Environmental impact investing

Tiziano De Angelis[1], Peter Tankov[2], Olivier David Zerbib[3]

[1] University of Leeds, [2] CREST-ENSAE Paris, [3] Tilburg University, ISFA and CREST

Chaire FDIR

November 4, 2020

Impact Investing

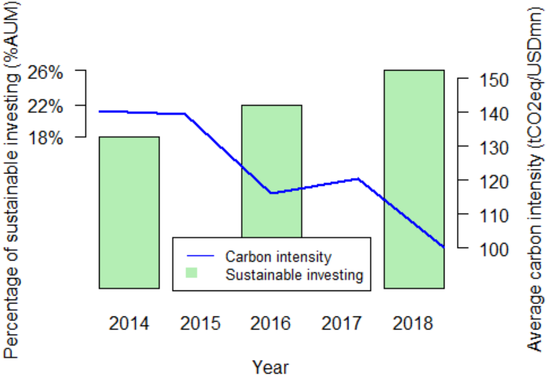
> "Generate *positive*, *measurable* social and environmental impact alongside a financial return"
> (Global Impact Investing Network).

2 major channels: Shareholder engagement and ESG integration

$\Rightarrow$ We focus on ESG integration, applied to green investing

Motivation

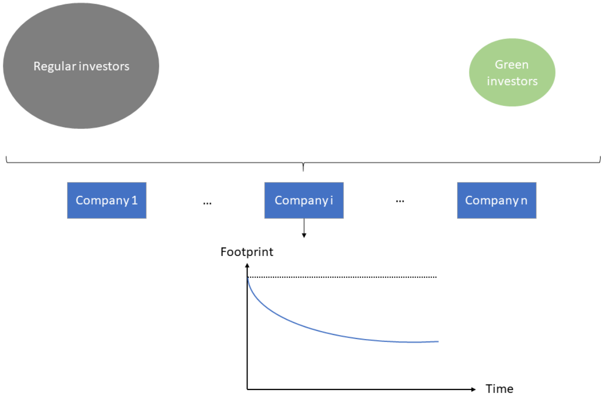
Does green investing spur companies to reduce their GHG emissions?



Contributions

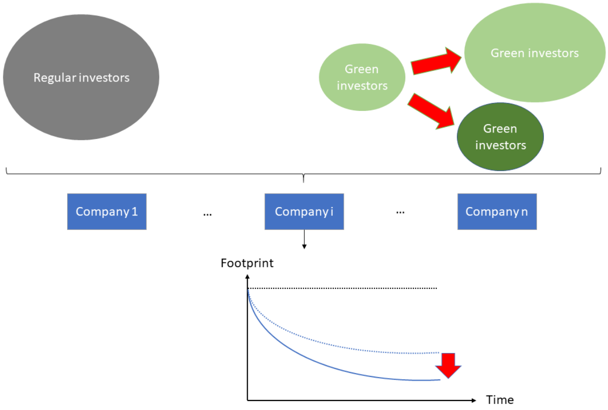
1. Dynamic setup + investors have heterogeneous beliefs about future environmental *deterministic* externalities

   ⇒ Impact (convex over time)



Contributions

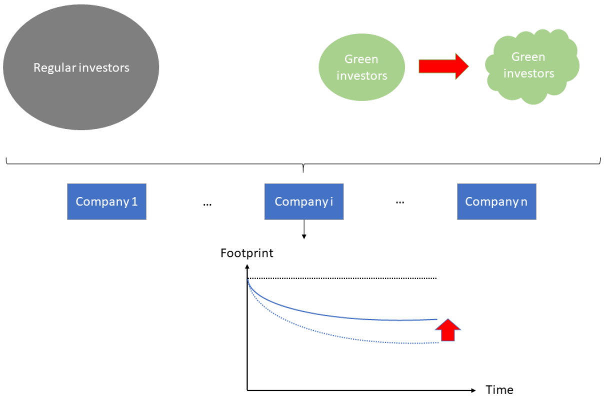
2. Higher wealth share of green investors or more stringent green investors
   $\Rightarrow \nearrow$ impact



