Socially Responsible Finance: How to Optimize Impact?

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HKUST October 2023

Stick and carrot in a general equilibrium approach(Landier and Lovo 2022)

- There are both VA investors and Impact impact.
- Two interconnected sectors: a clean and a dirty sector.
- SR fund's ultimate objective is to maximize AUM (endogenous size of the SR fund) b ut face competition from a RM fund.
- Firms can be required to reduce their direct emission (scope 1 and 2) and /or to their upstream or downstream emission (scope 3).
- How does the SR fund investment strategy depends on investor's preference? What is the effect on social welfare?

Stick and carrot in a general equilibrium approach(Landier and Lovo 2022)

The real economy:

Standard two-good general equilibrium production economy with Cobb-Douglas preferences.

- A firm in sector $i \in \{1, 2\}$ uses **1 unit of capital and the other sector's good.**
  - Good 1 firm: $\underbrace{y_1(\overbrace{x_2}^{\text{good 2 input}}, \overbrace{e}^{\text{firm 's emission}})}_{\text{typical firm 1 's output}} = e x_2^{\alpha}, \ e \in [0, 1]$
  - Good 2 firm: $\overbrace{y_2(x_1)}^{\text{typical firm 2 's output}} = x_1^{\alpha}$

    $\alpha \in [0, 1]$
- Market portfolio: K_i: endogenous mass of firms in sector i, with $K_1 + K_2 = 1$.
- Individual utility from consumption:

$$\frac{c_1^{\gamma_1} c_2^{\gamma_2}}{(K_1 e + 1)^{\delta}},$$

$K_1 e$ is the aggregate emission.

Exogenous parameters: $\alpha \in [0, 1]$, $\gamma_2 = 1 - \gamma_1$, $\delta > 0$.

Goods demand and supply

- Good 1 (polluting)
  - Consumer demand:
$$c_1(p_1, p_2) = \gamma_1 \frac{w}{p_1}$$
  - industry 2 firm's demand:
$$x_2(p_1, p_2) = \left(\frac{\alpha p_2}{p_1}\right)^{\frac{1}{1-\alpha}}$$
  - industry 1's firm supply
$$y_1(e, p_1, p_2) = e^{\frac{1}{1-\alpha}} \left(\frac{\alpha p_1}{p_2}\right)^{\frac{\alpha}{1-\alpha}}$$
- Good 2 (clean)
  - Consumer demand:
$$c_2(p_1, p_2) = \gamma_2 \frac{w}{p_2}$$
  - industry 1 firm's demand:
$$x_1(e, p_1, p_2) = \left(e\frac{\alpha p_1}{p_2}\right)^{\frac{1}{1-\alpha}}$$
  - industry 2's firm supply
$$y_2(p_1, p_2) = \left(\frac{\alpha p_2}{p_1}\right)^{\frac{\alpha}{1-\alpha}}$$

equilibrium conditions

$$
\begin{aligned}
c_1(p_1, p_2) + K_1 x_2(p_1, p_2) &= K_1 y_1(e, p_1, p_2) && (1)\\
c_2(p_1, p_2) + K_2 x_1(e, p_1, p_2) &= K_2 y_2(p_1, p_2) && (2)\\
w &= \pi_1 K_1 + \pi_2 K_2 && (3)
\end{aligned}
$$

where
w = Consumers' wealth
π_i profit of a typical firm of industry i

Goods market equilibrium with e and K_1 exogenously fixed:

1. The profit for a typical firm in sector i is

$$\pi_i(K_i) = \frac{K_i^*}{K_i}$$

where for any $i \neq j$ one has

$$K_i^* := \frac{(\gamma_i + \alpha\gamma_j)(1-\alpha)}{1-\alpha^2}$$

2. Aggregate social welfare amounts to

$$U(e, K_1) := \beta \frac{e^{Z_1}}{(1+eK_1)^\delta} \left(\frac{K_1}{K_1^*}\right)^{K_1^*} \left(\frac{1-K_1}{K_2^*}\right)^{K_2^*} \tag{4}$$

3. A typical firms profit given good prices p_1, p_1:

$$\begin{aligned} \pi_1 &= \left(ep_1 \left(\frac{\alpha_1}{p_2}\right)^{\alpha_1}\right)^{\frac{1}{1-\alpha_1}} (1-\alpha_1) \\ \pi_2 &= \left(p_2 \left(\frac{\alpha_2}{p_1}\right)^{\alpha_2}\right)^{\frac{1}{1-\alpha_2}} (1-\alpha_{21}) \end{aligned}$$

