The Macroeconomics of Inequality RTG 2281
Discussion Paper No. 2021-05

Redistribution, Demand, and Sustainable Production

March 2022

Sonja Dobkowitz

Research Area D: Inequality and macroeconomic policies

Funded by
Deutsche Forschungsgemeinschaft
German Research Foundation

UNIVERSITÄT BONN

Research Training Group 2281
Macroeconomics of Inequality
Kaiserplatz 7-9, 4th floor
53113 Bonn

ABSTRACT

Recent evidence points to an increase in consumers' willingness to pay for sustainable goods, i.e., social responsibility. What is the optimal policy response to such a shift in preferences? Advancing social responsibility suggests a demand-driven transition to sustainable production. This paper argues, however, that basic needs and income inequality pose an obstacle. Therefore, (i) lump-sum transfers alter the share of sustainable production, and (ii) social responsibility exacerbates consumption inequality. In the model, inequality renders labour taxes part of the optimal environmental policy for all levels of social responsibility. Greater social responsibility entails a policy shift away from corrective taxation towards redistribution. The aggravation of consumption inequality turns the policy focus on equity. As a consequence, redistribution arises as the central pillar of the optimal environmental policy.
JEL classification: E71, H21, H23, Q58

Sonja Dobkowitz
Department of Economics
Universität Bonn
sonja.dobkowitz@uni-bonn.de

Redistribution, Demand, and Sustainable Production
Discussion Paper No. 2021-05
March 2022
Research Area D: Inequality and macroeconomic policies

Funded by
Deutsche Forschungsgemeinschaft
German Research Foundation

Redistribution, Demand, and Sustainable Production

Sonja Dobkowitz
Bonn Graduate School of Economics
RTG 2281, The Macroeconomics of Inequality

1 Introduction

Recent research demonstrates the existence of *social responsibility* in markets (Bartling et al., 2015), that is, households' utility depends on the externalities associated with their consumption. And the share willing to pay a premium for sustainable products is rising.[1]Such a change in preferences suggests a transition to sustainable production and fewer externalities on aggregate. But income inequality renders sustainable goods unaffordable to poor households, posing an obstacle to a demand-led transition. As a result, (i) redistribution affects the externality and (ii) consumption inequality aggravates as social responsibility rises. In the light of changing social responsibility and high income inequality, I ask: What is the optimal policy as social responsibility increases?

The answer to this question depends on how counteracting effects of social responsibility relate quantitatively. On the one hand, the rise in social responsibility implies a demand-driven reduction in the externality. Ceteris paribus, less government intervention for environmental reasons is required. On the other hand, two other effects call for more government intervention. First, the efficient level of the externality reduces. Absent a behavioural change, it is optimal to lower the externality more. Second, a rise in social responsibility exacerbates consumption inequality, since the trade-off between satisfying a minimum consumption level and the wish to consume socially responsibly faced by poor households intensifies. This effect makes more government action to mitigate inequality optimal. The government faces a trade-off between the provision of the public environmental good and equity, since both environmental taxes and distortionary labour taxes induce efficiency costs. Hence, the rise

[1] In 2015 66% of households were willing to pay a premium for sustainable brands, compared to 50% in 2013 in a sample of 60 countries (The Nielsen Company, 2015). Indeed, the market share of sustainable consumer packaged goods in the US rose from 14.3% in 2013 to 16.6% in 2018 (Kronthal-Sacco et al., 2020) despite a price premium generally charged for sustainable goods (The Conference Board, 2020).

in the need for redistribution reduces the resources the government can spend to lower the externality. Consequently, it is a-priori unclear which effect of social responsibility dominates thereby determining the optimal policy.

Macroeconomic research has primarily focused on the supply side to study environmental policies in representative agent models. This paper, in contrast, scrutinises the optimal policy in a model with a demand-determined economic structure and income inequality. I find that for all levels of social responsibility labour taxes are part of the optimal environmental policy. A surge in social responsibility induces an optimal shift from corrective taxation to redistribution. The worsening of consumption inequality urges the government to focus on equity. Since redistribution attains a better balance between providing the public good and equity when social responsibility is high, it becomes the essential part of the optimal environmental policy. With this policy, the government relinquishes an efficient reduction in the externality.

I suggest a model economy that consists of a sustainable and an unsustainable, polluting production sector. Households choose between these two goods by trading off their desire to consume sustainably and a requirement to satisfy basic consumption needs. There are two household types which differ solely in the effective labour productivity they provide. This gives rise to income heterogeneity. Income inequality and the externality motivate government intervention. Having a distortionary labour tax and a corrective environmental tax at her disposal, a Ramsey planner maximises social welfare. Yet, both instruments distort households' labour supply decisions so that a trade-off between equity and environmental-good provision arises and the first-best allocation is not attainable.

In the model, social responsibility shapes the utility a household derives from consuming the sustainable over the unsustainable good. There is no heterogeneity in social responsibility across income groups which I provide evidence for in the empirical section of the paper. Instead, all household-specific variation in the composition of consumption bundles results from income inequality. I obtain this model behaviour by introducing utility costs which become positive whenever a household's consumption falls below basic needs. As a result, low-income households' consumption tilts towards the cheaper alternative and does not reflect their desire to act socially responsibly.

Contrary to an evolved household side, the production side is simple. The research question is studied in a partial-equilibrium set-up to focus on the most basic ambiguous effects which a change in social responsibility generates for the optimal policy. Both production sectors are perfectly competitive, prices are flexible, and firms produce with a constant returns to scale technology.

Before describing the results, I emphasise, in the next two paragraphs, the most important choices to calibrate the model. I calibrate the model to the US in 2018. The comparison of microdata on disposable income to a sustainable basic-needs bundle determines the share of poor and rich households in the model: the poor cannot afford to subsist on sustainable goods alone. One can think of the sustainable bundle as containing, for example, organic food and energy from sustainable sources, while the unsustainable one consists of conventional food and energy from emission-high alternatives. To proxy the relative price of the sustainable bundle, I use a time series on organic and conventional food prices provided by the US Department of Agriculture (USDA). Prices are then aggregated according to the food bundle suggested by the EAT-Lancet Commission (2019) - a bundle designed to respect planetary and health boundaries.

To zoom in on the role of inequality, I refer to an objective measure of needs which I take from the Institute for Women's Policy Research (IWPR). In contrast to observed subjective needs, this measure is less prone to habits or a keeping-up-with-the-Joneses motive of consumption levels, for instance. Therefore, in the model, households can lower their consumption beyond previous consumption levels as they become more socially responsible as long as basic needs are sufficiently covered.

I conduct several quantitative experiments to study the optimal policy response to growing social responsibility. The main exercise consists in exogenously changing the degree of social responsibility shared by households.[2] To differentiate the role of basic needs from the general effects of social responsibility, I run the experiment in both a *standard* model which does not account for basic needs and the *baseline* model sketched above.

In the standard model, by construction, income inequality does not affect the aggregate production ratio. Nevertheless, labour taxes are chosen higher for all levels of social responsibility to target the externality.[3] In the standard model, labour taxes only affect the externality through an efficiency channel. In other words, in an unequal economy, the optimal policy to mitigate externalities is a combination of both a recomposition (the corrective tax) and a reduction (the distortionary labour tax) of output. Solely relying on the corrective tax would be too costly in terms of equity.

As social responsibility rises in the standard model, consumption inequality remains constant. Nonetheless, greater social responsibility has opposing effects on the optimal policy. On the one hand, a shift in household behaviour directs production to the sustainable sector

[2] Changing preferences bears the risk of making a potentially invalid welfare comparison as the value measure changes. It is, for instance, questionable whether the world is indeed a better place from suddenly liking a previously disliked situation, while the situation as such remained the same. Nevertheless, observing a change in preferences is a legitimate motivation to think about how politics should respond to it. Therefore, the analysis focuses solely on policy discussions and how the economy is shaped by the change in preferences.

[3] The finding is in line with Jacobs and van der Ploeg (2019) who discuss the optimal usage of labour taxes to target the externality when corrective taxes are below the Pigouvian rate.

so that less government action for environmental reasons is necessary. On the other hand, the efficient level of the externality diminishes as households value the polluting good less. Therefore, the target level of the externality for the optimal policy reduces, too. Hence, even absent basic needs, it is a-priori unclear whether the policy should be more aggressive in lowering the externality.

The exercise uncovers that, absent basic needs, the optimal policy can set a lower environmental tax while converging to the efficient level of the externality due to the behavioural change in demand. Both the reduction in the environmental tax base before government intervention and the lower environmental tax lead to lower government revenues. The optimal labour tax rises with social responsibility to mitigate the drop in government revenues.

When basic needs are added to the analysis, the optimal policy shifts to redistribution away from corrective taxation as social responsibility grows. That is, transfers increase with social responsibility. In the following two paragraphs, I discuss the underlying mechanisms and the optimal policy in turn.

The enhancement in social responsibility exacerbates inequality in two ways. First, for the same distribution of income, consumption inequality grows with social responsibility. A stronger taste for the more expensive good raises the cost of the *desired* bundle - the bundle which would be chosen absent basic needs and which is in line with environmental preferences. Poor households, however, who are more concerned with satisfying their basic needs, consume a higher share of the cheaper good. The discrepancy between the composition of the actual and the desired bundle increases with social responsibility reducing composite consumption of the poor. Second, as the preference for the more expensive bundle becomes very strong, the poor eventually reduce the sum consumed accepting to suffer from consuming below basic needs. Both effects urge the government to spend more resources to mitigate inequality and to relinquish a further decline in the externality closer to the efficient level. Such a reduction of the externality would be possible by an escalated use of the corrective tax.

Since the policy focus turns to equity, the Ramsey planner optimally relies on redistribution as an environmental policy instrument. Lump-sum redistribution affects the externality because basic needs render the marginal propensity to consume unsustainable goods (MPCU) income dependent. Whenever the MPCU of a rich household is higher than that of a poor household, one more unit of lump-sum redistribution to the poor raises sustainable demand on aggregate. The mechanism emerges as poor households recompose their budget share towards the more expensive good once their basic needs are sufficiently met.

I quantify the importance of either tax instrument on the externality by assuming a sequential introduction of tax instruments. This approach enables me to disentangle each policy's effect separately. When social responsibility is low, the contribution of the labour tax to lowering the externality works through the efficiency channel. The corrective tax is the most important environmental policy tool. At high levels of social responsibility, redistribution accounts for a reduction of the externality by up to 44%, because the unsustainable good is inferior to poor households. The environmental tax, in contrast, becomes relatively unimportant under the optimal policy: Lowering the externality by only 10% at the highest level of social responsibility considered.

Finally, I show that since equity concerns imply an environmental tax which is so low that redistribution arises as an environmental policy instrument, the planner chooses a higher labour tax than in a counterfactual model without externality. This finding is in sharp contrast to Bovenberg and De Mooij (1994) who argue that environmental-tax revenues are optimally used to lower the distortionary labour tax when the government has to generate funds: The so-called *weak* double dividend hypothesis. The reason is that recycling environmental revenues as transfers intensifies the efficiency costs of labour taxation through the income channel of the wage rate. The introduction of basic needs into the model changes this result. Basic needs allow redistribution to increase the provision of the environmental good which adds to the benefits of labour taxation outweighing accelerated efficiency costs.

Literature The present paper is one of the first to relate social responsibility and inequality in a macroeconomic framework. Social responsibility has been studied in the behavioural economics literature. Bénabou and Tirole (2010) discuss the phenomenon and rationalise its existence, for example, by a (perceived) lack of government action. Bartling et al. (2015) provide experimental evidence that social responsibility shapes market interactions. The recent work by Aghion et al. (2021) is one rare example to integrate social responsibility in a general equilibrium model. The authors study its interactions with competition, while the present paper keeps the supply side simple yet introduces inequality and basic needs.

The paper is broadly related to the literature on optimal climate-change policy. This strand of literature generally focuses on a representative household and environmental taxation (compare Acemoglu et al., 2016; Golosov et al., 2014). While a supply-side perspective dominates in these papers, my paper shifts the focus on the demand side. Furthermore, my paper emphasises the role of labour income taxes in the optimal environmental policy which has hitherto been given less importance.

Therefore, more specifically, the paper adds to the discussion of the optimal environmental policy in a distortionary fiscal setting which has mainly focused on representative agent settings and exogenous governmental revenue constraints. Barrage (2020) studies optimal environmental taxation in a distortionary fiscal setting with carbon cycle and representative agent. As already alluded to, Bovenberg and De Mooij (1994) discuss the advantage of recycling environmental-tax revenues to lower distortionary labour taxes instead of increasing transfers. Similar to the model presented here, Jacobs and van der Ploeg (2019) add inequality and non-linear Engel curves to the setting in Bovenberg and De Mooij (1994). They show that distortionary labour taxes are used to target the externality when the corrective tax is not set to completely internalise the social costs of the externality. While the paper by Jacobs and van der Ploeg (2019) nests the present model as a special case, this paper here studies the effect of distinct intensities of the non-linearity due to varying degrees of social responsibility.

Finally, in the sense that demand initiates the transition to sustainability, the project contributes to the literature on structural transformation (for an overview, see Herrendorf et al., 2014). Introducing a penalty term to capture the importance of basic needs when income is low allows for inequality and redistribution to matter for the economic structure. That is not the case under the frequently used Stone-Geary preferences because marginal propensities to consume either good are independent of income. In this regard, the model relates to the work by Matsuyama (2002) and Foellmi and Zweimüller (2008) who both employ hierarchical consumption preferences. Yet, in contrast, the present paper's model does not assume a fixed hierarchy of goods a priori. This seems a better fit for the distinction of goods along the dimension of sustainability.

Outline In section 2, I provide an empirical motivation for the paper. Section 3 presents the model. The calibration follows in section 4. In section 5, I show and discuss results and sensitvity analyses. Section 6 concludes.

2 Empirical motivation

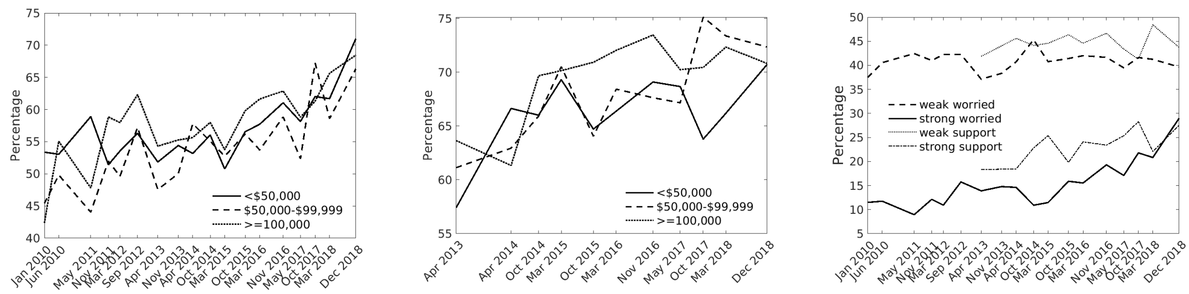
This section serves to motivate the paper's exercise: first, we observe a rise in households' willingness to pay for the avoidance of negative externalities, but, second, the distribution of income is such that poor households cannot afford sustainable goods.

2.1 Rising social responsibility

Rationales for the rise in socially responsible consumption behaviour are, for instance, a rising awareness of climate change (Bénabou and Tirole, 2010). I use a representative survey for the US population from the *Climate Change in the American Mind* project conducted by the Yale Program on Climate Change Communication (YPCCC) and George Mason University Center for Climate Change Communication (Mason 4C) (2020) to show that the awareness of climate change has accelerated. Panel (a) in figure 1 depicts the percentage by income group which indicated being worried about climate change. These shares have been rising steadily from early 2010 to end-2018 for all income groups.[4] Notice that not only have they been growing but also does the solicitude about climate change seem to converge over time across income groups. I take this evidence to model attitudes towards climate change homogeneously across income groups.

Figure 1

(a) Solicitude about climate change (b) Support of coal emission regulation (c) Intensive margin: Regulation support



Notes: I use data of the *Climate Change in the American Mind* project (Yale Program on Climate Change Communication (YPCCC) and George Mason University Center for Climate Change Communication (Mason 4C), 2020), a representative survey for the US population. The questions are "*How worried are you about global warming?*" for (a) and "*How much do you support or oppose the following policy? Set strict carbon dioxide emission limits on existing coal-fired power plants [...] The cost of electricity [...] would likely increase.*" for panels (b) and (c). Panels (a) and (b) show the share of *weakly* and *strongly* supporting/worried participants relative to the full weighted sample. Panel (c) shows the share of participants which *strongly support* and *weakly support* for the policy relative to all participants.

In line with concerns, the support for potentially costly policy interventions - which I take as a proxy of demand for sustainable goods[5] - has also been increasing. Compare panel (b) in figure 1, which shows the percentage by income group who expresses support for a regulation of coal emissions despite a possible increase in electricity costs. The support for such a policy displays some variation across income groups. In line with the narrative developed here, for almost all time periods the plot suggests that the richer a household the more likely it is to support costly policy interventions.[6]

The main exercise in the analysis is to exogenously increase social responsibility on household level. Relevant for income to drive a gap between desired and observed demand is the intensive margin as opposed to an extensive margin: individual households want to increase their share of sustainable consumption which might collide with basic needs. Yet, data limitations do not permit to study transitions on participant level. Panel (c), nevertheless,

[4] The question asked reads "*How worried are you about global warming?*". Appendix A provides more details and shows related graphs in figure 13.

[5] Demand, too, can be perceived as having a political dimension given the choice between sustainable and unsustainable products. On aggregate, individual consumption decisions implement the degree of sustainable production in the economy. This exhibits some parallels to a vote on the degree of sustainable production.

[6] Panels (g) and (h) of figure 13 show the evolution of support for a potentially costly regulation of the energy sector. The patterns are similar to the ones discussed for coal emission regulations.

provides evidence that the rise in the willingness to pay is driven by a more intense desire to support the policy on household level.

