Sustainable Investing in Equilibrium

JFE 2020/2/14

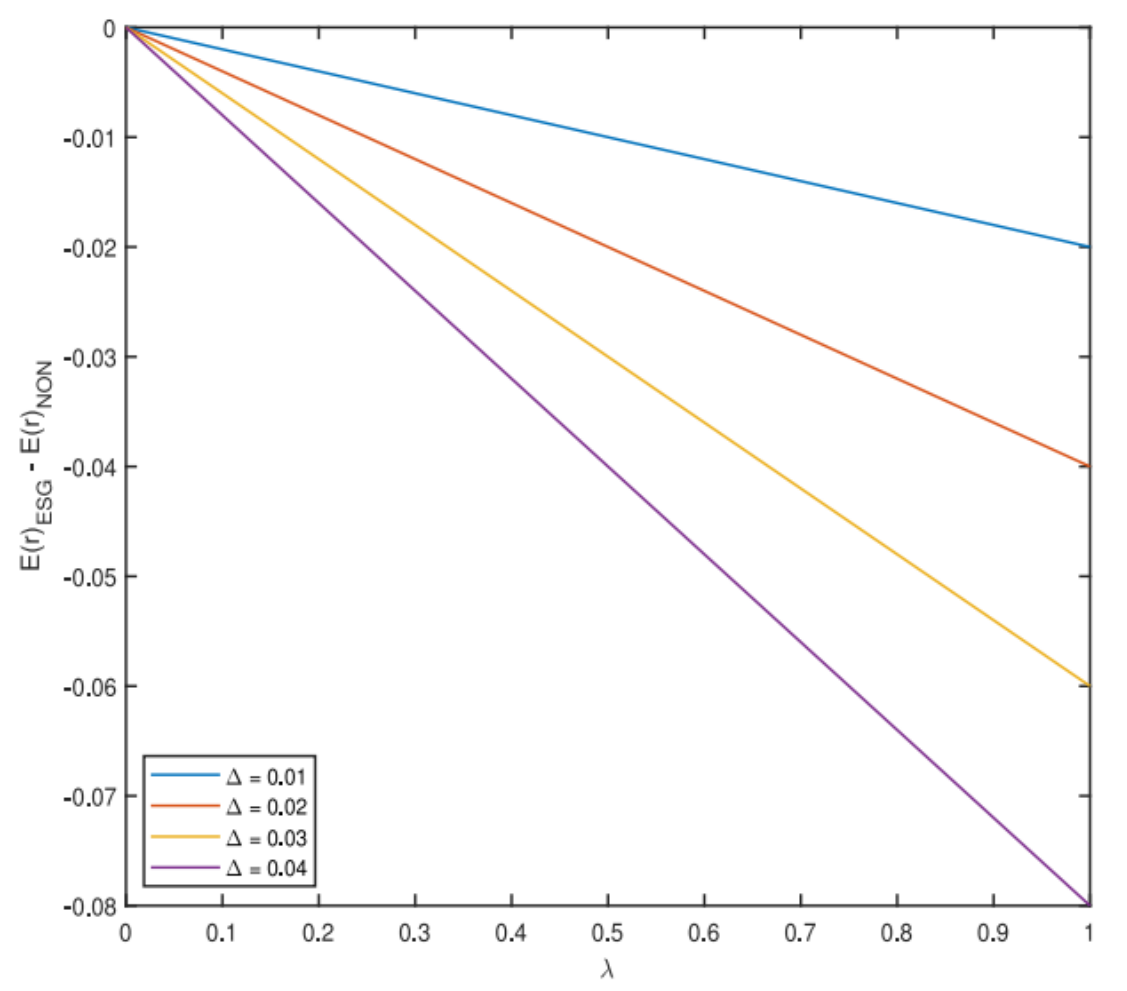
Outline

1. ESG portfolio return/ Alpha & Investor surplus
    - Portfolio return
    - Correlation
    - Alpha & investor surplus

