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Inequality, poverty and the composition of redistribution

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Abstract
We study the use of social expenditures and regulation for redistribution. When regulated goods are essential in the consumption bundle of the poor, a high poverty rate creates incentives to increase redistribution through regulation. By contrast, inequality directs redistribution towards social expenditures. We propose a theoretical model that captures the trade-off between these two redistributive policies and test the model implications with a novel municipality dataset on income and local government policies. Theory predicts and empirical evidence supports that failing to account for poverty biases the effect of inequality on redistribution. Our evidence also reflects the positive connection between poverty and the use of regulation for redistribution.

1 Introduction

Most government policies have redistributive consequences. Besides direct policies such as social expenditures, more indirect redistributive tools like regulating the provision of goods and services also result in a redistribution of welfare across society. How do governments choose the combination of redistributive policies?

A study of the trade-off between direct and indirect redistribution carries two key challenges. First, the analysis should incorporate the notion that the well-being of the poor largely depends on regulated goods and services.[1] As a result, inequality

[1] For evidence on poor households spending a substantial share of their income on (regulated) utility services, see, for instance, Fankhauser and Tepic (2007). To further illustrate the relevance of regulated services to the poor, consider the concept of Energy Poverty, which refers to the inability of people to keep their homes adequately warm. The main explaining factor is that their income does not pay the utility bills. In 2020, 8% of the European population self-reported as energy-poor (see https://ec.europa.eu/energy/topics/markets-and-consumers/energy-consumer-rights/energy-poverty_en).

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and poverty play different roles in determining the composition of redistribution. On the one hand, inequality creates incentives to increase social expenditures when higher-income citizens bear the burden. On the other hand, a high poverty rate offers a political reward for subsidizing regulated services that are essential in the consumption bundle of the poor.[2,3] In this paper, we propose a theoretical characterisation of the preferences of the poor that captures these ideas and provides a neat mechanism whereby poverty affects both regulation and social expenditures.

The second challenge is to provide robust empirical evidence on the effect of inequality on redistribution that accounts for changes in poverty. The difficulty arises because, even when conceptually different, poverty and inequality are highly correlated in practice. We then propose an estimation strategy that tests the claim that poverty is an omitted variable that empirical specifications should include. We support this claim using a panel dataset that exploits changes in inequality and poverty during the Great Recession.

The literature on redistribution in democracies rests to a great extent on the political incentives that income inequality creates. On one side, seminal works state that in a progressive or proportional tax system, the wider is the income distribution, the higher are the electoral incentives to increase public expenditures and taxation (Meltzer and Richard 1981; Persson and Tabellini 1994; Alesina and Rodrik 1994). On the other side, there is also a literature claiming that heterogeneous beliefs towards inequality (Benabou and Tirole 2006; Alesina and Angeletos 2005), and other-regarding preferences (Galasso 2003; Dhami and Al-Nowaihi 2010a, b; Alesina et al. 2012; Epper et al. 2020) break, or even reverse, the positive relationship between income inequality and direct redistribution.

We contribute to the literature by recognizing that governments have access not only to direct but also to indirect redistributive policies. Thus poverty affects the relationship between inequality and direct redistribution. For example, an increase in poverty may counteract the positive effect of inequality on social expenditures, shifting the redistribution towards indirect policies. In this way, our paper contributes with a new explanation for the frequent mismatch between the empirical evidence[4] and the implications of the pioneering literature on inequality and redistribution in democracies. Recent work builds on heterogeneous societies to propose alternative explanations for this discrepancy. For instance, the way differences in experienced income inequality affect the preferences for redistribution (Roth and Wohlfart 2018), the effect of immigration on natives' attitude towards redistribution (Alesina et al. 2019), how campaign contributions create political incentives in favour of the rich (Campante 2011), and other insights within the framework of behavioural economics (Luebker 2014).

[2] There exists a seminal political economy literature that studies regulation as a redistributive policy (Aranson and Ordeshook 1981; Abrams and Lewis 1987, among others).

[3] Coady et al. (2016) provides evidence suggesting that the use of regulation for redistribution responds to the poverty rate.

[4] For instance, evidence shows that countries with high levels of income inequality spend less on social services (Lindert 1994; Schwabish et al. 2006; Moene and Wallerstein 2008).

Our theory disentangles the effects of poverty and inequality on the trade-off between direct and indirect redistribution within a simple model of representative democracy (Besley and Coate 1997a; Osborne and Slivinski 1996) with two types of policies. The indirect policy is the price of a regulated good; for example, the tariff of a public utility. The direct policy is a universal income transfer. The consolidated costs of the government redistribution are subject to the budget constraint imposed by the revenues collected from a linear income tax.[5]

In this article, we highlight the attribute of poverty that best explains redistribution. For the poor, regulated goods and services are essential. We capture this idea, assuming quasilinear preferences such that, when income is low enough, the consumption of the regulated good increases with income. Thus, our model defines the poor and the poverty line through consumption behaviour, and this characterisation drives our theoretical results.

One of these results is that the trade-off between direct and indirect redistribution depends on the income threshold that divides the rich and the poor, and the swing voters within each of these groups. The relevance of both the poverty line and the multiple decisive voters becomes clear when considering a population comprising only non-poor citizens. If so, the median income is the only swing voter, and therefore income inequality drives the composition of the redistribution. Regulation and income transfers work as substitutes that satisfy the same end, i.e. they respond to the incentives that inequality creates.[6]

Instead, our model allows for the policy to affect the rich and the poor in different ways. As a result, it changes the characteristics of the distribution of citizens that are critical as follows. When the proportion of poor citizens is large, the model provides conditions for smaller income transfers and more redistribution through regulation. This outcome suggests it is politically efficient for governments in poor societies to offer less generous direct benefits with universal access along with high indirect benefits like low tariffs of public utilities. Further, the relationship between redistribution and inequality depends crucially on poverty, possibly to the extent where the effect of inequality on policies goes in opposite directions depending on the size of the poverty rate. As an example of our results, Proposition 2 supports that an increase in inequality leads to smaller income transfers when poverty is high, and larger income transfers when poverty is low.

Does the evidence support these results? We test the effects of inequality and poverty on redistribution using data on taxes and expenditures from Spanish municipalities from 2006 to 2015. Examining municipalities instead of countries helps reduce

[5] This definition of the policy space is a simplification of the complex tax-and-transfer schemes that take place in reality. Still, linear taxation provides a suitable description of the effective taxation scheme for many countries (Roemer et al. 2003). As for non-targeted transfers, public health systems or the minimum wage laws are examples of welfare benefits with universal access. Examples of targeted welfare benefits are infrequent because of the institutional constraints that prevent governments from implementing such policies.

[6] The results of our non-poor benchmark are in line with the papers that study redistribution with two policies, income transfers, and either the level of provision of a public good (Besley and Coate 1997b) or regulation (Austen-Smith 2003).

the unobserved heterogeneity that comes from institutional differences and other country-level unobserved characteristics. Still, we face a major identification challenge posed by reverse causality. Changes in the income distribution trigger changes in public policy components, and also changes in public policy affect the income distribution (Martínez-Vázquez et al. 2012; Smeeding 2006; Keane and Prasad 2002; Aaberge et al. 2019). We tackle endogeneity by exploiting the heterogeneous exposure of municipalities to the Great Recession. We show that municipalities with a larger share of individuals in their early careers were more exposed to the Great Recession. Besides, the recession has affected female and male workers differently (De la Rica and Rebollo-Sanz 2017; Bonhomme and Hospido 2013). Municipalities with higher shares of females in the population experienced lower income inequality growth.[7]

When instrumenting with these demographics, we find that inequality increases the share of social expenditures in the budget of municipalities while poverty decreases it. We find a similar pattern when testing the regulation of transport, albeit with results that go in the opposite direction. Poverty increases indirect redistribution while inequality decreases it. As we proxy poverty as the population's proportion with income below 60% of the median, the relevance of these results relies on how well the variation of this measure of poverty, and the instruments, captures the variation in the consumption-poverty rate we propose in our theoretical model. We cannot directly corroborate this, but we do show that omitting poverty biases the coefficients, even to the point of reversing the signs of the estimates.

Our empirical exercise shows that, accounting for poverty, high inequality provides incentives to engage in direct redistribution through social expenditures. In this way, we contribute to the large body of empirical work that proposes different identification strategies for the relationship between income inequality and redistributive policies (for example, Ramcharan 2010; Lupu and Pontusson 2011; Boustan et al. 2013; Karadja et al. 2017).

The rest of the paper proceeds as follows. Section 2 lays out the model, describes the preferences of poor citizens and builds the budget constraint of the government. Section 3 develops a benchmark without poor citizens. Section 4 explores a general environment where society comprises distinct groups of citizens based on their consumption behaviour. This section provides empirical evidence of the effects of poverty and inequality on the composition of government redistribution. It contains the major results of the paper. Section 5 concludes and opens further research questions. Appendix A describes the data and provides robustness checks. The Online Appendix contains all the theoretical proofs.

2 Preliminaries

We develop a model to illustrate how the composition of governments' redistribution depends not only on inequality but also on the poverty rate. To capture the notion of composition, we consider two policies; the price of a regulated good or service and

[7] Boustan et al. (2013), among others, also use demographics to instrument income distribution.

a universal income transfer. We depart from the idea that the consumption behaviour of the poor differs from that of the rest of the population to explore its effect on the relative importance of regulation and income transfers for redistribution.

Formally, a community of a unit mass of voters ($\mathbb{V}$) elects a policymaker from a large but finite set of potential candidates ($\mathbb{C}$) to implement a policy. Each citizen, either candidate or voter, consumes two goods: good x produced by a linear technology with a unit price; and the regulated good y, subject to decreasing average costs.

Once in office, the elected candidate chooses a policy vector $\mathbf{q} \in Q$ with three components: the price of the regulated good,[8] $p \in \mathbb{R}_+$; a lump-sum income transfer of $r \in \mathbb{R}$ per capita; and a linear tax rate on income, $t \in [0, 1]$. All subject to the government budget constraint by which the sum of expenditures on income transfers and subsidies to the price of the regulated good cannot exceed the total tax revenues.

The regulated good in our model captures the trade-off between price and lump-sum redistributions. For this purpose, this hypothetical good must satisfy two characteristics; the government (or the elected candidate) sets the price; and the good is essential, in the sense that the consumption increases with income for poor citizens but not for the non-poor ones. Are there real-world goods or services that suit this description? We think public utilities are good examples of regulated goods. Of course, in reality, governments do not directly set the price of, say, electricity. Still, a price-setting government is an accurate approximation for public utilities.[9] The same applies to public transport, where local governments usually hold significant power in setting fares. That is the case in most cities in Spain. Also, we can consider both electricity and public transport as essential services.

We identify voters with their exogenous income $\omega \in \Omega \subset \mathbb{R}_+$, which distribution responds to the CDF $F(\omega)$. Candidates are also concerned with how sustainable is the provision of the good under regulation. We represent this attribute of candidates by some number $\gamma \in \Gamma \subseteq (0, 1]$ that weighs the candidate's value of the profit.[10] This feature captures the idea that candidates differ not only on their preferences over income distribution but also on their preferences over sustainability. All traits are common knowledge. Voters know the value γ and the income associated with each candidate, and candidates know the voters' income distribution.

Preferences are represented by the utility function $V : Q \times \Omega \times \Gamma \to \mathbb{R}$. To compete in elections, any potential candidate must pay the same entry cost $\delta > 0$. All

[8] Throughout the paper, we refer to the price of the regulated good as the tariff.

[9] The assumption that the policymaker sets the price in a regulated market simplifies the complex regulatory process in practice. Besley and Coate (2003) discuss why a price-setting regulator is a reasonable approximation for public utilities. In reality, increased competition has taken place in those links of the supply chains with costs structure that opens room for introducing more competitive regulatory environments. That is the case of electricity generation and retailing, trains operation, or mobile services in telecommunications. Still, all the stages of supply chains that require large initial investments are non-competitive. Importantly, they have a significant influence on the price of final users.

[10] Including the profits in the preferences of the policymaker follows the normative literature on regulation (Laffont and Tirole 1986; Baron and Myerson 1982) whereby the regulator cares about both consumer and producer surpluses (also, Besley and Coate (2003)).

citizens derive utility from the policy implemented, regardless of the policymaker's identity.

The political process has three stages. First (entry-stage), potential candidates decide whether they compete in the election (and pay δ) or they stay out. $\mathbb{E} \subseteq \mathbb{C}$ denotes the set of self-declared candidates. Second, each voter casts one vote for one of the self-declared candidates. The appointed policymaker is the candidate who receives the most votes, with ties to be decided by a fair coin toss. If only one candidate runs, they are automatically appointed. Last, the winning candidate implements her preferred policy. The default policy $\mathbf{q}_0$ prevails if $\mathbb{E} = \emptyset$.