Contributions

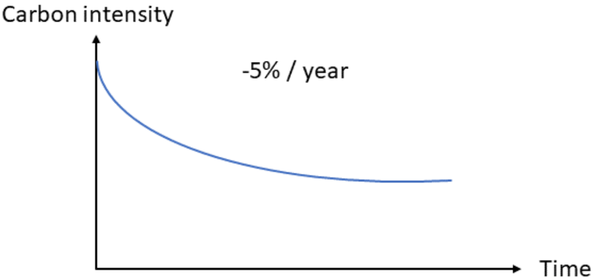
❸ Uncertainty about future environmental externalities

$\Rightarrow \searrow$ impact



Contributions

4. Empirical evidence: Using green fund holdings ; when the fraction of assets managed by green investors doubles, companies' carbon intensity drops by 5% over one year



Related literature

- Impact investing:
  - Heinkel, Kraus, and Zechner (2001): When green investors exclude the most polluting companies, they decrease their market value and push them to reform.
  - Chowdhry, Davies, and Waters (2018): optimal contracting perspective: impact investors must hold a large enough financial claim to incentivize the company to internalize social externalities.
  - Oehmke and Opp (2020): ESG investors relax financial constraint for clean production $\Rightarrow$ trigger the scaling of clean projets; sustainable and regular investors are complementary: together they achieve higher welfare.
  - Landier and Lovo (2020): Search frictions in financial markets allow an ESG fund to improve social welfare; the ESG fund forces companies to internalize externalities.
  - Pastor et al. (2020): Investors with preferences for ESG issues push (i) all companies (maximizing their market value) to become greener and (ii) green companies to invest more than brown companies.

Related literature

- Asset pricing (theory): Pastor et al. (2020); Pedersen et al. (2020); Zerbib (2020).

- Asset pricing (empirics): Hong and Kacperczyk (2009); Chava (2014); Barber, et al. (2018), Baker et al. (2018), Zerbib (2018).

The market

Arbitrage-free complete market with n risky stocks and a risk-free asset ($r = 0$).

Each stock i is a claim on a single liquidating dividend D^i_T at horizon T:

$$D_T = D_0 + \int_0^T \sigma_t dB_t,$$

where:

- $(B_t)_{t\in[0,T]}$ is a n-dimensional BM on filtered probability space $(\Omega, \mathcal{F}, \mathbb{P})$
- σ_t is a deterministic, $n \times n$ invertible matrix

$\Rightarrow$ $(\sigma_t dB_t)_{t\in[0,T]}$ is the sequence of cash flow news (see Barberis et al., 2015, 2018)

The market

Arbitrage-free complete market with n risky stocks and a risk-free asset ($r = 0$).

Each stock i is a claim on a single liquidating dividend D^i_T at horizon T:

$$D_T = D_0 + \int_0^T \sigma_t dB_t,$$

where:

- $(B_t)_{t \in [0,T]}$ is a n-dimensional BM on filtered probability space $(\Omega, \mathcal{F}, \mathbb{P})$
- σ_t is a deterministic, $n \times n$ invertible matrix

$\Rightarrow$ $(\sigma_t dB_t)_{t \in [0,T]}$ is the sequence of cash flow news (see Barberis et al., 2015, 2018)

We denote the dividend forecast in $t \in [0, T]$ by

$$D_t = \mathbb{E}[D_T | \mathcal{F}_t] = D_0 + \int_0^t \sigma_s dB_s.$$

Heterogeneous beliefs

The market is populated by two types of investors, regular and green investors.

Investors and companies have different expectations regarding future cash flows:

Heterogeneous beliefs

The market is populated by two types of investors, regular and green investors.

Investors and companies have different expectations regarding future cash flows:

- Under regular investors' probability $\mathbb{P}^r$,

$$\mathbb{E}_t^r(D_T) = D_t.$$

- Under green investors' probability measure $\mathbb{P}^g$,

$$\mathbb{E}_t^g(D_T) = D_t + \int_t^T \theta(\psi_s) ds,$$

  where:

  - ψ_s: GHG emissions at date s (deterministic)
  - $\theta(\psi_s) \in \mathbb{R}^n$: financial impacts of environmental externalities, $\psi_s \nearrow \Rightarrow \theta(\psi_s) \searrow$

Heterogeneous beliefs

The market is populated by two types of investors, regular and green investors.

