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Hendrik Hakenes   Eva Schliephake

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Responsible Investment and Responsible Consumption*

Hendrik Hakenes†
University of Bonn, ECONtribute, and CEPR

Eva Schliephake‡
Universidade Católica Portuguesa

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Abstract

To reduce a negative externality, socially responsible households can *invest* responsibly (SRI), *consume* responsibly (SRC), or do both. Which is better? In a closed microeconomic model with intertwined product and capital markets, we analyze how responsible households should use SRI and SRC to maximize their impact. Both strategies reduce the externality as long as investors are risk-averse and the products have no perfect substitutes. Responsible households gain the highest impact when using SRC in equal proportion to SRI. A mere focus on SRC is never efficient. SRI plays a role in any green strategy. The financial performance of green investments is determined by the responsible households' mix between SRI and SRC.

Keywords: Socially responsible investment (SRI), ethical investment, socially responsible consumption (SRC), sustainable investment, sustainable consumption, green investment, divestment, ESG, SPI.

JEL-Classification: D16, G30, G23, D62, D64, M14.

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†Institute for Financial Economics and Statistics, University of Bonn, Adenauerallee 24-42, 53113 Bonn, Germany, hakenes@uni-bonn.de.

‡Universidade Católica Portuguesa, Católica Lisbon School of Business & Economics, Portugal, Palma de Cima, 1649-023 Lisboa, schliephake@ucp.pt.

1 Introduction

Today, the need for a more sustainable economy is on top of the agenda of policy makers, investors and consumers. However, given the small size of an individual investor or consumer compared to the size of the externality, responsible households may wonder if their individual investment and consumption choices have an actual impact. Even if responsible individuals can have a non-negligible impact, their effort may be at least partially undone by other market participants. Especially divestment from dirty industries may be compensated by other investors on the financial markets. In a model with intertwined capital and product markets and endogenous market responses, this paper shows that both socially responsible investment (SRI) and socially responsible consumption (SRC) are effective. Both have a direct, symmetric and proportional impact in reducing a negative externality. To efficiently reach an impact, households should not try to shift asset returns and product prices. They should reduce investment and consumption proportionally. In particular, a reduction in consumption alone, without divestment in dirty industries, is never efficient.

SRI has seen a remarkable growth in the past decade, notably among retail investors (Bialkowski and Starks, 2017). Reallocating investments from dirty to clean companies is supposed to affect the production, and thus, the supply side of firms.[1] However, simply discarding dirty stocks from the investment portfolios might not be effective, as there are usually other less scrupulous investors willing to buy the shares.[2] Moreover, divesting from high yielding stocks might lead to a loss of household income. This raises the question whether household investments are actually the right way for responsible households to exert pressure. After all, SRI is not the only path that responsible households can take in their quest for social impact. In fact, consumption volumes are one of the main drivers of greenhouse gas emissions, as well as of other environmental problems (Alfredsson et al.,

[1] In this paper we will use the terms "clean" ("dirty") to refer to a production that causes low (high) negative externalities. The wording suggests an environmental externality, but the model applies to social or other externalities as well.

[2] The engagement literature on SRI makes an another important point: Even if the divestment from dirty companies actually raises the company's capital cost this makes investments into pollution reducing projects even less likely. In contrast, holding shares in dirty companies may be the only way to engage with a business and fund a sustainable change (The Economist, 2021).

2018). Would a focus on exerting pressure on the demand side in the form of sustainable household consumption, therefore, have a larger impact?

Two thirds of EU citizens realize that changing their consumption habits can have a significant sustainable impact (European Parliament, 2020). However, a number of studies identified a gap between consumers' good intentions and their actual behavior (e. g., Nguyen et al., 2019; White et al., 2019). Of course, consumption decisions are not exclusively driven by sustainability considerations. Other factors such as relative prices, preferences for the consumption good, income, as well as social norms and peer pressures affect the consumption decisions as well. Moreover, the consumer's perception of their individual impact is a moderator for more sustainable consumption (Chen and Hung, 2016). The higher the perceived impact, the more willing are households to behave responsibly. It is therefore important to understand how responsible households can maximize their impact on reducing an externality. Should they better refrain from dirty investment (SRI) or cut their dirty consumption instead (SRC)?

Our paper provides the first theoretical analysis of this fundamental question. Responsible households can choose to contribute to an externality reduction by affecting the supply side via their investment decisions and the demand side via their consumption choices. The responsible choice has indirect effects through market prices and the corresponding impact on the other households' consumption and investment decisions. Moreover, we explicitly acknowledge that both markets are intertwined: the cost of capital influences product prices as much as product market profits affect investment yields. When choosing how to exert their impact, responsible households anticipate the responses of the other market participants. The optimal impact level chosen by households depends on economic uncertainty, risk aversion, relative product preferences as well as social norms and peer pressures.

In our model, firms produce a good that entails a negative externality.[3] Households first invest into firms, then spend the investment return on consumption. A fraction of households is "responsible" and takes the externality of their decision into account, at least

[3]For a positive externality, the problem is similar to public good provision by private households, as in Bergstrom et al. (1986).

partially.[4] If they do so when investing, this is called SRI; if they do so when consuming, this is called SRC. Firms use the invested money to produce goods, then sell the goods on a competitive market, earn the revenue, and suffer from a profit shock. Households collect profits from the firms.

Our study makes three contributions to the literature on green finance. First, we show that both – SRI and SRC – are effective in reducing the externality. Their relative effectiveness depends on the risk aversion and goods preferences of the standard households, which alter the market response to price changes. This result implies that each household has the same impact no matter if the proportion of responsible households is high or low.

Second, we show that responsible households optimally exert their impact by cutting consumption in proportion to their divestment from the dirty firm. Intuitively, given a minimum acceptable utility, responsible households maximize their impact by divesting exactly the amount of capital that became redundant because of the intended reduction in dirty consumption, and thus leave equilibrium prices unchanged. It is optimal to reduce investment and consumption in proportion because any disproportionate effort in one market will be at least partially offset by the other market participants. For example, if risk aversion is low, it is cheap to reduce investment in the dirty industry, but other investors have also a low risk aversion and thus readjust their investment accordingly. Hence, the cost is low, but the effect is also low. The same argument holds for the other exogenous parameters. Introducing differences in risk aversion and product preferences between responsible and standard households allow us to analyze how preference heterogeneity affects the optimal mix of responsible behaviors. We show that the proportionality result holds even with heterogeneous preferences on risk and product substitutability.

Third, we show that the relative financial performance of responsible investments depends on how well households are able to coordinate on responsible behavior in both markets. We first describe the optimal coordinated action. If coordination (commitment) is not feasible, we show that social action can be implemented with the help of peer pressure ("shame & blame"). If households can only commit to SRC but not SRI, green invest-

[4] In the model, agents are called households. They can also be interpreted as states, deciding on how much to tax carbon emissions, and whether to invest into dirty firms, or in countries with a large carbon footprint.

ments financially underperform dirty shares, vice versa. Finally, we analyze the effect of imperfect competition and show that if firms have some market power, SRI and SRC can induce change towards a more sustainable technology.

Literature. One of the first attempts to introduce social aspects into finance theory is marked by Gali (1994) who extent the CAPM model by allowing investors to care about their relative standard of living. This consumption externality rather reflects a form of envy than the idea of a socially responsible investor. In contrast, Benabou and Tirole (2010) develop a theory of prosocial behavior to explain why people commonly engage in activities that are costly to themselves and mostly benefit others. Socially responsible households in our model behave also in this vein: they are willing to sacrifice utility to reduce a negative externality. Moisson (2021) proposes a model in which the morality of investors can take several forms, such as rule consequentialism, direct consequentialism, and shared responsibility. The modeling of social responsible households in our paper is closest to the moral concept of direct consequentialism as households are concerned with the direct impact of their investment and consumption decisions.