2. Introducing Climate Risk
    - Green Stocks as climate hedges (Decomposing alpha)

3. Social Impact
    - Notation
    - Green firms invest more
    - Firms become greener

1. ESG v.s non-ESG expected portfolio return

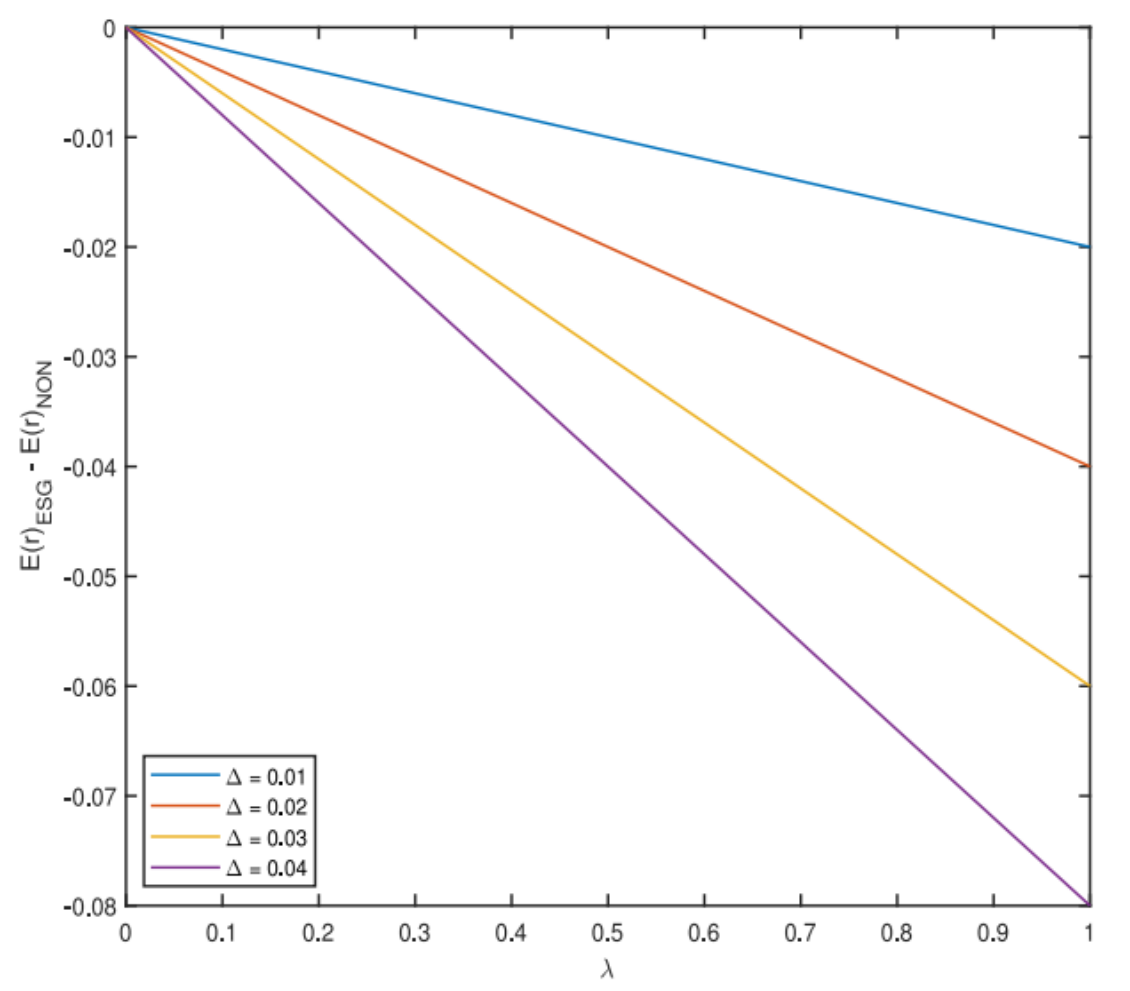


Δ: Maximum rate of return that ESG Investor willing to sacrifice

λ: Fraction of total wealth belonging to ESG investors

$$\mathrm{E}\{\tilde{r}_{esg}\} - \mathrm{E}\{\tilde{r}_{non}\} = -2\lambda\Delta,$$