Plot (c) contrasts the evolution of the share of participants (by income group) which weakly supports the regulation to the one which strongly supports the regulation, the thin lines. The thicker graphs refer to worries about climate change, i.e., the variable shown in plot (a). The rise in the percentage of households which strongly supports the policy dominates, while the share of weakly supporting households only increases minimally. The rise in environmental concerns was driven by a rise in the share of strongly concerned households, as well. Hence, the data rationalises to study a rise in social responsibility on individual household level.[7]

2.2 Basic needs and inequality

Assume the rise in social responsibility continues, how should the optimal policy react? This thought experiment is at the heart of the paper. When all households are rich enough to sufficiently satisfy their basic needs with the sustainable good, the exercise seems trivial: the behavioural change in demand directs production to the sustainable sector and the government can implement an allocation closer to the efficient one. A smaller environmental tax is needed thereby reducing efficiency costs. Furthermore, there are no costs in terms of inequality associated with a rise in social responsibility.

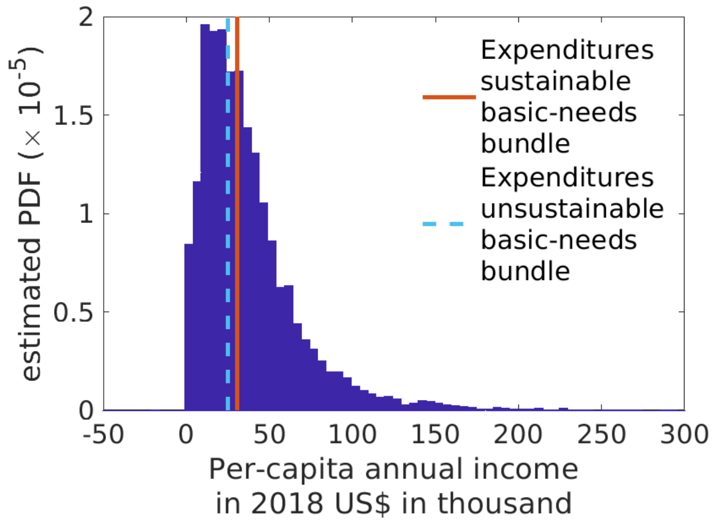
However, the need for government action remains, if the income distribution is such that low-income households cannot satisfy their basic needs with the sustainable good alone. Then, these households face a trade-off between sustainable consumption and the satisfaction of basic needs. As a result, first, demand does not lower the externality as intensely. Second, consumption inequality aggravates, since the poor want to consume a higher share of sustainable goods which conflicts with their basic needs.

Figure 2 highlights that inequality, indeed, constitutes a hindrance to a demand-led externality reduction. In the plot, I compare the estimated distribution of per-capita disposable income in 2018 in the US to the costs of a sustainable and an unsustainable consumption bundle. I use income data from the Panel Survey of Income Dynamics (PSID) and calculate disposable income using the NBER's TAXSIM tool; basic needs are taken from the Institute for Women's Policy Research (IWPR).[8]

In 2018, 44.96% of US households did not have the financial means to purchase basic needs in a sustainable quality alone, the solid orange line. Even if social responsibility is low and households only want to consume a small budget share of the sustainable good,

[7] Plots (c) to (f) in figure 13 show the evolution of weak and strong support/ solicitude by income group.
[8] Section A in the appendix describes the data presented in figure 2 in more detail.

Figure 2: Basic-needs constrained households



Notes: The information on income comes from the Panel Survey of Income Dynamics (PSID). Disposable income is derived using the NBER's TAXSIM tool. As an objective measure of basic needs I refer to the consumption bundle calculated by the Institute for Women's Policy Research (IWPR). Price information on organic and conventional food from the US Department of Agriculture (USDA) proxies the price premium for sustainable goods. I apply the relative price to expenditure categories for which a sustainable alternative is reasonable to exist. For a single-adult household annual expenses to cover basic needs amount to US$ 25,128 in unsustainable and to US$ 30,752 in sustainable quality.

inequality in the US prevents corresponding consumption: in 2018, a fraction of 36% was incapable of covering basic needs with the unsustainable good alone; compare the dashed blue line.

3 Model

I use a static partial equilibrium model of structural transformation. There are three agents in the model which will be described in turn: households, firms, and the government.

Households The economy is populated by a unit mass of households. A share λ is characterised by a high effective labour productivity z_h, and I will refer to them as *rich*. The share of *poor* households, $1-\lambda$, is less productive with $z_l < z_h$. Households are equal in all remaining aspects.

A generic household chooses labour supply, unsustainable, and sustainable consumption to maximise lifetime utility according to:

$$\begin{aligned}
&\max_{\{c_s\}_{t=0}^{\infty},\{c_{nt}\}_{t=0}^{\infty},\{l_t\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t U(c_t, l_t; H_{nt}) \\
&s.t. \\
&p_{st}c_{st} + c_{nt} \leq w_t(1-\tau_{lt})zl_t + T_t && \forall t \geq 0, \\
&l_t \leq L && \forall t \geq 0, \\
&c_t = \begin{cases} \left(\omega^{\frac{1}{\sigma}} c_{st}^{\frac{\sigma-1}{\sigma}} + (1-\omega)^{\frac{1}{\sigma}} c_{nt}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} & \text{if } \sigma \neq 1, \\ c_{st}^{\omega} c_{nt}^{1-\omega} & \text{if } \sigma = 1. \end{cases}
\end{aligned} \tag{1}$$

Each period, the household receives income from lump-sum tranfers, T, and effective labour supply, wzl, of which a fraction τ_l has to be paid as taxes. The choice of a linear labour tax is not innocent as a fully non-linear labour tax allows to correct for distributional effects of the environmental tax. I follow Jacobs and van der Ploeg (2019) who argue that a linear labour tax serves as a benchmark for the piece-wise linear tax schemes observed in reality which are not able to fully compensate for distributional effects of the environmental tax. The real wage, w, and the sustainable good's price, p_s, are denoted in units of the unsustainable good, c_n. A household's economic time endowment is denoted by L.

The household problem reduces to a static one as the model abstracts from capital, saving technologies and carbon cycles. Therefore, in what follows, time indices are dropped for simplicity.

Social responsibility The consumption goods, c_s and c_n, provide the same utility in terms of quantities consumed but differ with respect to the externalities occuring in the production process. The weight on sustainable consumption, ω, in the constant elasticity of substitution aggregator, equation 1, determines the willingness to pay for sustainable goods. As this parameter rises, households are willing to give up more units of the unsustainable good for an additional unit of the sustainable one. Therefore, ω is referred to as social responsibility. Goods are aggregated as imperfect substitutes in the composite consumption good emphasising their different ability to satisfy social responsibility concerns.

The period utility function is given by

$$U(c, l; H_n) = u(c, l) - \rho(\widehat{c}; \bar{c}) + g(H_n).$$

The felicity function u is strictly increasing and strictly concave in composite consumption,

c, and leisure, $L - l$.

The penalty term, $\rho(\widehat{c}_t; \bar{c})$, drives a wedge between social responsibility and actual consumption. The wedge depends on the gap between the sum of goods consumed and basic needs. Individual consumption goods enter as perfect substitutes: $\widehat{c} = c_n + c_s$. This assumption captures that goods are equal according to the consumption service they provide to cover basic needs. It holds that: $\rho(\widehat{c}) \geq 0 \ \forall \widehat{c}$. The function is strictly decreasing in $\widehat{c}$ and approaches zero as $\widehat{c} \to \infty$. The period utility function is calibrated such that the penalty term reduces utility quickly when quantities consumed fall below basic needs, $\bar{c}$. This urges affected households to lay more emphasis on maximising the sum consumed instead of consuming in line with their taste for sustainability. Throughout the paper, I refer to this model as *baseline* model and to a model without penalty term, i.e., $\rho(\widehat{c}; \bar{c}) = 0 \forall \widehat{c}$, as *standard* model.

The advantage of this utility specification above the common Stone-Geary preferences in the context of the paper is threefold. First, in contrast to Stone-Geary preferences, employing a penalty term generates not only heterogeneity in the *average* propensity to consume but also in the *marginal* propensity to consume either good. This effect is essential for redistirbution to matter for the economic structure. Second, the preferences suggested here induce households to reshuffle their budget share through cutting consumption of the previously necessary good. Since goods are perfect substitutes as regard basic consumption services, reducing consumption of one in favour of the other is sensible. Thirdly, the preferences I suggest allow to observe consumption below the basic-needs threshold. In contrast to common consumption minima studied in the literature, basic needs as understood here are a softer threshold in the sense that consuming below is a possibility. Given that consumption below this threshold is indeed observed in the data, this alternative approach presented here is more adequate.

To gain some intuition on how the penalty term affects households' consumption decisions, eqaution 2 below shows optimality conditions for unsustainable and sustainable consumption. Assuming that $u(c, l) = log(c) - \chi \frac{l^{1+\frac{1}{\theta}}}{1+\frac{1}{\theta}}$ and replacing the first order condition for sustainable consumption, the optimality condition reads:

$$c_n^{\frac{1}{\sigma}} = p_s \left(\frac{1 - \omega}{\omega} \right)^{\frac{1}{\sigma}} c_s^{\frac{1}{\sigma}} - (p_s - 1) \frac{\partial \rho(\widehat{c}; \bar{c})}{\partial c_n} \frac{c^{\frac{\sigma-1}{\sigma}} c_n^{\frac{1}{\sigma}} c_s^{\frac{1}{\sigma}}}{\omega^{\frac{1}{\sigma}}}. \tag{2}$$

Absent the penalty term, equation 2 coincides with the result in the standard model and unsustainable consumption is a constant fraction of income. Note that $\frac{\partial \rho(\widehat{c}; \bar{c})}{\partial c_n}$ is negative which implies that, whenever the sustainable good is more expensive, that is, $p_s > 1$, unsustainable consumption is higher than in the standard model. Although sustainability might be valuable to these households, their unsustainable demand remains high.[9] As income rises, the penalty term vanishes and households start to recompose their budget to eventually consume at the *desired* ratio, i.e., the ratio which is in line with social responsibility as it maximises the composite consumption good given prices. From this income level onward, a marginal increase in income does not cause a reallocation of budget shares and demand numerically coincides with the one in the standard model. When the unsustainable good is more expensive, unsustainable consumption is below its standard counterpart.

Importantly, social responsibility diminishes the effect of the penalty term on unsustainable demand.[10] As the more expensive good provides more and more consumption utility through the felicity function, the household accepts a rise in the penalty term to consume closer to the desired consumption ratio. It follows that the unsustainable good becomes inferior at lower income levels already (if $p_s > 1$).

These preferences capture two mechanisms through which income and environmental foodprint have been shown to be related by empirical work. For the US, Sager (2019) finds that the consumption of emissions is increasing and concave over the income distribution. In the model, first, poor households consume a higher budget share of polluting goods. Second, rich households' consumption has a negative effect on the environment through high levels of composite consumption.

Externality Households suffer from the size of the unsustainable sector represented by the strictly decreasing, convex function $g(H_n)$, which they take as given. To motivate this specification, think of households which understand the connection between unsustainable production and the environmental externality. The size of the unsustainable sector, captured by its labour input, H_n, is associated with a higher risk of climate catastrophies which lowers utility. The household may suffer from the potential to be hit directly by disastrous events. Alternatively, the disutility could arise from empathy with people around the globe or future generations whose risk to experience the consequences of climate change grows with the size of the unsustainable sector.

Alternative modelling approach The modelling choice of social responsibility assumes that households act responsibly irrespective of whether they perceive their action to have an impact on the externality or not. Alternatively, one could model households to internalise

[9] I perceive social responsibility as a desire to consume sustainably, as a willingness to pay independent of the necessity to cover basic needs. There, hence, exist socially responsible households in the model whose consumption basket does not reflect that they are socially responsible. Instead, these households suffer from low sustainable consumption.

[10] Note that $\frac{c^{\frac{\sigma-1}{\sigma}} c_n^{\frac{1}{\sigma}} c_s^{\frac{1}{\sigma}}}{\omega^{\frac{1}{\sigma}}} = c_s c_n \left(c_n^{\frac{1-\sigma}{\sigma}} + \left(\frac{1-\omega}{\omega}\right)^{\frac{1}{\sigma}} c_s^{\frac{1-\sigma}{\sigma}} \right)$.

a fraction of the externality. Both approaches capture distinct motives for sustainable consumption. The alternative model only captures perceived effectiveness of demand to lower the externality as the motive for sustainable consumption. In contrast, the version considered here is agnostic on the motives behind sustainable consumption. Social responsibility can also be driven by image concerns, social pressure or warm glow.

Furthermore, the alternative approach leaves the efficiency level of the externality unchanged as social responsibility rises, whereas the baseline model does not. However, this aspect is aimed to be captured by the model.

Production Individual consumption goods are produced by a sustainable and an unsustainable sector according to the following production function

$$Y_j = A_j H_j, \text{ for } j \in \{s, n\}.$$

While the sustainable sector does not cause negative externalities, the unsustainable one does. Profits of the sustainable and the unsustainable sector are given by

$$\begin{aligned} \pi_s &= p_s Y_s - w H_s \\ \pi_n &= p_n Y_n - w(1+\tau_n) H_n. \end{aligned}$$

The government levies ad-valorem excise taxes, τ_n, on unsustainable labour. This choice is similar to Golosov et al. (2014) and Barrage (2020) who both consider excise taxes levied on energy producers. The present model abstracts from an energy sector assuming that the unsustainable sector produces in a dirty fashion. Accepting further that labour and energy are complements, environmental taxes are levied on labour input of the unsustainable good to generate additional costs similar to a model with energy sector.[11]

Both sectors are assumed to be perfectly competitive. This, on the one hand, impedes to study interactions of social responsibility and monopolistic competition, yet, on the other hand, it allows to focus on mechanisms solely arising from the demand side. Profit-maximisation of firms and choosing the unsustainable good as numeraire imply the following

[11] Some algebra reveals that the ad-valorem excise tax is equivalent to an ad-valorem sales tax levied on unsustainable output. The unsustainable firm's problem under a sales tax, $\widehat{\tau_n}$, becomes: $(1-\widehat{\tau_n})Y_n - wH_n$, and equilibrium prices are $\widehat{w} = A_n(1-\widehat{\tau_n})$ and $\widehat{p_s} = \frac{A_n}{A_s}(1-\widehat{\tau_n})$. Since the environmental tax in both versions only affects prices directly, it follows that the equilibrium allocation is the same if $\tau_n = \frac{1}{1-\widehat{\tau_n}} - 1$. Results for a model with a corrective tax on unsustainable consumption are qualitatively and quantitatively similar to the ones from the baseline model. While a consumption tax leaves prices constant, the labour market distortion results from the complementability of unsustainable consumption and leisure (compare Jacobs and van der Ploeg, 2019).

equilibrium conditions:

$$p_n = 1$$
$$w = \frac{A_n}{1+\tau_n}$$
$$p_s = \frac{1}{1+\tau_n}\frac{A_n}{A_s}.$$

Due to the constant returns to scale technology, the wage rate and the price premium of sustainable goods are fully determined by the productivity gap, A_n/A_s, and the corrective tax.

Government The government maximises a Utilitarian social welfare function by the use of an environmental tax and a distortionary labour tax. It redistributes revenues to households as lump-sum transfers, T, and runs a balanced budget:

$$T = \tau_l wH + \tau_n wH_n,$$

where $H = \lambda z_h l_r + (1-\lambda) z_l l_p$. The government is assumed to act as a Ramsey planner. I solve the Ramsey planner's problem using a primal approach which goes back to Lucas and Stokey (1983). Here, the optimal allocation is found by maximising the social welfare function, subject to the behaviour of firms and households, and feasibility. In the primal problem, prices and policy instruments are replaced by optimality conditions which hold in a competitive equilibrium. Prices, taxes and transfers are then chosen to implement the optimal allocation. Section D in the appendix spells out the Ramsey problem.

Market clearance To close the model, I require that goods and labour markets clear in equilibrium:

$$\lambda c_{sr} + (1-\lambda)c_{sp} = Y_s$$
$$\lambda c_{nr} + (1-\lambda)c_{np} = Y_n$$
$$\lambda z_h l_r + (1-\lambda) z_l l_p = H_s + H_n.$$

Appendix C defines the competitive and social-planner equilibrium and provides an overview of all equations characterising a competitive equilibrium.

4 Calibration

To calibrate the model, I assume the following functional forms

$$
\begin{aligned}
u(c,l) &= \log(c) - \chi \frac{l^{1+\frac{1}{\theta}}}{1+\frac{1}{\theta}} \\
\rho(\widehat{c};\bar{c}) &= \frac{1}{\phi}\exp(-\phi(c_n + c_s - \bar{c})) \\
g(H_n) &= -\psi H_n^{\eta}.
\end{aligned}
$$

The model depends on five sets of parameters. Those that govern consumption prefernces, $\phi, \bar{c}, \sigma, \omega$, labour supply L, χ, θ, inequality, z_h, z_l, λ, production, A_n, A_s, and the externality η, ψ. In its initial steady state, the model is calibrated to the US economy in 2018. Table 1 provides an overview of all parameters, their target, and the calibrated values.

The parameters governing inequality and basic needs, $\bar{c}$, are calibrated by comparing micro data on disposable household income from the PSID using tax estimates from the NBER's TAXSIM tool to expenses required to satisfy basic needs defined by the IWPR as discussed in appendix A and section 2. A share of $\lambda = 0.55$ of US households is found to be able to fully cover basic needs with sustainable goods and is therefore considered *rich*. I define households which are not able to rely on sustainable goods alone as *basic needs-constrained* or *poor* since their income does not accommodate the satisfaction of basic needs to any arbitrary level of social responsibility. Output and income measures are expressd in terms of the basic needs bundle which is normalised to $\bar{c} = 1$. The unsustainable good is the numeraire. Thus, unsustainable output of $Y_n = 1$ is, for instance, equivalent to one annual basic needs bundle of unsustainable goods, and one unit of output in the sustainable sector, $Y_s = 1$, equals one annual basic needs bundles of the sustainable good.