The willingness of SRI investors to forgo financial performance to invest in accordance with their social preferences is well documented. For example, SRI money flows appear to be less sensitive to past performance than flows to otherwise comparable funds (Renneboog et al., 2011). Moreover, SRI funds have shown greater and more persistence growth despite similar financial performances (Bialkowski and Starks, 2017). In general, social preferences and social signalling are better predictors of SRI than financial motives (Riedl and Smeets, 2017) and certified green assets are issued at a premium (Baker et al., 2018). Even venture capital investors are willing to sacrifice returns in exchange for environmental impact (Barber et al., 2021). Other studies indicate that socially responsible investments are also rationally motivated. Several studies provide empirical evidence that SRI financially outperform their peers (Revelli and Viviani, 2015; Busch and Friede, 2018). As SRI becomes more popular, the difficulty is to find evidence for the direction of causality between of performance and certified social responsibility of assets. It is not clear if SRI indeed show better financial performance or if the reversed causality is true, that successful firms who want to attract investors focus more on social responsibility. A more established fact is that SRI allows to diversify the expected risks associated with climate change. To minimize climate risks, investors diversify between SRI and engagement in dirty stocks, which is perceived as a better risk management strategy than simple divestment from dirty stocks (Krueger et al., 2020). SRI thereby does not require an entire divestment from dirty stocks. Flammer (2021) shows that companies can credibly signal their commitment towards environmentally friendly investments by issuing corporate green bonds. SRI can therefore also foster a change towards more sustainability of dirty firms.

This distinction between engagement for impact and the effect of divestment also marks the two main strands of the theoretical literature on SRI. The engagement literature analyzes how SRI can actively influence a firm's decision to become more sustainable. Chowdhry et al. (2018) analyze conditions under which the joint financing of purely profit-oriented and socially responsible investors improve social outcomes. Similarly, Oehmke and Opp (2020) analyze the impact of social responsible investment on financially constrained firms' production choices. The model closest to our modeling of SRI is Heinkel et al. (2001). They show that exclusionary investment strategies alter the risk sharing opportunities such that dirty firms face an increasing cost of capital if investors invest socially responsible. This risk-sharing friction also alters the equilibrium funding costs in our setup. Heinkel et al. (2001) show that if the funding cost differences between clean and dirty firms become large enough, dirty firms switch to invest into a more sustainable production. Hence, if investors are risk averse, SRI can affect corporate behavior.[5]

We also discuss the impact of SRI on ex-ante production choices in an extension, but the main effect of SRI in our model is a reduction in the production quantity of dirty firms due to the increase in funding costs. Pedersen et al. (2021) develop a model in which they combine the income hurting effect of SRI with the income increasing effect of better long-term performance. Goldstein et al. (2021) show how the presence of green stocks and green investors influences price informativeness, and thus risk. Zerbib (2020) show that the focus of investors on SRI stocks and the according divestment from sin stocks actually improves the relative financial performance of sin stocks. This trade-off also plays a role in our model. As responsible investors refrain from investing in dirty stocks, the marginal yield increases and attracts more standard investors, which partially

[5]In a world without frictions, with risk neutral investors, SRI would not have an impact on corporate behavior because even though responsible investors eschew dirty stocks their investments would be perfectly substituted by less ethical investors. We discuss the importance of risk aversion in Section 5

offsets the responsible investment. Pastor et al. (2021) develop a model of sustainable capital markets. Sustainable firms face lower funding costs because investors accept lower returns. In equilibrium, asset prices adjust to investor preferences, which pushes the market portfolio toward the portfolio desired by socially responsible investors. The capital market mechanism in our model is similar but in addition, our model allows for spillover effects on the product market.

These synergies between SRI and SRC have been largely neglected in the literature. A remarkable exception is Albuquerque et al. (2019), who analyze how SRI can increase firm profitability due to an increase in the loyalty of their customer base. The loyalty shift increases the price elasticity of demand which allows socially responsible firms to be more profitable and to be more resistant in an economic downturn. Albuquerque et al. (2020) confirm these theoretical predictions, using the Covid-19 Pandemic as an exogenous shock on product demand. They find that more sustainable companies suffer less during the economic recession. In our model, responsible households are more sensitive to the price changes of the dirty good as well. Our extension shows that if companies reduce their production externalities, responsible households consume more of their products.

The impact of responsible household consumption on firm production choices is receiving increased attention from policy makers and academia (Peloza et al., 2013) as well. However, the focus of academic research is mainly based on consumer behavior (Nguyen et al., 2019; White et al., 2019) and how more sustainable production can increase demand for goods. In contrast, our paper contributes to the literature by analyzing the interplay between responsible investment, production, and consumption.

There is a second strand of related literature, dealing with the optimal taxation of financial markets and institutions. These models typically assume that a policy maker needs to collect taxes, mixing between different resources of tax income. It would then try to find a mix that *minimizes* the distortions and utility losses of households (see the seminal work of Diamond and Mirrlees (1971a,b), and also Grubert and Mackie (1999), Auerbach and Gordon (2002), Boadway and Keen (2003), Buettner and Erbe (2014), for example). In our approach, responsible households want to *maximize* the distortion they generate given an acceptable loss of utility.[6] Conceptually, our responsible households can also be

[6]If responsible households had political clout, they could convince the policy maker to introduce a

interpreted as responsible countries that try to commit to an international agreement on the restriction of a negative externality such as a commitment to reduce carbon dioxide emissions, e.g., by introducing a Pigouvian tax.

The remainder of the paper is organized as follows. Section 2 introduces the model, including socially responsible households and presents our main results. Section 3 investigates the impact outcome if responsible households can coordinate on a social action. The section also discusses how households can commit to reducing dirty investment and consumption, for example, by implementing a system of peer pressure ("shame & blame"). Section 4 analyzes the role of competition between firms and asks which investment and consumption strategy best induces firms to implement a cleaner technology. Section 5 analyzes how household heterogeneity (e. g., in preferences) influences the outcome. Section 6 concludes.

2 The Model

Setting. Consider an economy with a continuum of households of mass 1, each endowed with an initial wealth of w_0. Households first take an investment decision, earn a stochastic return, and then decide how much of the produced good to consume. The good is produced by a continuum of firms whose production function is $Q = I/c$, where Q is the production quantity, I is the aggregate investment and c is the production cost parameter. The firms' profit is

$$\Pi = (P + \varepsilon)\, Q = (P + \varepsilon)\, I/c, \tag{1}$$

where P is the price that clears the product market, and $\varepsilon \sim N(0, \sigma)$ is a normally distributed exogenous shock with zero mean and standard deviation σ. This shock introduces risk into the firms' profits. It can be interpreted as the uncertainty that stems from selling the firm's real assets.

Pigovian tax on the good with the negative externality. In this paper, we implicitly assume that this political way is not an option. One reason might be that responsible households do not have a majority, or that the externality occurs globally whereas the political system is implemented at regional levels.

The firms' profits are shared between investors, i. e., households that have invested in the firm. Given an aggregate investment I, a household that has invested i owns a fraction i/I of the shares. It has a claim on the fraction $i \cdot \Pi/I$ of firm profits. Households decide individually. Because household types have homogeneous preferences only symmetric equilibria exist. We can, thus, omit an index for each single household. The *gross* risk-free rate is r_f. In addition to consuming the good, households derive utility from money that they can use to consume other goods outside the focus of this model.