1. ESG v.s non-ESG expected portfolio return



Implication :

ESG investors earn significantly lower return than non-ESG investors

As λ increases, investors must pay more for the green stocks they desire

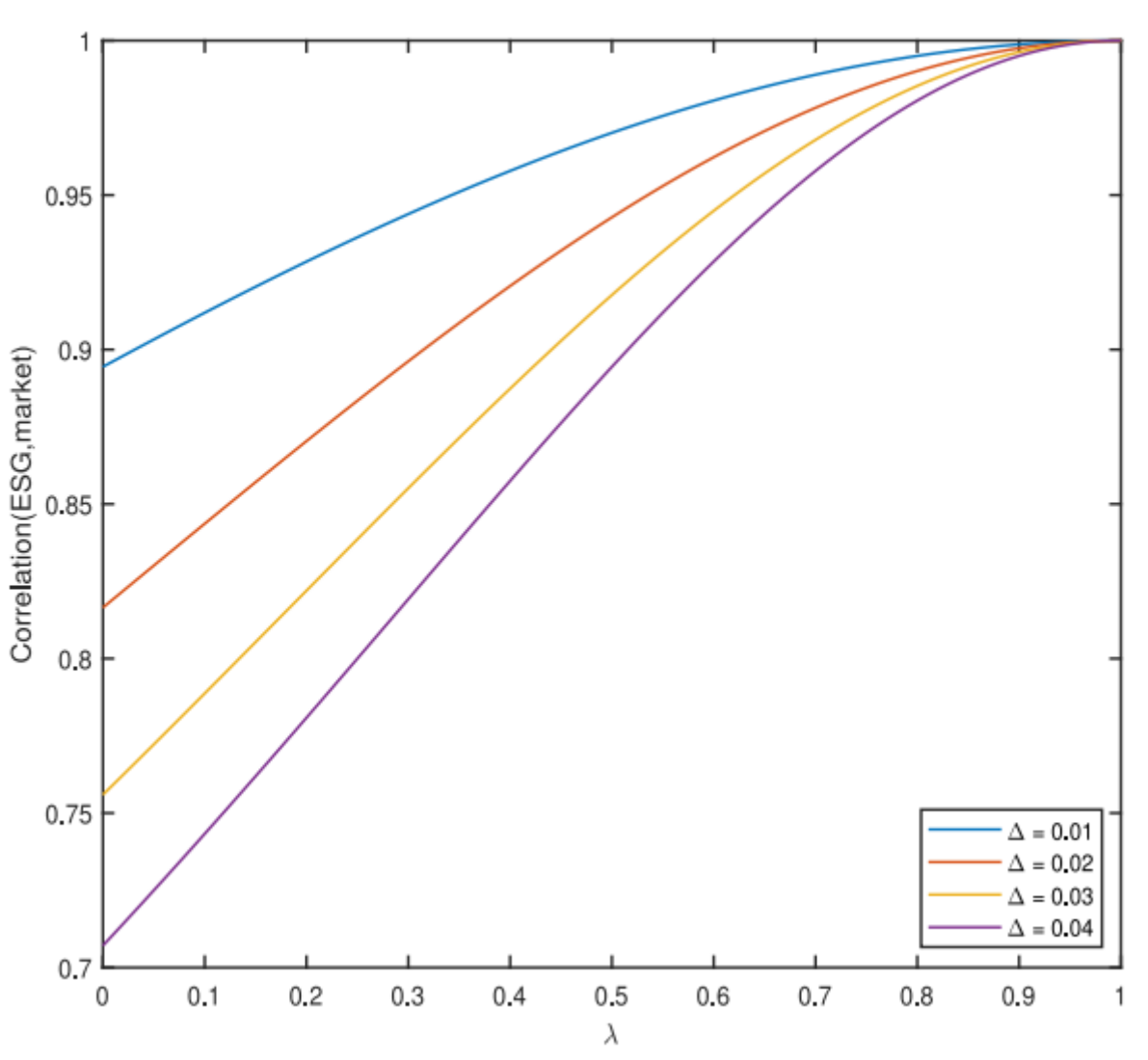
Outline

1. ESG portfolio return/ Alpha & Investor surplus
    - Portfolio return
    - Correlation
    - Alpha & investor surplus