Under sincere voting, all the strategic behaviour occurs at the entry stage.[11] Therefore, the solution concept is Nash equilibrium.

2.1 Defining the poor

Subsidising the prices of regulated goods and services aims to improve the well-being of the poor. This statement conveys that poor citizens consume regulated goods differently from the rest of society, and therefore, we can identify the poor by their consumption behaviour. We start from the basic notion that regulated goods are essential for the poor; they dispense with all goods but the regulated ones.

To model this idea, we assume consumers' preferences are represented by a quasilinear utility function in the form $\psi(y) + x$, where the non-linearity is over the regulated good, y, with $\psi'(y) > 0$ and $\psi''(y) < 0$. Then, an interior solution results in the following indirect utility function associated with $\psi(y) + x$ and the consumer's budget constraint,

$$V(\mathbf{q}; \omega, 0) = v(p) + (1 - t)\omega + r \tag{1}$$

where $\mathbf{q} = (p, r, t)$ is the policy vector comprising the regulated price, the income transfer, and the tax rate. Notice that $V(\mathbf{q}; \omega, 0)$ indicates $\gamma = 0$ for voters. In addition, $v(p) = \psi(\psi'^{-1}(p)) - \psi'^{-1}(p)p$ is the indirect utility of consuming the optimal quantity of the regulated good, $\psi(\psi'^{-1}(p))$, minus the budget spent on the regulated good, $\psi'^{-1}(p)p$. Given the assumptions on $\psi(\cdot)$, v satisfies $-v'(p) = \psi(p)'^{-1} > 0$ and $-v''(p) < 0$. The optimal consumption of good x is equal to the residual income given by $(1 - t)\omega + r - \psi'^{-1}(p)p$.

However, an interior solution is not guaranteed. By quasilinearity, the marginal utility of consuming the regulated good is decreasing while that of the linear good is constant. Therefore, when the support of the income distribution includes values low enough, there is a fraction of citizens that spend the entire budget on the regulated good. As a result, the demands of the regulated and the linear goods satisfy the general forms,

[11] We characterise the equilibria with at most two candidates. In such cases, voting sincerely is a weakly dominant strategy.

$$x^* = x(1, p, t, r; \omega) = max\left\{ (1-t)\omega + r - \psi'^{-1}(p)p; 0 \right\}$$
$$y^* = y(1, p, t, r; \omega) = min\left\{ \psi'^{-1}(p); \frac{(1-t)\omega + r}{p} \right\}$$

For a given policy vector $\mathbf{q}$, there exists an income threshold, the poverty line $\omega^0(\mathbf{q})$, that divides the community into two groups. One consists of those citizens with income higher than ω^0, namely "the rich" (R), who have preferences represented by function 1. The other is the group of citizens with income below $\omega^0(\mathbf{q})$, namely "the poor" (P), who spend all the budget on the regulated good. The following indirect utility function represents the preferences of the group P (for $p > 0$),

$$V(\mathbf{q}; \omega, 0) = \psi\left(\frac{(1-t)\omega + r}{p} \right) \tag{2}$$

Citizens at the poverty line are simultaneously poor and rich. As a result, at ω^0, the demand for the regulated good by a rich citizen ($-v'(p) = \psi'^{-1}(p)$, derived from (1) must equal the demand by a poor citizen (the total real net income that is the argument of function (2). The outcome, for $t \in [0, 1)$, is the following expression for the endogenous poverty line,

$$\omega^0(\mathbf{q}) = \frac{\psi'^{-1}(p)p - r}{1-t}. \tag{3}$$

The endogenous poverty rate is then the mass of citizens with income below $\omega^0(\mathbf{q})$ in 3, that is $F[\omega^0(\mathbf{q})]$. Note that mass equals rate (or percentage) because we normalise the total mass of voters to one.

Therefore, to focus on the main channel whereby poverty affects redistribution, we characterise the poor more by the bundle they consume than the income they receive. As a result, policy changes affect the well-being of poor and rich citizens differently, and also shift the poverty line. This is how our model relates a compound redistributive policy to income inequality and the poverty rate.

2.2 Candidates' preferences and the government budget constraint

Candidates have two attributes; their exogenous income and some number $\gamma \in (0, 1]$ that weighs their value of the profit. The subset of policies preferred by a generic candidate (ω, γ) is,

$$\mathbf{q} \in \arg\max_{\mathbf{q} \in Q} \left\{ V(\mathbf{q}; \omega, \gamma) = v(p) + (1-t)\omega + r + \gamma\Pi(\mathbf{q}) \right.$$
$$\left. s.t.\, \Pi(\mathbf{q}) + t\overline{\omega} - r \geq 0 \right\}. \tag{4}$$

The profits of the supplier are $\Pi(\mathbf{q}) = p\left[y^P(\mathbf{q}) + y^R(p)\right] - K$; where y^k is the demand for good y with $k = P, R$ referring to the poor and the rich. K represents the fixed

costs.[12] $\overline{\omega} = \int_{\omega^-}^{\infty} \omega dF(\omega)$ is the average income; $F(\omega)$ is the fraction of the community with income less than ω, and ω^- the lowest level of income in the society. Thus, $py^P(\mathbf{q}) = (1-t)\int_{\omega^-}^{\omega^0(\mathbf{q})} \omega dF(\omega) + rF(\omega^0(\mathbf{q}))$, since the poor spend all the income on y.

The relation between policies and the different groups presents three main features. First, the impact of policies on group P is different from the effect on R. This is clear when we define the vector of voters' utilities $\left(u_{jc}\right)_{j\in\mathbb{V}}$[13] with $u_{jc} = V(\mathbf{q_c}; \omega^j, 0)$, induced by the policy of generic candidate c.

$$u_{jc} = \begin{cases} v(p_c) + (1-t_c)\omega^j + r_c & \text{if } j \in R \\ \psi\left(\frac{(1-t_c)\omega^j + r_c}{p_c}\right) & \text{if } j \in P \end{cases} \tag{5}$$

Second, the demands for the regulated good by groups P and R determine the budget constraint[14] as follows,

$$B(\mathbf{q}) = \underbrace{(1-t)\int_{\omega^-}^{\omega^0(\mathbf{q})} \omega dF(\omega) + a^P(\mathbf{q})r - a^R(\mathbf{q})pv'(p) - K}_{\text{Profit from the Provision of the Regulated Good}} + t\overline{\omega} - r \geq 0 \tag{6}$$

where $a^P(\mathbf{q}) = F(\omega^0(\mathbf{q}))$ and $a^R(\mathbf{q}) = 1 - F(\omega^0(\mathbf{q}))$ are the masses of voters in group P and R, respectively. The budget constraint in 6 conveys that the sum of the profit accruing from the provision of the regulated good to the poor and the rich, and the tax collection ($t\overline{\omega}$) cannot be lower than the total amount of income redistributed (r). Note the profits generated from the provision of the regulated good enter directly into the government budget. We think this feature captures, in a simplified way, that, for the government, increasing redistribution via prices of regulated goods comes at a cost. This cost goes to the government budget directly when the good is publicly provided, or indirectly via subsidies to private providers. Of course, the second interpretation would be valid only if the provision raised negative profits and the government fully compensated the private provider.

Last, the definition of profit (loss) provides information on the relationship between candidates' objective functions and the size of groups P and R,

$$\begin{aligned} V(\mathbf{q}; \omega^c, \gamma^c) = {} & v(p) + (1-t)\omega^c + r \\ & + \gamma^c \left[(1-t)\int_{\omega^-}^{\omega^0(\mathbf{q})} \omega dF(\omega) + a^P(\mathbf{q})r - a^R(\mathbf{q})pv'(p) - K\right] \end{aligned} \tag{7}$$

A larger poor group has two effects on the value functions of candidates; it increases the profits for the total income of the poor $(1-t)\int_{\omega^-}^{\omega^0(\mathbf{q})} \omega dF(\omega) + a^P(\mathbf{q})r$ is larger,

[12] For tractability, we normalize the marginal cost to zero.

[13] If nobody is elected, then the default option, $\left(u_{j0}\right)_{j\in\mathbb{V}}$, is implemented. As common in citizen-candidate models, we assume that the default policy is bad enough for every potential candidate so that at least one of them has an incentive to run in elections.

[14] See the Online Appendix for a detailed derivation of the budget constraint.

and it reduces the revenues from selling the regulated good to a smaller rich group $-a^R(\mathbf{q})pv'(p)$.

The rest of the paper characterises the expected outcomes of this setting and provides empirical evidence that supports the results.

3 Benchmark: a community with no poor

In this section, we study the composition of redistribution in a society where all citizens have income high enough to consume strictly positive quantities of all goods, i.e. a society with no poor. This exercise provides a standard of reference to compare with the main results of the paper.

We restrict the attention to the subset of policies that satisfy $\omega^0(\mathbf{q}) \leq \omega^-$ or $-pv'(p) \leq \omega^-(1-t)+r$, where ω^- is the lowest level of income in the society. The absence of poor citizens allows projecting preferences over policies on voters' income. In this environment, our setting results in a solution that coincides with the policy preferred by the median income voter, as shown in Lemma A.1 in the Online Appendix.

This result leads to a straightforward characterisation of the situation where one candidate runs unopposed. The existence of one-candidate equilibrium requires the only candidate, say i, to have an incentive to run in elections ($\delta \leq V(\mathbf{q_i};\omega^i,\gamma^i) - V(\mathbf{q_0};\omega^i,\gamma^i)$); and any other candidate, $k \neq i$, with the same or higher vote share, to stay out ($\frac{1}{2}[V(\mathbf{q_k};\omega^k,\gamma^k) - V(\mathbf{q_i};\omega^k,\gamma^k)] \leq \delta$ or $V(\mathbf{q_k};\omega^k,\gamma^k) - V(\mathbf{q_i};\omega^k,\gamma^k) \leq \delta$).[15]

The general idea is that the only candidate must be the one who is closest to the median voter; when candidates' preferences for sustainability are controlled for. To illustrate this result, we consider the situation where all potential candidates have the same sustainability concern, i.e. the same γ. In this case, the optimal price of the regulated good is the same for all candidates; and the optimal income transfer r is weakly decreasing in income for both candidates and voters.[16] Thus, a low transfer must coincide with a high median income. Proposition A.1 in the Online Appendix formalizes these ideas. The next subsection extends the analysis to the context of two-candidate equilibrium.

3.1 Two-candidate equilibria under zero poverty

In this subsection, we develop a simple approach to analyse the two-candidate equilibria in a society with no poor.[17] The outcomes of this approach corroborate the

[15] See similar conditions in Besley and Coate (1997a), Corollary 1, pp. 92; and Osborne and Slivinski (1996), Proposition 2, pp. 71.

[16] This results from candidates' separable preferences.

[17] Throughout the analysis, we draw on two *citizen-candidate* conditions for two-candidate equilibria. First, the probability of winning of the candidates must be one-half; second, their positions must be distant enough for both getting a positive payoff from competing in elections.

intuition that, with no poor, prices of regulated goods and income transfers behave as substitutes: the relative responses to changes in income inequality depend on budget incentives and the characteristics of potential candidates.

We start the analysis with the characterisation of the citizens' space. The community comprises a unit mass of voters defined by the set $\mathbb{V} = \{(\omega, \gamma) \in \Omega \times \Gamma \mid \gamma = 0\}$, and a feasible space of potential candidates given by $C^A = \{(\omega, \gamma) \in \Omega \times \Gamma \mid \gamma \in (0, 1]\}$. Then, society is represented by the union $\mathbb{V} \cup \mathbb{C}^A$ which is convex for it forms a rectangle as the one showed in Fig. 1a.[18]

A second characteristic that makes the model tractable is the linearity of preferences w.r.t. citizens' traits. In other words, for any pair of candidates and their respective policies, there exists a line segment, namely the indifference line, that defines two convex subspaces consisting of citizens who prefer one policy or the other. The intersection of this line segment with the space of voters (the voters' horizontal line) defines the vote share of each candidate. Lemma A.2. in the Online Appendix formalises this result. Corollary A.1 in the Online Appendix shows that when the profits are increasing in the price of the regulated good, the slope of the indifference line is negative (positive) if the indifference line intersects the space of voters to the right (left) of the mean income.