The production and consumption of the good generate an externality. Let x_{C} denote the per-unit externality from consumption. Examples are the hazards of passive smoking, or the carbon emissions from driving a car, and so forth. Let x_{P} denote the per-unit externality from production. Examples are the ecological impact of intensive agriculture, the pollution and emissions of production plants, and so forth. Because of the linear production technology, input and output are proportional, hence it does not matter whether the externality occurs in the production process or at consumption. We can simply denote $x = x_{\mathrm{C}}/c + x_{\mathrm{P}}$ as the aggregate externality, with

$$x\, I = x_{\mathrm{C}}\, Q + x_{\mathrm{P}}\, I = x_{\mathrm{C}}\, I/c + x_{\mathrm{P}}\, I. \tag{2}$$

The aggregate x can be positive or negative in general, but we will concentrate on the negative externality case. This makes the good a "dirty" good. Households have the nested utility function

$$U = u\big(m + a\, q - b\, q^2/2 - x\, I\big) \quad \text{with} \quad u(c) = -e^{-\rho\, c} \tag{3}$$

where m is the amount of money left for the consumption of other goods that do not cause externalities. The quantity of the dirty good consumed is q, the preference for the product is a, and b measures its substitutability. The coefficient ρ gives the absolute risk aversion. As in (2), I is the aggregate investment volume of the firm, and x is the externality.

There are two types of households. A fraction $1-\gamma$ are *standard* households who do not care about the externality in their individual decisions. They invest i_{S} and consume q_{S} to maximize their expected utility. A fraction γ is called *responsible*. Responsible households want to reduce the negative externality. In exchange for such an impact, responsible households are willing potentially to sacrifice some of their utility. We first analyze which consumption and investment strategy optimizes the trade-off between impact and utility.

Later in Section 3, responsible households are able to coordinate with other responsible households on an optimal social action. The extent of that action depends on the responsible group size and the size of the externality.

To reduce the externality, responsible households can affect the supply side via their investment decision $i_\text{R} = i_\text{S} - \Delta i$, where Δi denotes the divestment from dirty production, and the demand side via their consumption choice $q_\text{R} = q_\text{S} - \Delta q$, where Δq denotes the responsible reduction in dirty consumption. However, they face two challenges: (i) their individual actions have very little impact, and (ii) their impact may be partially undone by the other market participants. Given the optimal behavior and responses of standard households, we first analyze the *effectiveness* of each responsible action $\Delta i > 0$ and $\Delta q > 0$ in reducing the externality. We then derive the *efficient* combination of responsible investment Δi and consumption Δq for any target impact level. Finally, we analyze the optimal target impact level, to which responsible households commit if they can coordinate their actions in both markets. The timeline of the model is given in Figure 1.

$t = 0$

- Households born with wealth w_0.
- Firms have no capital.
- *Capital market:* Each household invests i of w_0 into firms.
- *Production:* Firms invest aggregate $I = \sum i$ and produce $Q = I/c$ of the dirty good.

$t = 1$

- *Product market:* Firms sell dirty good to households at price P.
- A profit shock εQ hits the firm.
- Profits are distributed to investors.
- Households consume dirty good and use remaining wealth for other consumption.

Figure 1: Sequence of Events

Product Market Equilibrium. To solve the model by backward induction, we start with the product market. Resulting from the earlier investment decision, a standard household has wealth w_S at date $t = 1$. The wealth may depend on the outcome of earlier investment decisions, and potentially differ from that of responsible households. Given

w_{S}, each standard household decides on how much to buy of the good in $t = 1$. The budget constraint is $m_{\mathrm{S}} = w_{\mathrm{S}} - P\, q_{\mathrm{S}}$. Its objective function is therefore

$$U_{\mathrm{S}} = -e^{-\rho\,(w_{\mathrm{S}} - P\, q_{\mathrm{S}} + a\, q_{\mathrm{S}} - b\, q_{\mathrm{S}}^2/2)}\, e^{\rho\, x\, I} \tag{4}$$

The first order condition is

$$\frac{\partial U_{\mathrm{S}}}{\partial q_{\mathrm{S}}} = \rho\,(a - b\, q_{\mathrm{S}} - P)\, e^{-\rho\,(w_{\mathrm{S}} - P\, q_{\mathrm{S}} + a\, q_{\mathrm{S}} - b\, q_{\mathrm{S}}^2/2)}\, e^{\rho\, x\, I} = 0, \tag{5}$$

and we obtain

$$q_{\mathrm{S}}^* = \frac{a - P}{b}. \tag{6}$$

The optimal consumption depends on the price of the good and the preferences for it, but is independent of the wealth w_{S}. If responsible households behaved like standard households, aggregate consumption would be $Q = (a - P)/b$. To behave responsible they may reduce their consumption by Δq and consume only $q_{\mathrm{R}} = q_{\mathrm{S}}^* - \Delta q$. The aggregate demand is therefore

$$\begin{aligned} Q &= \frac{a - P}{b} - \gamma \Delta q, \quad \text{or equivalently} \\ P &= a - b\,(Q + \gamma \Delta q). \end{aligned} \tag{7}$$

Due to the nested structure of the utility function, neither the households' risk aversion nor return expectations play a role for their consumption choices. The inner utility function yields a linear demand function for the good. Responsible consumption (Δq) reduces the market price of the dirty good, which makes it more attractive for standard households.

Capital Market Equilibrium. Now we proceed to date $t = 0$ in the backward induction. Anticipating the optimal consumption choices at $t = 1$, standard households decide how much to invest into the firm and into other assets. Each household is marginal, hence they take the aggregate investment I as given. With $Q = I/c$, the return r from an individual investment is

$$\begin{aligned} r &= \frac{\gamma}{I} = \frac{(P + \varepsilon)\, Q}{I} = \frac{P + \varepsilon}{c} \\ &= \frac{1}{c}\Big(a - b\,(Q - \gamma \Delta q) + \varepsilon\Big) \end{aligned} \tag{8}$$

The return r decreases in the aggregate investment. A higher investment leads to a higher output, which depresses the prices and thus the firms' profits. Due to the profit shock ε, the return r is normally distributed with mean P/c and standard deviation σ/c. Substituting q_{S}^* into (4), we obtain the *standard* household's expected utility

$$U_{\mathrm{S}} = -e^{\frac{(a-P)^2}{2\,b}}\, e^{\rho\, x\, I} \int -e^{-\rho\, w_1}\, f(w_1)\, dw_1. \tag{9}$$

If *standard* households invest i_{S} of the initial wealth, they receive a random $r\, i_{\mathrm{S}}$ from that investment, in addition to the safe return $(w_0 - i_{\mathrm{S}})\, r_f$. The household's wealth at date $t = 1$ will be $w_1 = (w_0 - i_{\mathrm{S}})\, r_f + r\, i_{\mathrm{S}}$. It chooses i_{S} to maximize expected utility

$$\mathrm{E}U_{\mathrm{S}} = -e^{\frac{(a-P)^2}{2\,b}}\, e^{\rho\, x\, I}\, e^{-\rho\left((w_0 - i_{\mathrm{S}})\, r_f + i_{\mathrm{S}}\,(\frac{a}{c} - \gamma x - \frac{b}{c^2}\, I - i_{\mathrm{S}}\, \rho\, \sigma^2/2)\right)}. \tag{10}$$