Investors and companies have different expectations regarding future cash flows:

- Under regular investors' probability $\mathbb{P}^r$,

$$\mathbb{E}_t^r(D_T) = D_t.$$

- Under green investors' probability measure $\mathbb{P}^g$,

$$\mathbb{E}_t^g(D_T) = D_t + \int_t^T \theta(\psi_s) ds,$$

  where:

  - ψ_s: GHG emissions at date s (deterministic)
  - $\theta(\psi_s) \in \mathbb{R}^n$: financial impacts of environmental externalities, $\psi_s \nearrow \Rightarrow \theta(\psi_s) \searrow$

- Under companies's probability measure $\mathbb{P}^c$, similarly,

$$\mathbb{E}_t^c(D_T) = D_t + \int_t^T \theta^c(\psi_s) ds.$$

Investors' preferences and optimization

Investors maximize expected exponential utility of terminal wealth W_T:

$$\mathbb{E}^j(1 - e^{-\gamma^j W_T^j}), \quad \gamma^j > 0, \quad j \in \{r, g\},$$

Wealth processes follow the dynamics

$$W_t^j = w^j + \int_0^t (N_s^j)^\top dp_s,$$

where N_t^r and N_t^g are quantities of assets held by investors, and prices $(p_t)_{t\in[0,T]}$ are determined by the market clearing.

Investors' preferences and optimization

Investors maximize expected exponential utility of terminal wealth W_T:

$$\mathbb{E}^j(1 - e^{-\gamma^j W_T^j}), \quad \gamma^j > 0, \quad j \in \{r, g\},$$

Wealth processes follow the dynamics

$$W_t^j = w^j + \int_0^t (N_s^j)^\top dp_s,$$

where N_t^r and N_t^g are quantities of assets held by investors, and prices $(p_t)_{t\in[0,T]}$ are determined by the market clearing.

We denote by γ^* the global risk aversion, $\frac{1}{\gamma^*} = \frac{1}{\gamma^r} + \frac{1}{\gamma^g}$, and set $\alpha = \frac{\gamma^r}{\gamma^r + \gamma^g}$.

If two investors have the same relative risk aversion at time $t = 0$, $\alpha = \frac{w^g}{w^g + w^r}$ is the proportion of wealth held by green investors at $t = 0$.

Companies' utility and optimization

Companies choose their emissions schedules $(\psi_t^i)_{t\in[0,T]}$ at time $t=0$ aiming to maximize their expected market value:

$$\mathcal{J}^i(\psi^i, \psi^{-i}) = \mathbb{E}^c\left[\int_0^T e^{-\rho t} p_t^i(\psi_t^i, \psi_t^{-i})dt\right],$$

where ρ is the rate of time pref., ψ^{-i} is the emissions schedule of the other companies.

Companies' utility and optimization

Companies choose their emissions schedules $(\psi_t^i)_{t\in[0,T]}$ at time $t = 0$ aiming to maximize their expected market value:

$$\mathcal{J}^i(\psi^i, \psi^{-i}) = \mathbb{E}^c \left[\int_0^T e^{-\rho t} p_t^i(\psi_t^i, \psi_t^{-i}) dt \right],$$

where ρ is the rate of time pref., ψ^{-i} is the emissions schedule of the other companies.

They choose $(\psi_t^i)_{t\in[0,T]}$ as a tradeoff between:

- maximizing their future valuation at $(\psi_t^i)_{t\in[0,T]}$ irresp. of the cost of reform (the market price increases in ψ because of green investors' beliefs)
- minimizing the cost of reform to achieve the targeted $(\psi_t^i)_{t\in[0,T]}$ (the market value decreases in ψ because the company pays a cost of reform of $c_i(\psi_t^i - \psi_0^i)$)

$\Rightarrow$ Optimal schedule ψ^*: Nash equilibrium, each company determines $\psi^{i,*}$:

$$\mathcal{J}^i(\psi^{*,i}, \psi^{*,-i}) \geq \mathcal{J}^i(\psi^i, \psi^{*,-i}).$$