Effective labour productivity of the poor, z_l, is chosen to match average income of the poor in 2018 in terms of unsustainable basic needs. To ensure consistency with total per-capita output in $US, total income of the rich is the difference between GDP and total income of the poor. As a result, average household income of a rich household in the model overestimates income in the data. This approach is nevertheless followed since this project's focus rests on the financial capacity of low income households. Aggregate output is equally important as it determines the economies ability to satisfy basic needs. This approach results in $z_l = 0.03$, $z_h = 2.85$ and $A_n = 8.44$.[12]

The parameter which governs the importance of basic needs, ϕ, is set to 15. This value

[12] In a sensitivity analysis, section 5.4, I find that the relatively low productivity of the poor relative to the rich does not drive the results.

allows to solve the model for relatively low income levels while, at the same time, ensuring a decent importance of the penalty term when income is low. Given this value of ϕ, I calculate the price elasticity of substitution (PES) of households which are unconstrained by basic needs, σ, from micro data. Based on a study by Chen et al. (2018) for organic and conventional milk, the PES equals $\sigma = 1.73$.[13] The calibrated value is reasonable in that σ determines the elasticity of substitution between the unsustainable and the sustainable good in the composite consumption function which captures how the way a good is produced matters for utility. Hence, as regards the externality households perceive goods not as close substitutes but as having distinct characteristics. This renders high values of σ implausible. The goods are no complements either since it would be counterintuitive if utility from sustainable consumption can only be derived if there is unsustainable consumption, too.

The parameter determining social responsibility in the baseline calibration, ω, is chosen to reconcile model equations with the market share of sustainable consumer packaged goods in 2018, which is taken from Kronthal-Sacco et al. (2020). This approach leads to a value of $\omega = 0.24$. Therefore, on average, households derive a higher utility from unsustainable consumption. This seems questionable since the unsustainable good is equivalent in consumption services but is disadvantageous in satisfying social responsibility. How can such a good be preferred by consumers? Note that the model only explicitly accounts for income and price differentials to explain the attitudes-behaviour gap discussed in section 2. Therefore, the parameter ω captures not only attitudes but also factors other than income and prices which decouple attitudes from actual consumption behaviour. For example, the utility derived from unsustainable consumption can be higher as these goods are easier available or are in line with habits.

The total time endowment on household level in the model matches 14.5 hours per day (following Jones et al., 1993) and is normalised to 1. The Frisch elasticity, θ, is set to 0.75 as suggested by Chetty et al. (2011) who search to reconcile micro and macro estimates. The disutility of labour, χ, ensures that total labour supply matches the average hours worked in 2018 in the US provided by the OECD (2021) which is 0.34 (normalised by total economic time endowment taken from Jones et al. (1993)). The resulting value is $\chi = 43.06$.

The relative price observed for the food bundle in 2018, $p_s = 1.56$, is used to inform the production gap between the sustainable and unsustainable sector. It follows that the unsustainable sector produces 56% more output per unit of labour input. This price difference is used instead of the one resulting from the relative price of the sustainable versus unsustainable needs bundle since the expenditure categories in the basic-needs bundle are rather broad and do not allow to decide on a more granular level whether a sustainable counterpart exists.

[13] Section B expounds the derivation of the price elasticity of substitution.

This most likely reduces the relative price of the sustainable bundle which is found to equal 1.22. This approach is subject to caveats. For instance, it only relies on price differentials in selected food markets, and market imperfections such as monopolistic power and price stickiness are abstracted from. Furthermore, the productivity gap in other sectors might well differ from the one in the food sector. However, since the production gap is a crucial parameter in the model, section 5.4 discusses results for a lower productivity gap.

The labour tax rate is set to the value reported in Barrage (2020) for the US, $\tau_l = 0.24$. The tax on unsustainable labour input is set to $\tau_n = 0$.

Calibration of the parameters, χ, A_n, A_s, z_h, z_l, is performed jointly by ensuring that the model rationalises observed labour supply, output, prices and household income. Section B in the appendix displays the target equations.

Finally, I choose the parameters governing the externality to make a rich household willing to give up 2% of its annual unsustainable consumption for a 1% reduction in unsustainable labour input in 2018. It is also ensured that the function is convex.

Table 1: Calibration baseline model

Parameter	Target/Source	Calibration	Meaning
Utility			
ϕ	-	15	importance of basic needs
σ	PES found in Chen et al. (2018) at observed consumption levels	1.73	governs price elasticity of substitution (PES)
ω	sustainable market share Kronthal-Sacco et al. (2020) at observed income levels	0.24	social responsibility
$\bar{c}$	expenses for annual basic needs bundle from iwpr for single-adult household excluding taxes and savings in base year: 25,128$	1	basic needs, normalised
Labour supply			
L	time endowment per day: 14.5 Jones et al. (1993)	1	annual time endowment, normalised
χ	average hours worked: 0.34 (OECD)	43.06	disutility from labour
θ	Chetty et al. (2011)	0.75	Frisch elasticity
Externality			
η	percentag of composite consumption a rich household is willing to give up for a 1% reduction in H_n: 2%	1.30	curvature externality
ψ		9.43	importance externality
Inequality			
z_l	average disposable income poor in terms of basic needs in base year: 0.68	0.03	effective labour productivity poor
z_h	average disposable income rich in terms of basic needs in base year as difference between income poor and GDP: 4.00	2.85	effective labour productivity rich
λ	share able to purchase basic needs sustainably	0.55	share of rich households
Production			
A_n	GDP per capita in terms of $\bar{c}$ in base year: 2.5	8.44	TFP unsustainable sector
A_s	relative price of sustainable food bundle in base year: 1.56	5.4	TFP sustainable sector
Baseline policy			
τ_l	taken from Barrage (2020)	0.24	labour income tax
τ_n	carbon tax on national level in base year	0	environmental tax

5 Results

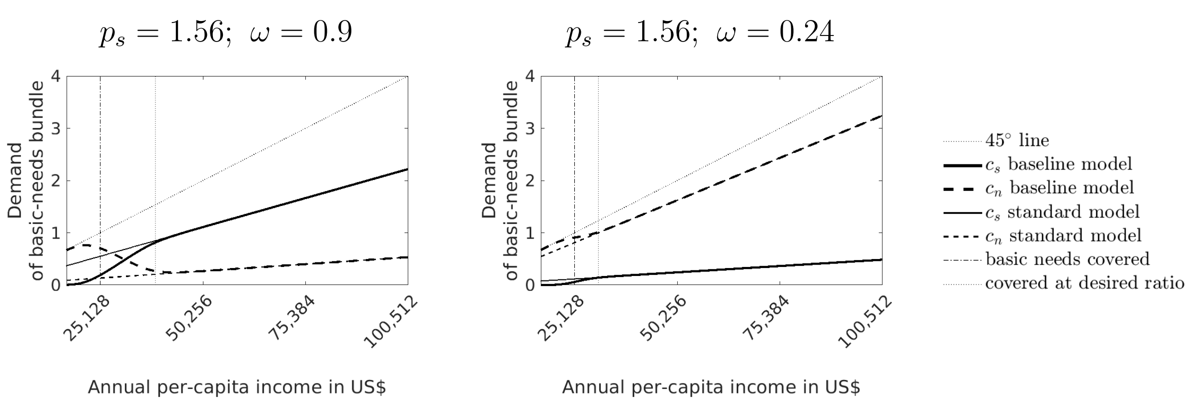
In this section, I present and discuss the results. First, in section 5.1, I analyse the role of redistribution as a function of social responsibility and the initial distribution of income. Section 5.2 shows the main results, which are subsequently discussed in section 5.3. Section 5.4 addresses how results change when crucial assumptions are altered.

5.1 Social responsibility and redistribution

In a standard model with homogeneous marginal propensity to consume (MPCU), redistribution does not affect the externality. The labour tax only alters the externality through an efficiency channel. On the contrary, in the baseline model, redistribution to the poor advantageously affects the externality when the MPCU of the rich is higher than that of the poor.

Whether the poor have a lower MPCU, depends on the distribution of income. The Engel curves in figure 3 illustrate how the MPCU (the slope of the Engel curve) varies with income and social responsibility. Each plot depicts demand as a function of income for two different values of social responsibility: a low one with $\omega = 0.24$ on the left (which corresponds to the calibrated value in 2018) and a high one with $\omega = 0.9$ on the right. The sustainable price is fixed at $p_s = 1.56$, which is in line with an environmental tax equal to zero in the baseline calibration. Demand for the unsustainable good is shown by the dashed graphs and for the sustainable one by the solid one. The thick graphs refer to the baseline model with basic needs. The thin ones refer to the equivalent variable in the standard model.[14]

Figure 3: Engel curves



Consider, first, the left-hand plot in figure 3 with $\omega = 0.9$ and a rich and a poor household with an income level of US$50,256 and US$25,128, which buy two and one annual unsustain-

[14] Engel curves for a scenario with a sustainable price below unity are presented in section E in the appendix.

able basic-needs bundle, respectively. In the baseline model, transferring a marginal unit of income lump-sum from the rich to the poor results in a reduction of unsustainable and an increase in sustainable demand on aggregate. The rich household reduces both sustainable and unsustainable consumption to keep the ratio constant. The poor household, in contrast, who is rich enough to cover basic needs with the cheaper alternative, is now able to recompose the consumption bundle towards the more preferred sustainable good: it reduces unsustainable consumption and raises sustainable consumption by more than $\frac{dI}{p_s}$. The unsustainable good is inferior from the perspective of the poor household.[15]

On the other hand, considering an initial income of the poor household sufficiently below the basic-needs threshold, lump-sum redistribution has the contrary effect. In this scenario, the poor household is financially unable to satisfy its basic needs with the cheaper good. An additional unit of income is then mainly spent on the unsustainable, cheaper good. On aggregate, unsustainable production rises. Income of poor households is, therefore, especially important for the size of transfers required to make redistribution negatively affect the externality.

Comparing now the right-hand plot, which depicts Engel curves with $\omega = 0.24$, reveals, first, that the effectiveness of redistribution as an environmental policy instrument strongly depends on households' tastes for sustainability. Lump-sum transferring one unit of income to the poor in the low-responsibility world leads to a negligibly low reduction of unsustainable consumption. The reallocation of consumption bundles is muted as the consumed ratio of goods at an income level below unity is closer to the desired allocation. Moreover, the unsustainable good becomes inferior only after a higher income level than in the high-responsibility world. Hence, redistribution is more effective to lower the externality when social responsibility is high, and the poor are more eager to recompose their budget shares.

While social responsibility reduces the externality, its effect on equity is detrimental. To see this, note that the recomposition of the consumption bundle is extended up to a higher income level when social responsibility is high. Thus, a higher income is needed for poor households to align demand with their environmental concerns. Not consuming in line with environmental concerns, in turn, implies a lower composite consumption. Therefore, consumption inequality increases with social responsibility while income inequality remains unchanged.

In addition, as already hinted at in the model section, basic-needs constrained households accept a lower sum consumed the higher social responsibility. Compare the left-hand plot,

[15] Inferiority of the cheaper good at some income levels might seem strange at first glance. However, recalling that the unsustainable and the sustainable good are perfect substitutes in terms of their ability to satisfy consumption needs, the result is plausible. For instance, a household which starts to consume organic milk most likely does not continue buying the same amount of conventional milk as it used to.

where already before basic needs are fully satisfied at an income of US$25,128, the household starts to increase its budget share of the more expensive good. This behaviour implies a higher disutility from too low consumption through the penalty term. Both observations, a higher consumption inequality and a higher disutility from too low consumption, aggravate inequality and increase the equity-benefits of redistribution.

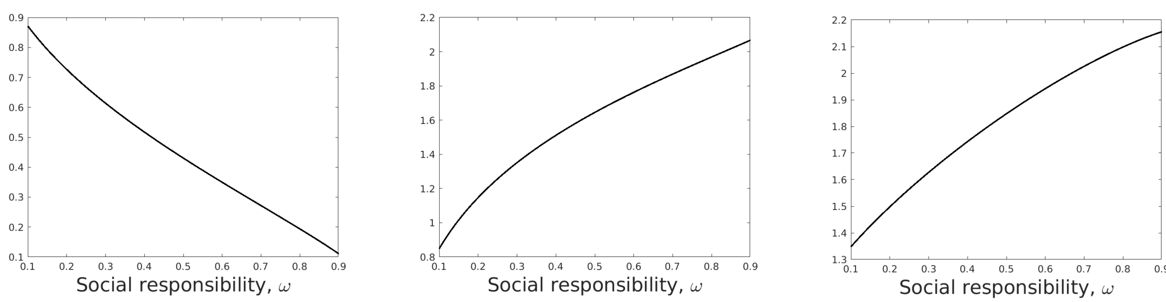
5.2 Main results

We are now equipped to run the main experiment: exogenously changing the degree of social responsibility shared by households. What is the optimal policy as households derive a higher utility from consumption of the environmentally-friendly good? See section 5.2.2. As a benchmark, I first present the efficient allocation a social planner chooses in section 5.2.1.

5.2.1 Social planner allocation

Figure 4: Efficient allocation

(a) Unsustainable output (b) Sustainable output (c) Composite consumption rich/ poor



The social planner maximises Utilitarian social welfare subject to resource constraints as formally laid out in appendix C. Figure 4 represents the results. One trade-off the social planner faces is, on the one hand, to reduce the environmental externality and, on the other hand, to increase utility from consumption. The trade-off loses in tension as households begin to prefer the environmentally-friendly good and the provision of the environmental good coincides with the provision of the composite consumption good. Therefore, the social planner reduces unsustainable output, panel (a), and increases the sustainable one, panel (b), as social responsibility rises. Hence, both composite consumption, panel (c), and environmental quality accelerate. In contrast, when social responsibility is low, the social planner prevents too high levels of consumption in order to curb environmental pollution.

A second trade-off the social planner faces arises from the utility of consumption, on the one hand, and the disutility from labour, on the other hand. A shift in preferences towards a more expensive bundle - in the sense that more labour is needed to produce the same level of composite consumption - exacerbates this trade-off. Indeed, absent the externality, more expensive preferences imply a reduction in composite consumption. Yet, the presence of the externality makes it efficient to choose a lower labour input and output, especially when tastes are prone towards the polluting good. In sum, composite consumption increases as preferences become more expensive. Nevertheless, the fact that preferences become more expensive explains the slow down of the reduction in unsustainable output as social responsibility increases.

The social planner allocation attains perfect consumption equity, due to the separability of labour and consumption in the utility function, and a steady reduction in unsustainable production as social responsibility advances. However, this allocation is not feasible under the Ramsey planner: Both tax instruments are distortionary which creates a trade-off between the provision of the environmental good and equity. The following section present the results under the Ramsey planner.

5.2.2 Optimal policy and allocation

Figure 5: Optimal policy

(a) Environmental tax, τ_n (b) Labour tax, τ_l (c) Transfers

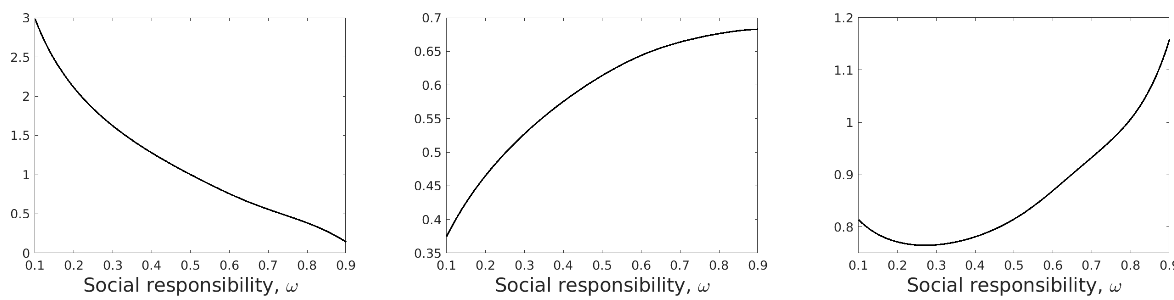


Figure 5 shows how optimal taxes and transfers vary with social responsibility. It stands out that the optimal policy mix shifts towards redistribution as social responsibility rises. This is the first main result. When social responsibility is relatively low, such as in the baseline calibration with $\omega = 0.24$, a high environmental tax of $\tau_n = 1.87$ characterises the optimal policy: that is, unsustainable producers' tax burden amounts to 1.87 times their production costs. The optimal labour tax for the baseline calibration is $\tau_l = 0.49$; the government charges roughly half of a household's labour income. Transfers equal 77% of the basic needs bundle in unsustainable goods.

As social responsibility rises to the highest value considered, $\omega = 0.9$, the environmental tax steadily reduces to 14%, and the labour tax increases to 68%. Transfers reach their peak with 1.16 units of the unsustainable needs bundle.

What allocation results from the optimal policy? Figure 6 depicts some key variables under the optimal policy as a function of social responsibility. The solid line reflects the variable; the dotted vertical line indicates when the sustainable good becomes more expensive than the unsustainable one.

First, unsustainable output, that is the externality, falls by more than 50% from 0.69 when $\omega = 0.24$ to 0.32 at $\omega = 0.9$. Sustainable output rises with social responsibility from 0.74 to 1 basic-need bundles, compare panel (a). This is driven not only by the shift in demand towards sustainable goods but also by policy interventions.[16] The output of both sectors displays some retardation in the rise/drop as social responsibility increases (roughly at $\omega = 0.55$). As the environmental tax reduces, the price premium for sustainable goods rises which slows down the demand-driven rise in sustainable output and the drop in unsustainable output through consumption by the rich. For the price premium and other additional variables compare figure 16 in appendix G. Unsustainable demand by the poor (panel (j) in figure 16) even resurges once the sustainable good becomes too expensive and the poor revert to unsustainable consumption to cover basic needs despite a stronger taste for sustainability. Sustainable demand by the poor (plot (k) in figure 16) mirrors this pattern.