The first order condition with respect to i_{S} yields

$$i_{\mathrm{S}}^* = c^2\, \frac{P/c - r_f}{\rho\, \sigma^2}. \tag{11}$$

In the aggregate, the capital market must clear:

$$I^* = c^2\, \frac{P/c - r_f}{\rho\, \sigma^2} - \gamma \Delta i. \tag{12}$$

Substituting the equilibrium price (7) yields

$$Q^* = \frac{1}{b + \rho\, \sigma^2}\left((a - c\, r_f) - \gamma\,(\Delta q\, b + \Delta i\, \rho\, \sigma^2/c)\right). \tag{13}$$

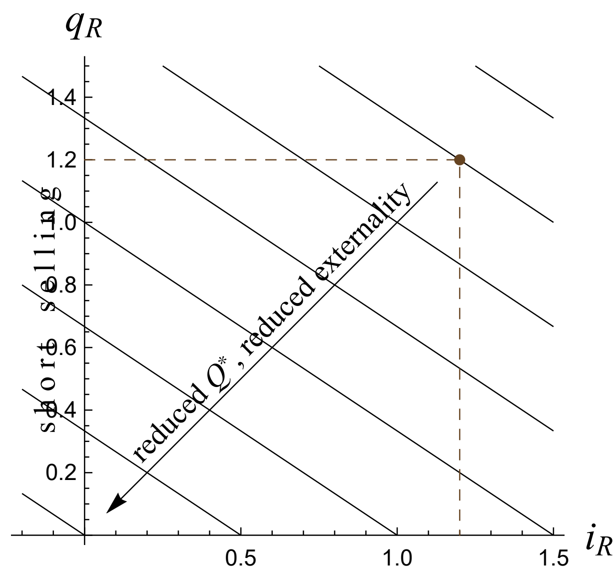
This proves our first result.

Proposition 1 (Effectiveness) *Both divestment Δi and consumption reduction Δq are effective measures to reduce the aggregate externality in equilibrium. The marginal rate of transformation between a reduction in investment (SRI) and a reduction in consumption (SRC) is*

$$MRT = \frac{\rho \sigma^2}{b}\, \frac{1}{c}.$$

The marginal rate of transformation reflects the amount of dirty consumption that responsible households can additionally consume if they give up a unit of dirty investment and hold their impact level constant. It measures the relative effectiveness between SRI

Figure 2: Impact of Reducing q_{R} or i_{R}



Here, and in all following figures: $c = 1, \sigma = 1, \rho = 1/3, a = 2, b = 1/2, x = 1, \gamma = 1/3$ and $r_f = 1$.

and SRC. Both a reduction in investment i_{R} and in consumption q_{R} have a comparable impact. The effectiveness of a reduction in investment i_{R} increases in the asset risk risk σ, and risk aversion ρ. The effectiveness of a reduction in consumption q_{R} increases in the product specificity b.

Figure 2 illustrates the proposition, showing that i_{R} and q_{R} have a symmetric impact. In the absence of responsible households, $Q^* = (a - c\, r_f)/(b + \rho\, \sigma^2)$. This is the individually rational choice of standard households, denoted by the brown point at $i = 1.2$ and $q = 1.2$. The parallel lines are iso-impact lines; their slope is the MRT. If responsible households reduce investment or consumption, also the aggregate externality $x\, I$ goes down.

We now analyze which mix of consumption reduction Δq and investment reduction Δi optimizes the responsible household's trade-off between expected utility and impact.This optimization requires that for any target impact, the household chooses the combination of q_{R} and i_{R} that maximizes expected utility. The marginal rate of substitution (MRS), defined by the household's utility function, must equal the marginal rate of transformation (MRT), defined by the standard households' reaction. According to the following proposition, this holds if Δq and Δi are proportional.

Proposition 2 (Efficiency) *The efficient responsible behavior satisfies*

$$\frac{\Delta q^*}{\Delta i^*} = \frac{1}{c}. \tag{14}$$

It is always optimal to reduce investment and consumption by the same factor, such that the equilibrium price and asset return remain unchanged.

The proof is algebraically involved but straightforward. Take the target I^* as constant, then $Q^* = I^*/c$ is also constant. Solve (13) for q_R, and substitute into U_R. The first order condition with respect to i_R yields the optimal i_R, and then also q_R. Looking at the ratio between the two and at the second order condition completes the proof. ■

Figure 3: Expected Utility of Responsible Households

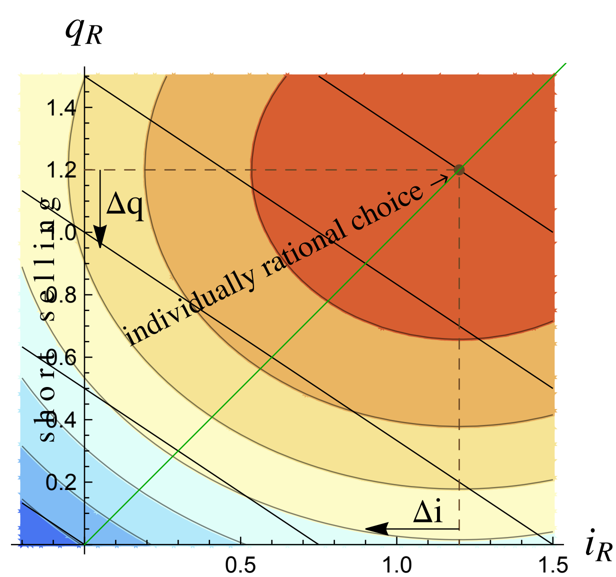


Figure 3 shows how the expected utility of individual responsible households depends on q_R and i_R (warm colors stand for high utility). The individual utility is maximized at $\Delta i = \Delta q = 0$. If responsible households want to have an impact, they must deviate from this point towards the origin. For each impact level, the utility is maximized on the green line, given by $q^*_\mathrm{R} = i^*_\mathrm{R}/c$, and thus also $\Delta q^* = \Delta i^*/c$.

There is an additional interesting property of the equilibrium. For given Δi and Δq, the equilibrium price is

$$P = \frac{b\,c\,r_f + a\,\rho\,\sigma^2}{b + \rho\,\sigma^2} + \gamma\,\frac{b\,\rho\,\sigma^2}{(b + \rho\,\sigma^2)}\,(\Delta q - \Delta i/c). \tag{15}$$

and the expected yield is

$$r = \frac{1}{c}\left(\frac{b\,c\,r_f + a\,\rho\,\sigma^2}{b + \rho\,\sigma^2} - \gamma\,\frac{b\,\rho\,\sigma^2}{(b + \rho\,\sigma^2)}\,(\Delta q - \Delta i/c)\right). \tag{16}$$

If responsible households efficiently reduce their dirty investment and consumption such that $\Delta q^* = \Delta i^*/c$, both the market price P for the good and the expected return from investment are the same as in the absence of responsible households. Consequently, the standard households' consumption level q^*_{S} and investment level i^*_{S} remain unchanged. In principle, responsible households could reduce consumption relatively more than they reduce investment. This would imply that the price for the good would decrease, and standard households would buy more of it. On the other hand, the financing cost for the firm would increase, and standard households would invest less. Responsible households could also do the opposite, reduce investment relatively more than consumption. Then the standard households' reaction would go in the opposite direction. Proposition 2 states that neither of this disproportionate reductions are efficient. The same impact can be achieved with a smaller reduction in utility. The rationale is that any disproportionate change is offset at least partially by the market response of standard households. If the utility loss from a reduction in the investment Δi is low, e. g., because risk aversion or the risk itself are low, it is also very easy for standard households to substitute for the reduced investment. The same is true for a reduction in q_{R}. Therefore, the highest impact results from a proportional reduction in both investment and consumption.