Summary of the game

Date	Agent	Choose	Given
At $t = 0$	Companies	Their deterministic emissions schedule from 0 to T	- Their expected market capitalization between 0 and T - The cost of reducing their emissions
$\forall t \in [0, T]$	Regular investors	Their asset allocation	- The observed cash flow news between 0 and t, and the expected cash flow news between t and T
$\forall t \in [0, T]$	Green investors	Their asset allocation	- The observed cash flow news between 0 and t, and the expected cash flow news between t and T - Companies' emissions schedule between t and T

Equilibrium price and allocation

Proposition

Given an emissions schedule $(\psi_t)_{t\in[0,T]}$, *equilibrium asset price is*

$$p_t = D_t - \int_t^T \mu_s ds \quad with \quad \mu_t = \gamma^* \Sigma_t \mathbf{1} - \alpha\theta(\psi_t), \quad \Sigma_t = \sigma_t^\top \sigma_t,$$

and optimal numbers of shares held by investors in equilibrium are

$$N_t^r = (1-\alpha)\left(\mathbf{1} - \frac{1}{\gamma^g}\Sigma_t^{-1}\theta(\psi_t)\right) \quad and \quad N_t^g = \alpha\left(\mathbf{1} + \frac{1}{\gamma^r}\Sigma_t^{-1}\theta(\psi_t)\right),$$

Equilibrium return

In terms of dollar returns:

$$dp_t = dD_t + \Big[\gamma^* \Sigma_t \mathbf{1} - \alpha\theta(\psi_t)\Big]dt$$

$$\mathbb{E}^r[dp_t] = \mu_t dt = \Big[\gamma^* \Sigma_t \mathbf{1} - \alpha\theta(\psi_t)\Big]dt$$

$\rightarrow$ Externality premium, $-\alpha\theta(\psi_t)$: Green investors accept (require) a lower (higher) expected return to hold green (brown) assets

This result in a dynamic setting is consistent with:

- Theoretical works (one-period models): Pastor et al. (2020), Pedersen et al. (2020), Zerbib (2020)
- Empirical evidence on realized returns (Brammer et al., 2006; Renneboog et al., 2008; Barber et al., 2019; Hsu et al., 2019; Bolton and Kacperczyk, 2020) and expected returns (Sharfman and Fernando, 2008; ElGhoul et al., 2011; Chava, 2014)

Equilibrium emissions schedule

Proposition

The optimal emissions schedule maximizes for all $t \in [0, T]$ the quantity

$$c_i \psi_t^i + \beta_t^c \theta_i^c(\psi_t^i) + \alpha \beta_t \theta_i(\psi_t^i),$$

where

$$\beta_t^c = \frac{1 - e^{-\rho(T-t)}}{\rho} \quad \textit{and} \quad \beta_t = \frac{e^{\rho t} - 1}{\rho}.$$

Equilibrium emissions schedule

Proposition

The optimal emissions schedule maximizes for all $t \in [0, T]$ the quantity

$$c_i \psi_t^i + \beta_t^c \theta_i^c(\psi_t^i) + \alpha \beta_t \theta_i(\psi_t^i),$$

where

$$\beta_t^c = \frac{1 - e^{-\rho(T-t)}}{\rho} \quad \textit{and} \quad \beta_t = \frac{e^{\rho t} - 1}{\rho}.$$

$\Rightarrow$ Trade-off between the cost of reducing the emissions and the positive effect of mitigating the climate-related financial risk perceived by the agents.

Equilibrium emissions schedule

- Special case with quadratic externalities (e.g., quadratic damage function by Barnett, Brock and Hansen, 2019):

Proposition

Assuming $\theta_i(x) = \kappa_0 - \frac{\kappa}{2}x^2$ and $\theta_i^c(x) = \kappa_0^c - \frac{\kappa^c}{2}x^2$, for $x \geq 0$, where κ, κ^c, κ_0 and κ_0^c are positive constants representing the stringency with which agents internalize externalities, the optimal emissions schedules are

$$\psi_t^{*,i} = \frac{c_i}{\beta_t^c \kappa^c + \alpha \beta_t \kappa}$$

Equilibrium emissions schedule

Recall:

$$\psi_t^{*,i} = \frac{c_i}{\beta_t^c \kappa^c + \alpha \beta_t \kappa}$$

Limiting cases:

- Limiting case #1: when $\rho \simeq 0$, $\beta_t \simeq t$ and $\beta_t^c \simeq T - t$

  $\Rightarrow$ The effect of green investors increases over time

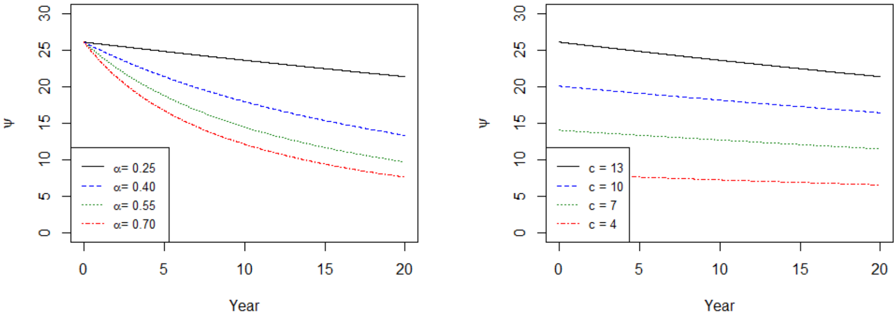
- Limiting case #2: when $\kappa^c = 0$, green investors still have impact since

$$\psi_t^{*,i} = \frac{c_i}{\alpha \beta_t \kappa}$$

- Limiting case #3: when $c_i = 0$, companies no longer emit GHG.

Equilibrium emissions schedule: simulations

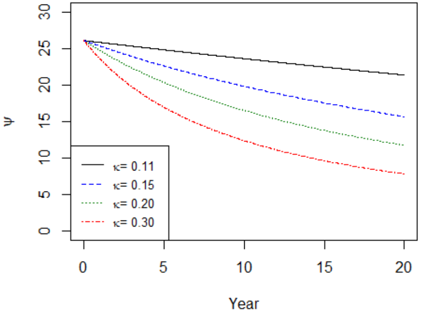
Emissions schedules, according to several values of the proportion of green investors (α, left), and the marginal abatement cost (c, right).

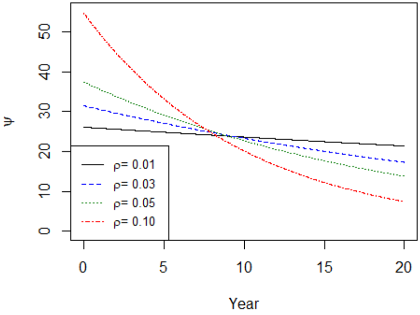


Example: When 25% (50%) of the AUM are managed by green investors, the company reduces its emissions by 1% (4.4%) per year on average.

Equilibrium emissions schedule: simulations

Emissions schedules, according to several values of the green investors stringency (κ, left), and the rate of time preference (ρ, right).





Uncertainty

Fundamental features of climate risks: uncertainty and nonlinearities.

"[...] given historical evidence alone it is likely to be challenging to extrapolate climate impacts on a world scale to ranges in which many economies have yet to experience. Both richer dynamics and alternative nonlinearities may well be essential features of the damages that we experience in the future due to global warming. (Barnett, Brock, Hansen, 2019)"

Model with environmental risk: Market and beliefs

Now, green investors internalize *uncertain* future environmental externalities (climate risks) as future random shocks on expected asset pay-offs.

Model with environmental risk: Market and beliefs

Now, green investors internalize *uncertain* future environmental externalities (climate risks) as future random shocks on expected asset pay-offs.

The market is no longer complete, and the liquidating dividend defined as

$$D_T = D_0 + \int_0^T \sigma_t dB_t + \sum_{k=1}^{\mathcal{N}_T} Y_k,$$

where:

- Y_k are independent random variables (environmental shocks) with distribution ν_t^{ψ} (consistent with transition risks).
- $\mathcal{N}$ is a Poisson process with time-dependent intensity ($t \geq 0$):
  - Under regular investors' beliefs ($\mathbb{P}^r = \mathbb{P}$): Λ_t
  - Under green investors' beliefs ($\mathbb{P}^g$): Λ_t^g

NB: For the moment, regular investors internalize climate-related financial risks.