2. Introducing Climate Risk
    - Green Stocks as climate hedges (Decomposing alpha)

3. Social Impact
    - Notation
    - Green firms invest more
    - Firms become greener

1. ESG v.s non-ESG return Correlation



$$\rho(\tilde{r}_{esg}, \tilde{r}_m) = \frac{\sigma_m}{\sqrt{\sigma_m^2 + \frac{2\Delta}{a}(1-\lambda)^2}}.$$

Implication :

As Δ increases, ESG investors feel increasingly strongly about ESG, increasing the difference between ESG and market portfolio

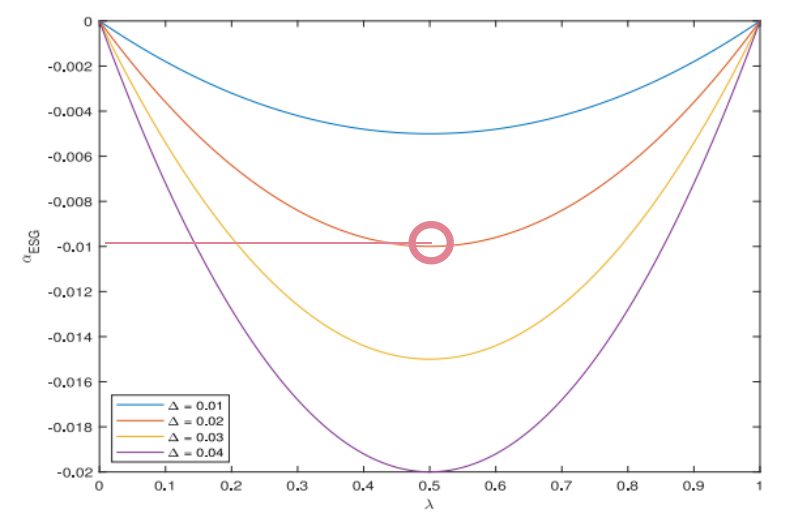
Outline

1. ESG portfolio return/ Alpha & Investor surplus
    - Portfolio return
    - Correlation
    - Alpha & investor surplus

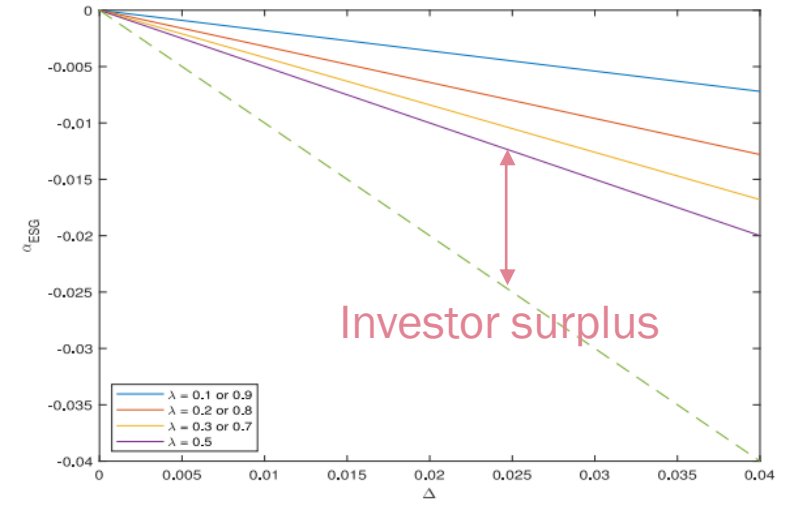
2. Introducing Climate Risk
    - Green Stocks as climate hedges (Decomposing alpha)