3 Coordinated Action

Up to now, we have considered the optimal combination of responsible reductions in consumption and investment to achieve a given target impact level. But how do responsible households decide on their target impact level? The individual impact of each individual responsible household is infinitesimally small. By reducing consumption and investment, each household can only achieve a marginal impact on the externality, but suffers a discrete utility loss. It is thus rational from the individual perspective to neglect the negative externality. However, from a collective perspective, households can benefit from responsible behavior. They profit not only from their own infinitesimal impact, but also from that of other responsible households. We therefore assume now that responsible households can coordinate on implementing the collectively optimal action.

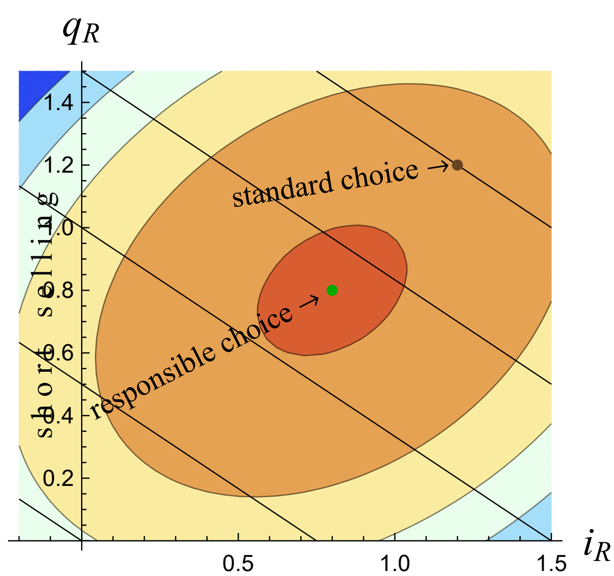
Proposition 3 (Optimum under Coordination) *If $\gamma x \leq a/c - r_f$, responsible households optimally coordinate on*

$$\Delta q^* = c\,\frac{\gamma\, x}{b + \rho\,\sigma^2} \quad \textit{and} \quad \Delta i^* = c^2\,\frac{\gamma\, x}{b + \rho\,\sigma^2}. \tag{17}$$

In the absence of short-selling, if $\gamma x > a/c - r_f$, households consume nothing and invest nothing.

Given these choices, because $i_R^* = c\, q_R^*$ as in Proposition 2, the equilibrium price P and standard households' choices i_{S} and q_{S} are all independent of x and γ.

Figure 4: Expected Utility of Responsible Households, $\gamma = 1/3$, $x = 1$



We illustrate the optimal choice of a collective action in Figure 4. In the figure, $\gamma = 1/3$ of households are responsible, and the externality is $x = 1$. If responsible households collectively reduce q_{R} and i_{R}, they profit from the reduced externality. The optimal point is at $q_\mathrm{R}^* = 0.8$ and $i_\mathrm{R}^* = 0.8$. As before, it is optimal for responsible households to reduce investment and consumption proportionally. An increase in the externality x or the fraction of responsible households increases moves the collectively optimal point towards the origin. For $\gamma\, x = a/c - r_f$, the origin is reached. For $\gamma\, x > a/c - r_f$, it is collectively optimal to consume nothing, $q_\mathrm{R}^* = 0$, and (if that is possible) to short-sell shares,

$$i_\mathrm{S}^* = -\frac{c\,(1-\gamma)\,(c\,(r_f + x\,\gamma) - a)}{b\,(c^2\,(1-\gamma) + 2\,\gamma) + c^2\,(1-\gamma)\,\rho\,\sigma^2} < 0.$$

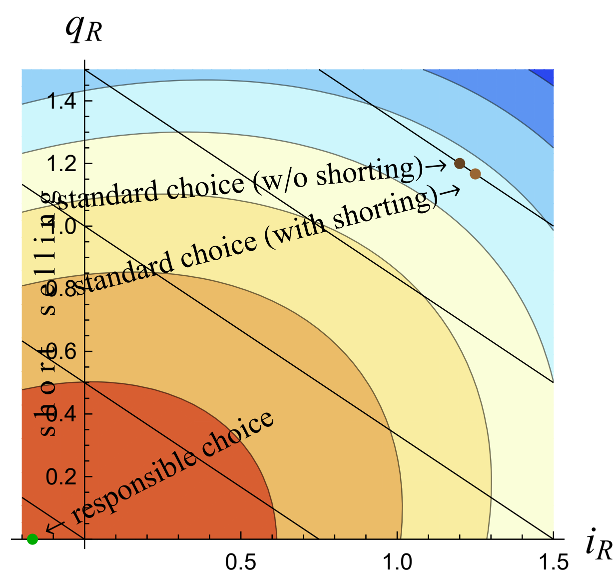
With short selling, investment and consumption are no longer reduced in proportion. Therefore, the responsible behavior now also affects the equilibrium price P. Standard households react by investing more and consuming less. This is visible in Figure 5. The standard choice in the absence of short-selling would be $i_\mathrm{S}^* = 1.2$ and $q_\mathrm{S}^* = 1.2$. In the presence of short-selling, $i_R^* = -0.17$, and standard households react with $i_\mathrm{S}^* = 1.25$ and $q_\mathrm{S}^* = 1.17$. Because standard households have reduced their consumption, and responsible households are already at zero, the externality is further reduced. Without short-selling, $Q^* = 0.8$, with short-selling, it is $Q^* = 0.78$. The numerical example also underlines that, if consumption and investment are not reduced proportionally, the impact is relatively small. In the figure, the two brown points (with and without shortselling) are seemingly on the same iso-impact line. The difference in impact is tiny.

So far we simply assumed responsible households could commit to a level of investment and consumption. However, without any credible commitment, responsible households would have an individual incentive to deviate from the collectively chosen consumption and free-ride on the responsible behavior of others. Households thus require a commitment device. We consider two devices: taxation and a mechanism based on "shame & blame".

Taxation. The γ responsible households can be interpreted as members of a country or some other political entity. They could then vote to implement a tax τ_I on investment, and a tax τ_C on consumption. If there are no administrative costs, investment and consumption are perfectly observable, and if taxes are redistributed to the households in the entity, the collectively optimal decision of Proposition 3 can be implemented.

Shame & Blame. In the absence of political institutions, responsible households can also be interpreted as members of a social group of size γ. Because of their potential

Figure 5: Expected Utility of Responsible Households, $\gamma = 1/3$, $x = 11/3$



connection, members can observe the actions of the others (e.g. through social media). To reduce the externality, the members of the group can shame & blame each other for the investment in the dirty industry, or the consumption of the dirty good. Assume that exerting shame & blame is free, but it leads to a reduction in utility of the blamed household by g_I for each dollar invested, and g_C for each unit consumed.[7] It is equivalent to a tax that is not restituted to the group. Shame & blame, thus, directly affects the expected utility of each household, similar to a warm glow (see Andreoni, 1990) with a negative sign. The utility function of a responsible household becomes

$$U_{\mathrm{R}} = u\big(m + a\, q_{\mathrm{R}} - b\, q_{\mathrm{R}}^2/2 - x\, I - g_{\mathrm{I}}\, i_{\mathrm{R}} - g_{\mathrm{C}}\, c\, q_{\mathrm{R}}\big). \tag{18}$$

The direct disutility from shame & blame is zero in the two limiting cases: If $g_I = 0$ and $g_C = 0$ such that households do not shame & blame each other, and if $i_{\mathrm{R}} = 0$ and $q_{\mathrm{R}} = 0$ such that responsible households abstain from any dirty investment and consumption. If responsible households gradually reduce their investment and consumption as in Proposition 3, shame & blame reduces the responsible households' utility. This additional

[7]The disutility can also be interpreted as a feeling of guilt. However, shame & blame can be chosen endogenously, whereas guilt, as part of the utility function, might be seen as exogenous.

reduction in utility creates a centrifugal force. These forces make any mix of SRI and SRC inefficient if households can only commit to responsible behavior by shaming and blaming each other.