The rise in aggregate output, panel (b), from 1.09 units of the unsustainable bundle to 1.68 is explained by two forces: first, a rise in labour supply as the wage rate rises (panel (f) in figure 16) increases output. Second, a reduction in the environmental tax implies a reduction in distortions of labour allocations.[17]

The Gini coefficient of composite consumption, plot (d), also rises with social responsibility but not monotonically: there is a downward sloping part starting from a value of social responsibility of approximately $\omega = 0.4$ to slightly below $\omega = 0.7$. This reduction in the Gini of consumption results from a convergence of prices under the optimal policy. Generally, when prices differ, the poor cannot consume the bundle which maximises composite consumption, the *desired* bundle. Instead, they have to take into account the quantities of individual goods they can purchase to satisfy their basic needs. This trade-off becomes more intense, the bigger the difference between prices. The reduction in inequality reaches its

[16] Figure 17 in the appendix compares the allocations in the laissez-faire economy to the one under the optimal policy to differentiate the effect of a behavioural change from policy interventions.

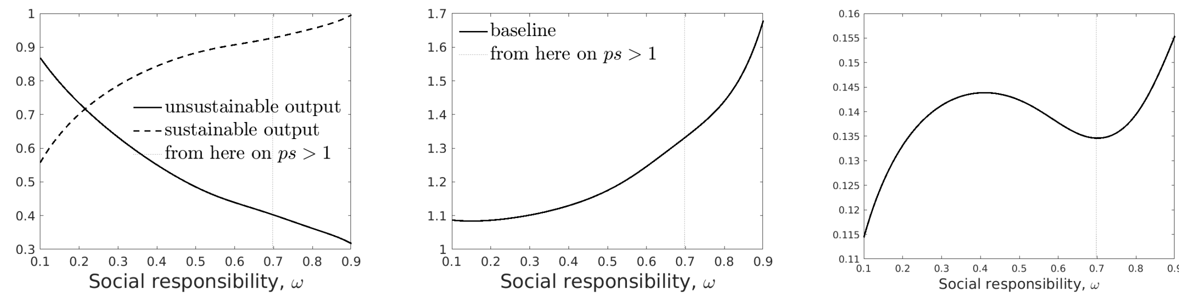
[17] With a non-zero environmental tax, labour is not allocated to maximise the composite consumption good given productivities but distorted by the environmental policy. This effect is present also in a representative agent model absent basic needs. Market clearance, utility-, and profit maximisation imply

$$\frac{h_s}{h_n} = (1 + \tau_n)\frac{\omega}{1 - \omega}.$$

The environmental tax renders the sustainable sector relatively more productive in the eyes of the agents. But it is not and aggregate output reduces with environmental taxation.

Figure 6: Optimal allocation

(a) Output by sector (c) Output (d) Gini consumption



peak when prices are exactly equal, and the trade-off between composite consumption and satisfaction of basic needs vanishes. I refer to this as the *compositional* effect of equity. Panel (c) in figure 16 shows how the actual consumption ratio of the poor relates to the desired bundle.

At lower levels of social responsibility, the increase in inequality follows from a divergence of income levels (plots (e) anf (f) in figure 16). As the environmental tax drops - implying a rise in the wage rate - the rich profit more from a higher labour income and the poor suffer from lower transfers. At very high levels of social responsibility a rise in the price of the desired bundle explains the rise in inequality. Indeed, composite consumption of the rich also reduces as they want to consume a more and more expensive bundle, however, the drop in composite consumption of the poor is more extreme; compare plots (a) and (b) in figure 16. The additional compositional effect reduces composite consumption by the poor even more.

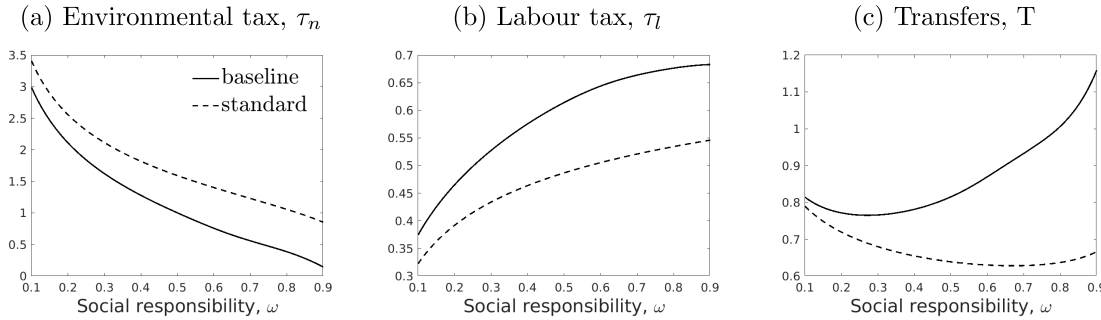
5.3 Discussion

What explains the optimal policy mix as social responsibility rises? I argue in the following that the increase in inequality dominates the policy trade-off faced by the government when social responsibility is high. The policy focus turns to equity as social responsibility grows, and poor households suffer from not consuming according to their social preferences (sections 5.3.1 and 5.3.2). As a result, the government chooses a lower environmental tax forfeiting an efficient reduction in the externality (section 5.3.3). The government sets a higher labour tax to target the externality (section 5.3.4), and redistribution becomes the essential tool for the environmental policy (section 5.3.5).

5.3.1 Optimal policy without basic needs

In the standard model, depicted by the dashed graphs in figure 7, there is also a shift from corrective taxation to higher labour taxes. However, there is no rise in transfers. In contrast,

Figure 7: Optimal policy with and without basic needs



transfers even diminish with social responsibility. The intuition for this result is as follows: As social responsibility reduces, government intervention for environmental reasons is less necessary. A lower environmental tax becomes optimal. The lower tax rate and a lower environmental tax base - due to the shift in demand away from the unsustainable good in the laissez-faire economy - reduce government revenues. To keep transfers from falling too much, a higher labour tax becomes optimal.[18] The finding is in line with Bovenberg and De Mooij (1994) who show that environmental tax revenues are optimally used to lower the distortionary labour tax.

Thus, the shift to redistribution is driven by basic needs. However, whether it is explained by equity or environmental concerns is not obvious given that redistribution in this model can be used to target both the externality and inequality. And both the externality and inequality are higher in the laissez-faire economy: On the one hand, basic needs prevent a recomposition of consumption by the poor similar to the standard model. Therefore, the reduction in unsustainable aggregate demand in the laissez-faire economy is less intense in the baseline model. But, the efficient level is equal to the one in the standard model. This would call for more government intervention for environmental reasons. On the other hand, inequality rises so that equity, too, becomes more important.

5.3.2 Policy focus

Figure 18 shows the effect of government intervention measured as the percentage change in the optimal allocation relative to the laissez-faire allocation for unsustainable production, the gini of consumption, and aggregate output. In the baseline model, the policy focus shifts to equity while a reduction of the externality loses in importance; compare the solid lines in panels (a) and (b). While the externality and output are reduced by around 62.5% and 56%

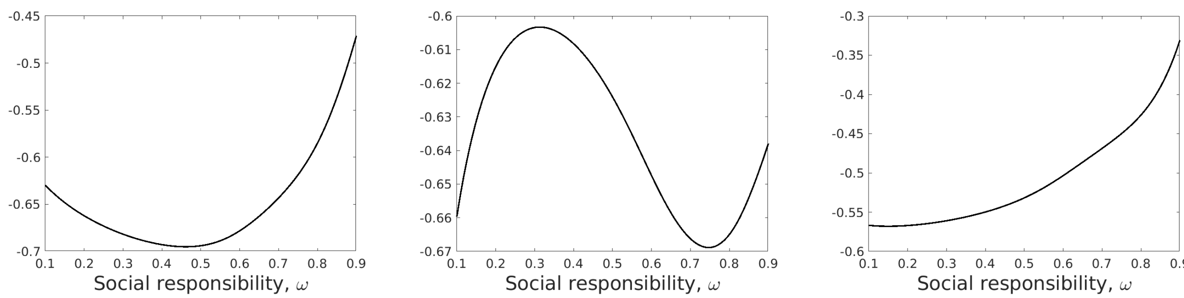
[18] This interpretation is supported by the impact of government intervention in the standard model shown by panels (a) to (c) in figure 18 in appendix section G.2. The government reduces the externality by roughly the same. The strong reduction in inequality when the environmental tax is high follows from the reduced labour income of the rich. It is a byproduct of the environmental policy.

when social responsibility is low, the impact reduces to around 47.5% and 38% when social responsibility is high, respectively. The Gini of consumption, however, is reduced almost similarly for all levels of social responsibility by between 66% and 60%.

I conclude from this observation that the increase in inequality makes it optimal for the government to intervene less for environmental purposes, since aggregate output and redistribution is more valuable when social responsibility rises. It is, thus, not the muted behavioural shift in demand which explains the shift to redistribution.

Figure 8: Effect of government intervention

(a) Unsustainable output (b) Gini of consumption (c) Output

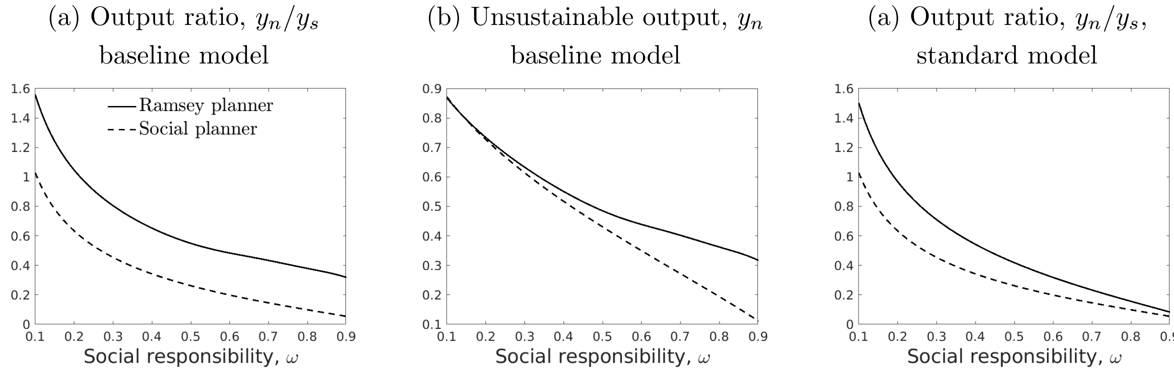


5.3.3 Comparison to the efficient allocation

As a result of the more pronounced importance of inequality, the optimal output ratio of unsustainable to sustainable production does not converge to the efficient ratio as social responsibility rises. The difference between optimal and efficient output ratio remains fairly constant over the range of social responsibility considered, compare panel (a) in figure 9. Panel (b) of the same figure depicts how the gap between unsustainable production in the optimal and the efficient allocation widens with social responsibility. This reflects that the optimal policy is more concerned with equity. Hence, the Ramsey planner relinquishes a more efficient reduction in the externality in favour of equity.[19] Panel (c) shows that in the standard model, the behavioural change in consumption is sufficient to enable the government to attain an output ratio closer and closer to the decreasing efficient ratio.

[19] I run an additional experiment, where I implement the optimal policy from the standard model into the baseline model. This policy features a higher environmental tax. Figure 19 in the appendix shows the results reassuring that the environmental tax would indeed attain a lower externality level very close to the efficient one. The reliance on redistribution, thus, is not rationalised by the environmental tax being less effective in lowering the externality.

Figure 9: Comparison of the optimal to the efficient allocation



5.3.4 Reliance on labour tax as environmental policy instrument

The policy shift towards equity does not fully explain the rise in redistribution. In fact, once the environmental tax is set lower to better cope with the higher degree of inequality, the government finds it advantageous to exploit the redistribution channel of environmental policy by setting an even higher labour tax than absent an externality.

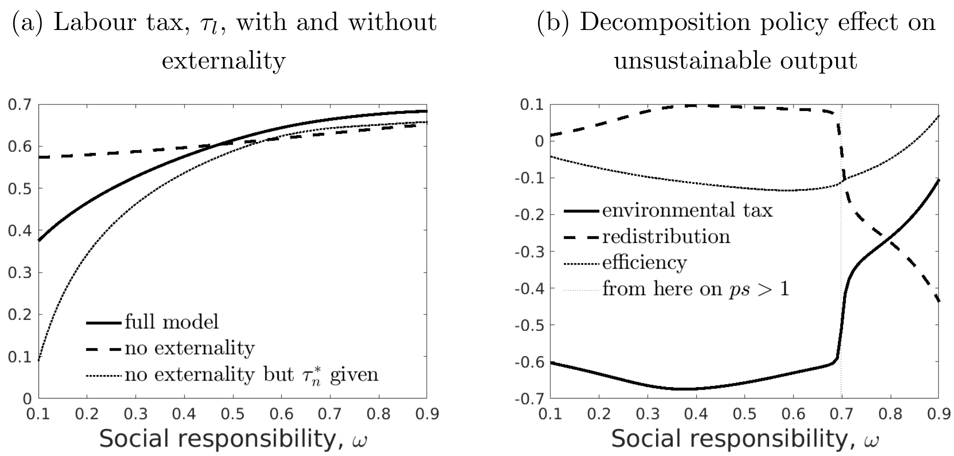
Indeed, the higher labour tax in the scenario with externality could also be due to the presence of the environmental tax. It is true that, as Bovenberg and De Mooij (1994) have argued, environmental tax revenues are optimally used to lower distortionary labour taxes in a model without income-dependent marginal propensity to consume due to higher efficiency costs. Nevertheless, in the present model, the environmental tax also changes the equity benefits of redistribution. Since poor households consume a higher share of the polluting good when the sustainable good is more expensive - which is the case at high levels of social responsibility - the environmental tax is regressive.[20]

To show that the labour tax is higher in the model with externality for environmental reasons, therefore, requires to compare the optimal labour tax in the full model to the optimal tax resulting in a model without externality but where the environmental tax is present as a parameter. Then, efficiency costs and equity benefits of labour taxation are equivalent to the full model. Comparing the optimal labour tax resulting in this setting when the externality is switched off to the full model, captures solely the impact of the externality on the optimal labour tax.

In panel (a) in figure 10, the dashed graph shows the optimal policy when the externality is set to zero so that the government only cares about inequality. The solid graph represents the optimal policy in the full baseline model. The thin dotted line shows the optimal policy when the optimal environmental tax resulting in the full model is fed into the Ramsey model

[20] Section F.1 defines environmental tax progressivity and proves this claim.

Figure 10: Labour taxes as environmental policy instrument



Notes: Panel (a): The solid graph represents the optimal policy in the full model. The dashed graph results in a model when the unsustainable sector does not produce any externality. Finally, the thin dotted line depicts the optimal labour tax in a model where the optimal environmental tax is fed into the model as a parameter but there is no externality. Panel (b) shows the additional change in unsustainable output implemented by the respective policy relative to the laissez-faire level, where first the environmental tax is implemented, followed by lump-sum redistribution, the redistribution channel, and finally labour is allowed to adjust, the efficiency channel.

as a parameter but the externality is kept at zero. The difference between the solid graph and the thin dotted one, hence, is solely explained by environmental concerns.

At all levels of social responsibility, labour taxation is used as an environmental policy measure. When social responsibility is low, the labour tax is up to 30 percentage points higher to reduce the externality. At these levels of social responsibility, labour taxation contributes to lowering the externality through the efficiency channel (as shown in section 5.3.5 below).

The use of labour taxes as environmental policy element is robust to whether basic needs are considered in the analysis or not; compare the equivalent graph for the standard model in panel (e) of figure 18. In a representative agent calibration of the economy[21], however, the corrective tax equals the social costs of the externality[22] and the labour tax is optimally set to zero; compare section G.4 in the appendix. Hence, inequality makes it optimal to set lower corrective taxes complemented with distortionary labour taxes to target the externality; the finding is similar to an result in Jacobs and van der Ploeg (2019).

Consider again panel (a) in figure 10. The reliance on labour taxation as environmental policy vanishes with social responsibility, but not completely; instead, the labour tax is constantly around 0.25 percentage points higher in the setting with externality. The role of labour taxes as an environmental policy instrument pushes them above optimal levels absent externality when social responsibility is relatively high, compare the solid and dashed

[21] Effective labour productivity of both households equals 0.81; all other parameter values remain as in the baseline calibration.

[22] In appendix section F.2, I define and derive the social costs of the externality and discuss how my approach relates to the literature.

graphs. This finding is in stark contrast to Bovenberg and De Mooij (1994) who argue that environmental tax revenues are optimally used to lower the distortionary labour tax. In this model, instead, the additional benefits through the redistribution channel of environmental policy outweigh increased efficiency costs through the environmental tax. The finding is in line with the work by Jacobs and van der Ploeg (2019) who show that with non-linear Engel curves labour taxes may be higher in the light of an environmental externality when the optimal environmental tax is below the Pigouvian tax.[23]

5.3.5 Effectiveness of policy instruments

Having established that the optimal policy shifts to redistribution for equity reasons, it remains an open question how important individual tax instruments are to lower the externality. Given that the impact of taxes on allocations is interdependent, further assumptions are necessary to tell apart the effect of distinct policy channels. I make the following assumption: the government chooses the optimal tax system jointly to maximise the social welfare function but implements them sequentially. First, the optimal environmental tax is implemented (step 1); second, the optimal labour tax is enforced. The effect of the labour tax is split into the redistribution channel (step 2) by keeping labour supply fixed but raising the labour tax to the optimal level, and the efficiency channel (step 3), where labour supply is allowed to react to the optimal labour tax.[24]

Panel (b) in figure 10 depicts the contribution of each channel on unsustainable output as a percentage of the laissez-faire level: the effect of the environmental tax (the thick solid line) the redistribution channel (the dashed graph) and the efficiency channel (the thin dashed-dotted graph).[25]

To summarise the main finding of this exercise: Redistribution positively affects the externality for levels of social responsibility below $\omega = 0.7$. For all levels of social responsibility above $\omega = 0.7$, redistribution adds to the reduction of the externality. Its importance increases with social responsibility eventually accounting for 93% of the total policy effect on the externality by implying a cut of up to 44%. Simultaneously, the impact of the environmental tax reduces to -10%, thereby only accounting for 22% of the total policy intervention.