4. An individual h equilibrium utility from consumption is linear in her revenue w_h:

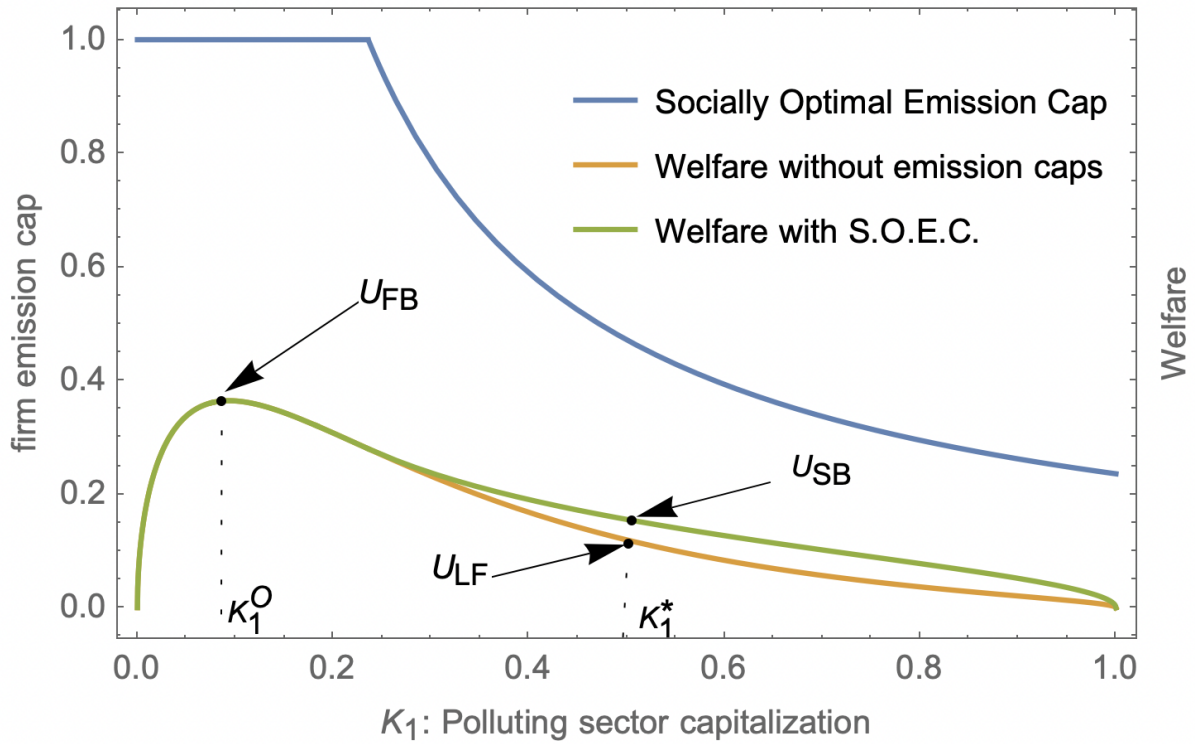
$$U_h = U(e, K_1) w_h$$

In an competitive general equilibrium economy where e and K_1 are exogenously fixed:

- A polluting sector firm's profit is increasing in the firm emission e.
- A firm equilibrium profit is decreasing with total capitalization of the firm's sector.
- Social welfare depends in a non-trivial way on the market capitalization K_1 of polluting sector and the per-firm emission e.
- Individuals indirect utility from consumption is linear in their revenuers.

Welfare maximizing firms emission regulation and planning

- There is a first-best socially optimal size $K_1^O > 0$ of the polluting sector, and $K_1^O < K_1^*$.
- If $K_1 > K_1^O$, then social welfare can be improved by caping polluting sector firm's individual emission (second best)



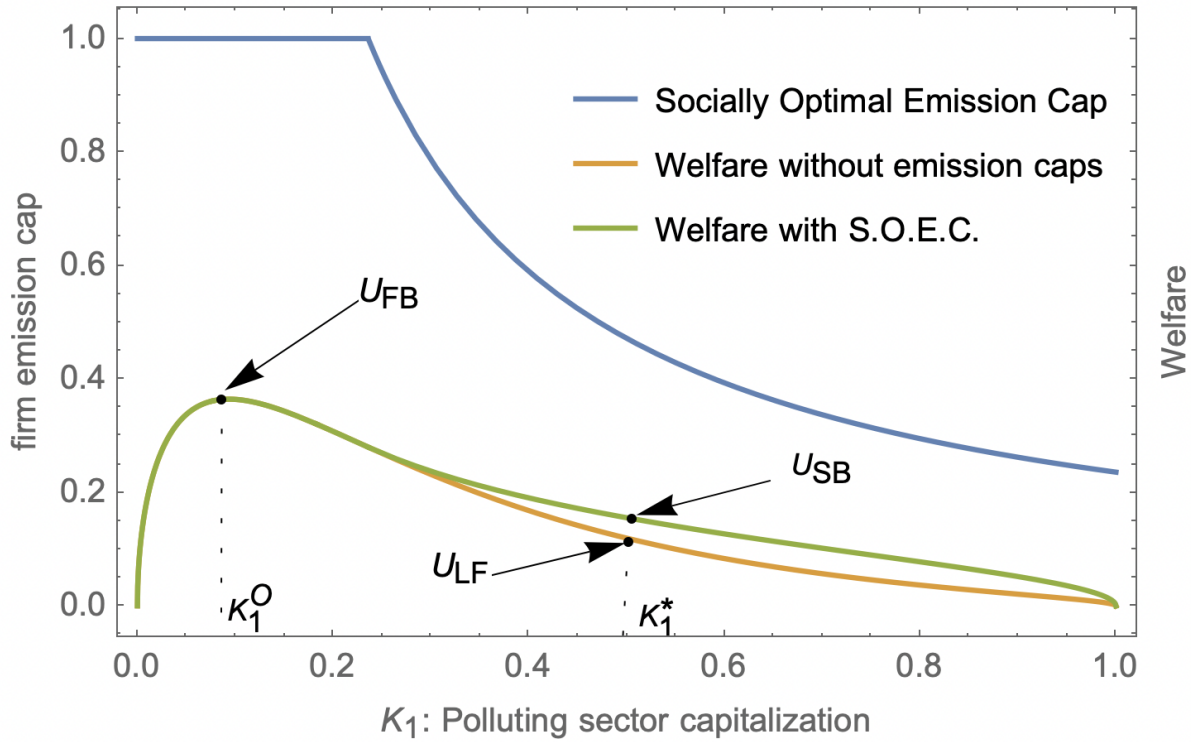
Laissez-faire: endogenous K_1 and e.