In any two-candidate equilibrium, the indifference line must intersect the space of voters at the median income (see Fig. 1b). This result follows straightforwardly from the condition for which each candidate must get one-half of the total vote; and from Lemma A.2, whereby the intersection of the indifference line with the space of voters defines the vote share of each candidate. The next lemma shows the decisive role of the median income on the choice of the redistributive policy when there are no poor citizens in society. It also provides an expression for the minimum distance between the candidates that ensures they get positive payoffs from competing in elections (see Fig. 1c).

Lemma 1 (Two-candidate equilibria: incentive compatibility) *Any equilibrium with two candidates* (i *and* k *such that* $\omega^0(\mathbf{q}_i) \leq \omega^-$ *and* $\omega^0(\mathbf{q}_k) \leq \omega^-$) *satisfies*,

(a) the indifference line intersects the space of voters at the median income,$(\omega^m, 0) \in I(\{i, k\})$;

(b) if $\omega_i < \overline{\omega} < \omega_k$ and $\omega^m > \overline{\omega}$, then $\gamma^i < \gamma^k$;

(c) there exist two lines, $I^-(\{i, k\})$ and $I^+(\{i, k\})$ parallel to $I(\{i, k\})$, that define the minimum horizontal distance between the candidates' locations. This distance is given by $\frac{4\delta}{|t_i - t_k|}$.

[18] The sets of self-declared, potential, and feasible candidates satisfy $\mathbb{E} \subseteq \mathbb{C} \subset \mathbb{C}^A$.

Lemma 1 helps locate the candidates in equilibrium, but these locations are not unique. The multiplicity of equilibria is two-fold: there exist a priori multiple pairs of candidates that define the same indifference line and multiple indifference lines that correspond to different equilibria. Notwithstanding, departing from the conditions provided in Lemma 1, we capture the effects of income inequality on the components of the redistributive policies and the potential location of candidates in equilibrium. As we formally do in the next proposition.

Proposition 1 (Inequality and the composition of redistribution: the zero-poverty case) *Any two-candidate equilibrium in a society with no poor citizens satisfies*,

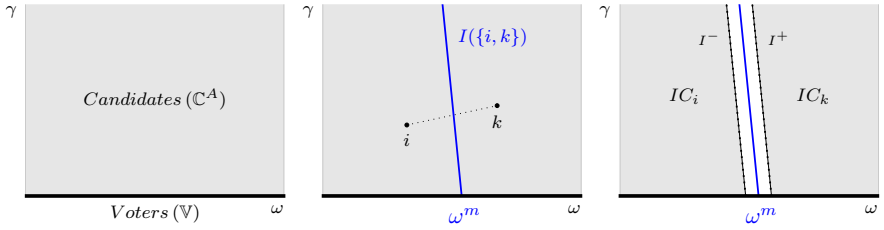
(a) if $\omega^m < (>) \overline{\omega}$, then the slope of the indifference line is increasing (decreasing) in the distance $|\omega^m - \overline{\omega}|$;

(b) for any continuous change in the income distribution such that the new distribution F' satisfies $F(x) < F'(x)$ with $x = F^{-1}(\frac{1}{2})$, the new candidate, say a, will prefer both lower (higher) income transfer and lower (higher) price of the regulated good if $-p_a v'(p_a) - r_a > (<) - p_{-a} v'(p_{-a}) - r_{-a}$, where $-a$ indicates the candidate other than a.

The general message of Proposition 1 is that regulated prices and income transfers are substitute components of redistributive policies: both serve the higher demand for redistribution when inequality increases.

Part b of Proposition 1 explores a change where the new distribution F' shows a greater probability that income takes a value less than or equal to the old median $F^{-1}(\frac{1}{2})$. If F and F' share the same mean, then the condition implies that F' has a higher mean-to-median ratio than F, which is the inequality measure used by Meltzer and Richard 1981. This change would also be compatible with an increase in inequality in the Lorenz sense if, for instance, derived from a regressive transfer. Note the Gini index we use in our empirical exercise is compatible with the Lorenz Criterion. Then, by Proposition 1, a higher income inequality drives a new equilibrium where the candidate with the greater revenue from the regulated good provision ($-pv'(p)$) relative to transfers (r) prefers both lower tariff and lower transfers. Thus, they redistribute relatively more through a lower price of the regulated good. Instead, after the increase in inequality, the new candidate with a smaller revenue relative to transfers prefers higher tariffs and transfers, i.e. they redistribute more through income transfers.

The non-poor outcome is driven not only by the relative traits of the candidates but also by the functional form of the revenues that make regulation a more effective redistributive policy when the price of the regulated good is relatively high. We can draw a similar intuition from the result that the distance $|\omega^m - \overline{\omega}|$ increases the slope of the indifference line when $\omega^m < \overline{\omega}$, i.e. $I^m(\{i, k\})$ moves counterclockwise. Then, we should expect a new subset of equilibrium candidates with lower γ's and



(a) Voters and candidates **(b)** ω^m's indifference line **(c)** Two-candidate location

Fig. 1 Zero poverty and two-candidate equilibria. The space of potential candidates is depicted in gray, while the space of voters is the black horizontal line. The blue line represents all the citizens (voters and potential candidates) that are indifferent between candidates *i* and *k*

higher ω's, which contains more candidates preferring lower prices of the regulated good and smaller transfers as a response to the increased level of inequality. This interpretation is valid as long as the distance between the mean and median incomes accurately measures inequality. Of course, this is not always the case.

The general conclusions of this section are as follows. When there are no poor citizens in society, the median income is the only decisive voter. In this environment, regulation and income transfers are substitute components of the redistributive policy, in the sense that both respond to an increase in inequality similarly. In contrast, in the next section, we show poor citizens change not only the decisive voters in society but also the relationship between the components of the redistributive policy.

4 Poverty, inequality and redistribution

This section presents the main results of the paper. The goal is to characterise, both theoretically and empirically, the way poverty and inequality affect the components of redistributive policies.

As for the theory, we come back to the general version of the model by considering the existence of poor citizens for whom the consumption of the regulated good is monotone in income. In contrast to the non-poor benchmark, this environment can induce equilibria with multiple swing voters. Also, it may result in multiple poverty lines.

Indeed, a two-candidate equilibrium involves one poverty line per candidate. Since the poverty line is endogenous, two different policies result in two lines. Moreover, as the preferences of the poor are distinct from those of the rich, we cannot apply a separation argument to localize a unique swing voter for both groups. Thus multiple swing voters may arise. How many? On the rich side, it is straightforward that there is at most one swing voter's income. Our benchmark analysis in Sect. 3 builds on this case. The next lemma shows that, on the side of the poor, there is also at most one swing voter, which makes all in all four

potential income cut-offs: the rich and the poor swing voters, and one poverty line per candidate.

Lemma 2 (The poor and the rich: swing voters and cut-offs) *For any pair of candidates i and k there exist at most four income cut-offs*: *one poor swing voter* $\omega^{P*}(i,k)$, *one rich swing voter* $\omega^{R*}(i,k)$, *and the poverty lines* $\omega^0(k)$ *and* $\omega^0(i)$.

This lemma searches for the income in each group that is indifferent between the two candidates and then checks whether a separation argument applies. By separation argument, we mean that in a specific group all citizens with income strictly greater, or smaller, than the swing voter prefer the same candidate. Since the lemma proves that this is the case, we have at most one rich swing voter and one poor swing voter. The lemma's proof in the Online Appendix provides the expressions for the poor swing voter $\omega^{*P}(i,k)$, the rich swing voter $\omega^{*R}(i,k)$, and the poverty lines under candidate k, $\omega^0(k)$, and i, $\omega^0(i)$, as functions of candidates' policies.

Lemma 2 has two main corollaries. First, the income cut-offs define the grouping of voters as follows. The "Very poor" ("Very rich") comprises all voters with income smaller (greater) than the poor swing voter's $\omega^{*P}(i,k)$ (rich swing voter's $\omega^{*R}(i,k)$). The "Poor middle class" ("Rich middle class") comprises all voters with income greater (smaller) than the poor swing voter's $\omega^{*P}(i,k)$ (rich swing voter's $\omega^{*R}(i,k)$) and smaller (greater) than the poverty line under candidate k (i), $\omega^0(k)$ ($\omega^0(i)$). The "Poor & rich" contains all voters lying in between the poverty lines $\omega^0(k)$ and $\omega^0(i)$. Figure 2 displays these groups on the voters' line.

A second corollary draws the incentive compatibility conditions for the two-candidate equilibria in every possible cut-offs scenario. The starting general condition is that candidates have an incentive to compete in elections. Both must have a one-half probability of winning the election. This condition, together with the distribution of voters $F(\cdot)$, locate the actual candidates and the cut-offs. An example is a case where there is only one cut-off that coincides with the poor swing voter, $\omega^{*P}(i,k)$. Then, it must be both that the "Very poor" represents half of the voters $F(\omega^{*P}(i,k)) = \frac{1}{2}$, and that they vote for i when the "Poor & Rich" prefers k, and consequently, all income greater than $\omega^{*P}(i,k)$ must prefer k too. On the other side, when the only cut-off is the rich swing voter $\omega^{*R}(i,k)$, the equilibria satisfy both the "Very rich" are half of the voters $1 - F(\omega^{*R}(i,k)) = \frac{1}{2}$ and they vote for i when the "Poor & Rich" prefers k. Here again, we cannot discard the multiplicity of equilibria. Therefore, we do not look for unique locations of candidates but insights on the factors that affect the policy components in equilibrium. Corollary A.2 in the Online Appendix presents the six alternative incentive compatibility conditions. The first two correspond to single poor and rich swing voters; the remaining four to multiple swing voters.

The incentive compatibility conditions, the budget constraint, and the cut-offs as functions of the policy components shape different systems of equations that the two-candidate equilibria must satisfy. If we take differentials of these systems, we can explore the simultaneous changes in policy components and income

distribution parameters. In the next lemma, we show that the solutions of these systems for all types of equilibrium take a common general form.

Lemma 3 (General form of policy differentials) *Consider a two-candidate equilibrium with candidates i and k such that* $\omega^0(k) < \omega^0(i)$. *Then, for a fixed location of candidate i, the differentials of the policy components of candidate k take the form*

$$\begin{aligned}\Big(\Upsilon_a(i,k)MR_R - \Lambda_a(i,k)\Big)dr_k &= -\frac{\Lambda_a(i,k)t_k}{[1-F(\omega^0(k))]} \times d\overline{\omega} \quad \text{and} \\ \Big(\Upsilon_a(i,k)MR_R - \Lambda_a(i,k)\Big)dp_k &= -\frac{\Upsilon_a(i,k)t_k}{[1-F(\omega^0(k))]} \times d\overline{\omega}\end{aligned} \tag{8}$$

where $MR_R = -v''(p_k)p_k - v'(p_k)$ *is the marginal revenue derived from the demand of the regulated good by the rich,* $\Upsilon_a(i,k)$ *and* $\Lambda_a(i,k)$ *are functions of candidates' policies with* $a = 1,2,3,4,5,6$ *denoting the incentive compatibility conditions enumerated in Corollary A.2.*

Equilibrium policies change only if the income distribution changes. For instance, suppose that the mean income changes; i.e., $d\overline{\omega} \neq 0$. Then, Lemma 3 states that dp_k and dr_k depend on the mass of poor voters $F(\omega^0)$, the marginal revenue from the rich's demand of the regulated good and the size of the government measured by t_k. Further, every type of equilibrium, defined by conditions $a = 1, \ldots, 6$ of Corollary A.2 , results in different functions Υ_a and Λ_a that determine the sign of the relation between mean income and policy components. To illustrate, suppose that Υ_a and Λ_a are such that $\Upsilon_a(i,k)MR_R - \Lambda_a(i,k) < 0$, $\Upsilon_a(i,k) > 0$, and $\Lambda_a(i,k) > 0$. In this case, Lemma 3 states that an increase in the average income $\overline{\omega}$ pushes up both the income transfer r_k and the tariff of the regulated good p_k. That translates into more direct redistribution and less indirect redistribution through regulation. Moreover, the size of these effects hinges on the mass of poor citizens $F(\omega^0)$.

Still, there are further changes in income distribution, other than mean-income changes, that involve poverty and inequality.

The next proposition explores their effects on the policy components for equilibria with one swing voter.