[23] In the standard model, the optimal labour tax in the specification with externality never exceeds the level in the world without externality, as predicted by Bovenberg and De Mooij (1994). When the environmental tax can almost implement the efficient level of the externality, labour taxation is almost only used for equity purposes.

[24] Figure 22 in the appendix shows the results for the standard model without basic needs. As expected, redistribution has no effect on the externality, compare panel (a).

[25] For any variable X, percentage changes are calculated as $\frac{X^2-X^1}{X^0} = \frac{X^2-X^0}{X^0} - \frac{X^1-X^0}{X^0}$ =% *change due to step 2 in addition to the effect of step 1*. Where the superscript indicates the step in the experiment, and zero indicates the laissez-faire economy.

The efficiency channel of labour taxation contributes to lowering the externality until social responsibility is very high at around $\omega = 0.8$. At the highest levels of social responsibility, the efficiency channel causes an increase in the externality of 7%. I provide a more in depth analysis on each instrument's mechanism in section G.5 in the appendix. The section also shows additional variables in figure 21.

5.4 Sensitivity

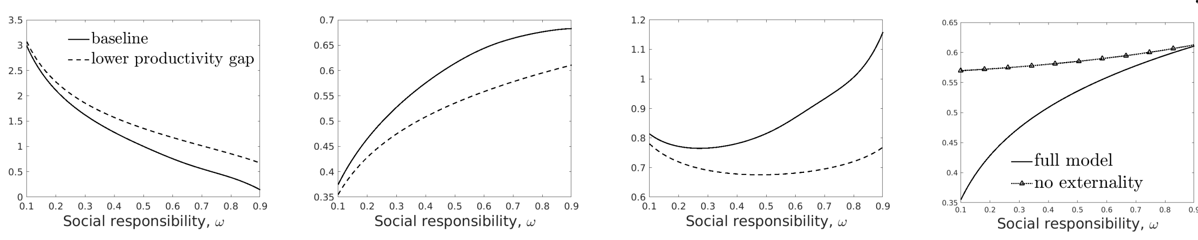
While social responsibility is changed exogenously, it is assumed that all other features of the economy remain unchanged. This seems questionable since variations in social responsibility most likely take time. This section, therefore, discusses results with (i) a lower productivity gap and (ii) changes in the income distribution.

5.4.1 Lower productivity gap

Comparison of the optimal policy at a lower productivity gap of $A_n/A_s = 1.22$ to the baseline calibration[26] resembles the comparison to the standard model. As shown by figure 11, there is no shift to redistribution when productivity in the sustainable sector is higher. The environmental tax is so high so that the sustainable good is the cheaper alternative for all values of social responsibility. As a result, the redistribution channel of environmental policy increases the externality throughout. Indeed, the optimal labour tax never exceeds the optimal tax absent an externality, compare panel (d), which is in line with the finding in Bovenberg and De Mooij (1994).

Figure 11: Optimal policy with lower productivity gap

(a) Environmental tax, τ_n (b) Labour tax, τ_l (c) Transfers, T (d) Labour tax, τ_l, with and without externality



5.4.2 Less inequality

Income of the poor plays a crucial role; as argued, the severity of inequality makes the shift to redistribution optimal when social responsibility is very high. Furthermore, the distribution

[26] This calibration results in $A_s = 6.9$ instead of $A_s = 5.4$ in the baseline calibration. All other parameters remain unchanged.

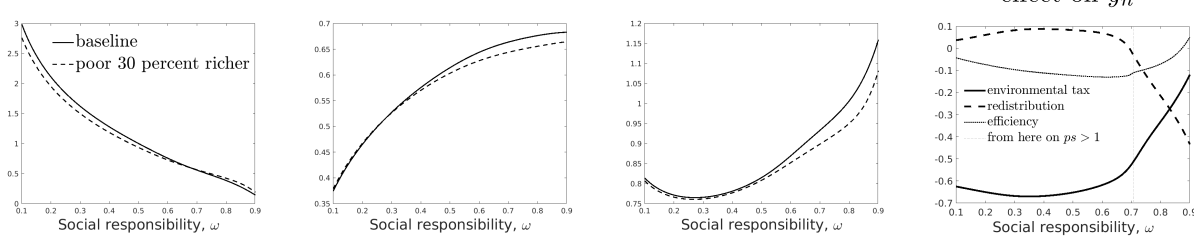
of income determines the direction of the effect of redistribution on the externality.

Increasing income of the poor by 30% so that they can consume 90% of an unsustainable basic needs bundle in the baseline calibration[27] results in a reduced shift to redistribution as depicted by figure 12. When social responsibility is low, the environemnetal tax is lower and the labour tax is slightly higher. The explanation is that when poor households are richer and their consumption bundle is less determined by basic needs, poor households are more responsive to the environmental tax through small changes in the relative price. The labour tax is higher at these values of social responsibility to counter the smaller revenues through environmental taxation.

The environmental tax is higher than in the baseline calibration for high levels of social responsibility, and the labour tax is relatively smaller. As inequality is less intense, a more aggressive corrective tax can be implemented. Furthermore, as discussed, the elasticity of demand by the poor to the environmental tax is higher. These two observations raise the effectiveness of the environmental tax on the externality compared to the baseline model; see panel (d) in figure 12. Albeit redistributing less, the redistribution channel of environmental policy remains important an environmental policy instrument. A smaller increase in income of the poor already raises their sustainable budget share similarly to the baseline calibration.

Figure 12: Optimal policy with poor 30% richer

(a) Environmental tax, τ_n (b) Labour tax, τ_l (c) Transfers (b) Decomposition policy effect on y_n



6 Conclusion

This paper shows that growing social responsibility causes a shift in the optimal policy mix away from corrective taxation towards redistribution. Redistribution becomes the preferred environmental policy tool above corrective taxes when social responsibility is very high. The reason is that rising social responsibility induces a detrimental increase in consumption inequality, as more sustainable consumption conflicts with the satisfaction of a minimum

[27] In this counterfactual calibration $z_h = 2.7$ and $z_l = 0.17$ in contrast to $z_h = 2.8$ and $z_l = 0.03$ in the baseline calibration. All other parameters remain unchanged.

consumption level by the poor. Then, redistribution achieves a better balance between equity and the provision of the public good, and the government forfeits a further reduction of the externality closer to the efficient level. More generally, I find that, in an unequal economy, labour taxes form part of the optimal environmental policy. They complement corrective taxation in lowering the externality by reducing aggregate production or through redistribution. This finding is robust to the level of social responsibility and the linearity of Engel curves.

The results constitute a warning against policy ambitions to foster consumers' willingness to pay for sustainable goods at today's high income inequality. One might expect that a behavioural shift in demand allows for a more efficient reduction in the externality since less government intervention is required. However, the rise in social responsibility increases inequality so that the need for government intervention remains high. Eventually, the aggravation of inequality prevents the government to attain the efficient level of the externality.

To finish, I briefly point out directions for further research. First, the paper focuses on the role of inequality abstracting from dynamics in other dimensions. For example, in parallel to changing preferences, technological progress could ameliorate the increase in consumption inequality by narrowing the productivity gap between sectors. Second, basic needs are calibrated to an objective measure. This is informative on what would happen, if we were willing to reduce consumption to a minimum. In reality, however, basic needs are most likely subjective. A calibration from observed consumption shares would allow to take the subjectivity of consumption minima into account.

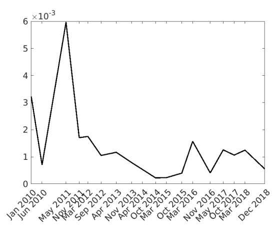
A Attitudes, basic needs and inequality

Attitudes Figure 1 draws from the *Climate Change in the American Mind* project from the Yale Program on Climate Change Communication (YPCCC) and George Mason University Center for Climate Change Communication (Mason 4C) (2020). A participant is categorised as concerned about climate change or supporting a coal emission regulation if he/she chooses category 3 or 4 out of 4 categories in response to the question "*How worried are you about global warming?*" or "*How much do you support or oppose the following policy? Set strict carbon dioxide emission limits on existing coal-fired power plants to reduce global warming and improve public health. Power plants would have to reduce their emissions and/or invest in renewable energy and energy efficiency. The cost of electricity to consumers and companies would likely increase*". The highest category 4 was labeled *a great deal* or *strongly support* and category 1 *not at all* or *strongly oppose*. Participants who refused to answer whether they are worried at maximum made up 2.3% of the whole weighted sample population which was in 2010. As regards the support for coal emissions at maximum roughly 3.7% of the weighted sample did not answer which was in April 2013.

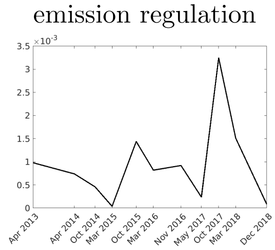
Panel (a) and (b) in figure 13 show the variances of the two measures discussed above: being worried and support for the regulation of coal emissions. While concerns about climate change seem to converge across income groups, the support for coal emissions, if anything, diverges. Panel (c) and (d) show the strongly and the weakly worried share of households across income groups. The similar shares are shown by panels (e) and (f) for the support of coal emissions. In line with this paper's approach, the increase in strong support for the policy stems from medium to high-income households. The rise in the weakly supporting share is driven by the lowest income group; compare panel (e) and (f). As regards attitudes about climate change, the strong and the weak share behave similarly across income groups; see panels (c) and (d) in the same figure. Finally, panel (g) highlights how the support for another potentially costly energy policy evolved over time; that is, the answer to the question: "*How much do you support or oppose the following policies? Require electric utilities to produce at least 20% of their electricity from wind, solar, or other renewable energy sources, even if it costs the average household an extra \$100 a year.*" Panel (h) differentiates total support for energy regulation into weak and strong support similar to panel (c) in figure 1 and compares it to the evolution of concerns. Panels (g) and (h) support the evidence of the plots on coal emission regulation.

Figure 13

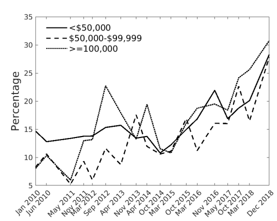
(a) Variance: Concerns



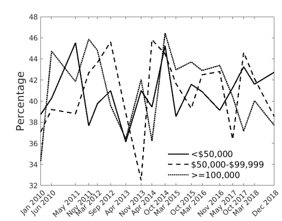
(b) Variance: Coal emission regulation



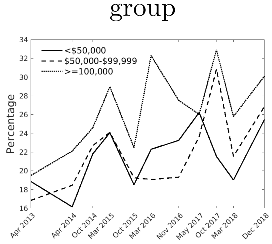
(c) Strongly worried



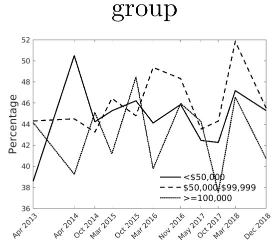
(d) Weakly worried



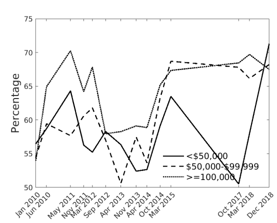
(e) Strong support coal emissions by income group



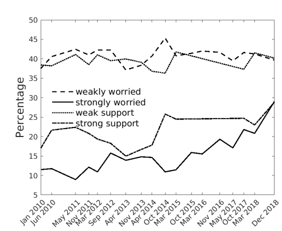
(f) Weak support coal emissions by income group



(g) Support for utility regulation



(h) Intensive margin: Utility regulation



Basic needs Basic needs for a single-adult working household are taken from the *Basic Economic Security Tables* provided by the Institute for Women's Policy Research (2018) (IWPR).[28] The basic needs bundle is more objective in that it does not (solely)[29] rely on observed consumption and expenses which most likely do not reflect needs but are affected by financial constraints or habits. For example, rents and utilities are taken from the US Department of Housing and Urban Development Fair Market Rents which are rents at the 40th or 50th percentiles of US rents. Food is taken from the USDA Center for Nutrition Policy and Promotion's low-cost food plan. Which is the third lowest out of four consumption food plans. The USDA includes a bit more than a minimal standard of nutrition but does only allow for self-prepared food. For more information on the methodology see McMahon et al. (2018).

Table 2 shows for each consumption category expenses for an unsustainable, column (1), and sustainable quality, column (2). Throughout the calculations, I make conservative choices so that the resulting expenses can be interpreted as a lower bound of basic needs. Therefore, basic needs for a single adult without child but with employer benefits are considered reducing expenses for childcare and health. Furthermore, savings for emergencies and retirement are also abstracted from.

In the next three paragraphs, I explain in more detail how I derive estimates of the sustainable basic-needs expenses. I assume that the expenses provided by the IWPR are given in terms of unsustainable goods which make up the biggest market share and are generally cheaper, more in line with a basic needs bundle. To proxy expenses for sustainable counterparts, I use the relative price resulting from a food basket constructed by the EAT-Lancet Commission (2019), represented by table 3,[30] and prices of the USDA for organic and conventional goods (United States Department of Agriculture, 2021).

Prices are provided on a weekly basis from the beginning of 2015 to the end of 2020 as a national weighted average for a variety of items such as "*yoghurt*" or "*mushrooms*". I classify these granular product categories into the product categories used by the EAT-Lancet Commission (2019). I have price data available for seven out of 14 items; compare column (2) of table 3. Weeks for which prices are not available are imputed using the average of 4 adjacent weeks. In figure 14, I plot the weekly expenses for the resulting food bundle in

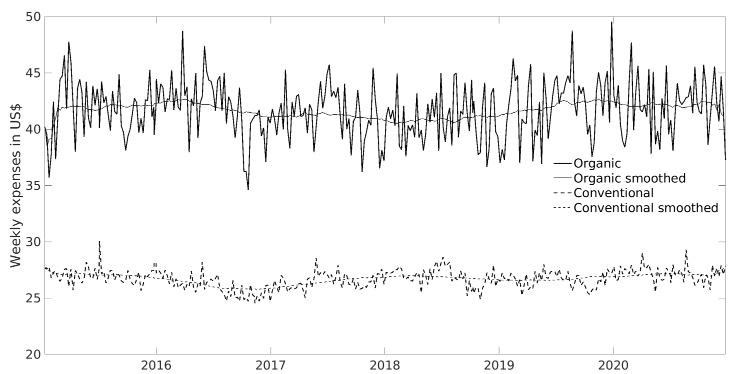
[28] For the US, a variety of basic needs measures exists. For an overview see Gordon M. Fisher (2012). The one calculated by the IWPR has been choosen as it provides a nation-wide measure and necessary expenses by consumption category so that the overall price of a sustainable bundle can be calculated more granularly.

[29] The *Health care* and *Personal and Household items* are based on observed expenditures.

[30] The EAT-Lancet Commission (2019) constructed dietary plans which respect both health and planetary boundaries. The advantage of this consumption basket is that it contains detailed information on quantities and product types and therefore allows to calculate a sustainable price which is not the case for the more granular food category in the IWPR's basic needs bundle. At the same time, it is designed to meet basic needs.

organic and conventional prices. To smooth short run fluctuations, I take the mean over the full time span over the weekly relative expenses of the organic relative to the conventional basket. The price for the organic bundle is on average 56% higher than its unsustainable counterpart. The result is taken to approximate the relative sustainable price in 2018.

Figure 14: Weekly expenses of organic and conventional food bundle



Notes: Expenses for a food consumption bundle as suggested by the EAT-Lancet Commission (2019) for which organic and conventional prices are available. The thick lines refer to weekly expenses, while the thin lines show smoothed expenses as the floating average over one year.

I apply the relative price to those categories in the IWPR basic-needs bundle which plausibly have a sustainable counterpart, as indicated by column (3) in table 2. Again, since categories are fairly broad, I only apply the price difference to categories which broadly allow for a sustainable choice. For instance, since rents make up the biggest part of the *Housing & Utilities* category, I do not multiply this item despite energy expenses falling into this category, too. Summing over all consumption categories gives expenses for a sustainable and an unsustainable bundle.

Table 2: Monthly basic expenses for a US single working adult in 2018 US$

Category	(1) Unsustainable	(2) Sustainable	(3) Sustainable exists
Housing & Utilities	785	785	false
Food	267	417.23	true
Transportation	476	476	false
Personal & Household items	389	607.88	true
Healthcare	177	276.59	true
Monthly basic needs (sum)	2,094	2,562.70	
Annual basic needs	25,128	30,752.38	

Income inequality Expenses for the single-adult sustainable basic needs bundle are compared to households' per-capita disposable income to judge whether a household has too few

Table 3: Requierd nutrient intake

Product	(1) Intake in grammes per day	(2) Price available
Rice, wheat, corn	232	-
Potatoes	50	✓
Vegetables	300	✓
Fruits	200	✓
Whole milk, equivalents	250	✓
Beef, lamb, pork	14	✓
Chicken, other poultry	29	✓
Eggs	13	✓
Fish	28	-
Legumes	75	-
Nuts	50	-
Unsaturated oils	40	-
Saturated oils	11.8	-
Sugars	31	-

resources to consume according to an arbitrary level of social responsibility.

Annual income data comes from the PSID. The total family income measure encompasses pre-tax income from all sources including transfers and social security income. I derive households' disposable incomes using the NBER's TAXSIM tool[31] The "old" OECD equivalence scale[32] is applied to derive the respective per-capita income a household has at its disposal.