Absent SRF:

- Firms in the polluting sector have no incentive to reduce their emission $\Rightarrow e = 1$
- To have capital on both sectors profits must be the same across sectors

$$\pi_1 = \pi_2 \Rightarrow \frac{K_1^*}{K_1} = \frac{K_2^*}{K_2} \Rightarrow K_1 = K_1^*, K_2 = K_2^*$$

- Social welfare is $U_{LF} := U(1, K_1^*)$



The finance dimension

- Mass 1 of investors, each owning 1 unit of capital.
  - θ of the investors are VA (value low footprint portfolio)
  - $1-\theta$ of the investors are Impact investors
- Mass 1 of entrepreneurs, each able to run 1 firm
- There are two mutual funds: a SRF and RMF
- Capital flow: Investors $\rightarrow$ funds (SRF and RMF) $\rightarrow$ Entrepreneurs

The RMF and the SRF fund

- Return maximizing fund (RMF):
  - Must invests all capital in the firms that generate the highest profits
- Socially responsible fund (SRF): Aims at maximizing asset under management.
  - Can choose the composition of its portfolio
  - Can condition the financing of firms to compliance to emission standards
  - Faces an exogenous management cost ψ per unit of capital.

Timing

1. The SRF announce its investment strategy σ:
   - Portfolio weight of each sector
   - Sector specific compliance criteria for recipients of SRF capital
2. Each investors choses between the SRF fund and the RMF
3. Each entrepreneur chooses what good to produce (1 or 2) and whether to comply with SRF standards or not.
4. Each entrepreneurs search for capital (search frictions)
5. Production takes place
6. Entrepreneur retains exogenous fraction λ of her firm's profit. The rest is paid to capital providers.
7. Consumption takes place

Investors capital allocation choice

- Trade-off: willing to accept lower financial return from SRF the extent that it compensate with non pecuniary performance A (warm-glow Andreoni 1990)

$$\max_{q\in[0,1]} \overbrace{\underbrace{(r-q\Delta)}_{\text{investor's wealth}}\ U}^{\text{indirect utility from consumption}} + \underbrace{q\mu A}_{\text{warm-glow}} \tag{5}$$

where

$r :=$ RMF return.

$q :=$ amount invested in the SRF.

$\Delta :=$ return spread of the RMF over the SRF.

$U :=$ Consumption indirect utility per unit of revenue $=$ Social welfare.

$\mu \in [0, \overline{\mu}]$: idiosyncratic sensitivity to A.

Two types of investors

- A fraction θ of the investors are value-aligned investors $A := A_V$
- A fraction $1-\theta$ of the investors impact-driven investors $A := A_I$

SRF's pecuniary and non-pecuniary performance

Suppose that in the presence of SRF social welfare is U.

- Financial performance: spread between SRF's and the RMF's returns: $\Delta := r_{SRF} - r \leq 0$
- Impact performance:

$$A_I := \frac{\text{U} - \text{Social welfare in laissez-faire}}{\text{First-best social welfare} - \text{Social welfare in laissez-faire}} \leq 1$$

- Value-aligned performance:

$$A_V := \frac{\text{Market portfolio's footprint} - \text{SRF portfolio's footprint}}{\text{Market portfolio footprint}} \leq 1$$

Portfolio footprint = portfolio weight of sector 1$\times$ average emission of a sector 1 firm.