3. Social Impact
    - Notation
    - Green firms invest more
    - Firms become greener

1. Alpha-ESG & Investor surplus



Panel B. The role of Δ

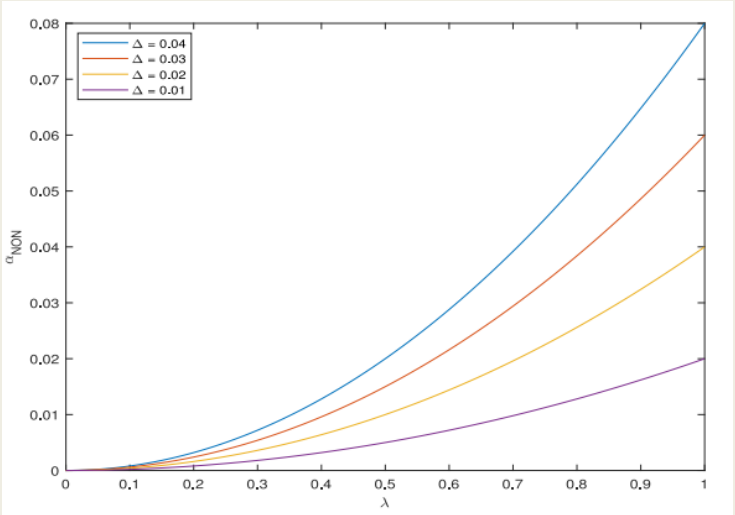


Implication (trade off):

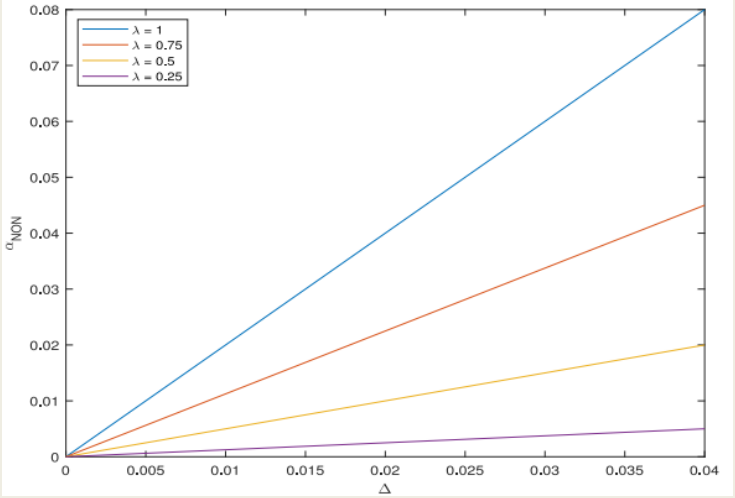
When ESG investors are willing to give up a 2% certain return to hold their portfolio rather than the market(i.e., Δ = 0.02), their worst-case alpha is only -1%.

The surplus increases with Δ because the stronger the ESG investors feel about greenness, the more they move market prices

1. Alpha-ESG & Investor surplus



Panel B. The role of Δ



Implication:

A non-ESG investor earns the highest alpha when all other investors are ESG (i.e., λ = 1) and when those investors' ESG tastes are strong (i.e Δ is large).

Overweighting brown stocks, whose alphas are positive and large, non-ESG investor earns a large positive alpha.

Outline

1. ESG portfolio return/ Alpha & Investor surplus
    - Portfolio return
    - Correlation
    - Alpha & investor surplus

2. Introducing Climate Risk
    - Green Stocks as climate hedges (Decomposing alpha)

3. Social Impact
    - Notation
    - Green firms invest more()
    - Firms become greener

1. Alpha-ESG & Investor surplus

$$\alpha_n = -\left[\frac{\bar{d}}{\bar{a}} + \bar{c}\left(1 - \rho_{mC}^2\right)\xi\right] g_n.$$

Implication:

- Greener stocks now have lower CAPM alphas not only because of investors' tastes for green holdings, but also because of greener stocks' ability to better hedge climate risk

Outline

1. ESG portfolio return/ Alpha & Investor surplus
    - Portfolio return
    - Correlation
    - Alpha & investor surplus