The unsustainable basic needs expenses are almost twice as big as the official poverty threshold provided by the Bureau of Labour Statistics in 2018 which on average across the US amounts to US$12,784 for a single adult. The official poverty measure is an inflation-corrected measure of a poverty level defined in 1963. The measure is three times expenses for a minimum diet in 1963.[33] It, hence, does not account for changes in medical care or transportation costs.[34]

[31] Provided here `https://users.nber.org/~taxsim/taxsim32/`.

[32] I use the "old" OECD equivalence scale which applies a higher weight on the second adult and children than the modified version. I follow Bradshaw et al. (2008) who show for the UK that the modified scale underestimates the needs of families.

[33] The factor of three equals the relation of food expenses to total after-tax money income of the average US family in 1955.

[34] For more details on how the census bureau's poverty threshold is derived see `https://www.census.gov/topics/income-poverty/poverty/guidance/poverty-measures.html`.

B Calibration

Price elasticity of substitution The price elasticity of substiution between sustainable and unsustainable produce, defined as

$$PES = \frac{\frac{d\left(\frac{c_n}{c_s}\right)}{\frac{c_n}{c_s}}}{\frac{d\left(\frac{p_s}{p_n}\right)}{\frac{p_s}{p_n}}},$$

is matched with the price elasticity of substitution between organic and conventional milk purchases derived from estimates found by Chen et al. (2018). The study uses Nielsen scanner data for 2013 in the US with a final sample of 24,861 households who purchased milk regularly. The milk market seems to be a good proxy for the market for sustainability as no close substitutes are available.

In the model, the unsustainable price is held fix with the unsustainable good being the numeraire. This is not the case in the data and both conventional and organic prices vary. In order to reconcile this discrepancy, the following identity is used. It is further assumed that the unsustainable price is constant in the data, too. As a result, the 1 percentage change in the relative price is solely driven by a change in the sustainable price.

$$\frac{d\left(\frac{p_s}{p_n}\right)}{\frac{p_s}{p_n}} = \frac{dp_s}{p_s} - \frac{dp_n}{p_n} = \frac{dp_s}{p_s}. \tag{3}$$

and the price elasticity of substitution becomes

$$PES = \frac{\frac{d\left(\frac{c_n}{c_s}\right)}{\frac{c_n}{c_s}}}{\frac{dp_s}{p_s}} = \frac{\frac{dc_n}{c_n}}{\frac{dp_s}{p_s}} - \frac{\frac{dc_s}{c_s}}{\frac{dp_s}{p_s}}. \tag{4}$$

In the data, cross and own price elasticities of three milk categories are documented: *organic, conventional brand* and *conventional private label*. The organic category is treated as the sustainable counterpart in the data. The conventional subcategories are added to match unsustainable consumption. Hence,

$$c_n = c_{cpl} + c_{cb},$$

where *cpl* and *cb* indicate *conventional private label* and *brand*, respectively. The elasticity of unsustainable consumption with respect to sustainable prices is then given by

$$\frac{\frac{dc_n}{c_n}}{\frac{dp_s}{p_s}} = \frac{\frac{dc_{cpl}}{c_{cpl}}}{\frac{dp_s}{p_s}} \frac{c_{cpl}}{c_n} + \frac{\frac{dc_{cb}}{c_{cb}}}{\frac{dp_s}{p_s}} \frac{c_{cb}}{c_n}.$$

All terms on the right-hand side are available from Chen et al. (2018) as is the own price elasticity of sustainable consumption. The resulting price elasticity is 2.52. That is, a 1 percentage increase in the price of organic milk implies a 2.5% rise in the ratio of unsustainable to sustainable consumption.

The elasticities estimated in Chen et al. (2018) are measured at the average consumer in the sample; therefore, the model is calibrated to match the price elasticity of substitution at the observed average values of consumption and budget shares in the data.

B.1 Calibration

In the final step of the calibration, I jointly choose effective labour productivity, total factor productivity, and the disutility from labour, χ, by requiring that in the baseline calibrated equilibrium the following target equations

$$\begin{aligned}
\text{average annual labour supply} &= \lambda l_{r,base} + (1-\lambda) l_{p,base} \\
\text{income rich} &= z_h w_{base}(1-\tau_l) l_{r,base} + T_{base} \\
\text{income poor} &= z_l w_{base}(1-\tau_l) l_{p,base} + T_{base} \\
\text{unsustainable output} &= A_n H_{n,base} \\
\text{sustainable output} &= A_s H_{s,base}
\end{aligned}$$

and the equilibrium equations for labour supply, labour market clearing, firms maximise profits, the government budget is balanced, and the complementary slackness conditions for labour supply hold.

C Equilibrium definitions and equations

Social planner equilibrium The social planner's problem is defined as an allocation $\{c_{sr}, c_{nr}, c_{sp}, c_{np}, l_r, l_p, H_s, H_n\}$ which solves

$$\begin{aligned} \max_{c_{sr}, c_{nr}, c_{sp}, c_{np}, l_r, l_p, H_s, H_n} W^{SP} = (1-\lambda)U_p + \lambda U_r \\ s.t.\ \lambda c_{nr} + (1-\lambda)c_{np} = A_n H_n \\ \lambda c_{sr} + (1-\lambda)c_{sp} = A_s H_s \\ \lambda z_h l_r + (1-\lambda) z_l l_p = H_n + H_s \\ l_r \leq L \\ l_p \leq L. \end{aligned}$$

Competitive equilibrium A competitive equilibrium is defined as an allocation $\{c_{sr}, c_{nr}, c_{sp}, c_{np}, l_r, l_p, H_s, H_n\}$, a set of prices $\{p_s, w\}$ and a tax system $\{\tau_n, \tau_l, T\}$ such that
(i) households maximise their lifetime utility subject to their budget and time constraint in each period,
(ii) in each period sustainable and unsustainable firms maximise profits,
(iii) the government maximises social welfare subject to a balanced budget, and
(iv) markets for the consumption goods and labour clear.

Model equations of the competitive equilibrium

$$
\begin{aligned}
\text{FOC consumption rich} \quad & U_{csr} = p_s \mu_r \\
& U_{cnr} = \mu_r \\
\text{FOC consumption poor} \quad & U_{csr} = p_s \mu_p \\
& U_{cnr} = \mu_p \\
\text{Labour supply} \quad & \chi l_r^{1/\theta} + \gamma_{lr} = \mu_r w(1-\tau_l) z_h \\
& \chi l_p^{1/\theta} + \gamma_{lp} = \mu_p w(1-\tau_l) z_l \\
\text{Household budgets} \quad & c_{sr} p_s + c_{nr} = l_r w(1-\tau_l) z_h + T \\
& c_{sp} p_s + c_{np} = l_p w(1-\tau_l) z_l + T \\
\text{Profit maximisation by firms} \quad & A_n = w(1+\tau_n) \\
& p_s A_s = w \\
\text{Production} \quad & Y_s = A_s H_s \\
& Y_n = A_n H_n \\
\text{Government budget} \quad & T = \tau_n w h_n + \tau_l w(H_n + H_s) \\
\text{Market clearance} \quad & H_s + H_n = \lambda z_h l_r + (1-\lambda) z_l l_p \\
& \lambda c_{sr} + (1-\lambda) c_{sp} = Y_s \\
\text{Complementary slackness conditions} \quad & \gamma_{lp}(L - l_p) = 0 \\
& \gamma_{lr}(L - l_r) = 0
\end{aligned}
$$

The variables μ_i, γ_{li} with $i \in \{r, p\}$ are the Lagrange multipliers in the household problem on the budget and time constraint, respectively. The market for the unsustainable good clears by Walras's law.

D Primal Approach

Throughout an interior solution is assumed. In a competitive equilibrium, the following holds:

$$\text{FOC consumption rich} \qquad p_s = \frac{U_{c_{sr}}}{U_{c_{nr}}} \tag{5}$$

$$\text{FOC labour rich} \qquad w(1-\tau_l) = \frac{-U_{l_r}}{z_h U_{c_{nr}}}, \tag{6}$$

$$\text{Profit max. sustainable sector} \qquad w = A_s p_s \tag{7}$$

$$\text{Profit max. unsustainable sector} \qquad \tau_n = \frac{A_n}{w} - 1 \tag{8}$$

$$\text{Government budget} \qquad T = \tau_l(H_s + H_n)w + \tau_n H_n w, \tag{9}$$

where $U_{lr} = -\chi l_r^{1/\theta}$.

Using the equations characterising a competitive equilibrium, see section C, the Ramsey problem can be written as

$$\begin{aligned}
\max_{c_{sr},\ c_{sp},\ c_{np},\ l_r\ l_p,\ H_s,\ H_n} \mathcal{L} =& \lambda U_r + (1-\lambda)U_p \\
& - \mu_{imr}\lambda \left[c_{sr}U_{c_{sr}} + (c_{nr} - T)U_{c_{nr}} + l_r U_{lr}\right] \\
& - \mu_{imp}(1-\lambda)\left[c_{sp}U_{c_{sp}} + (c_{np} - T)U_{c_{np}} + l_p U_{lp}\right] \\
& - \mu_{rc}\left[p_s\left(\lambda c_{sr} + (1-\lambda)c_{sp}\right) + \lambda c_{nr} + (1-\lambda)c_{np} - p_s A_s H_s - A_n H_n\right] \\
& - \mu_{lab}\left[H_n + H_s - (\lambda z_h l_r + (1-\lambda)z_l l_p)\right] \\
& - \mu_{FOCps}\left[ps - \frac{U_{c_{sp}}}{U_{c_{np}}}\right] \\
& - \mu_{FOCw}\left[w(1-\tau_l) - \frac{-U_{lp}}{z_l U_{c_{np}}}\right] \\
& - \mu_{sus.market}\left[\lambda c_{sr} + (1-\lambda)c_{sp} - A_s H_s\right],
\end{aligned}$$

where prices and policy instruments are substituted by equations 5 to 9. I further assume that the Ramsey planner's first-order conditions are also sufficient to maximise the objective function.

The first two constraints, following μ_{imp} and μ_{imr}, the *implementability constraints*, ensure that the households budget holds under the optimal allocation. Satisfaction of the resource constraint, following μ_{rc}, and labour market clearing, μ_{lab}, is also ensured. To account for inequality, the first order conditions of the poor household type which include prices are explicitly considered as constraints to the Ramsey problem, following the Lagrange multipliers

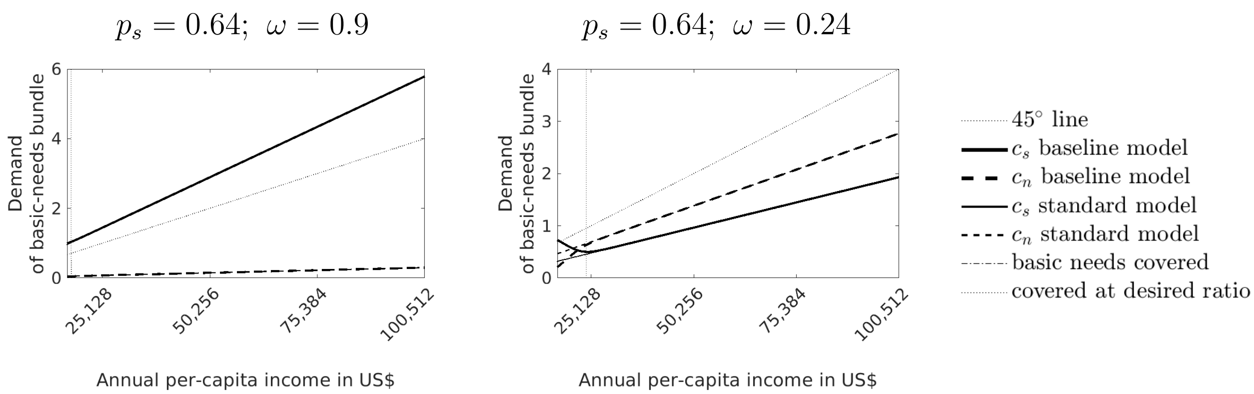
μ_{FOCps} and μ_{FOCw}, while the respective equations for the rich household type are used to replace prices and policy instruments. In contrast to Barrage (2020), where only one consumption good exists, the market clearing condition for the sustainable market needs to be explicitly considered as a constraint, too; the respective multiplier is $\mu_{sus.market}$.

By substituting the optimal allocation from the Ramsey problem into equations 5 to 9, prices and the optimal policy are determined.

The proofs to show (1) that the resulting optimal allocation can be implemented as a competitive equilibrium and (2) that a competitive equilibrium satisfies the constraints on the Ramsey planner's problem follow Barrage (2020).

E Social responsibility and redistribution

Figure 15: Engel curves for $p_s < 1$



F Definitions

F.1 Environmental tax progressivity

I define a tax as regressive, if the average tax over total income is higher for the poor than for the rich at the resulting allocation since transfers are homogeneous. It follows that the environmental tax is regressive, whenever the unsustainable budget share of the poor is higher than that of the rich under the optimal policy.

<u>Proof</u>:

Replacing firms profit-maximising conditions into the household's expenditures yields:

$$c_s \frac{w}{A_s} + c_n \frac{w}{A_n}(1 + \tau_n).$$

The environmental tax incidence by household is, thus, given by

$$c_n \frac{w}{A_n} \tau_n,$$

and the average tax rate by

$$\frac{c_n}{I} \frac{w}{A_n} \tau_n.$$

Hence, whenever the poor consume a higher share of unsustainable goods than the rich, this fraction is higher for the poor and the environmental tax is regressive.

F.2 Social costs of the externality

The Pigouvian rate, i.e., the social costs of the externality (SCE), is given by the aggregate willingness to pay for a marginal reduction in the externality. In contrast to Jacobs and van der Ploeg (2019), I define the Pigouvian rate as only capturing the marginal social benefits of an externality reduction not accounting for effects on tax bases. The proposed definition here is closer to the notion of "social costs of the externality" and in line with Barrage (2020). The Pigouvian tax as defined here results from maximising the average household's problem assuming the existence of a market for the externality. The maximisation problem reads

$$\max \mathcal{L} = \lambda U_r + (1-\lambda) U_p + \lambda \mu_r (I_r - c_{nr} - p_s c_{sr} - p_E h_n) + (1-\lambda) \mu_p (I_p - c_{np} - p_s c_{sp} - p_E h_n).$$

Note that the total amount paid by unsustainable producers for causing the externality is given by $w \tau_n H_n$ so that

$$\tau^{Pigou} = \frac{-p_E}{w} = \frac{-\frac{\partial g}{\partial h_n}}{\lambda \mu_r + (1-\lambda)\mu_p}.$$

Defined in this manner, the Pigouvian rate can be interpreted as the aggregate willingness to pay by households for the avoidance of a marginal increase in the externality. As regards aggregation, the Pigouvian rate is similar to the one defined in Jacobs and van der Ploeg (2019) when the distortionary tax equals zero.

G Results

G.1 Optimal allocation in the baseline model

Figure 16 depicts additional variables under the optimal policy in the baseline model.

To better understand how the Gini of consumption moves with social responsibility, panels (a) and (b) show composite consumption by household type. Composite consumption is affected by three factors. First, the change in social responsibility mechanically alters composite consumption as the weight on individual consumption goods changes, and households react to this change in preferences. Absent any policy intervention, this implies that the desired bundle becomes more expensive with social responsibility and, at a constant level of income, composite consumption reduces; compare the laissez-faire allocation in figure 17. Second, taking the optimal policy into account, both income (of the rich) and the sustainable good's price become an increasing function of social responsibility; compare panel (e) and panel (l) in figure 16. This explains the inverted U-shaped behaviour of composite consumption of the rich: at the upward sloping part, income is low and the price of the more preferred good is high. As income rises and the unsustainable good becomes less expensive, the composite consumption of the rich increases. The rise in composite consumption stops once the continuing rise in income is not enough to make up for the desired bundle becoming more expensive again.

Composite consumption of the poor (panel (b)) is affected by a third factor: basic needs. Not only is their composite consumption lower than that of rich households due to a lower quantity of the composite bundle consumed, but also because they do not allocate their income to maximise composite consumption for the given price. Panel (c) shows how the actual consumption ratio of the poor deviates from the desired one, the dashed-dotted graph. The rich always consume their desired bundle (not shown). When the unsustainable good is more expensive, to the left of the vertical indicator, the poor consume a higher share of the sustainable good; this pattern reverses once the unsustainable good becomes the cheaper alternative.

When the unsustainable good is more expensive, a rise in the sustainable price implies convergence of both good's prices which allows poor households to consume closer to the desired ratio. Once the sustainable good is more expensive, a further rise widens the price differential and the poor consume further away from the desired ratio; at the extreme when prices are identical basic-needs constrained households consume the desired ratio. In addition, when the sustainable good is cheaper, a rise in social responsibility reduces the gap since the desired bundle becomes cheaper. In contrast, as the sustainable good is more expensive the rise in social responsibility intensifies the gap. The rise in income of the poor starting from at around $\omega = 0.3$, panel (d), adds to closing the gap between actual and desired consumption.

Since there is a reduction of the gap until the sustainable price exceeds unity, the initial small reduction of composite consumption by the poor is driven by a reduction in income. Roughly, as income starts to rise, the composite consumption of the poor reaches a trough. The fall in the actual-desired consumption gap adds to the rise in composite consumption until the sustainable good becomes more expensive than the unsustainable one. From here on, the widening of the gap amplifies the reduction in composite consumption of the poor relative to the reduction in composite consumption by the rich.

The initial rise of the Gini of consumption is, thus, explained by a reduction of income of the poor while consumption of the rich rises. It reduces once composite consumption of the poor increases faster than that of the rich as they can close the actual-desired consumption gap. As the unsustainable good eventually becomes cheaper, and the gap widens again, consumption of the poor reduces faster, and the Gini of consumption increases.