Investors capital allocation choice across funds

- Value aligned investor's supply of SR capital
  - Increases with SRF low-footprint performance A_V
  - Increases with SRF return spread vs RMF
- Impact investor's supply of SR capital
  - Increases with SRF Impact performance A_I
  - Increases with SRF return spread vs RMF

Equilibrium size of S of the SRF

If there SRF adopts a strategy is σ, then the equilibrium size S of the SRF fund satisfies

$$S = \underbrace{\theta \max\left\{0, 1 + \frac{\Delta_\sigma(S)}{A_{V,\sigma}(S)\overline{\mu}} U_\sigma(S)\right\}}_{\text{SR capital from Value-alignment investors}} + \underbrace{(1-\theta) \max\left\{0, 1 + \frac{\Delta_\sigma(S)}{A_{I,\sigma}(S)\overline{\mu}} U_\sigma(S)\right\}}_{\text{SR capital from Impact investors}}$$

Equilibrium size of SRF increase

- financial performance Δ
- Social performance A_I, A_V
- Investor sensitivity to social performance $\overline{\mu}$

SRF startegies

Which of the following three will the SRF fund choose to maximize is size S?

- **Scope 1**: Invest in priority in the polluting sector to induce its firm to reduce their emissoin.
- **Scope 3**: In vest in priority in the clean sector to induce its firm to ask its polluting sector supplier to reduce their emissions.
- **Exclusion**: Invest ecxlusively in the clean sector

How can SRF induce entrepreneurs to reduce their emissions?

- π_{iC} := typical profit of a firm in sector i if the firm complies with the standards required by the SRF
- π_{iN} := typical profit of a firm in sector i if the firm just maximize profit ignoring the standards required by the SRF.

$$\pi_{iC} \leq \pi_{iN}$$

- **In equilibrium all entrepreneurs of sector i comply with SRF standard if and only if:**

$$\underbrace{\lambda \pi_{iC}}_{\text{entrepreneur's expected revenue if complies}} \geq \underbrace{\overbrace{\left(1 - \frac{S_i}{K_i}\right)}^{\text{Pr of finding brown capital}} \lambda \pi_{iN}}_{\text{entrepreneur's expected if does not comply}}$$

Non-compliant firm is finance with probability that is decreasing in $\frac{S_i}{K_i}$, the fraction of the sector's capital managed by the SRF.

Scope 1 SRF strategy: Definition

SRF managing an exogenous fraction S of total capital

- Invests in priority in the polluting sector

$$\begin{aligned} S_1 &= \min\{S, K_1^*\} \\ S_2 &= S - S_1 \end{aligned}$$

- Commits not to finance polluting sector firms that emits more than $\hat{e}_{dir}$ where $\hat{e}_{dir}$ is the one maximizing social welfare subject to

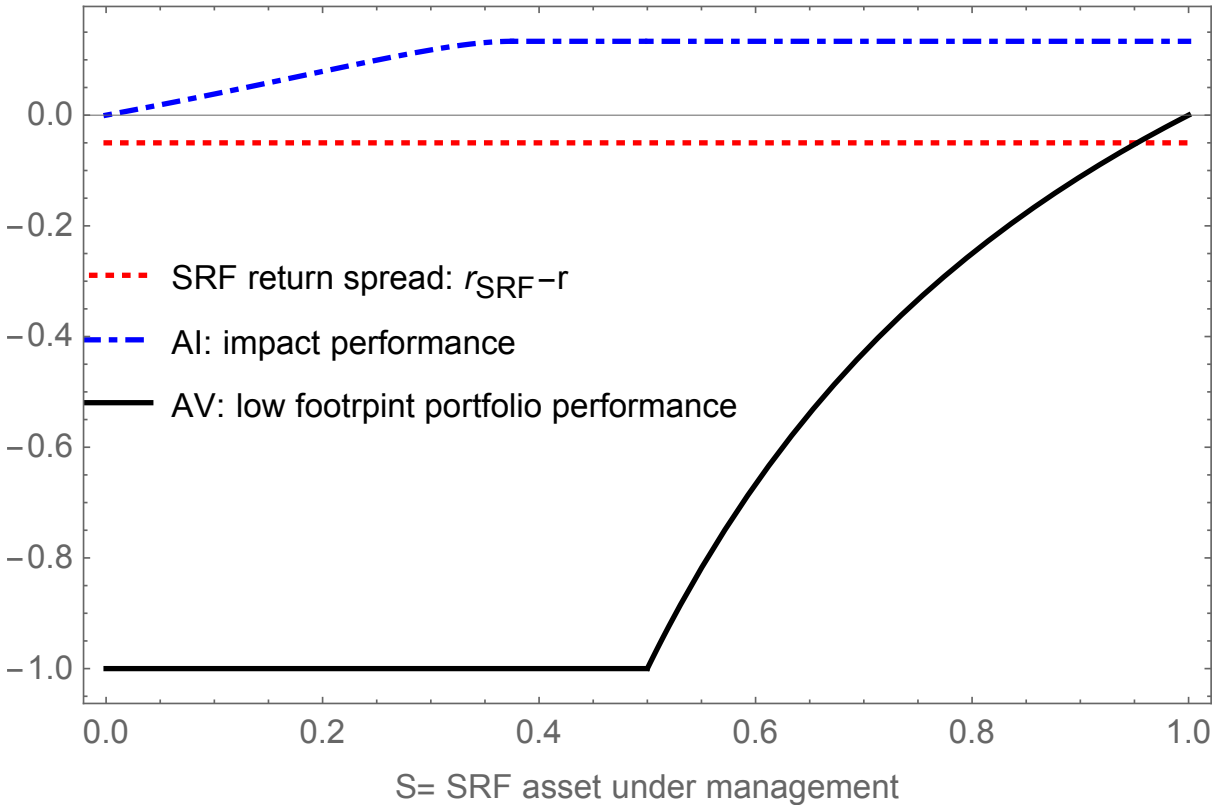
$$e_{dir} \geq \left(1 - \frac{S_1}{K_1^*}\right)^{\frac{1-\alpha}{\alpha}}$$

