ESG Investing: How to Optimize Impact?

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Motivation

- How to reduce negative externalities generated by corporations?
- Traditional economic prescription: (Pigouvian) Taxes
- However, limited real world results due to :
  - Free-riding among countries (ex. greenhouse gas emission),
  - Political short-termism,
  - Lobbying frictions
  - Protests etc.
- This paper : Using the **financing channel** to curb firms's behavior.

ESG finance

- Rise of "ESG finance" ("Sustainable Investment")
  - Broadly defined: " investment approach that considers environmental, social and governance (ESG) factors in portfolio selection and management."

Table 2: Proportion of SRI Relative to Total Managed Assets

Region	2014	2016
Europe	58.8%	52.6%
United States	17.9%	21.6%
Canada	31.3%	37.8%
Australia/New Zealand	16.6%	50.6%
Asia	0.8%	0.8%
Japan		3.4%
Global	30.2%	26.3%

Source: Global Sustainable International Alliance

Research question:

Can responsible fund investing have a real impact in reducing externalities?

If yes how?

This paper approach and roadmap for this talk

General equilibrium analysis to dissect the problem and analyze the optimal sytrategy of a ESG fund willing to maximize social welfare.‘

Roadmap

1. General economic intuition
2. Formal model

Building block 1: Production, externality, and inefficiency

- The more firms pollute, the more they produce, the more people consume.
- Individuals enjoy consumption but suffer from industries' aggregate pollutions.
- Because individuals are atomistic, they do not internalize the effect of their investment, entrepreneurial and consumption choices.

Laissez faire leads to a level of pollution that is superior to its social optimum level.

Building block 2: capital market

1. Atomistic investors delegate investment decisions to intermediaries:
   - Standard funds: care only about financial returns
   - ESGF: Maximizes social welfare
2. Funds allocate their capital under management to entrepreneurs in a matching market with frictions.

Building block 3: entrepreneurs

Each (atomistic) entrepreneur chooses:

1. In which industry to operate.
2. The level of pollution of her firm (lower pollution leads to lower productivity)
3. Search for capital to finance her firm.

How can ESGF have an impact on firms actual pollution?

1. Raise capital from investors:

   For this the ESGF needs to generate (at least) the same return as other funds.

2. Provide capital only to entrepreneurs who commit to curb their firms' pollution.

Why would entrepreneurs comply to low pollution?

- A firm with low level of pollution has low production and hence low profits.

  HOWEVER...

- By not compiling with ESG standards, entrepreneurs run the risk of not being financed shall they be matched with the ESG capital provider.

- The stronger this risk, the lower the pollution cap that entrepreneur will comply with in order to avoid this risk.

What determines the impact ESGF can have in a given industry?

The grip of ESGF on entrepreneurs in a given sector increases with

- The fraction of the sector's capital that is under ESGF control.
- The level of frictions in the capital market
  - ESGF capital alleviate these frictions, but only to complying firms.
  - Absent matching friction, non-complying firms can directly be matched with non-ESG capital.

ESG optimal policy

Step 1 social optimum

Could the ESG perfectly control industries emissions, what levels would it choose?

Social optimum level of emission in a given industry

- Decreases in consumer's disutility that industry pollution generates.
- Increases in
  - Utility elasticity from consumption of that industry good.
  - Marginal productivity of emission in producing the good.

ESG optimal policy

Step 2: Where ESG capital has most grip?

The same amount of fund will have more impact in sectors where

- Capital market friction is higher
- Small sectors ("big fish in small pound" effect)

ESG optimal policy

Step 3: Resulting tradeoffs

ESGF's portfolio choice has a direct link with the pollution reduction that the ESGF can induced across industries.

1. More portfolio weight in a given sector decreases this sector's pollution but increases pollution in all other sectors.
2. Invest where pollution needs to be reduced the most vs invest where entrepreneurs are the most sensitive to capital incentives.

ESG optimal policy

Step 4: indirect incentives and supply chain

How to reduce a sector i pollution without investing ESGF capital into it?

1. Invest into the industry that is downstream to i
2. Require the ESGF financed firms to purchase from low emission firms of industry i.