Aggregate labour supply is shown in panel (f) followed by household-specific supplies in panels (g) and (h). The aggregate level mainly reflects labour supply of the rich as they are characterised by a relatively high effective labour productivity. Absent any policy intervention, labour supply is constant except for a negligibly small rise in labour supply by the poor; compare figure 17.[35] The movements in labour supply are, therefore, the effect of taxes and transfers.

The initial rise in labour supply is driven by the strong reduction in the environmental tax. The higher after-tax wage rate (panel (n)) makes the rich want to work more. The slow down in the reduction of the environmental tax and the rise in labour taxes diminishes the rise of the after-tax wage. This adds to the decrease in labour supply. The rise in transfers additionally mitigates work efforts by the rich. As the rise in the after-tax wage accelerates again, labour supply by the rich resurges.

Labour supply of the poor tells a different story. For this household group the penalty term dominates the pattern of labour supply; compare panels (h) and (i). The high penalty term increases the shadow value of income so that the household is willing to work more. Despite the rise in transfers and income, the poor experience a cutback in the sum consumed as social responsibility rises. When the sustainable good is cheaper, the shift in social responsibility towards the sustainable good should imply at most no reduction in the quantity consumed. However, the parallel increase in the sustainable price outweighs this effect. So that the sum consumed falls. After the sustainable good becomes more expensive than the unsustainable good, the penalty term reduces again, although tastes become more expensive. This reduction

[35] The rise in labour supply by the poor in the laissez-faire economy is driven by an increase in the penalty term. As social responsibility rises, the poor eventually accept a lower sum consumed at the expense of a higher penalty. This makes them willing to work more.

is, therefore, explained by the accelerated rise in income through transfers.

Figure 16: Optimal allocation: additional variables

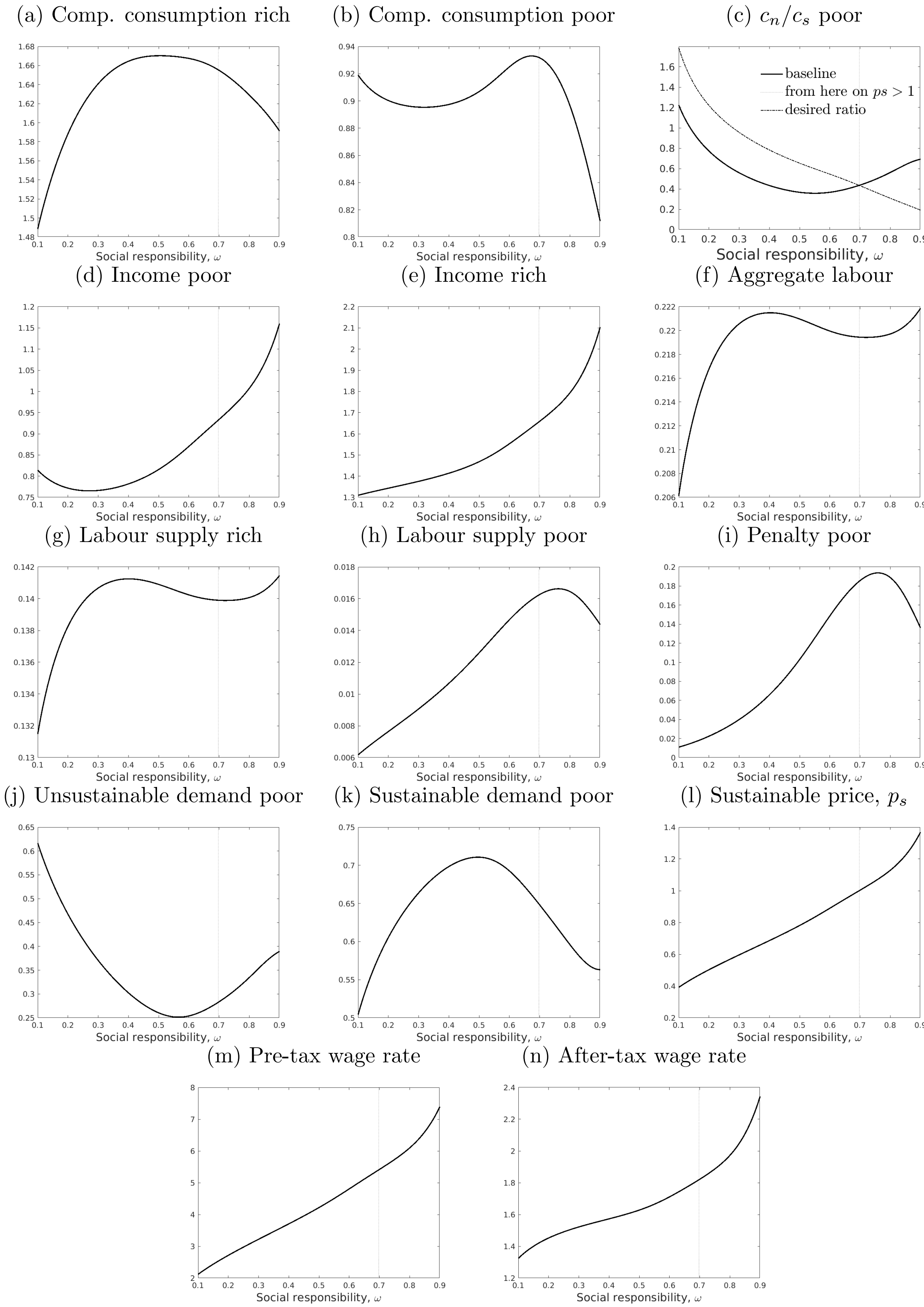
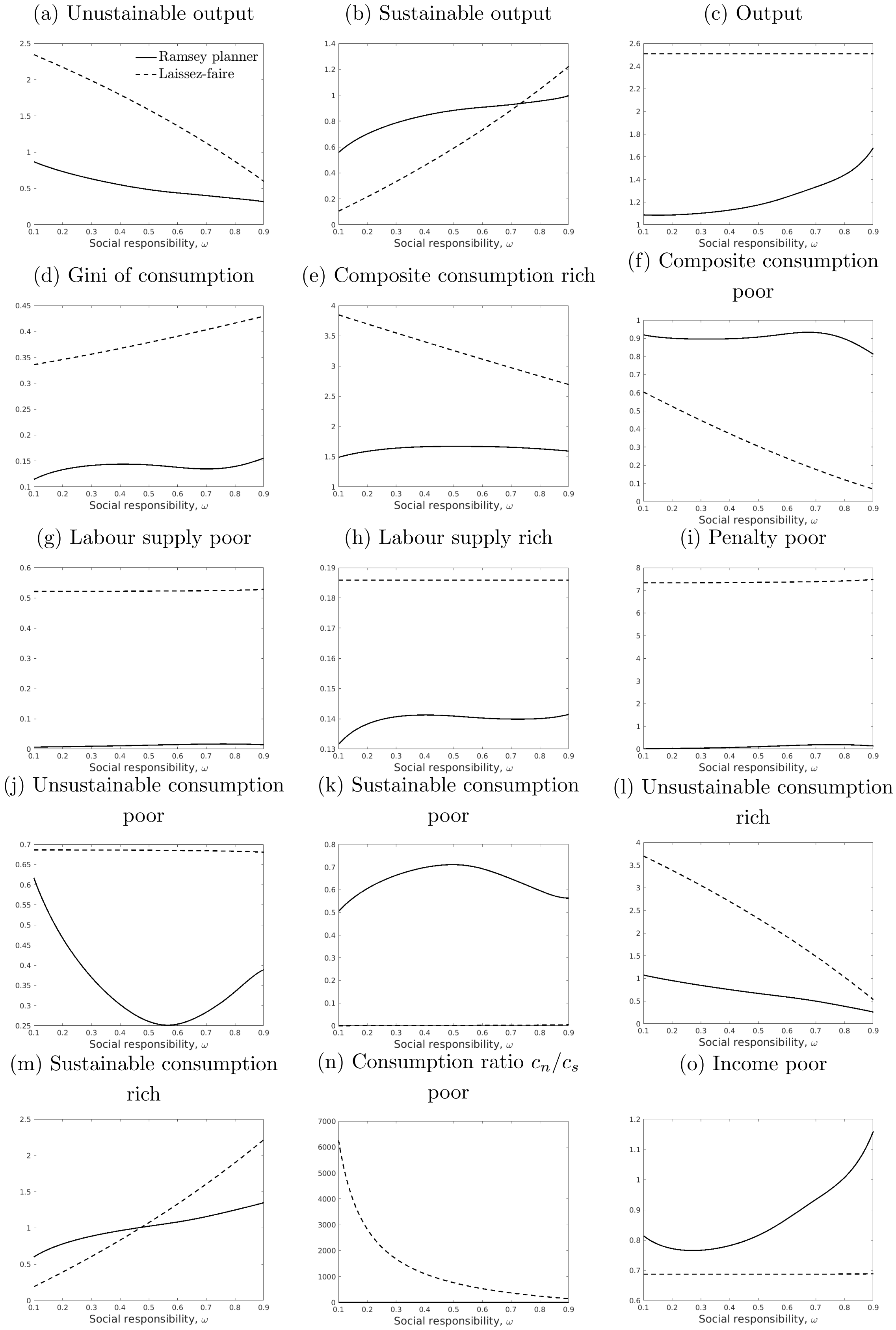


Figure 17: Optimal and laissez-faire allocation

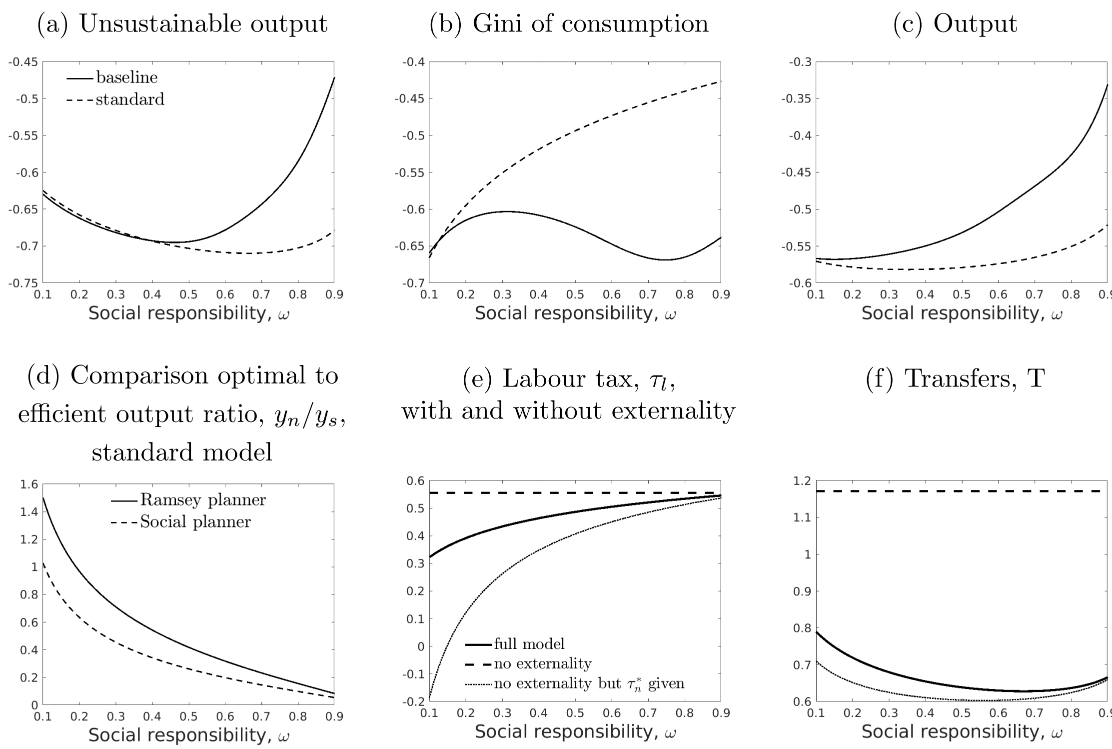


(a) Unustainable output (b) Sustainable output (c) Output (d) Gini of consumption (e) Composite consumption rich (f) Composite consumption poor (g) Labour supply poor (h) Labour supply rich (i) Penalty poor (j) Unsustainable consumption poor (k) Sustainable consumption poor (l) Unsustainable consumption rich (m) Sustainable consumption rich (n) Consumption ratio c_n/c_s poor (o) Income poor

G.2 Results in the standard model

The focus of the optimal policy in the standard model remains on the externality, the dashed line in panel (a). In fact, the government reduces the externality even more the higher social responsibility: from -62.5% at $\omega = 0.1$ to -67.5% at $\omega = 0.9$.[36] By doing so, the government in the standard model accepts a higher level of inequality and a strong reduction in output for all levels of social responsibility by more than 50%, panel (c). The initial bigger reduction in inequality is a byproduct of the revenues from environmental taxation.

Figure 18: Effect of government intervention with and without basic needs



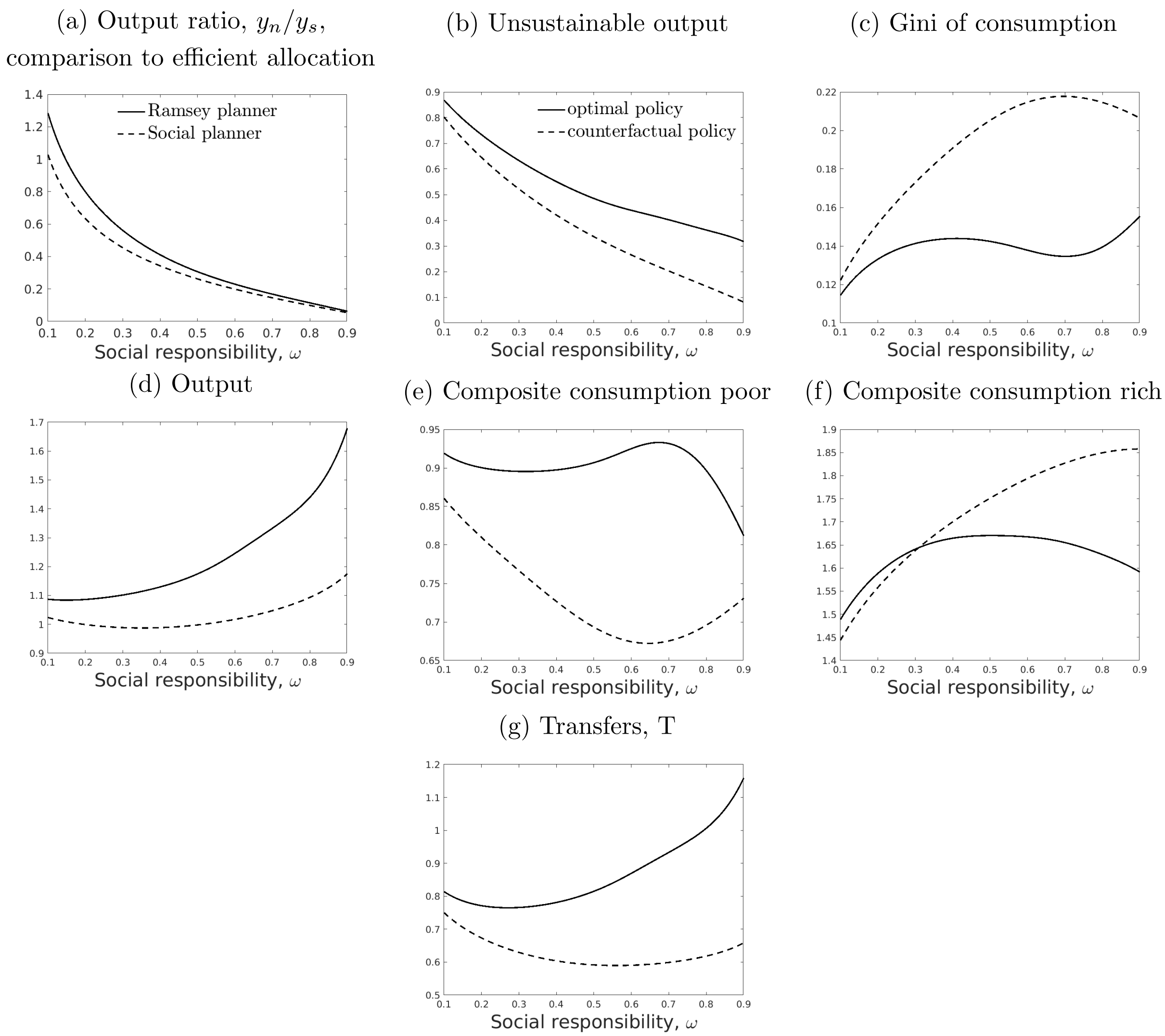
G.3 Counterfactual policy

As counterfactual policy I consider the optimal policy chosen in the standard model. In this model, the optimal environmental tax is always higher than in the model with basic needs. With this policy, the government would be able to attain an output ratio closer to the efficient one; compare panel (a). The counterfactual policy considered enforces a sustainable price below unity (so that the poor use the sustainable good to cover their basic needs) for all levels of social responsibility. This causes a lower externality throughout, panel (b). The cost of this aggressive environmental policy is borne by the poor who see a substantial drop

[36] There is a small decline in the reduction of the externality at very high levels of social responsibility.

in their unsustainable consumption. Consumption of the rich rises for medium to high levels of social responsibility. The Gini coefficient of comsposite consumption is higher troughout. The increase in inequality is driven by too high efficiency costs of the environmental tax which implies lower output on aggregate and, thus, transfers.