Proposition 2 (One-cut-off equilibrium and policy components) *Consider a one-cut-off equilibrium with candidates i and k. Then, for any continuous change in the income distribution such that the new distribution* F' *satisfies* $F(x) < F'(x)$ *with* $x = \omega^{*b}(i,k)$ *and* $b = P, R$, *it must be that*;

(*a*)

$$\begin{aligned}dr_k &< L\Big(\Upsilon_1, \Lambda_1, F'[\omega^0(k)], MR_R\Big) \times d\overline{\omega} \text{ and} \\ dp_k &< M\Big(\Upsilon_1, \Lambda_1, F'[\omega^0(k)], MR_R\Big) \times d\overline{\omega}\end{aligned} \tag{9}$$

if the cut-off is $\omega^{*P}(i,k)$ *and* $\frac{\omega^{*P}(i,k)(1-t_i)+r_i}{p_i} > MR_R$, *or*;

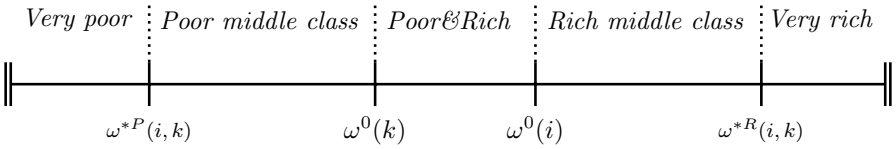


Fig. 2 Swing voters and poverty lines. For candidates i and k, there are at most four cut-offs: one poor swing voter, $\omega^{*P}(i,k)$, one rich, $\omega^{*R}(i,k)$, and the poverty lines $\omega^0(i)$ and $\omega^0(k)$. The resulting groups are very poor, poor middle class, poor & rich, rich middle class, and very rich

$$(b) \qquad \begin{aligned} dr_k &> L\left(\Upsilon_2, \Lambda_2, F'[\omega^0(k)], MR_R\right) \times d\overline{\omega} \text{ and} \\ dp_k &> M\left(\Upsilon_2, \Lambda_2, F'[\omega^0(k)], MR_R\right) \times d\overline{\omega} \end{aligned} \tag{10}$$

if the cut-off is $\omega^{*R}(i,k)$;

with $L(\cdot), M(\cdot) > 0$.

This result states that the policy effect of a change in the income distribution associated with higher inequality depends on whether the swing voter is rich or poor. Under a poor swing voter, more inequality leads to more redistribution through regulation and less income transfer. The outcome reverses with a rich swing voter. All these policy changes are relative to the mean income since, for a fixed tax rate, the mean income determines the tax revenue.

Proposition 2 requires only a greater mass of citizens below the swing voter, and so it is compatible with different changes in the income distribution. The relevance of this approach becomes apparent when looking at the measures of poverty and inequality in the empirical exercise. Poverty is the percentage of the population with income lower than 60% of the median, say income-poverty, while the Gini index measures inequality. Recall poverty in our theoretical model is the proportion of the population that consumes only the regulated good, say consumption-poverty. Consider now the case of a mean-preserving increase in the mass of individuals with less income than the poor swing voter. Under certain conditions, like regressive transfers, this change involves higher inequality in the Lorenz sense. Also, higher inequality as measured in our empirical analysis since the Gini index is Lorenz-consistent. We can now interpret Proposition 2: increased inequality results in less direct redistribution, like social expenditures, and lower prices of regulated goods like transport. We should expect opposite effects when the swing voter is rich or non-poor, as in Spain from 2006 to 2015, where social expenditures have increased with inequality.

What role does poverty play? Consumption-poverty in our model captures the incentive for the poor to consume a bundle that relies on regulated goods and services. Then Proposition 2 shows the consequences of such incentive: the sign of the effect of inequality on the use of different redistributive policies depends on

how politically relevant poverty is. Our empirical exercise represents consumption-poverty using income-poverty as a proxy. Thus, the relevance of our estimations relies on how well the population with income below 60% of the total median captures the consumption behaviour of the poor we aim to highlight. We cannot corroborate this directly. What we find is that omitting poverty biases the coefficients, even reversing the signs of the correlations between inequality and redistribution.

The next proposition is the analogous to Proposition 2 for the cases with multiple cut-offs.

Proposition 3 (Multiple-cut-offs equilibria and policy components) *In any multiple-cut-off equilibrium with candidates i and k where* $\frac{\omega^{*P}(i,k)+r_i}{p_i} > MR_R$,

$$\begin{aligned} dr_k &= L\left(\Upsilon_a, \Lambda_a, F[\omega^0(k)], MR_R\right) \times d\overline{\omega} \text{ and} \\ dp_k &= M\left(\Upsilon_a, \Lambda_a, F[\omega^0(k)], MR_R\right) \times d\overline{\omega} \end{aligned} \tag{11}$$

where $L(\cdot), M(\cdot) > 0$ *and* $a = 3, 4, 5, 6$ *denotes the incentive compatibility conditions enumerated in Corollary A.2.*

In this proposition, we provide a general version of equilibrium conditions as equalities. The reason is that, in multiple cut-offs environments, changes not only in the mass of poor citizens but also in the relative size of the other groups of citizens alter the equilibrium policy. Therefore, a general characterisation of a meaningful change in the distribution is less straightforward than in the case with one swing voter. The takeaway, common to all the multiple cut-offs equilibria, is that we should expect more income transfers and a higher price of the regulated good as a response to a *ceteris paribus* increase in the mean income.

Other changes in the distribution also convey our general message on the relevance of consumption-poverty in explaining the relation between inequality and redistribution. For instance, consider the class of equilibria with two swing voters, $\omega^P(i,k)$ and $\omega^R(i,k)$. Then, using the lexicon of Fig. 2, an increase in the size of the "Very Poor" relative to the three middle class groups, results in policy changes $dr_k < L \times d\overline{\omega}$ and $dp_k < M \times d\overline{\omega}$. That is more redistribution through regulation and less through income transfers for any change that preserves (or increases) the mean income.

The main idea of the theory is that when governments have discretion in the use of regulation, the components of a redistributive policy depend not only on inequality but also on the mass of the poor citizens, relative to other groups in society. This general notion is embodied in Propositions 2 and 3 above. Next, we test empirically the effects of poverty and inequality on the use of two different redistributive policies, social expenditures, and transport prices.

4.1 Empirical evidence

In this section, we provide empirical evidence for the model's implications using a novel panel of Spanish municipalities for the period 2006–2015. We have compiled these data combining information from multiple sources. We measure poverty and income inequality using a 4% sample of all Social Security records provided in the *Muestra Continua de Vidas Laborales* (MCVL). These contain earnings information, mainly from wages, for over a million individuals per year. Because of individual de-anonymization concerns, only municipalities with at least 40K inhabitants are identifiable. Besides, our data exclude Navarra and the Basque Country, as these operate outside the national common fiscal regime, implying that no earnings tax data is available for their residents. Overall, our analysis is representative of Spanish larger[19] municipalities other than those of Navarra and the Basque Country. To these data, we add municipality expenditures and taxes from local budgets, both provided by the Ministry of Finance.[20] We have also collected data on demographics from the continuous census[21] that we used to measure exposure to the Great Recession. Last, from the Home Office, we have obtained electoral data with which we construct political controls for our regressions.[22]

We use data from the Great Recession of 2008 to identify exogenous variations of our variable of interests, poverty and inequality. Table 1 provides descriptive statistics that account for the overall impact of the recession on poverty, inequality, demographics and political variables before, during, and after the shock. Both poverty and inequality have increased, although the growth rate of the latter has been larger. Also, the political environment has changed. The vote share of the main left-wing party declined and that of the main right-wing party increased. In addition, participation in elections and vote fragmentation experienced a decline. As for public policies, municipalities have decreased the share of their total expenditure on housing and other social purposes, our outcomes of interest.[23]

4.1.1 Empirical strategy

The fundamental challenge for identification is that of reverse causality.[24] Changes in the income distribution trigger changes in public policy components, and also

[19] Large municipalities are the most relevant ones since, in Spain, the number and scope of discretionary policies of a municipality are typically higher the larger its population.

[20] This data is available at https://serviciostelematicosext.hacienda.gob.es/SGFAL/CONPREL and https://serviciostelematicosext.hacienda.gob.es/SGFAL/ConsultaTipos.

[21] *Padrón Continuo* is the name of this dataset.

[22] Appendix A.1 contains a detailed description of our dataset.

[23] As a note of caution, the classification of expenditures changed from 2010 onwards. Thus the decrease observed in social expenditures between 2008 and 2011 may result from the change in the classification. This does not distort our analysis as the change applies to both the national level and all the municipalities in our sample. Thus year fixed effects capture the classification change effect.

[24] In addition, measurement error on inequality and/or poverty may cause attenuation bias (e.g. Cameron and Trivedi 2005, pp. 903–904), thus driving the estimate towards zero. Under linearity-on-parameters and classical measurement error, the IV estimator deals with both endogeneity and attenuation bias.

changes in public policy affect the income distribution (Wenli and Sarte 2004). We tackle this endogeneity by exploiting demographic heterogeneity in exposure to the Great Recession across Spanish municipalities. In particular, we use the higher exposure to the Great Recession of municipalities with a larger share of individuals in their early career, together with the differential effect of the Great Recession across genders (see De la Rica and Rebollo-Sanz 2017; Bonhomme and Hospido 2013).

The burst of the construction bubble that predominantly destroyed male employment with lower-middle wages largely explains the increase in inequality during the great recession (Bonhomme and Hospido 2017). Table 2 confirms this claim, showing that municipalities with a larger share of females within the working-age population have experienced lower inequality. The Great Recession also had a higher impact on those citizens in their early career. Table 2 shows a positive correlation between inequality and the share of individuals in age 25–35 (young for shorter) within the 25-to-65 population (working-age population). Bell and Blanchflower (2011) provide evidence of the negative effect of the Great Recession on early career workers for Spain and other OECD countries.[25]

The first stage of our estimation strategy in Table 2 is the regression of municipality-level inequality or poverty on the share of female and young adults in the working-age population. Importantly, we exploit the interaction of these demographics with post-recession dummies. For example, our first stage for inequality has the following form,

$$\begin{aligned} ineq_{mt} = & Demo_{mt}\theta^{\top} + \varpi_t + \mathbb{1}\left[t >= 2008\right] Demo_{mt}\vartheta_1^{\top} \\ & + \mathbb{1}\left[t >= 2011\right] Demo_{mt}\vartheta_2^{\top} + X_{mt}\sigma^{\top} + \mu_m + \xi \end{aligned} \tag{12}$$

Demo stands for a vector containing the age and female composition of the municipality's working-age population. These demographics have not only a stationary effect on inequality, captured by θ, but also an amplifying effect because of the recession, captured by ϑ_1 and ϑ_2. We allow for municipality-level fixed unobserved heterogeneity and national-level time-varying shocks through μ and ϖ, respectively. Something to highlight from (12) is that we exploit both the first impact and the second-dip of the great recession (see Ortega and Pe nalosa 2014).[26]

The results in Table 2 are as follows. First, a larger number of young citizens as a proportion of the working-age population increases inequality. In particular, a one percentage point increase in the young share produces a 0.854% increase in the Gini index. Second, a rise in the female's share negatively affects inequality. A one percentage point increase in the female share decreases the Gini index by 1.19%.

[25] Our dataset corroborates this result showing that municipalities with relatively more individuals at the beginning of their careers experienced substantially higher unemployment rates. See Fig. 6 in the appendix.

[26] Similar to Gonzalez et al. (2011), we weight municipalities by the factor $\left[2 * \bar{N}_m^{-1}\right]^{-0.5}$ where $\bar{N}_m$ is municipality m average population over the period of study. Gonzalez et al. (2011) perform their study in differences thus weight by $\left[N_{mt}^{-1} + N_{mt-\tau}^{-1}\right]^{-0.5}$ where τ is the time different used in the analysis (see also Dustmann and Glitz 2015; Lewis 2003).

Table 1 Descriptive statistics

	2006		2008		2011	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Inequality log-level	− 0.89	0.09	− 0.86	0.08	− 0.81	0.08
Poverty log-level	− 1.37	0.23	− 1.36	0.25	− 1.23	0.26
Share of female	0.50	0.01	0.50	0.01	0.50	0.01
Share of young	0.26	0.02	0.25	0.02	0.22	0.02
Housing expenditure	0.16	0.07	0.16	0.07	0.11	0.05
Social expenditure	0.14	0.05	0.14	0.05	0.07	0.02
Car's tariff	190.89	28.10	198.82	25.93	205.12	25.16
Election participation rate	0.63	0.06	0.59	0.08	0.61	0.07
Vote fragmentation	0.35	0.10	0.34	0.08	0.29	0.07
Left-wing vote share	0.36	0.11	0.36	0.10	0.26	0.08
Right-wing vote share	0.35	0.15	0.37	0.16	0.39	0.15
Municipalities	131		131		131	

Housing and social expenditure measured as share of total expenditure. Share of young is the share of 25–35 year olds in the 25–65 population. Share of female is the share of females in the 25–65 population. Election participation is the share of valid votes over the voting census population. Vote fragmentation measured using the Herfindahl–Hirschman index. Left-wing vote share is the share of valid votes received by the PSOE, the main state level left-wing party. Right-wing vote share is the share of valid votes received by the PP, the main state level right-wing party. All are population weighted

Figure 3 shows these relations in scatter-plots of inequality deviations w.r.t. to the municipality means for post-2008 demographics. Demographic heterogeneity results in different exposure to the Great Recession not only in terms of inequality but also in terms of poverty.[27] The bottom panel of Table 2 shows that a one percentage point rise in the share of young citizens increases poverty by 1.613%. Besides, the female share is associated with 1.7% less poverty.