The bigger is S_1/K_1 the tighter is the emission cap that can be required.

The effect of Scope 1

By investing in priority into polluting sector but excluding firms whose emission exceed $\hat{e}_{dir}$ SRF achieves:

- Market portfolio is as in laissez-faire: (K_1^*, K_2^*)
- All sector 1 firms comply and set $e = \hat{e}_{dir}$
- High-footrpint portfolio
- Positive Impact, even with small SRF
- No deterioration of SRF financial performance



Upstream Scope 3 strategy

SRF of size S

- Invests in priority in the clean sector

$$\begin{aligned} S_2 &= \min\{S, K_2^*\} \\ S_1 &= S - S_2 \end{aligned}$$

- Commits not to finance clean sector firms that purchase input from polluting sector firms who emit more than $\hat{e}_{up}$, where $\hat{e}_{up}$ is the one maximizing social welfare subject to

$$\hat{e}_{up} \geq \left(1 - \frac{S_2}{K_2^*}\right)^{\frac{1-\alpha}{\alpha}}$$

The bigger is S_2, the tighter is the upstream emission cap that can be required to sector 2 firms

The effect of mere Scope 3

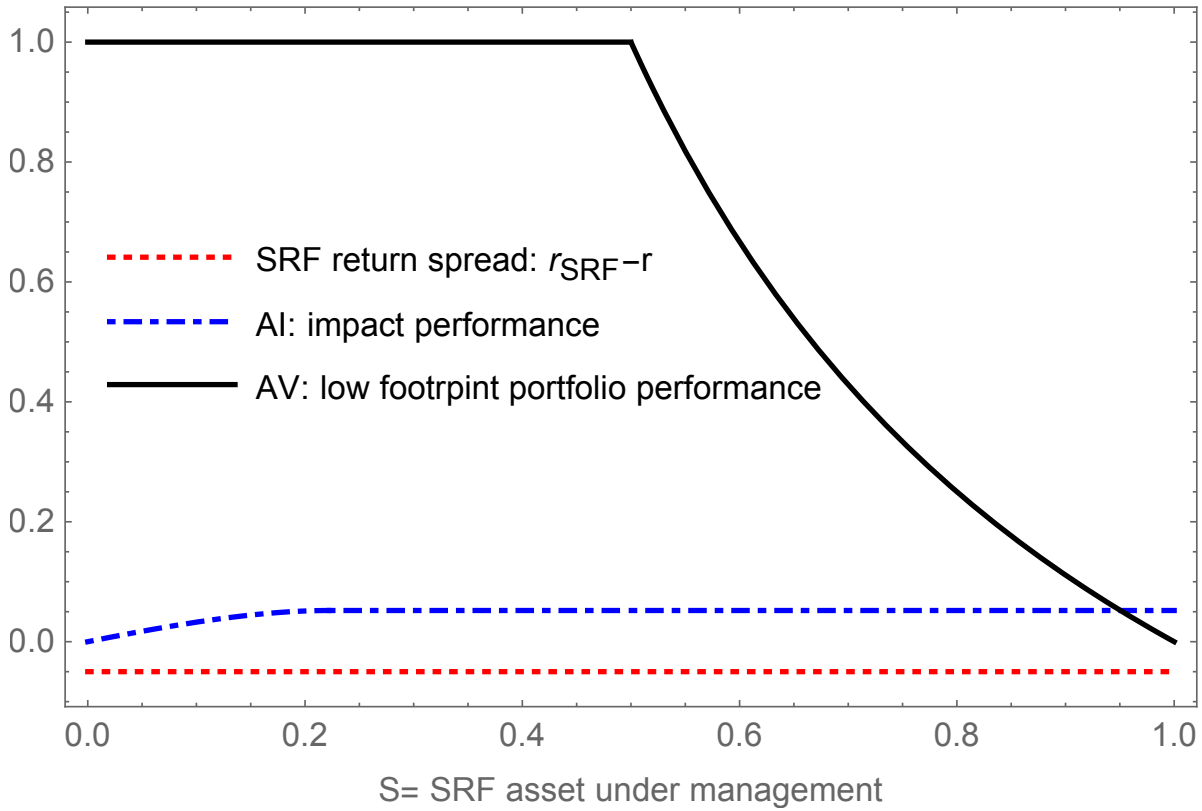
Then in equilibrium:

- Market portfolio is as in laissez-faire: (K_1^*, K_2^*)
- All firms in the clean sector comply regardless whether they are financed with SR capital or not.
- Polluting sector splits into
  - A mass of $K_1(1) = (1-\alpha)\gamma_1$ do not cap their emissions and sell only to consumers
  - A mass of $K_1^* - K_1(1)$ who cap their emissions to $\hat{e}_{up}$ only sell to the clean sector firms .

The effect of mere Scope 3

By investing in priority into the clean sector but excluding firms whose suppliers emit more than $\hat{e}_{up}$ SRF achieves:

- All sector 2 firms comply
- A fraction of sector 1 firm lower their emission to sell to sector 1 firms
- Low-footprint portfolio
- Positive Impact, even with small SRF
- No deterioration of SRF financial performance



Mere Mere Exclusion SRF strategy: Definition

S:= fraction of total capital managed by the SRF .

SRFS invests all its capital S in the clean sector without any further requirements from recipients of SR capital.

The effect of Mere Exclusion of Polluting Sector strategy

If the SRF managing exogenous fraction S adopt a Mere exclusion strategy, then in equilibrium

- Each firm in the polluting sector emits $e = 1$.
- If $S \leq K_2^*$, RMF capital flows to equalize profits across sectors

$$\Downarrow$$

Firms emissions and polluting sector size are as in laissez faire

- If $S > K_2^*$, then $K_2 > K_2^*$ and $K_1 < K_1^*$,

$$\Downarrow$$

- Firms' profits are higher in the polluting sector than in the clean sector

$$\Downarrow$$

- RMF only invests in the high profit sector, i.e., the polluting sector.
- The SRF fund only invests in the clean sector, i.e., the low profit sector

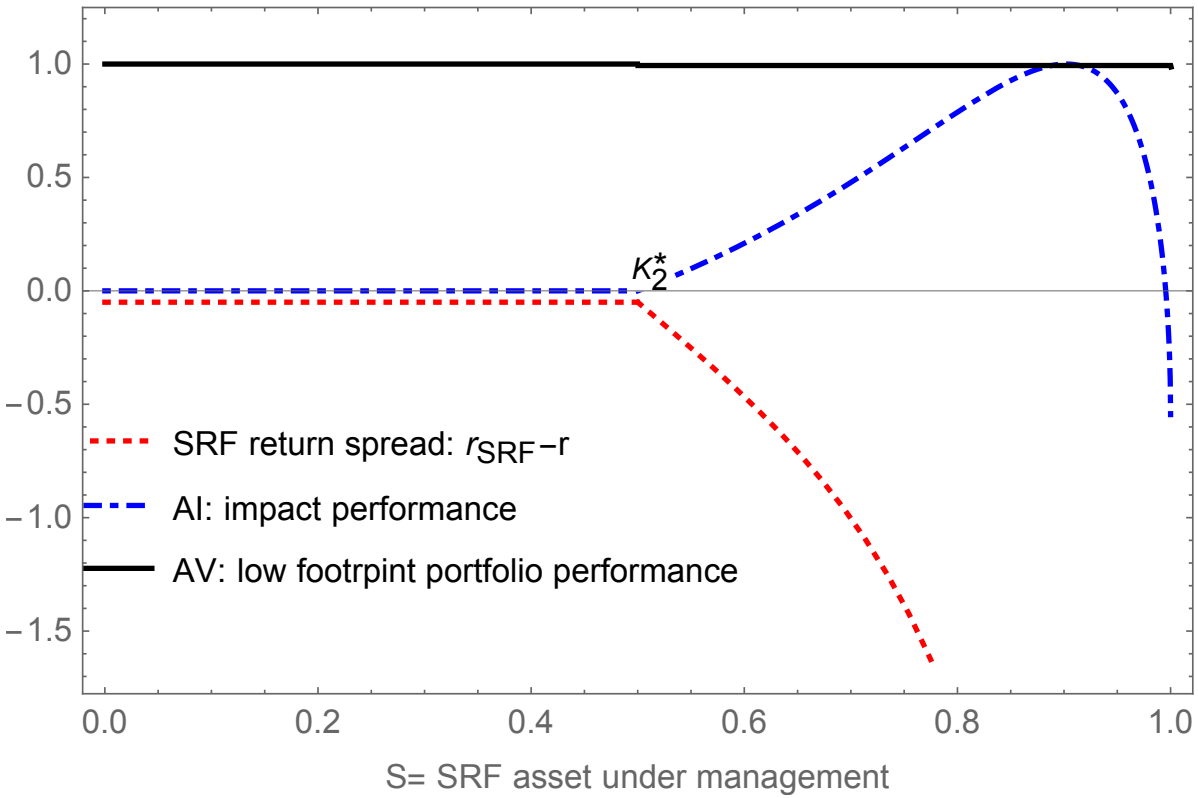
$$\Downarrow$$

- The SRF returns is substantially smaller than the one of the RMF.