To see this, consider first the demand for the product of responsible households

$$q^*_{\mathrm{R}} = \frac{a - P - c\,g_{\mathrm{C}}}{b}, \tag{19}$$

toned down due to disutility g_{C}. Similarly, the investment for a given share price is

$$i^*_{\mathrm{R}} = \frac{P/c - r_f - g_I}{\rho\,\sigma^2}. \tag{20}$$

In combination with the market clearing conditions on the product market and the stock market, and the demand of standard households, we obtain an aggregate quantity

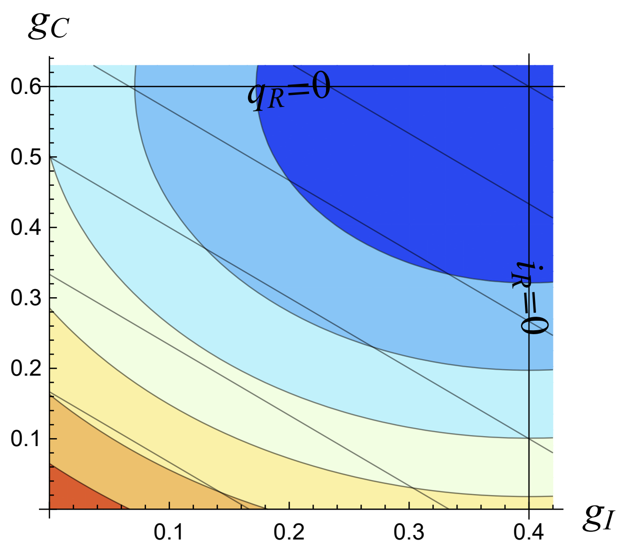
$$Q^* = \frac{a - c\,(r_f + \gamma(g_{\mathrm{I}} + g_{\mathrm{C}}))}{b + c^2\,\rho\,\sigma^2}. \tag{21}$$

The disutility from investment g_I and from consumption g_C have an identical effect on aggregate production Q^*. If ρ is low, an increase in g_I has a strong effect on investment by responsible households i^*_{R}, but the standard households are also more willing to substitute by investing more. The role of risk aversion cancels out. The same holds for a larger b. Figure 6 shows the iso-impact lines as black diagonals. Each line has a slope of -1. The impact is lowest at the origin and increases towards the north-east.

The figure also shows the expected utility of responsible households, depending on the disutility from investment g_I and that from consumption g_C. In the numerical example, for $g_I = 0.4$, investment i_{R} by responsible households becomes zero. For $g_C = 0.6$, consumption q_{R} by responsible households becomes zero. Increasing g_I or g_C above these levels has no additional impact.

The disutility created from shame & blame has an important implication for the optimal individual choice. For a given target impact on the externality, the utility-maximizing choice is always a corner solution. In contrast to Proposition 2, responsible households now focus on *either* divestment or consumption reduction. For small impact levels, it consists of either reducing investment (by an increase in g_I), or reducing consumption (by an increase in g_C), but not both. For large impact levels, it consists of either $q_{\mathrm{R}} = 0$ or

Figure 6: Expected Utility of Responsible Households



$i_{\mathrm{R}} = 0$, and a reduction of the other amount. The rationale is the mentioned centrifugal force due to the direct disutility induced by guilt.

Also the insights from Proposition 3 change. The collectively optimal choice does not depend continuously on the fraction γ and the externality x. The optimal shame & blame policy is rather binary. For low levels of γ and x, it is optimal to do nothing and set $g_I = g_C = 0$. At the point

$$2\,\gamma\,x = a/c - r_f,$$

it becomes optimal to set g_I and g_C to a level that prevents responsible households from both dirty investment and dirty consumption. In a sense, the responsible households' choice is always extreme. Either they behave just like standard households (for low $\gamma\,x$), or they neither invest nor consume (for high $\gamma\,x$). In that second case, they use shame & blame on each other, but because they neither invest nor consume, this does not create any direct disutility. The group size becomes crucial for social action. If the group size is too small, given the externality, responsible households fail to coordinate on reducing the externality. If the group size is large enough, responsible households credibly commit to reduce the externality without any direct disutility from shaming and blaming. The coordination implies a commitment on a shame & blame threat that deters any dirty investment or consumption of the group members.

Empirical Implications of Imperfect Coordination. Commitment to coordinated social action can be achieved in several ways. Coordination might be more feasible in one market than in the other. On the one hand, one could argue that investing in a green fund offers a natural way of coordinating SRI. Yet, the individual investment decision is hard to observe. Consumption behavior on the other hand, might be easily observed such that coordination based on peer pressure might be more feasible for SRC. Our model implies testable empirical implications for the case where households can better coordinate in one market than in the other. We use (16) to derive the implications of responsible household behavior on the financial performance of SRI.

If responsible households can coordinate on SRC, but fail to coordinate on SRI, green investments yield a lower financial performance than dirty shares. If responsible households focus on SRI, neglecting SRC, green investments outperform dirty shares. This result may explain why empirical papers obtain contradicting results on the relative performance of green investments over time and in different countries.

4 Market Power and Green Transition

In our baseline model we assume that the producers sell their goods under perfect competition. The residual profit of firms is zero, because all profits are allocated to households. We now consider a monopolistic firm.[8] For exposition, assume that the monopolist is penny-less and very risk averse. In the absence of a moral hazard problem, the monopolist chooses to hold no shares by herself, but to earn a fixed margin m. The time structure is: the monopolist first sets her margin m. Responsible households consider how much to consume and to invest. The monopolist sells the shares of the firm on the capital market, produces, and sells the goods on the product market.

There is one major change in this setting. The firm still has earnings of $\gamma = (P + \varepsilon)\, Q$, but now the margin m is deducted, so the profit is $\gamma = (P - m + \varepsilon)\, Q$. For shareholders,

[8] In our model, the degree of competition is assumed to be exogenous. Aghion et al. (2019) propose a model in which firms can implement a clean technology to reduce competition. To some degree, this is also captured in this section, when firms choose a cleaner technology to attract more customers.

the return per unit of investment is thus $\gamma/I = (P - m + \varepsilon)/c$. In analogy to (11), the investment supply of standard households is then

$$i_S^* = c^2\,\frac{(P-m)/c - r_f}{\rho\,\sigma^2}.$$

Product demand is unchanged. For given i_{R} and q_{R}, the equilibrium quantity is

$$Q^* = \frac{1}{b+\rho\,\sigma^2}\Big((1-\gamma)\,(a-m-c\,r_f) + \gamma\,(q_{\mathrm{R}}\,b + i_{\mathrm{R}}\rho\,\sigma^2/c)\Big). \tag{22}$$

The responsible households' effect on the equilibrium quantity is unchanged. Proposition 1 does not even have to be adapted. Also Proposition 2 is unchanged. For any given impact level, the ratio $i_{\mathrm{R}}^*/q_{\mathrm{R}}^* = c$ is constant. This means that responsible households should reduce investment and consumption in proportion. The choices of standard households are unaffected. If responsible households can coordinate, their optimal choice is

$$\begin{aligned} i_{\mathrm{R}}^* &= c\,\frac{a-m-c\,(r_f+\gamma\,x)}{b+\rho\,\sigma^2},\\ q_{\mathrm{R}}^* &= \frac{a-m-c\,(r_f+\gamma\,x)}{b+\rho\,\sigma^2}. \end{aligned} \tag{23}$$

Hence, the message from Proposition 3, that responsible households should reduce investment and consumption in proportion, holds true in the absence of competition. The according equilibrium quantity is

$$Q = \frac{a-m-c\,(r_f+\gamma^2\,x)}{b+\rho\,\sigma^2}.$$

The monopolist will maximize $m\,Q$ and thus set

$$m^* = \frac{a-c\,(r_f+\gamma^2\,x)}{2}, \tag{24}$$

resulting in an equilibrium quantity of

$$Q^* = \frac{a-c\,(r_f+\gamma^2\,x)}{2\,(b+\rho\,\sigma^2)}.$$

Hence, the quantity is reduced by half, no matter whether responsible households are present or not. Inserting (24) into (23) shows that the equilibrium investment and consumption of responsible households decrease by half. In proportion to the choices of standard households, the optimal divestment and cutting consumption are unchanged in the monopoly.

