10 | 2.36 | 0.06 | 1.59 | 0.34 |
| Version | | | | | | | | | | | | |
| No hints | 2.05 | 0.14 | 1.06 | 0.71 | 0.88 | 0.72 | 1.68 | 0.00 | 1.14 | 0.68 | 1.16 | 0.49 |
| Pictures | 2.09 | 0.12 | 1.11 | 0.50 | 2.07 | 0.01 | 1.57 | 0.00 | 1.97 | 0.01 | 0.83 | 0.37 |
| Internet | 1.55 | 0.62 | 1.31 | 0.42 | 1.58 | 0.44 | 0.60 | 0.17 | 1.94 | 0.22 | 1.93 | 0.14 |
| Political view | | | | | | | | | | | | |
| Center | 1.58 | 0.37 | 1.05 | 0.77 | 0.83 | 0.55 | 0.81 | 0.19 | 1.27 | 0.43 | 1.05 | 0.83 |
| Right | 1.16 | 0.82 | 1.27 | 0.23 | 0.74 | 0.45 | 0.82 | 0.32 | 1.27 | 0.51 | 1.38 | 0.25 |
| Income parents | | | | | | | | | | | | |
| Middle | 0.69 | 0.38 | 0.91 | 0.53 | 1.14 | 0.69 | 0.85 | 0.32 | 1.05 | 0.86 | 0.99 | 0.95 |
| High | 0.47 | 0.15 | 0.90 | 0.58 | 1.59 | 0.21 | 0.67 | 0.03 | 0.93 | 0.83 | 0.70 | 0.17 |
| Mobility prospects | | | | | | | | | | | | |
| Same as parents | 1.29 | 0.65 | 1.15 | 0.45 | 1.40 | 0.41 | 1.22 | 0.29 | 1.23 | 0.56 | 1.26 | 0.37 |
| Better than parents | 1.02 | 0.97 | 1.03 | 0.86 | 2.08 | 0.07 | 0.99 | 0.97 | 1.44 | 0.29 | 1.03 | 0.90 |

TABLE C4

EFFECT OF INDIVIDUAL CHARACTERISTICS ON ANSWERS TO
QUESTION 16

| | RRR | p-value | RRR | p-value |
|---|---|---|---|---|
| | b | | c | |
| Age | 1.02 | 0.26 | 1.00 | 0.90 |
| Male | 1.68 | 0.00 | 1.98 | 0.00 |
| Employed | 0.95 | 0.72 | 0.94 | 0.78 |
| Subject of study | | | | |
|   Business | 1.16 | 0.39 | 2.44 | 0.00 |
|   Social Sciences | 0.90 | 0.63 | 2.48 | 0.01 |
|   Other | 0.73 | 0.36 | 1.56 | 0.32 |
| Language | | | | |
|   English | 1.12 | 0.60 | 1.64 | 0.12 |
|   Spanish | 0.75 | 0.13 | 0.55 | 0.04 |
|   Uruguayan | 0.88 | 0.58 | 0.71 | 0.41 |
|   English (Turkey) | 0.94 | 0.89 | 5.87 | 0.00 |
| Version | | | | |
|   No hints | 0.66 | 0.02 | 1.18 | 0.53 |
|   Pictures | 0.86 | 0.34 | 0.89 | 0.67 |
|   Internet | 1.78 | 0.13 | 1.87 | 0.23 |
| Political view | | | | |
|   Center | 0.89 | 0.49 | 1.27 | 0.41 |
|   Right | 1.20 | 0.41 | 1.89 | 0.07 |
| Income parents | | | | |
|   Middle | 0.63 | 0.01 | 0.76 | 0.28 |
|   High | 1.07 | 0.73 | 0.72 | 0.30 |
| Mobility prospects | | | | |
|   Same as parents | 1.05 | 0.81 | 0.83 | 0.54 |
|   Better than parents | 0.97 | 0.90 | 0.96 | 0.90 |

*Note*: Orthodox and comparison answer is "a."

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