The effect of Mere Exclusion of Polluting Sector strategy

By excluding polluting sector, the SRF achieves:

- Zero-footrpint portfolio
- No impact, unless SRF is large enough
- Impact, if large enough, but with deterioration of SRF financial performance



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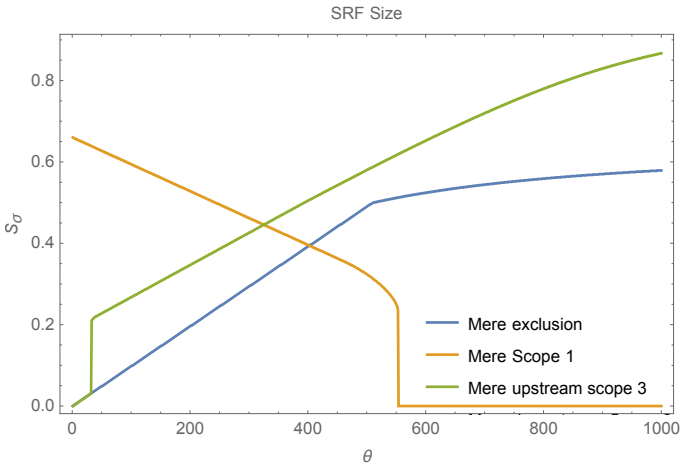
Equilibrium size of SRF increase

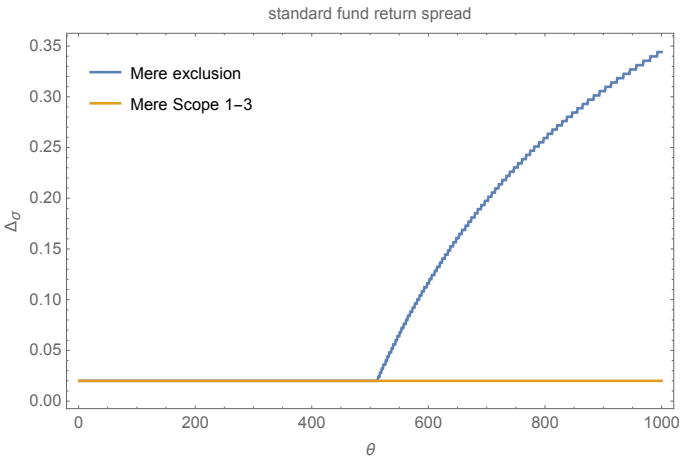
- financial performance Δ
- Social performance A_I, A_V
- Investor sensitivity to social performance $\overline{\mu}$

Equilibrium size (symmetric sectors)

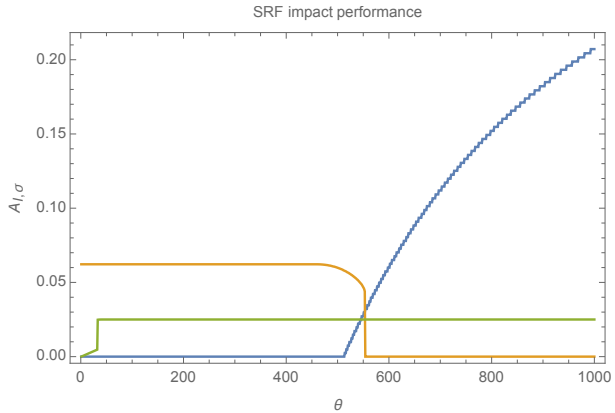
$\gamma_1 = \gamma_2 = \alpha = \alpha = \eta_1 = \eta_2 = 0.5$, $\delta = 4$, $\mu = 0.2$,$\psi = 0.02$