Industry i endogenously split into

- Low pollution firms selling to the downstream industry at high price.
- High pollution firms selling to consumers at low price.

Particularly effective to affect emission of sectors where capital market is frictionless

Our Preliminary findings

1. Absent financial frictions, the ESGF has not impact.
2. Industry tilts alone have no impact. (ex. invest in already clean industries)
3. Impact requires to commit financing only firms compliant with explicit pollution limit below laissez-faire levels.
4. ESGF impact on a given industry increases with
   - Amount of ESG capital invested in the industry
   - Financial frictions in that industry
5. Supply-chain network can be used to amplify impact
   - Imposing standards on suppliers (i.e. indirect emissions of a firm)
6. Portfolio environmental footprint is not a good measure of impact.

The economy

- Two goods, both used for consumption and production.
- Individual utility: depends on consumption (c_i) and aggregate pollution (E_i) in each industry:

$$u(c_1, c_2, E_1, E_2) = \frac{c_1^{\gamma_1} c_2^{\gamma_2}}{(1+E_1)^{\delta_1}(1+E_2)^{\delta_2}}$$

- Mass 1 of atomistic entrepreneurs: each can run 1 firm.
- Production requires 1 unit of capital:

$$y_i = e_{i,f}^{\beta_i} x_{ij}^{\alpha_{ij}}$$

  - $x_{ij} > 0$ is other sector's good quantity (hence we can consider supplier network),
  - $e_{i,f} \in [0,1]$ is pollution of individual firm f in sector i.
  - $E_i \int_0^{K_i} e_{i,f}\, df \in [0,1]$ is the aggregate pollution in sector i.
  - $K_i \in (0,1)$ is the equilibrium size of sector i

Capitalist and entrepreneurs

- Mass 1 of atomistic (selfish) capitalists each endowed with 1 unit of capital,
- Delegate portfolio choice to competitive intermediaries:
  1. "Regular" funds (maximize returns).
  2. An ESG fund willing to maximize social welfare under constraint that returns are competitive,
- If funds have same return, then s (exogenous) capitalists invest ESG.
- Mass 1 of atomistic (selfish) entrepreneurs each endowed with the ability to run one firm but requiring 1 unit of capital.

Timing

1. Each capitalist choses between investing via the ESG fund or the non-ESG,
2. ESGF announces:
   - Industry weights (ω_1, ω_2) of its portfolio
   - Emission limits $(\hat{e}_1, \hat{e}_2)$ for firms to be eligible to receive ESG capital.
3. Entrepreneurs choose industry and firm's emission level.
4. Capital and entrepreneurs are matched
5. Production occurs and firms profits are shared between entrepreneurs and capitalists, $(\lambda, 1-\lambda)$
6. All individuals spend their revenue to consume.

Capital market : Timing of Matching

1. Given ESGF emission cap policy $(\hat{e}_1, \hat{e}_2) \in [0,1] \times [0,1]$ and the fraction of each industry capital controlled by the ESGF (s_1, s_2)
2. Each entrepreneur chooses sector $i \in \{1,2\}$ and emission $e_f \in [0,1]$, and then seeks capital
   - Entrepreneur complies if $e_f \leq \hat{e}_i$.
   - Entrepreneur does not complies if $e_f > \hat{e}_i$.
3. **Capital matching friction:**
   - Complying entrepreneur can be financed with ESG and non-ESG capital. $\Rightarrow$ financed with probability 1
   - non-complying entrepreneurs cannot be financed with ESG capital. $\Rightarrow$ financed with probability

$$\left(\frac{1 - s_i}{1 - \eta_i s_i} \right)$$

   $\eta_i \in [0,1]$ measures sector i's capital matching efficiency (perfect market $\eta = 1$)
4. non-compliant has lower probability to be matched, especially so when s_i is large, η_i is small

Equilibrium Definition

Definition: An equilibrium is a set of good prices mutual fund returns, such that

- all individuals maximize utility, taking the prices, the aggregate emissions and the ESG policy as given;
- prices are such that the markets for goods and for capital clear;
- the ESGF chooses its portfolio and emission caps to maximize agents' utility taking into account how its choice impacts the whole economy.