Model with environmental risk: Market and beliefs

Similarly, we denote the dividend forecast in $t \in [0, T]$ by

$$D_t = \mathbb{E}[D_T | \mathcal{F}_t] = D_0 + \int_0^t \sigma_s dB_s + \sum_{k=1}^{\mathcal{N}_t} Y_k.$$

Model with environmental risk: Market and beliefs

Similarly, we denote the dividend forecast in $t \in [0, T]$ by

$$D_t = \mathbb{E}[D_T | \mathcal{F}_t] = D_0 + \int_0^t \sigma_s dB_s + \sum_{k=1}^{\mathcal{N}_t} Y_k.$$

Assumption 1: Let

$$L_t(u) := \int_{\mathbb{R}^n} e^{u^\top z} \nu_t^\psi(dz),$$

for $t \in [0, T]$ and $u \in \mathbb{R}^n$.

We assume that $L_t(u) < \infty$ for all $t \in [0, T]$ and $u \in \mathbb{R}^n$ (env. impact $< \infty$).

Model with environmental risk: Equilibrium price

Proposition

The optimal numbers of shares for regular investors in equilibrium is the unique solution of

$$\Lambda_t^g \nabla L_t(-\gamma^g(\mathbf{1} - N_t^r)) - \gamma^g \Sigma_t(\mathbf{1} - N_t^r) - \Lambda_t \nabla L_t(-\gamma^r N_t^r) + \gamma^r \Sigma_t N_t^r = 0.$$

The equilibrium price process is unique and given by

$$p_t = D_t - \int_t^T \mu_s ds$$

with drift

$$\mu_t = \gamma^r \Sigma_t N_t^r - \Lambda_t \nabla L_t(-\gamma^r N_t^r).$$

Model with environmental risk: Additional assumptions

Assumption 2: For simplicity, and consistent with the first model, we now assume that regular investors do not internalize risk: $\Lambda = 0$.

Model with environmental risk: Additional assumptions

Assumption 2: For simplicity, and consistent with the first model, we now assume that regular investors do not internalize risk: $\Lambda = 0$.

Since we cannot have a closed form formula of μ_t, N_t^r, and N_t^g, we analyze the limiting case with small but frequent shocks:

- The intensity of shocks as seen by the green investors is $\Lambda_t^{g,h} = h^{-1}\Lambda_t^g$
- The shock sizes are multiplied by h: $\nu^{h,\psi}(A) = \nu^{\psi}(\{x \in \mathbb{R}^n : hx \in A\})$

Model with environmental risk: Additional assumptions

Assumption 2: For simplicity, and consistent with the first model, we now assume that regular investors do not internalize risk: $\Lambda = 0$.

Since we cannot have a closed form formula of μ_t, N_t^r, and N_t^g, we analyze the limiting case with small but frequent shocks:

- The intensity of shocks as seen by the green investors is $\Lambda_t^{g,h} = h^{-1}\Lambda_t^g$
- The shock sizes are multiplied by h: $\nu^{h,\psi}(A) = \nu^{\psi}(\{x \in \mathbb{R}^n : hx \in A\})$

Introduce the first and second moments of environmental risk:

$$\theta(\psi_t) = \Lambda_t^g \int_{\mathbb{R}^n} z\nu_t^{\psi}(dz), \qquad \pi(\psi_t) := \Lambda_t^g \int_{\mathbb{R}^n} z\, z^\top \nu_t^{\psi}(dz), \qquad \text{for } t \in [0, T].$$

Model with environmental risk: Equilibrium allocation

Proposition

In the paper, we give a first order approximation of $N^{r,h}$, $N^{g,h}$ and μ_t^h.

In particular, as $h \to 0$, the quantity of assets held by green investors in equilibrium satisfies

$$N^{g,h} = \Big(\mathbf{I} - h(1-\alpha)\Sigma_t^{-1}\pi(\psi_t)\Big)N^{g,0} + O(h^2),$$

where $N^{g,0}$ is the quantity held in the case of deterministic externalities.