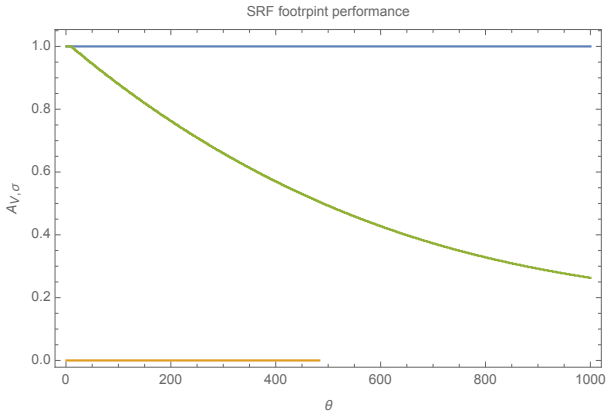
(a) SRF Size



(b) RMF return spread



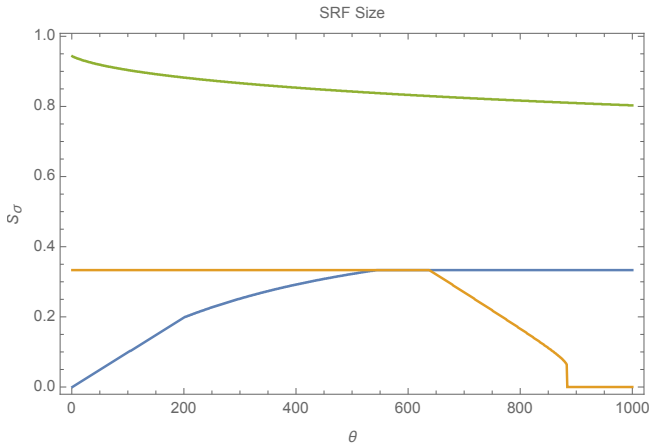
(c) SRF Impact performance



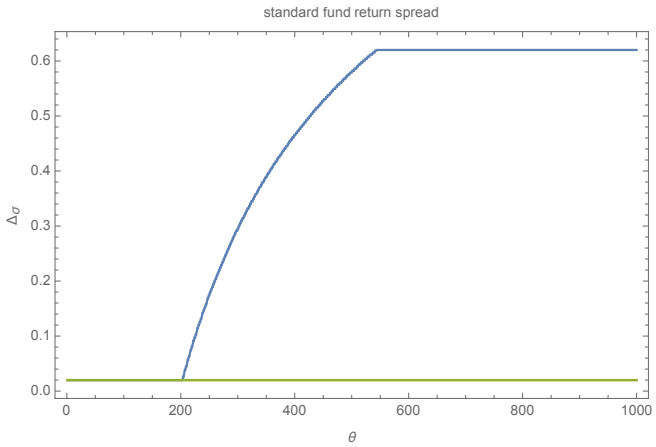
(d) SRF Low-footprint performance

Equilibrium size (good 1 is intermediary good)

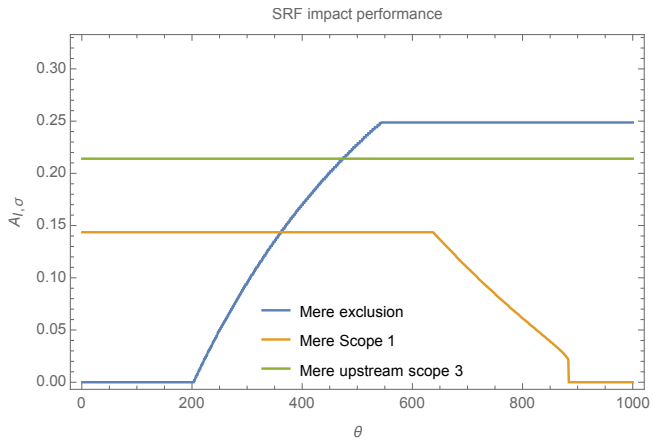
$\gamma_1 = \alpha = 0.2$, $\gamma_2 = \alpha = 08$, $\eta_1 = \eta_2 = 0.5$, $\delta = 4$, $\mu = 0.2$,$\psi = 0.02$



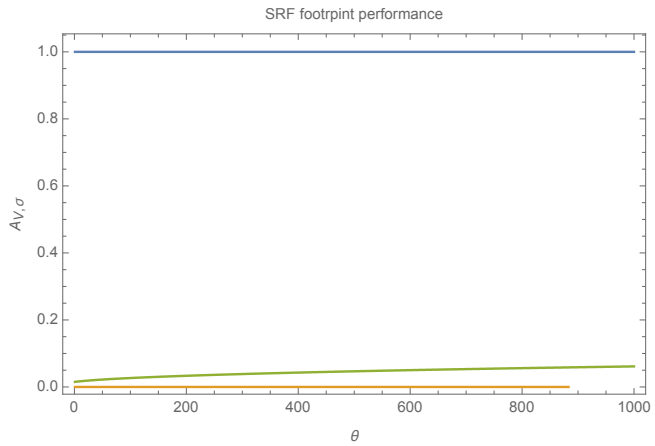
(e) SRF Size



(f) RMF return spread



(g) SRF Impact performance



(h) SRF Low-footprint performance

Summary

- A SRF willing to maximize asset under management can cater to value-aligned investors and impact-driven investors by investing in clean sector and using scope 3 strategise.
- Such strategy can improve social welfare but cannot bring to the first best.
- To reach the first best social welfare a SRF should
  - Invest exclusively in the clean sector
  - Control a fraction of capital large enough to starve capital the polluting sector.

  However becuase such strategy substantially deteriorates the SRF financial perfomrance relative to the RMF performance, it cannot attract enough capital to be implemented by a SRF willing to maximize its size.

THANK YOU!