The Green Transition. In the basic model, the externality is assumed to be fixed. More realistically, firms can choose between different production technologies. The engagement literature on SRI argues that responsible investors can affect the firms' choice of production technology. Rather than simply divesting from dirty firms, they can try and make dirty firms cleaner (Chowdhry et al., 2018; Landier and Lovo, 2020; Oehmke and Opp, 2020; Krahnen et al., 2021). In the model, one technology (dirty) may be cheaper, whereas the other (clean) may lead to fewer emissions. Responsible investors exert pressure on dirty firms by not buying their shares or products, thus reducing their profits. In analogy to the basic model, we analyze whether responsible households have a higher effect on the choice of a production technology when investing responsibly, or consuming responsibly.[9]

Consider the following time structure. The monopolist first chooses her profit margin, and a production technology. A reduction of the externality is accompanied by an cost increase. After the production technology has been selected, responsible households decide how much to invest and to consume, anticipating the standard households' reaction. We assume that responsible households are able to coordinate on the optimal divestment and consumption reduction characterized in Proposition 3.

The optimal margin m^* is given by (24), leading to an expected profit for the monopolist

$$m^* \, Q^* = \frac{\left(a - c\,(r_f + \gamma^2 \, x)\right)^2}{4\,(b + \rho\,\sigma^2)}.$$

This profit is decreasing in both c and x. Now assume that the cost c is a decreasing function of the externality, $c'(x) < 0$, and it is zero at the maximal emission, $c(x_{\max}) = 0$. The monopolist will then reduce emissions until $c'(x) = -\frac{\gamma^2 \, c(x)}{r_f + \gamma^2 \, x}$, or equivalently

$$-\frac{c'(x)}{c(x)} = \frac{\gamma^2}{r_f + \gamma^2 \, x}.$$

This implies that, if there are no responsible households at all ($\gamma = 0$), the monopolist will not bother to reduce the externality and choose $x = x_{\max}$. The higher the fraction

[9] In a more complex model, responsible investors could buy shares of dirty firms and then use their voting rights to push the firm towards implementing a cleaner technology. To do so, they need to hold a considerable fraction of shares, or one needs to assume probabilistic voting. Otherwise, a minority of responsible investors has no clout.

γ, the more the monopolist will invest in its reduction. Only the amount of responsible households matters because they optimally reduce their consumption proportional to their divestment. The lower the externality, the more willing are responsible households to consume and invest. This creates an ex ante incentive for the monopolist to choose a lower production externality. Given that responsible households exist, the monopolist chooses a lower production externality, the lower the risk-free rate r_f and (cum grano salis) the higher the initial externality x.

5 Heterogeneity

In the basic model, standard and responsible households have identical preferences. In reality, this need not be the case. For example, one could interpret standard investors as large institutional investors, which might have better diversification opportunities, and therefore a smaller effective degree of risk aversion. Moreover, the dirty good might be a regional product. Standard households could then be interpreted as international consumers in the market, caring less about consuming the good. Such a heterogeneity may affect our results. For example, if responsible households are more risk averse, they will start from a lower level of investment, even if their intended impact level was zero. On the other hand, once the more risk averse responsible households reduce their investment, less risk averse standard households will react stronger and increase their investment more, because they care less about the increased risk exposure. In this section, we analyze the aggregate effects of possible heterogeneity in preferences.

Heterogeneous Risk Aversion. We first analyze the effect of different degrees of risk aversion. Responsible households may have fewer possibilities to diversify, and may therefore be more risk averse than standard households such that it is reasonable to assume $\rho_{\mathrm{R}} \neq \rho_{\mathrm{S}}$. We concentrate on the case $\rho_{\mathrm{R}} > \rho_{\mathrm{S}}$.

Equation (13) depends only on the standard households' preferences, but not on those of responsible households. Consequently, Proposition 1 refers exclusively to the risk and consumption preferences of standard households. For $\rho_{\mathrm{R}} > \rho_{\mathrm{S}}$ the marginal rate of technical substitution for an impact on the externality becomes

$$\text{MRT} = \frac{\rho_{\text{S}}\,\sigma^2}{b}\frac{1}{c}.$$

The effect of a reduction in investment i_{R} decreases if *standard households'* risk aversion ρ_{S} is small.

Proposition 2 also changes. While it is still optimal to reduce investment and consumption in proportion, the optimal ratio changes to

$$q^*_{\text{R}} = \frac{1}{c}\,\frac{(1-\gamma)\,\frac{\rho_{\text{R}}}{\rho_{\text{S}}} + 2\,\gamma}{1+\gamma}\,i^*_{\text{R}}.$$

The intuition is the following. If the risk aversion of responsible households is higher than that of the standard households, reducing investment is relatively costly for responsible households and will be nearly completely offset by standard households. However, in equilibrium, responsible households will not invest much anyway due to their high risk aversion. Hence, it is efficient to reduce investment only a little, but also from a low starting level. This, in the end, leads to the proportionality result. Both investment and consumption are reduced in proportion.

Figure 7: Expected Utility of Responsible Households, $\rho_{\text{R}} > \rho_{\text{S}}$

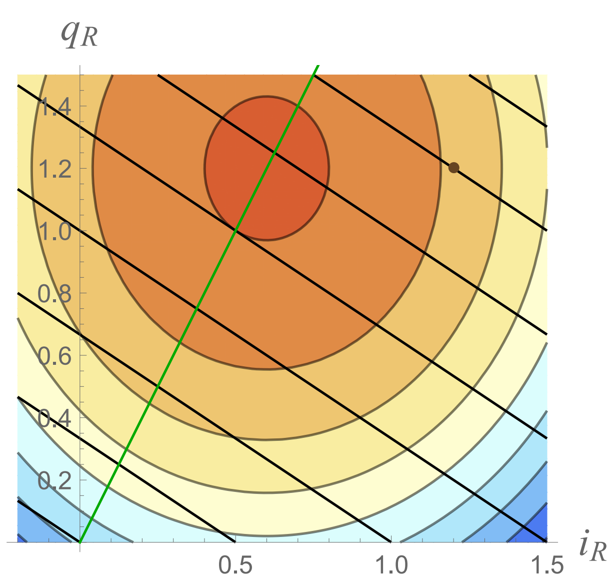


Figure 7 illustrates the effects. The brown point shows the combination of investment and consumption for standard households. In the example, $\rho_{\mathrm{R}} = 2\,\rho_{\mathrm{S}}$, thus the optimal investment by responsible households is half as large. The optimal consumption is identical. For each impact level, given by the black diagonal lines, the utility of responsible households is maximized on the green line. In comparison to Figure 3, the green line is steeper, but it still goes through the origin. Responsible households should still reduce investment and consumption proportionally.