Model with environmental risk: Equilibrium allocation

Proposition

In the paper, we give a first order approximation of $N^{r,h}$, $N^{g,h}$ and μ_t^h.

In particular, as $h \to 0$, the quantity of assets held by green investors in equilibrium satisfies

$$N^{g,h} = \left(\mathbf{I} - h(1-\alpha)\Sigma_t^{-1}\pi(\psi_t)\right)N^{g,0} + O(h^2),$$

where $N^{g,0}$ is the quantity held in the case of deterministic externalities.

By comparison with the deterministic case, green investors decrease their overall absolute allocation to risky assets by a certain factor, since $\|N^{g,h}\| < \|N^{g,0}\|$.

Green investors alleviate the relative pressure they exert on the costs of capital of the brown companies compared to those of the green companies

$\Rightarrow$ Weakens incentives for brown companies to mitigate emissions

Model with environmental risk: Emissions schedule

Assumption 3: The size of the shocks $(Y_t)_{t\in[0,T]}$ is deterministic.

Proposition

When $\theta(\psi)$ and $\theta^c(\psi)$ are defined as in the deterministic case, the optimal emissions schedule of the i-th company reads

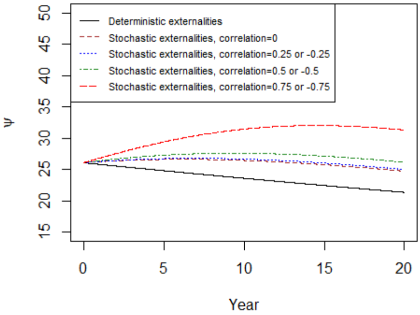
$$\psi_t^{*,i} = \frac{\psi_t^{*,0,i}}{1 - h\,\Gamma_t^i\,\psi_t^{*,0,i}} + O(h^2), \quad \text{for } i=1,\dots n, \tag{1}$$

with $\psi_t^{*,0,i} = \frac{c_i}{\beta_t^c\kappa^c + \alpha\beta_t\kappa}$ being the emissions schedule in the deterministic case and

$$\Gamma_t^i := \kappa\beta_t \frac{\alpha(1-\alpha)}{c_i\Lambda_t^g}\Bigg[\underbrace{\left(\gamma^r \mathbf{1}^\top \theta(\psi_t^{*,0}) + \theta^\top(\psi_t^{*,0})\Sigma_t^{-1}\theta(\psi_t^{*,0})\right)}_{Market\ adjustment} + \underbrace{\left(\gamma^r\theta_i(\psi_t^{*,0}) + 2\theta^\top(\psi_t^{*,0})\Sigma_t^{-1}\delta_i\theta_i(\psi_t^{*,0})\right)}_{Stock\ adjustment}\Bigg],$$

where δ_i is a vector whose i-th coordinate is equal to one and all other coordinates are zero.

Model with environmental risk: simulations



Market with 2 companies:

- One brown company ($c_2 = 13$)
- One green company ($c_1 = 0.5$)

$\Rightarrow$ For all correlation values, the brown company increases its emissions compared to the deterministic case.

Empirical evidence: Specifications

We estimate our two main results in the deterministic case:

1) the equilibrium return

$$\mathbb{E}[dp_t^i] = \left[\gamma^* \Sigma_t^i - \alpha\theta_i(\psi_t^i)\right] dt,$$

Estimated using gaussian returns:

$$r_t^i = c + \gamma \mathrm{Cov}(r_t^i, r_t^m) - \alpha\theta_i(\psi_t^i) + \varepsilon_{i,t}$$

Empirical evidence: Specifications

We estimate our two main results in the deterministic case:

1) the equilibrium return

$$\mathbb{E}[dp_t^i] = \Big[\gamma^* \Sigma_t^i - \alpha\theta_i(\psi_t^i)\Big] dt,$$

Estimated using gaussian returns:

$$r_t^i = c + \gamma \mathrm{Cov}(r_t^i, r_t^m) - \alpha\theta_i(\psi_t^i) + \varepsilon_{i,t}$$

2) The emission schedule

$$\psi_t^i = \frac{c_i}{\alpha\beta_t\kappa}$$

Estimated over 1 year ($\rho \simeq 0 \Rightarrow \beta_1 \simeq 1$):

$$log(\psi_{i,t+1}) = \iota + f_i + \beta_\alpha log(\alpha_t) + \varepsilon_{i,t} \qquad (2)$$

Empirical Evidence: Proxies

We use the carbon intensity to represent $\psi_{i,t}$.