The equilibrium is said to be **symmetric** if all firms in the same industry choose the same emission level.

Necessary condition for a symmetric equilibrium

Proposition

Take a symmetric equilibrium. Let e_i be the emission of a typical in industry i firm. Then

1. **Irrelevance of ESGF for the equilibrium in the financial market**
   - *The capitalization of industry i is $K_i = \frac{\gamma_i + \alpha_{ji}\gamma_j}{1-\alpha_{ij}\alpha_{ji}}(1-\alpha_{ij})$.*
   - *All firms are financed and realizes the same profits $\pi_i = 1$.*
   - *Individual revenues are $1-\lambda$ for a capitalist and λ for an entrepreneur.*
   - *All funds provide the same return on capital $r = 1-\lambda$.*
2. **Social welfare**
   - *Individual utility is proportional to*

$$U(e_1, e_2) := \frac{e_1^{\beta_1 Z_1} e_2^{\beta_2 Z_2}}{(1+K_1 e_1)^{\delta_1}(1+K_2 e_2)^{\delta_2}} \tag{1}$$

laissez faire vs social optimum

- Laissez faire : $U(1,1)$
- First best social optimum

$$\max_{(e_1,e_2)\in[0,1]^2} U(e_1,e_2)$$

gives

$$e_i^* = \min\left\{\frac{\beta_i}{\delta_i(1-\alpha_{ij})-\beta_i K_i}, 1\right\}$$

Priority intervention industry:=$\arg\min_{i=1,2} e_i^*$, i.e. the industry where emission need to be reduced the most in order to maximize social welfare

ESGF maximisation problem

Total capital managed by the ESGF$= s$

The ESGF choses its portfolio and the eligibility policy $(\hat{e}_1, \hat{e}_2)$ solves

$$\max_{\hat{e}_1, \hat{e}_2} U(\hat{e}_1, \hat{e}_2)$$

Subject to

- Impact constraint:

$$\hat{e}_i \geq \left(\frac{1 - s_i}{1 - \eta_i s_i} \right)^{\frac{1-\alpha_{ij}}{\beta_i}}$$

- Portfolio constraint:

$$s_1 K_1 + s_2 K_2 \leq s$$

where s_i is the fraction of industry i capital K_i under ESGF control

ESGF strategy

There are $\underline{K} < \overline{K} < 1$, such that

$s \geq \overline{K}$: Large ESGF invests in both industries and reduces each industry emission to first best social optimum

$$(e_1, e_2) = (e_1^*, e_2^*)$$

$\underline{K} < s < \overline{K}$: Medium size ESGF invests in both industries; reduces emission but not to first best:

$$(e_1^*, e_2^*) < (e_1, e_2) < (1, 1)$$

$s < \underline{K}$: Small size ESGF focuses its capital on one industry and reduces only this industry 'semission:

$$e_i^* < e_i < 1, e_j = 1$$

Specialization of small ESGF

Small ESGF invests in one sector only:

$$i_0 = \operatorname{argmax}_{i \in \{1,2\}} \underbrace{\left(\frac{1-e_i^*}{e_i^*}\right)}_{\text{economic efficiency}} \overbrace{\left(\underbrace{(1-\eta_i)}_{\text{Fin. friction}} \underbrace{\left(\frac{1}{1+K_i}\right)}_{\text{Size effect}}\right)}^{\text{Grip on entrepreneur}}$$

Sector prioritization takes 3 things into consideration

1. What is economically efficient
2. Where is financial friction higher
3. What sector is small enough ("big fish in small pound" effect)