The assertion that municipality demographics influence both inequality and poverty comes as no surprise, given the strong correlation between inequality growth and poverty growth. Figure 4 shows that those municipalities that experienced larger inequality growth over the Great Recession also experienced larger growth in poverty. Next, we use these results to identify the effect of inequality on redistribution while controlling for poverty. In particular, we use municipality variations in age and gender composition to instrument changes in poverty and inequality. This allows us to identify both the effect of poverty and inequality on redistribution. With this strategy, we can compare estimates of the effect of inequality on redistribution with and without accounting for changes in poverty. Our major claim is that failing to control for poverty biases inequality estimates.

Before introducing our estimates, we further discuss our identification assumptions. The validity of our instruments relies on the direct effect of demographics

[27] We define poverty as the proportion of municipality inhabitants earning less than 60% of the national median income.

Table 2 Municipality demographics, inequality and poverty

	Inequality				
Sh.Young × year ≥ 2008	0.854*** (0.103)	0.738*** (0.104)			0.540*** (0.121)
Sh.Young × year ≥ 2011		0.228** (0.097)			0.232** (0.098)
Sh.Female × year ≥ 2008			− 1.194*** (0.158)	− 1.072*** (0.147)	− 0.838*** (0.169)
Sh.Female × year ≥ 2011				− 0.313** (0.140)	− 0.312** (0.144)
	Poverty				
Sh.Young × year ≥ 2008	1.613*** (0.248)	1.509*** (0.237)			1.165*** (0.271)
Sh.Young × year ≥ 2011		0.202 (0.216)			0.313 (0.211)
Sh.Female × year ≥ 2008			− 1.708*** (0.308)	− 1.877*** (0.290)	− 1.376*** (0.340)
Sh.Female × year ≥ 2011				0.432 (0.301)	0.392 (0.297)
Obs.	1310				

Inequality measured as the log of the Gini index. Poverty measured as the log-share of population with income lower than 0.6 times the national median income. Demographic measures included in levels as controls,the reported estimate is for levels interacted with time dummies, i.e. we report the demographic shock multiplier. All specifications include year and municipality fixed effects. Municipality times period clustered robust standard errors in parenthesis. We divide our time window into three periods: pre-2008, post-2008 and post-2011. Estimates are population weighted

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

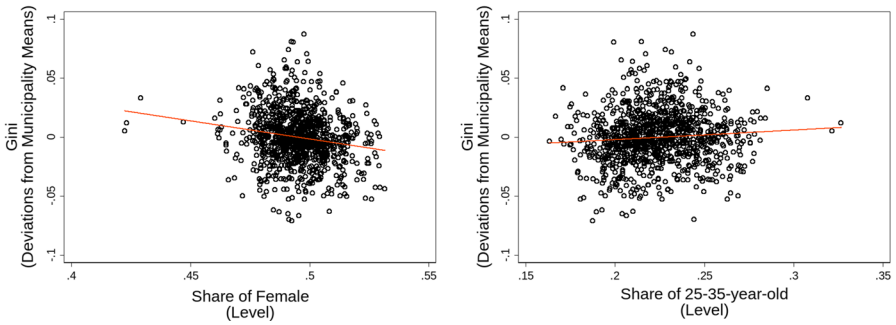


Fig. 3 Inequality growth and demographics. Scatter plot of Gini five year log-changes (y-axis) on share of female (x-axis, left figure) and those aged 25–35 (x-axis, right figure) in the working age population. All residualized with respect to year averages. Best-fit line in red

on redistribution being time-invariant, rather than on policy changes being orthogonal to municipality demographics. We assume that all changes in the effect of demographics on redistribution over the great recession work through changes in

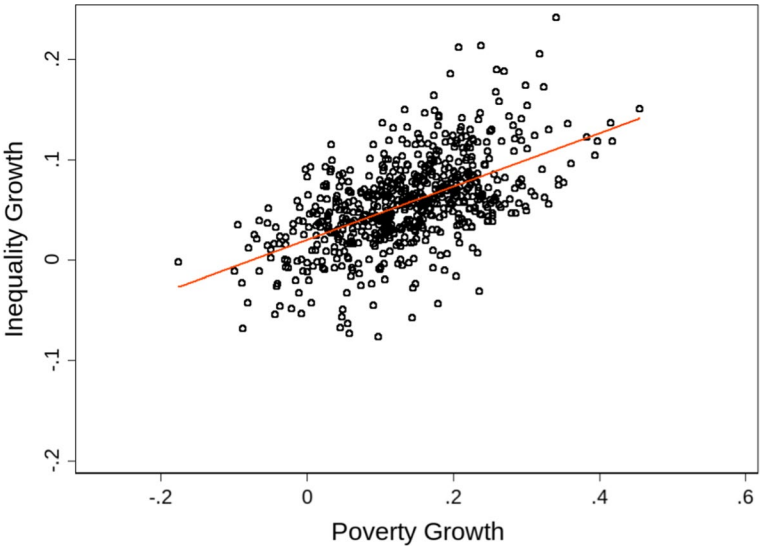


Fig. 4 Inequality and poverty. Municipality level five year inequality and poverty log-differences. Inequality measured using the Gini index, poverty is the proportion of the municipality population with income lower than 60% the national median. Inequality and poverty growth figures depicted are residuals from regressions with year dummies

the income distribution. This reflects in our specification which restricts the policy-demographic gradient, α in the equation below, to be constant across time,

$$\begin{aligned} Policy_{mt} = \beta_1 Inequality_{mt} + \beta_2 Poverty_{mt} \\ + Demo_{mt}\alpha^{\top} + X_{mt}\varsigma^{\top} + \gamma_t + \psi_m + \epsilon_{mt} \end{aligned} \tag{13}$$

Thus our empirical model in (13) allows demographics to affect policy, although it constraints the direct demographics effects on policy to be time-constant. Namely, we exclude interactions of demographics and the Great Recession from our main equation. As a result, our proposed IV estimator allows the policy to respond directly to changes in the municipality demographic composition and use the interaction of the demographic composition and the post-recession period as an instrument for the income distribution.

To explain our use of multiple instruments, we start with the first stages. Assuming a single instrument z and abstracting from control variables,

$$\begin{aligned} Inequality_{mt} &= \pi z_{mt} + \xi^I_{mt} \\ Poverty_{mt} &= \varpi z_{mt} + \xi^P_{mt}. \end{aligned} \tag{14}$$

Endogeneity of the income distribution implies the moment conditions $\mathbb{E}[\xi^I \epsilon] \neq 0$, $\mathbb{E}[\xi^P \epsilon] \neq 0$, while if our instrument is valid, then $\mathbb{E}[z\epsilon] = 0$. We can use the system of equations formed by (13) and (14) to investigate the effect of failing to account for differences in poverty on the IV estimator of the effect of inequality on

redistribution. Suppose that $\varpi \neq 0$, i.e. the inequality instrument also shifts poverty.[28] Then, the use of z as an instrument for inequality in a specification that omits poverty leads to an IV estimator, $\tilde{\beta}_{IV}$, with the following property,[29]

$$\tilde{\beta}_{IV} \xrightarrow{p} \beta_1 + \underbrace{\beta_2 \frac{\varpi}{\pi}}_{\text{OVB}} . \tag{15}$$

Omitting poverty leads to a bias proportional to the ratio of the poverty first-stage to the inequality first-stage. For example, our female share interacted with the dummy post-2008 would cause a bias proportional to 1.430 (≈1.194 / 1.708). In turn, the share of young citizens results in a bias proportional to 1.910 (≈ 1.931/.854).[30]

Next, we present the estimates of poverty and inequality on direct and indirect redistribution that result from our empirical strategy. The evidence supports the claim that failing to account for poverty introduces a bias in the estimates of the effect of inequality on redistributive policies.

4.1.2 Inequality, poverty and direct redistribution

Our theoretical setting opens the possibility for diverse effects of poverty and inequality on the use of direct redistribution. Here, we capture direct redistribution by municipality-level social expenditure, in particular social services and housing. In Spanish municipality budgets, the entry social-services expenditures results from the aggregation of expenditures on all activities involved in the administration of social services, the social reintegration of those marginalised, and the promotion of gender equality. Housing expenditures comprise all services related to housing and urbanism, such as access to housing, public housing, and help to land purchasers.[31]

We first report the OLS estimates of the effects of poverty and inequality on the social and housing share of total municipality expenditures.[32] Column (1) of Table 3

[28] This is the case for both our instruments, see Table 2.

[29] If we omit poverty when $\varpi \neq 0$, the instrumental variable estimator behaves as described in the *plausibly exogenous instruments* framework where the effect is not point-identified. For estimators allowing set identification with *plausibly exogenous instruments* see Conley et al. (2012).

[30] When poverty is endogenous, poverty as control and instrumented inequality does not produce an unbiased estimator of the effect of inequality on poverty.

[31] For years previous to 2010, the dataset provides aggregated spending on housing and social services, while posterior to 2010, the data allows identifying each category. In 2010, a reform by *Orden EHA/3565/2008* introduced a new classification for functional expenditures. We track social and housing expenditures across pre and post-reform budgets using a table of equivalences, see appendix II in *Orden EHA/3565/2008*.

[32] We use shares instead of per capita levels to eliminate revenue effects. Feler and Senses (2017) provides a meaningful example of the revenue effects on public policy levels. They show that a higher exposure to trade shocks leads to lower housing prices and business activity, and therefore, a decline in public services provision as local government revenues rely on property and sales taxes. In Spain, the collapse of the housing sector explains to a large extent the increase in inequality during the great recession (Bonhomme and Hospido 2017). Then, a regression of per capita expenditure on inequality is likely to confound the structural effect that we are after and a revenue effect through reduced municipality resources.

shows a negative, small and statistically insignificant effect of inequality on housing expenditure. This estimate turns positive and grows in magnitude once we control for poverty, as shown in column (2) that also presents a negative and significant correlation between poverty and housing expenditure. Using only housing expenditure (excluding urbanization), we find a larger effect of inequality and a small and statistically insignificant negative effect of poverty; see columns (3) and (4).[33] Finally, regressing social expenditures on either inequality or inequality and poverty produces a positive, although statistically insignificant partial correlation estimate.

To address the endogeneity bias, we now report the results of our instrumental variables strategy. We start with the estimates of the sole effect of inequality on housing expenditure for then comparing with the specification that includes both poverty and inequality. The estimates of inequality instrumented with the share of young citizens in Columns (1) and (2) of Table 4 show a negative effect of inequality on housing that is strongly significant. Panel *A* in column (1) reports the baseline specification, i.e. with a single interaction and no controls other than the fixed effects. We find that a 10% increase in inequality reduces housing expenditure by 9 percentage points (p.p.).[34] Introducing controls for demographics and political characteristics barely alters this estimate. Again, we get very similar estimates when adding the interaction of demographics with the second Great Recession dip that took place after 2011, column (2) of Table 4. Last, when we instrument inequality using the share of females, we obtain an estimate of the opposite sign but this time statistically insignificant.

Our major claim is that it is the omission of poverty that creates these differences and not the validity of our instruments. We can preliminarily see this by looking at the first stage estimates. By results in Table 2, if we include poverty in the main equation and instrument inequality with the share of young citizens, the bias is 1.34 ($\approx$1.91/1.43) times the bias produced when instrumenting inequality with the share of females. In this case, the switch in sign observed between estimates with different instruments (columns (1) and (3) of Table 4) suggests a positive effect of inequality on housing expenditure, and a negative effect of poverty.

Our main specification provides robust evidence of a positive effect of inequality on direct redistribution when we account for poverty. The left-half of Table 5 reports the effect of inequality and poverty on housing expenditure using all the instruments. In particular, when instrumenting with the share of females interacted with the two recession dummies, the results support a positive (negative) effect of inequality (poverty) on housing expenditure. Pooling all instruments together produces similar estimates, and all these are robust to controls for demographics and political characteristics. Also, we provide estimates of the effects of inequality and poverty on social expenditures (right-half of Table 5). We find a positive effect of inequality, and our results suggest a mild effect of poverty on social expenditure. Importantly, the estimates of the effect of inequality are of similar magnitude as

[33] Note we only observe the sole effect of housing from 2010 onwards, thus this estimation accounts for the period 2010–2015.