Heterogeneous Product Preferences. Similar to the better diversified international investors, international standard households might have a lower preference for the local product, $a_{\mathrm{S}} < a_{\mathrm{R}}$. In (13), the parameter a only depends on the standard households such that we can replace it with a_{S}. The heterogeneity of product preferences does not affect Proposition 1. However, Proposition 2 needs to be adapted. The optimal combination of i_{R} and q_{R} now satisfies

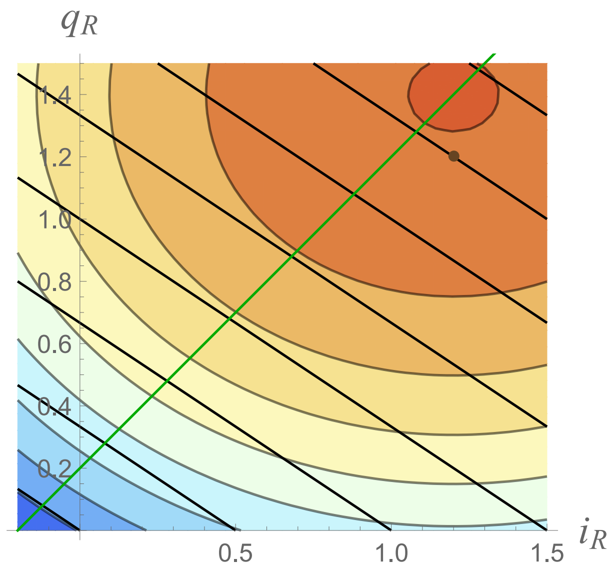
$$q^*_{\mathrm{R}} = \frac{1}{c}\, i^*_{\mathrm{R}} + \frac{1-\gamma}{1+\gamma}\,\frac{a_{\mathrm{R}} - a_{\mathrm{S}}}{b}.$$

Due to the preference heterogeneity, it is no longer optimal for responsible households to reduce i_{R} and q_{R} in the same proportion. In the case that $a_{\mathrm{S}} < a_{\mathrm{R}}$, the investment should be reduced more than proportionally.

We illustrate this point in Figure 8, which shows the expected utility of responsible households with a stronger preference for the good, $a_{\mathrm{R}} = 2.1 > a_{\mathrm{S}} = 2.0$. The utility-maximizing investment is still at $i^*_{\mathrm{R}} = 1.2$, but the consumption increases to $q^*_{\mathrm{R}} = 1.4$. Standard households optimally invest the same amount, but consume less. For each targeted impact level, responsible households maximized their consumption on the green line. In comparison to Figure 3, the line is shifted upwards by $\frac{1-\gamma}{1+\gamma}\,\frac{a_{\mathrm{R}}-a_{\mathrm{S}}}{b}$. Here, $a_{\mathrm{R}} - a_{\mathrm{S}} = 0.1$, $b = 0.5$, and $\gamma \to 0$, such that the shift is 0.2. In the numerical example, investment should be reduced more than proportionally, consumption should be reduced less than proportionally. For large target impact levels, short selling the shares may be optimal.

Heterogeneous Product Substitutability. The substitutability parameter b may also differ between the two groups of investors. For example, responsible investors might find it easier to switch between producers such that $b_{\mathrm{R}} > b_{\mathrm{S}}$, or vice versa.

Figure 8: Expected Utility of Responsible Households, $a_R > a_S$



Proposition 1 refers exclusively to the substitutability of standard households such that the marginal rate of technical substitution becomes

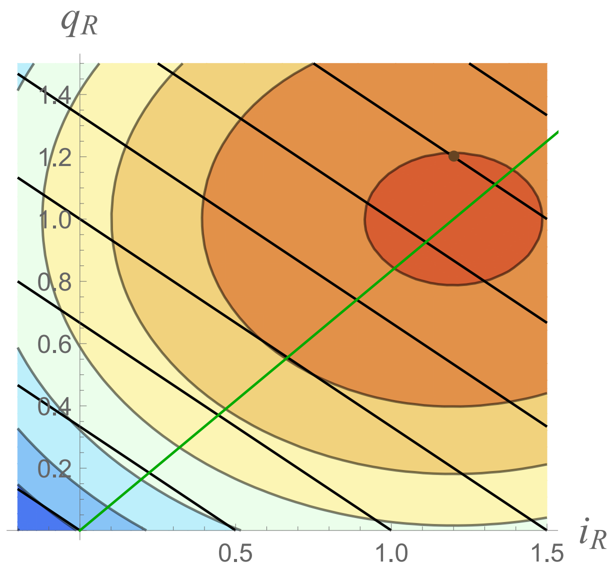
$$\frac{\rho\,\sigma^2}{b_S}\frac{1}{c}.$$

The impact of consumption reduction Δq vanishes if *standard* households' find it very easy to switch to another product. Proposition 2 also changes. It is still optimal for responsible households to reduce investment and consumption in proportion. However, the relation is now

$$q_R^* = \frac{1}{c}\,\frac{1+\gamma}{(1-\gamma)\,\frac{b_R}{b_S} + 2\,\gamma}\,i_R^*.$$

In Figure 9, we still have $b_S = 0.5$, but $b_R = 0.6$. This means that for responsible households, the utility from the good decreases faster as they consume more of it. Consequently, $i_R^* = 1.2$ still, but now $q_R^* = 1.0$ instead of 1.2. The green line, again showing the optimal combination of i_R and q_R for a given impact level, is flatter. However, it still goes through the origin; a proportional reduction in i_R and q_R is efficient.

Figure 9: Expected Utility of Responsible Households, $b_R > b_S$



6 Conclusion

Ethical concerns gain importance for retail investors. However, investment, production, and consumption decisions are intertwined and should not be studied separately. We raise the question whether small household investors should worry about ethics when investing money. Alternatively, households could focus on more sustainable consumption and worry less when investing. We develop a tractable, closed microeconomic model of interlinked capital and goods markets that allows us to analyze the optimal choice of responsible households. We show that responsible concerns matter, regardless of whether they occur when investing (socially responsible investment, SRI) or when consuming (socially responsible consumption, SRC) as long as standard households ("the others") are risk averse and find it difficult to replace the dirty good. However, to achieve the greatest impact at the lowest possible utility loss, responsible households need to reduce their dirty consumption proportionally to their divestment from dirty firms (Proposition 2). A disproportional reduction would be substituted by other market participants, at least partially, and is therefore never optimal.

If responsible households are able to coordinate, their commitment to proportional consumption and investment reduction increases with the externality and their group size. The proportionality implies that responsible households do not influence product prices and capital returns. If responsible households, however, can only coordinate in one market, market prices and returns change. A focus on SRC without coordination on SRC implies that clean firms yield a lower financial performance than dirty firms and vice versa. A commitment device to such a collective action could be a consumption and investment tax. If responsible households cannot implement such a tax, they can exert peer pressure in the form of "shame & blame" to yield an impact. Peer pressure introduces a pecking order between responsible consumption and investment, such that responsible households first focus on the market where substitution is harder. If responsible households can coordinate on a "shame & blame" policy on dirty consumption and dirty investment, they optimally go for an extreme. They either behave just like standard households, or they choose to not consume and to not invest at all. Finally, we show that the responsible behavior of households can induce change by forcing firms to choose more sustainable production technologies.

In the paper, especially for the figures and their interpretation, we have assumed that production and consumption come with a negative externality. However, the formalism holds also for the opposite sign. Hence, if the product bears a positive externality, responsible households should increase their consumption and investment by the same factor. A green financial strategy should always be part of a responsible household's behavior. They should divest from dirty industries and overinvest in clean industries.

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