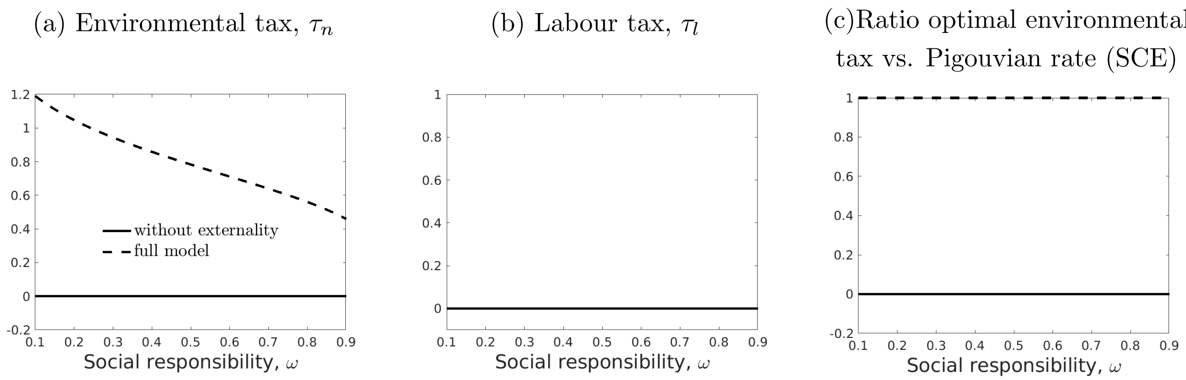
Figure 19: Counterfactual policy, $p_s < 1$ throughout



G.4 Representative agent

When households are alike, a representative agent exists that represents the economy. Then the model replicates the findings in the literature. First, since there is no requirement on government revenues, the optimal environmental tax equals the Pigouvian rate, aka the social costs of the externality; compare panel (c) in figure 20. For a definition of the Pigouvian rate and the derivation of the SCE see section F.2 in the appendix. The labour tax is set to zero, as there are no benefits from government funds or redistribution; panel (b). Hence, when the environmental tax can be set to fully internalise the social costs of the externality, there is no role for labour taxes as an environmental policy instrument.

Figure 20: Optimal policy no inequality



G.5 Quantification of policy effects

In this section, I discuss the mechanisms shaping the externality of each policy instrument resulting from the experiment explained in section 5.3.5. The discussion mainly refers to figure 21. The plots show variables in levels in the laissez-faire economy, with vertical markers, after implementation of the environmental tax, the solid graphs, after implementation of the optimal labour tax but labour supply fixed, the dashed graph, and finally as labour supply reacts to the labour tax, the thin dotted graph.

Environmental taxation The environmental tax accounts for a reduction in unsustainable output by between 60% and 70% when social responsibility is below $\omega = 0.7$, as shown by the solid graph in plot (b) in figure 10, thereby accounting for the bulk of the impact of environmental policy. The environmental tax affects unsustainable production through two mechanisms: (1) by changing the relative price and (2) by altering households' income. Rendering the sustainable good the cheaper alternative implies a strong response of demand by the poor who now rely on the sustainable good to cover their basic needs, compare the solid graph in panel (a) relative to the one with vertical lines.

The additional reduction going from $\omega = 0.1$ to $\omega = 0.3$ is explained by the demand of poor households. A decrease in transfers, compare panel (d) in figure 21, makes the poor poorer such that these households recompose their budget towards the cheaper, that is, the sustainable good. Transfers reduce due to the cut in the tax base and the demand-driven reduction in the tax base relative to lower values of social responsibility. Furthermore, the cross-price effect of the sustainable good's price on unsustainable demand by the poor is negative at the marginal environmental tax rate, that is, a fall in the sustainable price implies a rise in unsustainable demand; compare panel (e) in figure 21. How does the negative cross-price effect come about? Being constrained by basic needs implies a small substitution effect in reaction to a marginal change in the relative price. Demand for the cheaper good remains strong so that the income effect of a price change exceeds the substitution effect. Therefore, in sum, demand by the poor for the unsustainable good falls as the sustainable good becomes more expensive. This adds to the importance of the environmental tax for low levels of social responsibility.

The total impact of the environmental tax on unsustainable output reduces as social responsibility rises above $\omega = 0.4$ up to a value equal to $\omega = 0.7$. This is driven by the consumption behaviour of the rich; see panel (b) in figure 21. As the environmental tax reduces with social responsibility, the unsustainable good becomes cheaper and the rich recompose their consumption less intensely than in the laissez-faire economy towards sustainable demand; contrast the slopes of the solid graphs and the one with vertical lines. Furthermore, the rich become richer again (panel (f)) as the pre-tax wage rate rises; this, as well, increases their demand for unsustainable produce.

Once the environmental tax is so low that the sustainable good is more expensive than the unsustainable one, the absolute impact of the environmental tax drops sharply from 60% to roughly above 40%. The main reason is that the price elasticity of demand by the poor is low. What matters most for their demand decision is the ranking of prices and not the relative price. As long as the unsustainable price is the cheaper alternative, marginal changes in the relative price are of minor importance to the poor; consider panel (a).

Redistribution channel Redistribution counteracts the effect of the environmental policy whenever the sustainable good is the cheaper alternative. Consider now the dashed graph. When the unsustainable good is more expensive, until $\omega = 0.7$, redistribution implies a rise in the externality of up to 12% compared to the laissez-faire world in addition to the environmental tax. As the poor demand too high a budget share of the sustainable good relative to the desired bundle, a higher income allows them to recompose their consumption towards the more expensive alternative, i.e., the unsustainable good.[37] In contrast, the rich reduce their unsustainable demand as their income falls.

The picture changes once the environmental tax is set such that the unsustainable good becomes the cheaper one. Now, the MPCU of the poor is, aggregated over the amount

[37] The poor might have a lower MPCU at the initial income level, however, transfers are such that in sum the poor raise unsustainable demand relative to the allocation after only the corrective tax got implemented.

redistributed, lower than that of the rich, and the amount redistributed causes a contraction in unsustainable demand on aggregate. The difference in the MPCUs across households increases with social responsibility and an increase in the sustainable price. Consequently, redistribution becomes more and more important an environmental policy as households' taste for the sustainable good rises. Redistribution accounts for a reduction in the externality rising gradually from 10% to 44% with social responsibility.

Efficiency channel Finally, the effect of labour taxation on labour supply adds to the reduction in the externality when social responsibility is relatively low; focus on the thin dotted graphs. The labour supply of both household types decreases in reaction to labour taxation, and the income of both types falls, causing a cutback in unsustainable demand relative to the allocation after lump-sum redistribution. However, starting from a level of social responsibility slightly above $\omega = 0.8$ the efficiency channel has a positive additional effect on the externality. This again is driven by basic-needs constrained households. The reduction in their income (compare the dashes and the thin dotted graphs in panel (g)) boosts unsustainable demand. To cover basic needs, they revert to consume the less preferred but cheaper good.

Figure 21: Policy decomposition baseline model additional variables

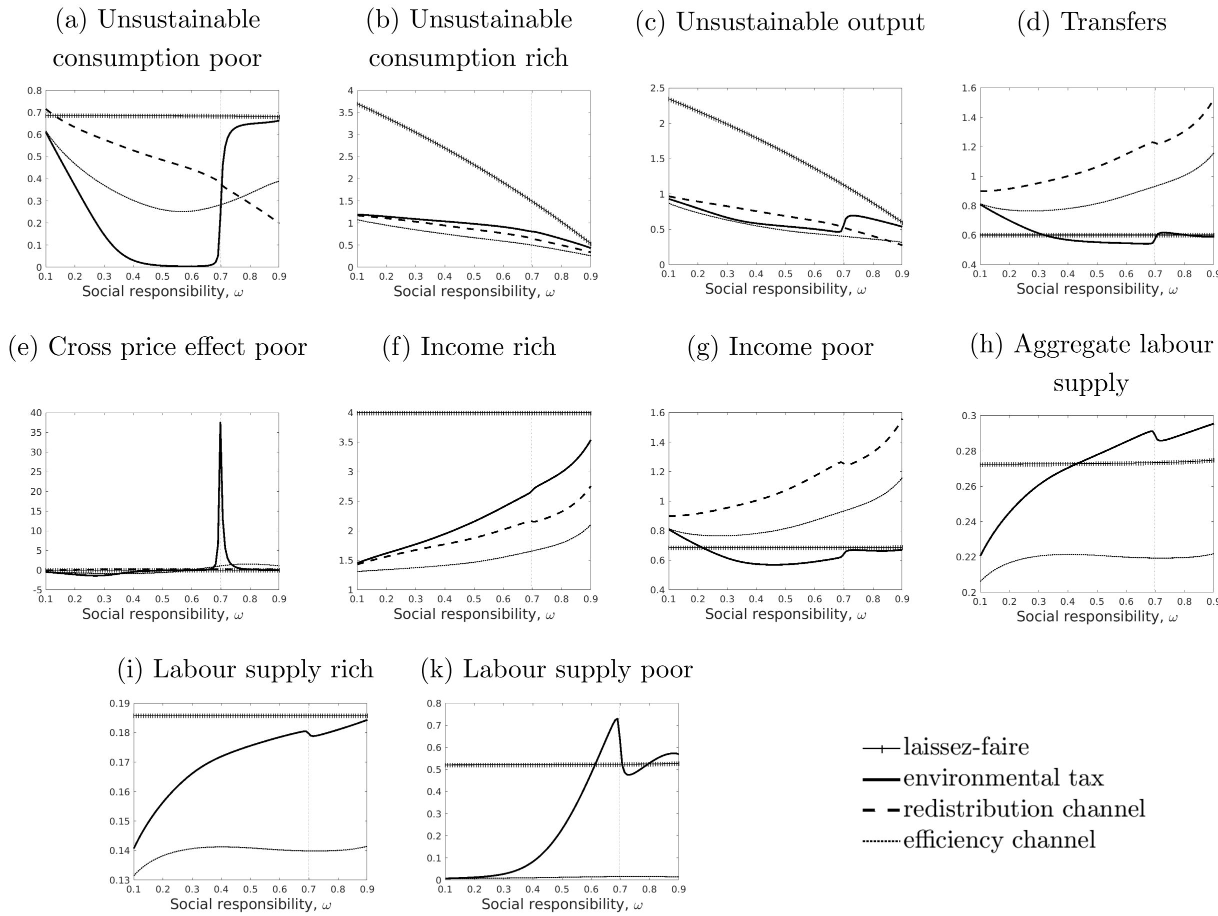
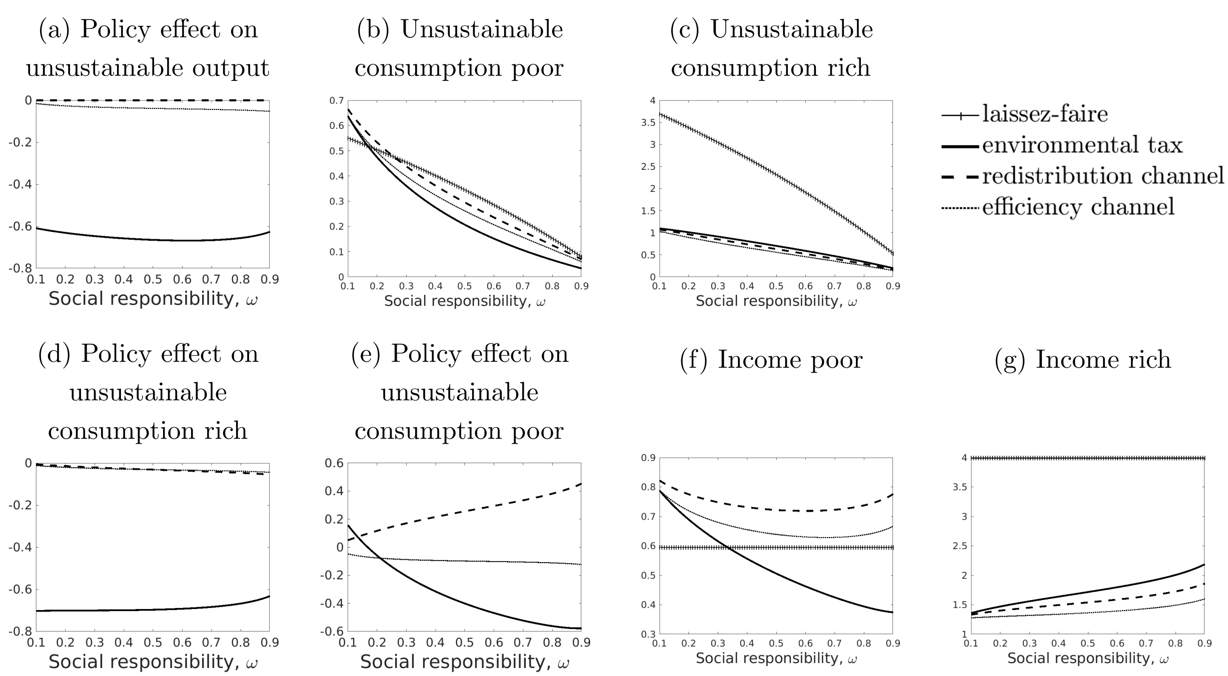


Figure 22: Policy decomposition standard model



References

Acemoglu, D., Akcigit, U., Hanley, D., and Kerr, W. (2016). Transition to Clean Technology. Journal of Political Economy.

Aghion, P., Bénabou, R., Martin, R., and Roulet, A. (2021). Environmental Preferences and Technological Choices: Is Market Competition Clean or Dirty?

Barrage, L. (2020). Optimal Dynamic Carbon Taxes in a Climate-Economy Model with Distortionary Fiscal Policy. Review of Economic Studies, 124(2):1–39.

Bartling, B., Weber, R. A., and Yao, L. (2015). Do markets erode social responsibility? Quarterly Journal of Economics, 130(1):219–266.

Bovenberg, A. L. and De Mooij, R. A. (1994). Environmental Levies and Distortionary Taxation. American Economic Review, 84(4):1085–1089.

Bradshaw, J., Middleton, S., Davis, A., Oldfi, N., Smith, N., Cusworth, L., and Williams, J. (2008). A minimum income standard for Britain: What people think. Retrieved from `https://www.jrf.org.uk/report/minimum-income-standard-britain-what-people-think`, May 2020.

Bénabou, R. and Tirole, J. (2010). Individual and corporate social responsibility. Economica, 77(305):1–19.

Chen, B., Saghaian, S., and Zheng, Y. (2018). Organic labelling, private label, and U.S. household demand for fluid milk. Applied Economics, 50(28):3039–3050.

Chetty, R., Guren, A., Manoli, D., and Weber, A. (2011). Are micro and macro labor supply elasticities consistent? A review of evidence on the intensive and extensive margins. American Economic Review, 101(3):471–475.

EAT-Lancet Commission (2019). Healthy Diets From Sustainable Food Systems Summary Report of the EAT-Lancet Commission. Retrieved from `https://eatforum.org/eat-lancet-commission/eat-lancet-commission-summary-report/`, May 2020.

Foellmi, R. and Zweimüller, J. (2008). Structural change, Engel's consumption cycles and Kaldor's facts of economic growth. Journal of Monetary Economics, 55(7):1317–1328.

Golosov, M., Hassler, J., Krusell, P., and Tsyvinski, A. (2014). Optimal Taxes on Fossil Fuel in General Equilibrium. Econometrica, 82(1):41–88.

Gordon M. Fisher (2012). Standard Budgets (Basic Needs Budgets) in the United States Since 2006. Retrieved from https://www.census.gov/content/dam/Census/library/working-papers/2012/demo/udusbd3.pdf, 29/07/2021.

Herrendorf, B., Rogerson, R., and Valentinyi, A. (2014). Growth and Structural Transformation. In Handbook of Economic Growth, volume 2, pages 855–941.

Institute for Women's Policy Research (2018). Basic Economic Security in the United States: How Much Income Do Working Adults Need in Each State? Retrieved from https://iwpr.org/wp-content/uploads/2020/08/R590_National_finalx.pdf, 29/07/2021.

Jacobs, B. and van der Ploeg, F. (2019). Redistribution and pollution taxes with non-linear Engel curves. Journal of Environmental Economics and Management, 95:198–226.

Jones, L. E., Manuelli, R. E., and Rossi, P. E. (1993). Optimal Taxation in Models of Endogenous Growth. Journal of Political Economy, 101(3):485–517.

Kronthal-Sacco, R., Van Holt, T., Atz, U., and Whelan, T. (2020). Sustainable Purchasing Patterns and Consumer Responsiveness to Sustainability Marketing Messages. Journal of Sustainability Research, 2(2).

Lucas, R. E. and Stokey, N. L. (1983). Optimal Fiscal and Monetary Policy in an Economy without capital. Journal of Monetary Economics, 12:55–93.

Matsuyama, K. (2002). The Rise of Mass Consumption Societies. Journal of Political Economy, 110(5):1035–1070.

McMahon, S., Horning, J., and Suh, J. Y. (2018). The basic economic security tables. Methodology and Supplemental Data. Retrieved from https://iwpr.org/wp-content/uploads/2020/08/US-BEST-Draft-Methodology-Report_Suh1-CH_JC.pdf, 29/07/2021, Institute for Women's Policy Research.

OECD (2021). Average annual hours actually worked per worker. Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=ANHRS, 11/02/2021.

Sager, L. (2019). Income inequality and carbon consumption: Evidence from Environmental Engel curves. Energy Economics, 84.

The Conference Board (2020). Consumers' Attitudes about Sustainability. Retrieved from https://conference-board.org/pdfdownload.cfm?masterProductID=20499, 11/01/2021.

The Nielsen Company (2015). The Sustainability Imperative. Retrieved from https://www.nielsen.com/wp-content/uploads/sites/3/2019/04/Global20Sustainability20Report_October202015.pdf, 11/01/2021.

United States Department of Agriculture (2021). Market News Retail Dataset. Retrieved from https://marketnews.usda.gov/mnp/dataDownload, 11/01/2021.

Yale Program on Climate Change Communication (YPCCC) and George Mason University Center for Climate Change Communication (Mason 4C) (2020). Climate Change in the American Mind: National survey data on public opinion (2008-2018). doi: 10.17605/OSF.IO/JW79P.