[34] Recall that we measure expenditure as the proportion of total expenditure.

Table 3 Inequality, poverty and municipality expenditures *OLS estimates*

	Housing		Housing[a]		Social	
	(1)	(2)	(3)	(4)	(5)	(6)
Inequality	− 0.026 (0.071)	0.054 (0.081)	0.065** (0.030)	0.068** (0.033)	0.067 (0.043)	0.040 (0.044)
Poverty		− 0.079** (0.039)		− 0.004 (0.016)		0.027 (0.026)
Obs.	1310		786		1310	

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

[a]Housing expenditure taking only expenditure directed at promoting the access to housing, this is only available from 2010 onwards. All specifications include demographic and political controls plus year and municipality fixed effects. Municipality times period clustered robust standard errors in parenthesis. We divide our time window into three periods: pre-2008, post-2008 and post-2011. Estimates are population weighted

those in Table 7 where we exclude poverty. In numbers, a 10% increase in inequality increases expenditure on social services in a range between 7 and 3 p.p., depending on the controls included. These results are robust to all instruments, i.e. the estimates have the same sign and are of similar magnitudes.

Our empirical strategy may raise three major concerns. The first is the under-identification of our proposed system of equations. This problem is relevant since the Kleibergen and Paap (2006) reduced rank statistic for weak instruments is below the i.i.d. critical values in Stock and Yogo (2005) and when instruments are weak, the IV estimator is likely biased (Bound et al. 1995). We follow the recommendation by Andrews et al. (2019) and report identification-robust Anderson and Rubin (1949) confidence sets in Figs. 7 and 8. These figures show that for housing expenditure, 90% confidence sets are bounded from below at $\beta_{inequality} = 0$, and from above at $\beta_{poverty} = 0$. With social services expenditure, the 90% confidence set crosses zero in both dimensions, although most of the confidence set lies on the sub-space of positive (negative) inequality (poverty) effects. These results further support that inequality increases direct redistribution while poverty decreases it.

A second concern is that our demographic instruments may have different effects on inequality in different income levels of the distribution. For example, Schwabish et al. (2006) finds that the relationship between inequality and social spending depends on whether inequality increases at the top (90/50 percentile ratio) or bottom (50/10 percentile ratio) of the income distribution. If this is the case, then changes observed in Table 4 may reflect heterogeneous treatment effects. We show that this is unlikely in Tables 8 and 9, by regressing changes in expenditures on different measures of inequality, including the top (90/50 percentile ratio) and the bottom (50/10 percentile ratio) of the income distribution. These estimates show that instrumenting inequality with the share of young produces a positive effect of inequality on social service expenditure, regardless of the type of inequality, top or bottom. We find a similar result when we instrument inequality with the female share. As for housing expenditure, instrumenting inequality with the share of young (female) produces negative (positive) and statistically significant (insignificant) effects. As a robustness

Table 4 Inequality and municipality housing expenditure *IV estimates*

	(1)	(2)	(3)	(4)	(5)
A	Baseline				
Inequality	− 0.914** (0.377)	− 0.884** (0.391)	0.101 (0.257)	0.221 (0.274)	-0.103 (0.245)
KP-RK	35.849	16.987	64.937	36.578	19.577
B	Include level demographics				
Inequality	− 0.890*** (0.324)	− 0.878*** (0.335)	0.141 (0.266)	0.275 (0.280)	-0.247 (0.251)
KP-RK	68.837	33.878	57.419	30.704	15.615
C	Include political controls				
Inequality	− 0.877*** (0.306)	− 0.833*** (0.315)	0.083 (0.255)	0.228 (0.270)	− 0.262 (0.240)
KP-RK	69.478	34.754	55.904	30.004	15.194
	Inequality instrumented with				
Sh.Young × year ≥ 2008	Yes	Yes	No	No	Yes
Sh.Young × year ≥ 2011	No	Yes	No	No	Yes
Sh.Female × year ≥ 2008	No	No	Yes	Yes	Yes
Sh.Female × year ≥ 2011	No	No	No	Yes	Yes
Obs.	1310				

Municipality level data covering period 2006–2015. All specifications include year and municipality fixed effects. Municipality times period clustered robust standard errors in parenthesis. We divide our time window into three periods: pre-2008, post-2008 and post-2011. Panel *B* introduces controls for level share of females and level share of young individuals. Additionally, panel *C* introduces controls for the share of votes received by the main left- and right-wing parties, participation and vote fragmentation at the last municipality election. Log-gini instrumented with demographic as indicated in the bottom of the table. Estimates are population weighted. KP-RK is the Kleibergen and Paap (2006) reduced rank statistic

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

check, we also estimate the effect of inequality on social and housing expenditures using a Gini index that accounts for long-term unemployment (columns (1) and (5) of Tables 8 and 9). This exercise results in estimates that are similar to those using the general definition of inequality in Tables 4 and 7.

The last concern is about the validity of our instruments. Those young individuals that were more exposed to the recession may likely have migrated to municipalities with more generous social services. The literature on welfare-benefits-induced migration (e.g. Kennan and Walker 2010; De Giorgi and Pellizzari 2009) documents that welfare access provides weak incentives to geographical mobility. Still, this literature has focused on mobility across areas considerably larger than municipalities. We address this concern by using demographics measured in 2006 before any sign of the upcoming recession was apparent. Results show that the estimates

Table 5 Inequality and municipality expenditure *IV estimates, controlling for poverty*

	Housing			Social services		
	(1)	(2)	(3)	(4)	(5)	(6)
A	Baseline					
Inequality	− 0.588 (1.533)	0.879* (0.505)	1.062** (0.532)	0.342 (1.106)	0.309 (0.378)	0.047 (0.364)
Poverty	− 0.154 (0.719)	− 0.608* (0.344)	− 0.890** (0.351)	0.171 (0.503)	− 0.087 (0.263)	0.239 (0.233)
KP-RK	1.440	5.765	3.698	1.440	5.765	3.698
B	Include level demographics					
Inequality	− 0.557 (1.944)	1.318** (0.554)	1.501** (0.611)	0.986 (1.355)	0.728* (0.400)	0.634 (0.393)
Poverty	− 0.176 (1.012)	− 0.823** (0.339)	− 1.168*** (0.378)	− 0.305 (0.689)	− 0.312 (0.229)	− 0.165 (0.228)
KP-RK	0.847	7.215	4.114	0.847	7.215	4.114
C	Include political controls					
Inequality	0.115 (1.933)	1.321** (0.552)	1.502** (0.610)	0.309 (1.202)	0.664* (0.394)	0.559 (0.386)
Poverty	− 0.522 (1.022)	− 0.871** (0.344)	− 1.179*** (0.378)	0.040 (0.620)	− 0.269 (0.232)	− 0.134 (0.227)
KP-RK	0.831	6.763	3.830	0.831	6.763	3.830
	Inequality instrumented with					
Sh.Young × year ≥ 2008	Yes	No	Yes	Yes	No	Yes
Sh.Young × year ≥ 2011	Yes	No	Yes	Yes	No	Yes
Sh.Female × year ≥ 2008	No	Yes	Yes	No	Yes	Yes
Sh.Female × year ≥ 2011	No	Yes	Yes	No	Yes	Yes
Obs.	1310					

Municipality level data covering period 2006–2015. All specifications include year and municipality fixed effects. Municipality times period clustered robust standard errors in parenthesis. We divide our time window into three periods: pre-2008, post-2008 and post-2011. Panel *B* introduces controls for level share of females and level share of young individuals. Additionally, panel *C* introduces controls for the share of votes received by the main left- and right-wing parties, participation and vote fragmentation at the last municipality election. Log-gini instrumented with demographic as indicated in the bottom of the table. Estimates are population weighted. KP-RK is the Kleibergen and Paap (2006) reduced rank statistic for weak instruments

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

produced with lagged demographics (Tables 10, 11) are very close to the baseline ones (Tables 4, 7).

4.1.3 Inequality, poverty and indirect redistribution

How can we identify the effect of inequality on indirect redistribution? Our theoretical model offers two fundamental insights. We should control for poverty, and we should consider a policy that works as the price regulation of goods or services. One broad policy area that satisfies the second insight is the regulation on transport, both private and public. To the best of our knowledge, there is no systematic collection of data on the finances and prices of public transport for Spain. Instead, we use tax rates on private vehicles as proxies for the prices of road usage.[35]

The choice of tax rates on private road vehicles has three advantages. First, compared to tax revenues, tax rate information better identifies a pricing policy since the former confounds the effects of changes in both the tax rate and the tax base. This feature is relevant for Spain, where during the Great Recession, not only income but also consumption inequality experienced significant changes (Anghel et al. 2018). Second, vehicle taxes are a good proxy for the price of a public service given that the use of roads is subject to decreasing average costs of provision. Last, the tax rate we consider does not charge sales and purchases but vehicle potential use. In Spain, taxes on vehicles depend on two characteristics, engine power and type of vehicle.[36] This allows us to focus on the use of roads by high-power cars,[37] which clearly is not a necessity. We refer to the high-power-car tariff as the "large-cars" tariff.

Opposite to the effect on public transport fares, our theoretical framework suggests we should expect tariffs on private vehicles to depend positively on poverty and negatively on inequality; for the poor consume intensively public transport and not private vehicles (Asensio et al. 2003). In Table 6 we provide IV estimates of the effect of inequality on log-tariffs for the largest car segment. When we instrument inequality with the municipality share of the young, we find an insignificant effect with an unclear sign. Instead, when the instrument is the share of females, we find a 6–9% decrease on the tariff per 10% increase in inequality. Given the first stages in Table 2, the change observed in these estimates suggests a positive effect of poverty, so that estimates in Table 6 that do not control for poverty, have an upward bias. IV estimates of the effect of inequality and poverty reported in Table 12 corroborate this result. We find a negative effect of inequality on the large-cars tariff, with a 10% increase in inequality decreasing the tariff by 8–18%, depending on the added

[35] The car tax we use has a minimum rate set centrally for the whole of the state, over which municipalities can apply an incremental coefficient to the baseline tariff.

[36] The tax step of a particular vehicle is a function of its *Fiscal Horse Power*. This measure results from the formula $FHP = T \times (0.785 \times D^2 \times R)^{0.6} \times N$ where T is a multiplying factor that depends on whether it is a two- or four-stroke engine, D is the cylinder's diameter, R is the length of the piston's move, and N is the number of cylinders.

[37] These are cars with twenty or more *fiscal horses*. To give a tangible example of what this means, the entry-level version of the car most sold in Spain in 2019 has a *fiscal power* of 7.83 and a price tag of €16K. The entry-level version of a top sold luxury SUV has a fiscal horsepower of 19.95 and a price tag of €78K.

controls. Poverty has a positive effect, with a 10% increase positively affecting the tariff by 2–9%.[38]

5 Final remarks

In this paper, we propose a theoretical and empirical approach to study the effects of poverty and inequality on the mix of government redistributive policies. Our model builds upon the claim that the poor have identifiable consumption patterns. In particular, they consume regulated goods more intensively than the rest of the citizens. This feature prevents an exogenous definition of poverty. That is why we have chosen a theoretical model that allows for endogenously defined groupings. This choice has a cost in terms of the precision of the model's predictions. Also, it makes it difficult to arrive at a neatly reduced form for empirical analysis. Future work might take on these two key challenges.

Our theoretical results convey that inequality and poverty may create diverging incentives for the combinations of indirect and direct redistributive policies. This idea has great significance for the rich literature on redistribution in democracies, for it provides further insights into the relationship between inequality and redistribution. Importantly, it suggests that a robust study of such a relationship should account for the effects of poverty.

Our empirical results are consistent with the notion that a greater mass of poor citizens creates incentives to redistribute more through regulation at the expense of social expenditures. Using data at the municipality level, we provide evidence whereby inequality increases direct redistribution and decreases indirect redistribution when we control for poverty. We further show that poverty and inequality may have opposite effects on redistribution; despite being strongly correlated. This evidence provides a further explanation for previous divergent results on the redistributive effects of inequality.

Still reminds the question of how all other types of government policy respond to incentives brought by changes in the income distribution. Understanding the trade-offs involved in the menu of government redistributive policies and their welfare implications is of critical relevance for identifying more particular relationships between income distribution and public policy. Future work can depart from the framework here introduced to better understand these trade-offs.