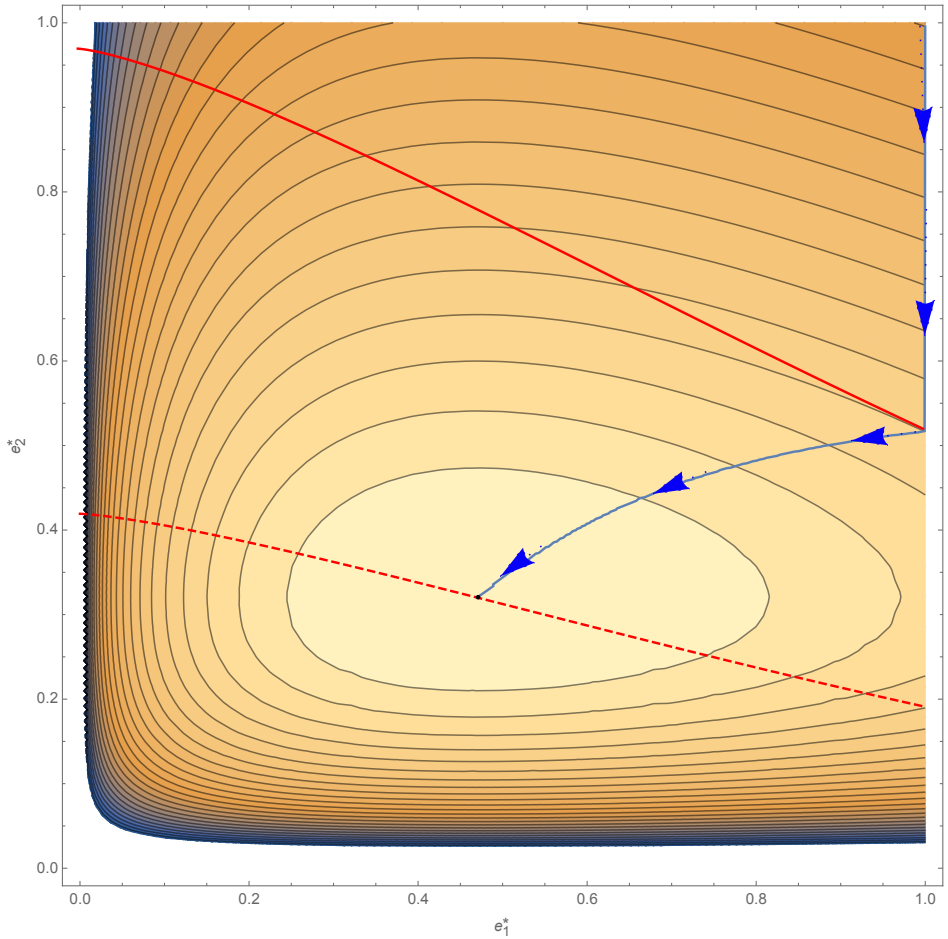

Figure: ESGF's optimum in the plane (e_1, e_2). The continuous red curve indicates the minimum levels of (e_1, e_2) that can be achieved when $s = \underline{K}$. The dashed red curve indicates the minimum levels of (e_1, e_2) that can be achieved when $s = \overline{K}$. The blu line indicate the constraint optimum level of emission for the different $s \in [0, 1]$ where arrows move from $s = 0$ toward $s \geq \overline{K}$.

Direct and indirect emission

Definition

- A firm's direct emissions are those that enter as a direct input in the firm production process,

$$y_i = {e_f}^{\beta_i} x_{ij}^{\alpha_{ij}}$$

- A firm's indirect emission are the direct emissions of the firm's suppliers.

Creating clean supply chains

Proposition

Suppose ESGF only invests in industry i, requiring compliant firms to reduce their direct and indirect emissions to $\hat{e}_i$ and $\hat{e}_{Ui}$, respectively, with:

$$e_i^{\beta_i} \hat{e}_{Ui}^{\beta_j \alpha_{ij}} \geq \left(\max \left\{ 0, \frac{K_i - s}{K_i - \eta_i s} \right\} \right)^{1-\alpha_{ij}} \tag{2}$$

Then, in equilibrium

1. *In industry i all firms comply*
2. *Industry j is split into a mass of size $K_j \theta_j$ of high-emission firms with $e_j = 1$, and a mass of size $K_j(1-\theta_j)$ of low-emission firms with $e_j = \hat{e}_{Ui}$, where $\theta_j := \frac{\gamma_j(1-a_{12}a_{21})}{\gamma_j + a_{ij}\gamma_i} \in (0,1)$.*
3. *Per firm average emissions $e_i = \hat{e}_i$ and $e_j = \theta_j + (1-\theta_j)\hat{e}_{UI}$.*
4. *Social welfare is proportional to*

$$U_I(e_i, e_j) := \frac{e_i^{\beta_i Z_i}}{(1 + \hat{e}_i K_i)^{\delta_1}} \frac{\left(\frac{e_j - \theta_j}{1-\theta_j} \right)^{\beta_j \alpha_{ij} Z_i}}{(1 + e_j K_j)^{\delta_2}} \tag{3}$$

Clean supply chain and dedicated markets

If ESGF fund only go to industry i, why should an industry j entrepreneur be willing to reduce its emission?