We use green fund holdings to proxy for $\theta(\psi)$ and α:

- Proxy for $\theta(\psi)$:

$$\tilde{\theta}_i(\psi_t^i) = \frac{w_{i,t} - w_{i,t}^b}{w_{i,t}^b},$$

  where w is the weight of i-th industry in the holdings of a sample of green funds and w_i^b is the market weight;

- Proxy for α:

$$\tilde{\alpha}_t = \frac{\text{Market value of U.S. stocks in green funds holdings at } t}{\text{Total market value of U.S. stocks in } t}$$

Empirical illustration: Asset returns

	ι	γ	$\alpha\delta$	β_{SMB}	u_{HML}	u_{MOM}	$u_{\Delta\theta}$	Adj OLS/GLS R^2
Estimation of the market and externality premia separately								
Estimate	0.0141	-0.6871						0.05 [0.03,0.07]
t-value	(11.54)	(-0.94)						0.07 [0.05,0.09]
Estimate	0.0142		-0.0002					-0.01 [-0.02,-0.01]
t-value	(18.16)		(-3.41)					0.01 [0.01,0.01]
Main estimation								
Estimate	0.0142	-0.6855	-0.0002					0.04 [0.02,0.05]
t-value	(11.73)	(-0.92)	(-3.6)					0.08 [0.06,0.09]
Main estimation with SMB, HML and MOM betas								
Estimate	0.0138	0.4387	-0.0003	-0.00004	0.0002	-0.0001		0.22 [0.18,0.26]
t-value	(12.38)	(0.59)	(-5.6)	(-0.33)	(1.27)	(-1.36)		0.31 [0.27,0.34]
Main estimation with SMB, HML and MOM betas, and control for unexpected shifts in beliefs								
Estimate	0.014	0.2866	-0.0002	-0.00005	0.0002	-0.0001	0.0138	0.22 [0.18,0.26]
t-value	(12.43)	(0.38)	(-1.95)	(-0.38)	(1.09)	(-1.41)	(3.89)	0.32 [0.28,0.35]

Empirical illustration: Asset returns

Industry	Externality premium (% annual return)
Precious metals	0.18
Coal	0.15
Mining	0.13
Consumer goods	-0.01
Health care	-0.06
Food	-0.07
Electrical equipment	-0.69

Empirical illustration: Emissions

	Dependent variable: $log(\psi_{i,t+1})$
$log(\tilde{\alpha}_t)$	-0.079^{***}
	(0.014)
Industry FE	Yes
Observations	564
R^2	0.964
Adjusted R^2	0.961
F Statistic	297.502^{***} (df = 47; 516)
Note:	*p<0.1; **p<0.05; ***p<0.01

When the percentage of green assets $\tilde{\alpha}$ doubles, the carbon intensity ψ drops by 5.3% the following year ($\frac{\psi_2 - \psi_1}{\psi_1} = e^{-0.079 log(2)} - 1 = -0.053$).

$\Rightarrow$ Limited impact

Main take-aways: Impact

- $\nearrow$ with the wealth share of green investors
  $\Rightarrow$ Emphasizes the need to support the development of green finance (raising awareness, offering green securities, etc.)
- $\nearrow$ with green investors environmental stringency
  $\Rightarrow$ Advocates the development of frameworks, taxonomies and labels to allow green investors to discriminate more clearly between green and brown companies and be more selective in the asset allocation
- $\searrow$ with uncertainty about future environmental risks
  $\Rightarrow$ Highlights the need for more transparency from companies about their future environmental risks

Future research: More efficient approaches for green investing? Combining green investing with shareholder engagement (Broccardo, Hart and Zingales, 2020)?

Thank you for your attention!

o.d.a.zerbib@tilburguniversity.edu