[38] As a robustness exercise, we further support the claim that poverty and inequality affect indirect redistribution in opposite directions using data on subsidies to public transport fare. These subsidies are reported by the Metropolitan Mobility Observatory (MMO) and are available at http://www.observatoriomovilidad.es/es/publicaciones/informes.html. We use this data to regress changes in the ratios transfer to total revenues on changes in both inequality and poverty (Table 13). The results show that, controlling for differences in the political environment, poverty (inequality) has a positive (negative) effect on the subsidies to public transport fares. We interpret these results with caution since they only represent a small sample of large municipalities and suffer from the bias sources of OLS estimators under potential endogeneity. We do not report IV estimates since the small sample size renders these uninformative.

Appendix A

A.1 Data description

We compute municipality level earnings distributions from annual tax data records provided by the Spanish Social Security for the period 2006–2015. These data is contained in the *Muestra Continua de Vidas Laborales* (MCVL), a 4% random sample of the population that has had any relation with the social security on a given year. Earnings information contained in the MCVL comes from the 190 tax form, an informative fiscal declaration that all entities paying wages, pensions and unemployment benefits must annually provide to the fiscal agency. Thus this information is detailed and exhaustive.[39] However, these data exclude household workers and most of the self-employed along with some specific sources of earnings as, for example, those generated from incapacitation pensions, and certain grants and public transfers. Furthermore, one disadvantage of these data is that those in long-term unemployment, i.e. that have not had any relation with the Social Security, are outside of the sample's scope. To check whether this may drive our results, we impute long-term unemployment rates for every municipality that we use to reconstruct the left tail of the earnings distribution.[40] Estimates using Gini coefficients computed with the imputed distributions are reported in Tables 8 and 9.

From the MCVL we selected records of individuals 25–65 that are living in identifiable municipalities. These are municipalities with more than 40K habitants. Our analysis, therefore, reflects policy changes on the larger municipalities. Nonetheless, these are arguably the most interesting ones as they have broader policy powers. For example, only those municipalities with more than 20K habitants have to provide certain civil protection and social services, and only municipalities with more than 50K habitants have to provide urban public transport. Moreover, we select individuals aged 25 and over because this is the age at which occupation rates peaked before the Great Recession.

As a sanity check, we have compared our inequality measures with alternative measures of inequality at the municipality level provided by Hortas-Rico and Onrubia (2014). These alternative measures are available for years 2004–2007, 2011 and 2014; and have been computed using data from personal income taxes. This data source, as compared with the MCVL, has the disadvantage of not, or only partially, covering those with earnings below a certain income threshold for whom filling a personal tax return is non-mandatory.[41] Thus the MCVL gives a more comprehensive measure of earnings inequality as it covers everyone with a relation with the

[39] See pages 164–174 of the MCVL's manual, available at http://www.seg-social.es.

[40] To reconstruct the left-tail of the distribution we assume that everyone in long-term non-unemployment has zero income.

[41] The *Instituto de Estudios Fiscales* provides these tax microdata together with a complementary sample covering those for whom filling income tax is non-mandatory. However, the latter data does not contain municipality identifiers.

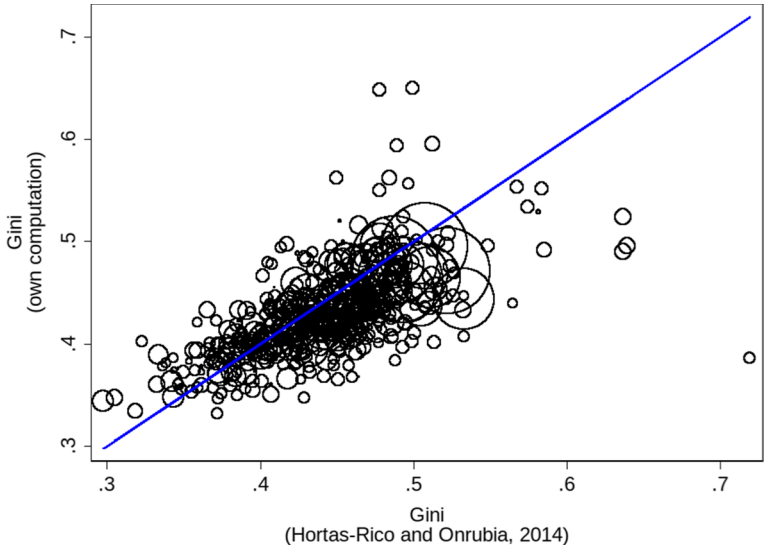


Fig. 5 Comparison of inequality measures. Our measure of inequality in the y-axis versus Hortas-Rico and Onrubia (2014) inequality measure (x-axis). 45-degree line in blue. Marker proportional to population

social security.[42] Nonetheless, the MCVL does not contain certain types of income, in particular capital income. Thus, it may underestimate inequality at the top of the distribution if those at the very top of the earnings distribution also have higher capital income. In Fig. 5 we compare our Gini measures with the ones produced by Hortas-Rico and Onrubia (2014). These are comparable, although our measure of inequality is higher (lower) for those municipalities with low (high) inequality.

Data on municipality level public policy come from two sources. From the Spanish Ministry of Finance we obtain data on municipality tax rates and tariffs. Also from the Ministry of Finance, we obtain data on budgets of local entities containing information on expenditure and revenue classified in terms of economic and functional characteristics. From these budget data we compute social and housing expenditure as the share of total expenditure.

Other than the fiscal and public policy data we also compile population and electoral information. From the continuous census provided by the Office for National Statistics (INE, from it Spanish name), we obtain information on population levels by age and sex for every municipality over the period 2006–2015. We use these data to construct our measures of exposure to the Great Recession that we use to instrument shifts in the earnings distribution. Finally, electoral information comes from the Home Office and contains, for every municipality and election between 2003–2015, the electoral census, total number of votes cast and votes received by

[42] The MCVL has been used to study earnings inequality in Bonhomme and Hospido (2013, 2017); Anghel et al. (2018).

each party. From these data we compute participation rates (= total number of votes / electoral census), share obtained by the main, state level, left-wing (Partido Socialista Español, PSOE) and right-wing (Partido Popular, PP) party and a fragmentation measure of vote.[43]

A.2 Additional tables

See Tables 6, 7, 8, 9, 10, 11, 12, and 13

Table 6 Inequality and municipality's large car tariff *IV estimates*

	(1)	(2)	(3)	(4)	(5)
A	Baseline				
Inequality	− 0.273 (0.426)	0.116 (0.401)	− 0.640* (0.342)	− 0.680* (0.347)	− 0.434 (0.286)
KP-RK	35.849	16.987	64.937	36.578	19.577
B	Include level demographics				
Inequality	0.078 (0.299)	0.232 (0.301)	− 0.979** (0.406)	− 1.069** (0.417)	− 0.450 (0.289)
KP-RK	68.837	33.878	57.419	30.704	15.615
C	Include political controls				
Inequality	− 0.005 (0.321)	0.132 (0.336)	− 0.818** (0.379)	− 0.927** (0.389)	− 0.414 (0.300)
KP-RK	69.478	34.754	55.904	30.004	15.194
	Inequality instrumented with				
Sh.Young × year ≥ 2008	Yes	Yes	No	No	Yes
Sh.Young × year ≥ 2011	No	Yes	No	No	Yes
Sh.Female × year ≥ 2008	No	No	Yes	Yes	Yes
Sh.Female × year ≥ 2011	No	No	No	Yes	Yes
Obs.	1310				

Municipality level data covering period 2006–2015. All specifications include year and municipality fixed effects. Municipality times period clustered robust standard errors in parenthesis. We divide our time window into three periods: pre-2008, post-2008 and post-2011. Panel *B* introduces controls for level share of females and level share of young individuals. Additionally, panel *C* introduces controls for the share of votes received by the main left- and right-wing parties, participation and vote fragmentation at the last municipality election. Log-gini instrumented with demographic as indicated in the bottom of the table. Estimates are population weighted. KP-RK is the Kleibergen and Paap (2006) reduced rank statistic

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

[43] For the fragmentation measure we use the Herfindahl–Hirschman index.

Table 7 Inequality and municipality social services expenditure *IV estimates*

	(1)	(2)	(3)	(4)	(5)
A	Baseline				
Inequality	0.705** (0.302)	0.672** (0.312)	0.197 (0.170)	0.214 (0.179)	0.360** (0.183)
KP-RK	35.849	16.987	64.937	36.578	19.577
B	Include level demographics				
Inequality	0.409* (0.232)	0.430* (0.247)	0.281* (0.168)	0.332* (0.179)	0.387** (0.177)
KP-RK	68.837	33.878	57.419	30.704	15.615
C	Include political controls				
Inequality	0.386* (0.226)	0.382* (0.231)	0.281 (0.174)	0.326* (0.184)	0.359** (0.175)
KP-RK	69.478	34.754	55.904	30.004	15.194
	Inequality instrumented with				
Sh.Young × year ≥ 2008	Yes	Yes	No	No	Yes
Sh.Young × year ≥ 2011	No	Yes	No	No	Yes
Sh.Female × year ≥ 2008	No	No	Yes	Yes	Yes
Sh.Female × year ≥ 2011	No	No	No	Yes	Yes
Obs.	1310				

Municipality level data covering period 2006–2015. All specifications include year and municipality fixed effects. Municipality times period clustered robust standard errors in parenthesis. We divide our time window into three periods: pre-2008, post-2008 and post-2011. Panel *B* introduces controls for level share of females and level share of young individuals. Additionally, panel *C* introduces controls for the share of votes received by the main left- and right-wing parties, participation and vote fragmentation at the last municipality election. Log-gini instrumented with demographic as indicated in the bottom of the table. Estimates are population weighted. KP-RK is the Kleibergen and Paap (2006) reduced rank statistic

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

Table 8 Inequality and housing expenditure *IV estimates, robustness*

	Inequality instrumented with							
	Share of young				Share of female			
	Gini[a]	P90/P10	P90/P50	P50/P10	Gini[a]	P90/P10	P90/P50	P50/P10
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Inequality	− 1.239*** (0.428)	− 0.222*** (0.081)	− 0.497*** (0.191)	− 0.400*** (0.151)	0.105 (0.322)	0.036 (0.109)	0.076 (0.232)	0.067 (0.207)
KP-RK	52.560	81.190	80.291	28.533	54.198	30.487	44.890	11.004
Obs.	1310							
	Controls							
Demographic	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Political	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

[a]Gini computed with distribution corrected for long-term unemployment. All specifications include demographic and political controls plus year and municipality fixed effects. Municipality times period clustered robust standard errors in parenthesis. We divide our time window into three periods: pre-2008, post-2008 and post-2011. Estimates are population weighted. KP-RK is the Kleibergen and Paap (2006) reduced rank statistic for weak instruments

Table 9 Inequality and social service expenditure *IV estimates, robustness*

	Inequality instrumented with							
	Share of young				Share of female			
	Gini[a]	P90/P10	P90/P50	P50/P10	Gini[a]	P90/P10	P90/P50	P50/P10
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Inequality	0.545* (0.319)	0.098* (0.054)	0.219* (0.121)	0.176* (0.099)	0.356 (0.220)	0.121* (0.069)	0.259* (0.155)	0.227* (0.134)
KP-RK	52.560	81.190	80.291	28.533	54.198	30.487	44.890	11.004
Obs.	1310							
	Controls							
Demographic	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Political	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

[a]Gini computed with distribution corrected for long-term unemployment. All specifications include demographic and political controls plus year and municipality fixed effects. Municipality times period clustered robust standard errors in parenthesis. We divide our time window into three periods: pre-2008, post-2008 and post-2011. Estimates are population weighted. KP-RK is the Kleibergen and Paap (2006) reduced rank statistic for weak instruments

Table 10 Housing expenditure on inequality and poverty *IV estimates, 2006 demographics*

	(1)	(2)	(3)	(4)	(5)
A	Baseline				
Inequality	− 0.858*** (0.310)	− 0.849*** (0.321)	0.019 (0.314)	0.054 (0.320)	− 0.501* (0.281)
KP-RK	82.330	40.993	45.894	23.845	13.644
B	Include level demographics				
Inequality	− 0.873*** (0.309)	− 0.865*** (0.319)	0.167 (0.298)	0.254 (0.309)	− 0.348 (0.263)
KP-RK	74.198	36.906	46.783	24.528	14.125
C	Include political controls				
Inequality	− 0.857*** (0.292)	− 0.817*** (0.301)	0.104 (0.284)	0.203 (0.297)	− 0.352 (0.250)
KP-RK	74.386	37.512	46.048	23.735	13.816
	Inequality instrumented with				
Sh.Young × year ≥ 2008	Yes	Yes	No	No	Yes
Sh.Young × year ≥ 2011	No	Yes	No	No	Yes
Sh.Female × year ≥ 2008	No	No	Yes	Yes	Yes
Sh.Female × year ≥ 2011	No	No	No	Yes	Yes
Obs.	1310				