Corollary

Suppose ESG only invests in industry i, requiring compliant firms to reduce their direct and indirect emissions to $\hat{e}_i$ and $\hat{e}_{Ui}$, respectively, with:

$$e_i^{\beta_i}\hat{e}_{Ui}^{\beta_j\alpha_{ij}} \geq \left(\max\left\{0, \frac{K_i - s}{K_i - \eta_i s}\right\}\right)^{1-\alpha_{ij}} \tag{4}$$

Then, in equilibrium

- *Good j equilibrium prices satisfy $p_j(1) < p_j(\hat{e}_{Ui})$.*
- *Consumers buy good j exclusively from high emission firms, whereas industry i firms buy input j exclusively from low emission firms.*

Direct vs indirect incentives

To maximize impact:

- A small enough ESGF should
  - invest all its capital in the industry with the highest capital market friction: $\hat{i} = \text{argmin}_{i=1,2}\{\eta_i\}$
  - Put an emission cap only on the emission of the priority intervention industry: $i^* \text{argmin}_{i=1,2} e_i^*$
  - The emission cap on i^* are
    - direct emission cap if $\hat{i} = i^*$,
    - indirect emission cap if $\hat{i} \neq i^*$
- A medium size ESG should focus its capital on a sector i and impose direct and indirect emission caps, whenever
  - $\eta_i \ll \eta_j$, i.e. capital market friction in i is substantially stronger than in j,
    or
  - $\alpha_{ij} - \gamma_j$ is larger, i.e., consumers derive utility mostly from good i, and good j is crucial for production of good i.
- A large enough ESGF can achieve social optimum with direct emission caps.

Summary

Can ESG reduce negative corporate externalities?

Yes provided that

1. there are some frictions in the capital market
2. ESGF finances firms that comply with production standards "greener" than laissez-faire .

How to maximize ESGF impact?

1. Small ESG fund should focus intervention on one sector
2. Sectors in which ESGF should invest are those in which emissions are the most damaging and/or those where there are capital market frictions

Practical and Policy implications

1. If concerned about impact, ESG investors should prioritize sectors of intervention,
2. Focus on segments where markets less efficient (private equity, primary offerings, small caps)
3. Optimizing carbon footprint does not maximize impact
4. Leverage supply chain to amplify impact
5. Importance of reliable firm-level info on direct and indirect emissions (regulation)

Next steps

- Solve with n sectors (formalize role of centrality in supplier network)
- Heterogenous firms (unobservable idiosyncratic cost to adapt)
- Calibration; Relax Cobb-Douglass assumption
- Dynamics (incentives on changes rather than levels)
- Coordination between investors

Related literature

- **Theories of moral investors:**
  - Heinkel et al. (2001) , Morgan and Tumlinson (2019) , Chowdhry et al. (2014), Oehmke and Opp (2019), Gollier and Pouget (2019) , Bénabou and Tirole (2010).
- **Empirics : propagation of ESG standards along the supply chain network.**
  - Dai et al. (2019) and Schiller (2018)
- **Empirics of moral investors (size, flows, preferences)**
  - Krueger et al. (2018), Hartzmark and Sussman (2018), Riedl and Smeets (2017) , Barber et al. (2018).
- **Ambiguous performance of virtuous firms**
  - Hong and Kacperczyk (2009) ,El Ghoul et al. (2011) , Bolton and Kacperczyk (2019), Zerbib (2019) and Baker et al. (2018) find that "virtuous firms" have lower returns.
  - However, Edmans (2011) , Derwall et al. (2005), Gibson and Krueger (2018) , Henke (2016) Andersson et al. (2016) report over-performance of virtuous portfolios