Municipality level data covering period 2006–2015. All specifications include year and municipality fixed effects. Municipality times period clustered robust standard errors in parenthesis. We divide our time window into three periods: pre-2008, post-2008 and post-2011. Panel *B* introduces controls for level share of females and level share of young individuals. Additionally, panel *C* introduces controls for the share of votes received by the main left- and right-wing parties, participation and vote fragmentation at the last municipality election. Log-gini instrumented with demographic as indicated in the bottom of the table. Estimates are population weighted. KP-RK is the Kleibergen and Paap (2006) reduced rank statistic for weak instruments

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

Table 11 Social services expenditure on inequality and poverty *IV estimates, 2006 demographics*

	(1)	(2)	(3)	(4)	(5)
A	Baseline				
Inequality	0.156 (0.233)	0.143 (0.245)	0.190 (0.198)	0.191 (0.204)	0.159 (0.196)
KP-RK	82.330	40.993	45.894	23.845	13.644
B	Include level demographics				
Inequality	0.335 (0.227)	0.362 (0.242)	0.325* (0.181)	0.349* (0.190)	0.363** (0.179)
KP-RK	74.198	36.906	46.783	24.528	14.125
C	Include political controls				
Inequality	0.315 (0.221)	0.325 (0.230)	0.320* (0.188)	0.341* (0.196)	0.334* (0.178)
KP-RK	74.386	37.512	46.048	23.735	13.816
	Inequality instrumented with				
Sh.Young × year ≥ 2008	Yes	Yes	No	No	Yes
Sh.Young × year ≥ 2011	No	Yes	No	No	Yes
Sh.Female × year ≥ 2008	No	No	Yes	Yes	Yes
Sh.Female × year ≥ 2011	No	No	No	Yes	Yes
Obs.	1310				

Municipality level data covering period 2006–2015. All specifications include year and municipality fixed effects. Municipality times period clustered robust standard errors in parenthesis. We divide our time window into three periods: pre-2008, post-2008 and post-2011. Panel *B* introduces controls for level share of females and level share of young individuals. Additionally, panel *C* introduces controls for the share of votes received by the main left- and right-wing parties, participation and vote fragmentation at the last municipality election. Log-gini instrumented with demographic as indicated in the bottom of the table. Estimates are population weighted. KP-RK is the Kleibergen and Paap (2006) reduced rank statistic for weak instruments

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 12 Large-cars tariff on inequality and poverty *IV estimates*

	(1)	(2)	(3)	(4)	(5)	(6)
	A Baseline			*B* Demographics		
Inequality	4.017 (2.571)	− 0.898 (0.613)	− 0.836 (0.617)	4.313 (3.530)	− 1.766** (0.753)	− 1.863** (0.837)
Poverty	− 2.026 (1.288)	0.201 (0.415)	0.307 (0.383)	− 2.244 (1.874)	0.551 (0.426)	0.944** (0.477)
KP-RK	1.440	5.765	3.698	0.847	7.215	4.114
	C Political controls					
Inequality	3.124 (3.110)	− 1.749** (0.738)	− 1.797** (0.810)			
Poverty	− 1.647 (1.620)	0.655 (0.435)	0.924** (0.465)			
KP-RK	0.831	6.763	3.830			
	Inequality instrumented with					
Sh.Young × year ≥ 2008	Yes	No	Yes	Yes	No	Yes
Sh.Young × year ≥ 2011	Yes	No	Yes	Yes	No	Yes
Sh.Female × year ≥ 2008	No	Yes	Yes	No	Yes	Yes
Sh.Female × year ≥ 2011	No	Yes	Yes	No	Yes	Yes
Obs.	1310					

Municipality level data covering period 2006-2015. All specifications include year and municipality fixed effects. Municipality times period clustered robust standard errors in parenthesis. We divide our time window into three periods: pre-2008, post-2008 and post-2011. Panel *B* introduces controls for level share of females and level share of young individuals. Additionally, panel *C* introduces controls for the share of votes received by the main left- and right-wing parties, participation and vote fragmentation at the last municipality election. Log-gini instrumented with demographic as indicated in the bottom of the table. Estimates are population weighted. KP-RK is the Kleibergen and Paap (2006) reduced rank statistic for weak instruments

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

Table 13 Inequality, poverty and subsidy to tariff income ratios *OLS estimates*

	(1)	(2)	(3)	(4)
Inequality	0.687 (0.962)	0.161 (1.100)	− 0.443 (1.117)	− 0.263 (1.165)
Poverty	0.201 (0.454)	0.293 (0.460)	0.859* (0.509)	0.885* (0.508)
Obs.	124			
	Controls			
	No	Yes	No	Yes
Political	No	No	Yes	Yes

Left-hand-side is the share of income from subsidies over tariff plus subsidy income. All specifications include year and municipality fixed effects. Heteroskedasticity robust standard errors in parenthesis

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

A.3 Additional figures

See Figs. 6, 7, and 8.

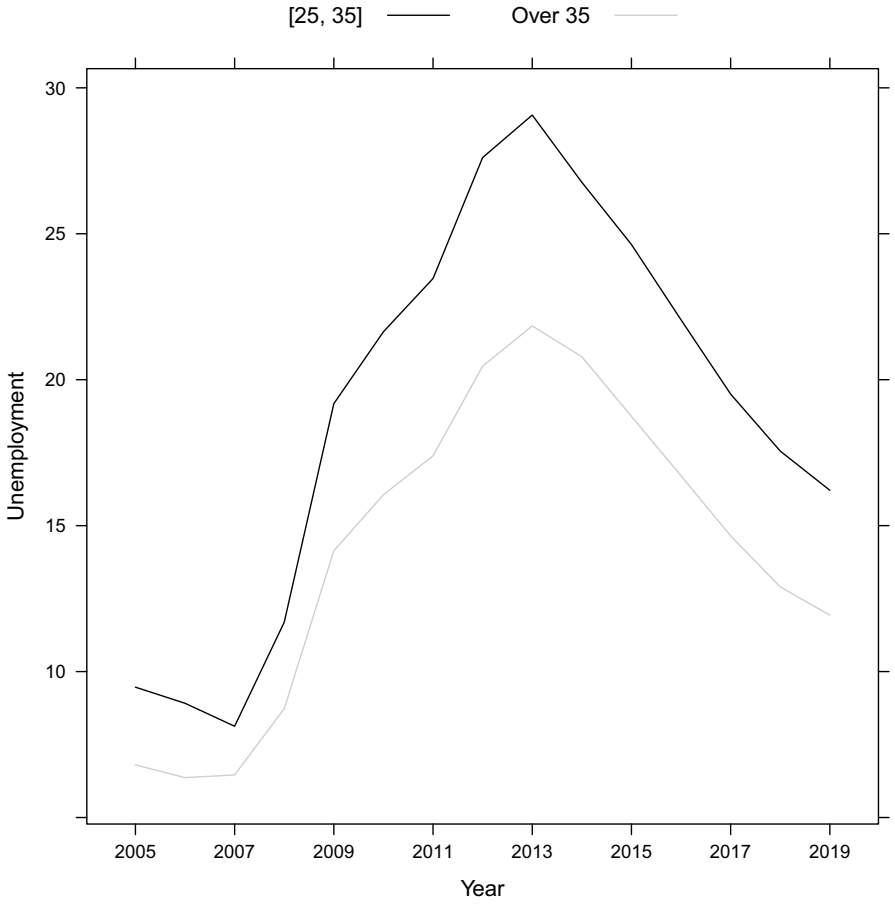


Fig. 6 Unemployment rates. Unemployment rates computed from Spanish Labour Force Survey (Encuesta de Población Activa)

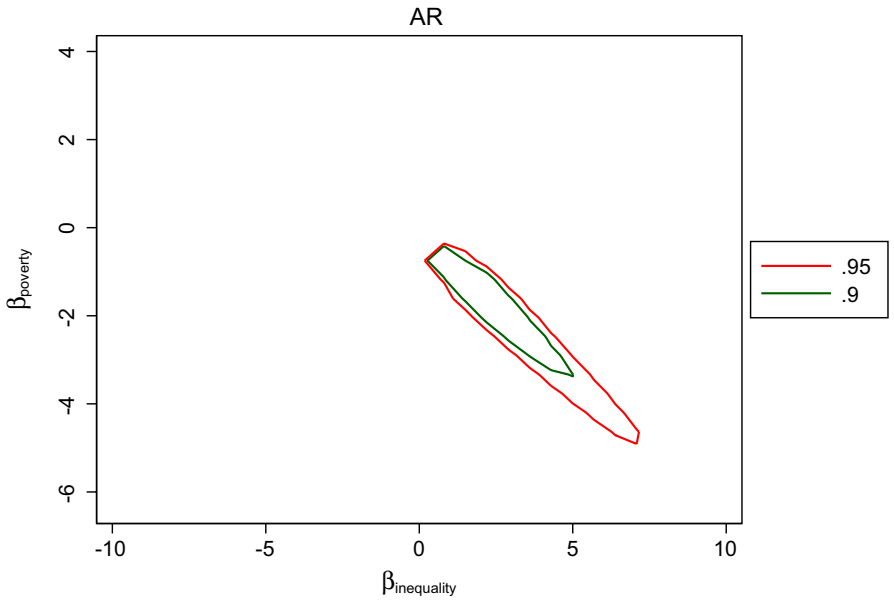


Fig. 7 Robust confidence sets: housing expenditure on inequality and poverty. This plot depicts robust rejection areas using the AR statistic introduced by Anderson and Rubin (1949). The AR statistic for the null $\beta_{poverty} = \beta_{inequality} = 0$ is 15.49, thus it is rejected at the 99%

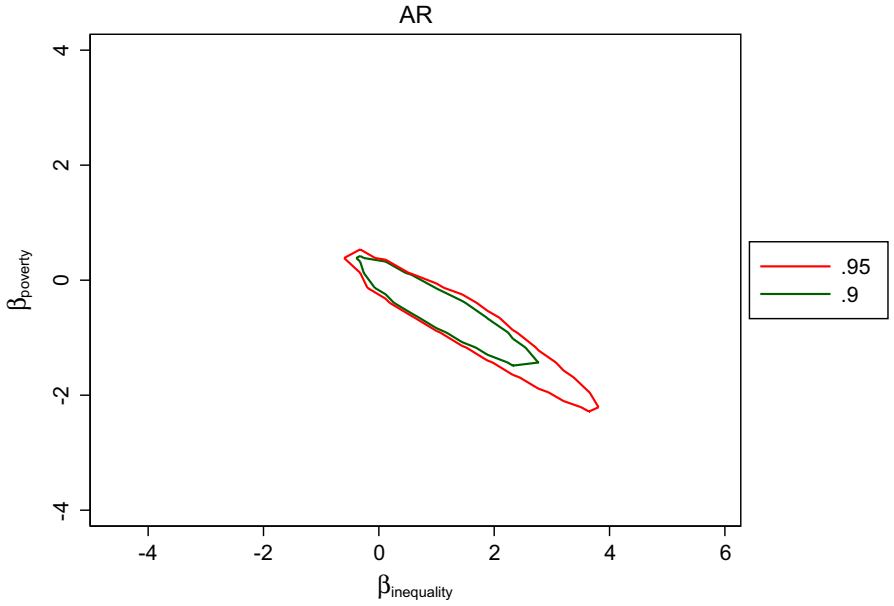


Fig. 8 Robust confidence sets: social services expenditure on inequality and poverty. This plot depicts robust rejection areas using the AR statistic introduced by Anderson and Rubin (1949). The AR statistic for the null $\beta_{poverty} = \beta_{inequality} = 0$ is 5.39, thus we fail to reject at typical levels of significance

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Author contributions Both authors contributed equally.

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Availability of data and material All data but that contained in the Muestra Continua de Vidas Laborales (MCVL) is of open access and can be obtained from sources detailed in the paper. Data from the MCVL can be requested from the Social Security (http://www.seg-social.es/wps/portal/wss/internet/EstadisticasPresupuestosEstudios/Estadisticas/EST211?changeLanguage=es).

Declarations

Conflict of interest None.

Code availability We have created R code to pre-process the data and Stata code for the main analysis. These will be provided by the authors.

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