2. Introducing Climate Risk
    - Green Stocks as climate hedges (Decomposing alpha)

3. Social Impact
    - Notation
    - Green firms invest more()
    - Firms become greener

3. Notation

$$S_n \equiv g_n K_n,$$

Social Impact = firm's externality (i.e g_n) weighted by firms size (i.e K_n)

$$\Delta K_n(\bar{d}) = \frac{1}{\kappa_n}\left[\frac{\Pi_n}{1 + r_f + \mu_m \beta_{m,n} - \frac{\bar{d}}{a} g_n} - 1\right].$$

Firm's investment in capital (i.e ΔK_n) is a function of investors ESG taste (i.e $\bar{d}$)

$$S_n(\bar{d}) - S_n(0) = g_n\left(\Delta K_n(\bar{d}) - \Delta K_n(0)\right).$$

Social Impact caused by ESG taste
i.e $S_n(\bar{d}) - S_n(0)$

Outline

1. ESG portfolio return/ Alpha & Investor surplus
   - Portfolio return
   - Correlation
   - Alpha & investor surplus

2. Introducing Climate Risk
   - Green Stocks as climate hedges (Decomposing alpha)

3. Social Impact
   - Notation
   - Green firms invest more (g_n given)
   - Firms become greener (g_n endogenous)

3. Greener Firms Invest more

$$S_n \equiv g_n K_n,$$

$$\Delta K_n(\bar{d}) = \frac{1}{\kappa_n}\left[\frac{\Pi_n}{1 + r_f + \mu_m \beta_{m,n} - \frac{\bar{d}}{a} g_n} - 1\right].$$

$$S_n(\bar{d}) - S_n(0) = g_n\big(\Delta K_n(\bar{d}) - \Delta K_n(0)\big).$$

Implication:

ESG tastes lead green firms to invest more and brown firms to invest less. ESG tastes reduce green firms' expected returns and hence their costs of capital. Green firms' lower costs of capital increase their projects' NPVs, so green firms invest more

3. Greener Firms Invest more (Social Impact)

$$S_n(\bar{d}) - S_n(0) = \frac{\bar{d}\, g_n^2\, \Pi_n}{a\kappa_n\left(1 + r_f + \mu_m\beta_{m,n} - \frac{\bar{d}}{a}g_n\right)\left(1 + r_f + \mu_m\beta_{m,n}\right)} > 0$$

$$X_i = w_m + \left(\delta_i / a^2\right)\Sigma^{-1}g.$$

Implication(Social impact ↑):

$\bar{d}$ ↑(stronger ESG taste)
a↓ (weaker risk aversion)
K_n ↓ (Capital less likely to adj)
π ↑ (firm being more productive)

3. Greener Firms Invest more (Empirical Evidence)

$$\mu = \mu_m \beta_m - \frac{\bar{d}}{a} g.$$

$$\alpha_n = -\frac{\bar{d}}{a} g_n.$$

Baker and Wurgler (2012) : Negative relation between alpha and Investment

Implication :

investors' ESG tastes tilt real investment from brown to green firms because those tastes generate alphas, which affect the cost of capital, which in turn affects investment

Outline

1. ESG portfolio return/ Alpha & Investor surplus
    - Portfolio return
    - Correlation
    - Alpha & investor surplus

2. Introducing Climate Risk
    - Green Stocks as climate hedges
    - Decomposing Alpha

3. Social Impact
    - Notation
    - Green firms invest more (g_n given)
    - Firms become greener (g_n endogenous)

3. Firms become greener

$$\Delta g_n(\bar{d}) \approx \frac{\bar{d}}{a\chi_n}$$

$$\Delta K_n(\bar{d}) = \frac{1}{\kappa_n}\left[\frac{\Pi_n\left(1-\frac{\chi_n}{2}(\Delta g_n(\bar{d}))^2\right)}{1+r_f+\mu_m\beta_{m,n}-\frac{\bar{d}}{a}g_n(\bar{d})}-1\right],$$

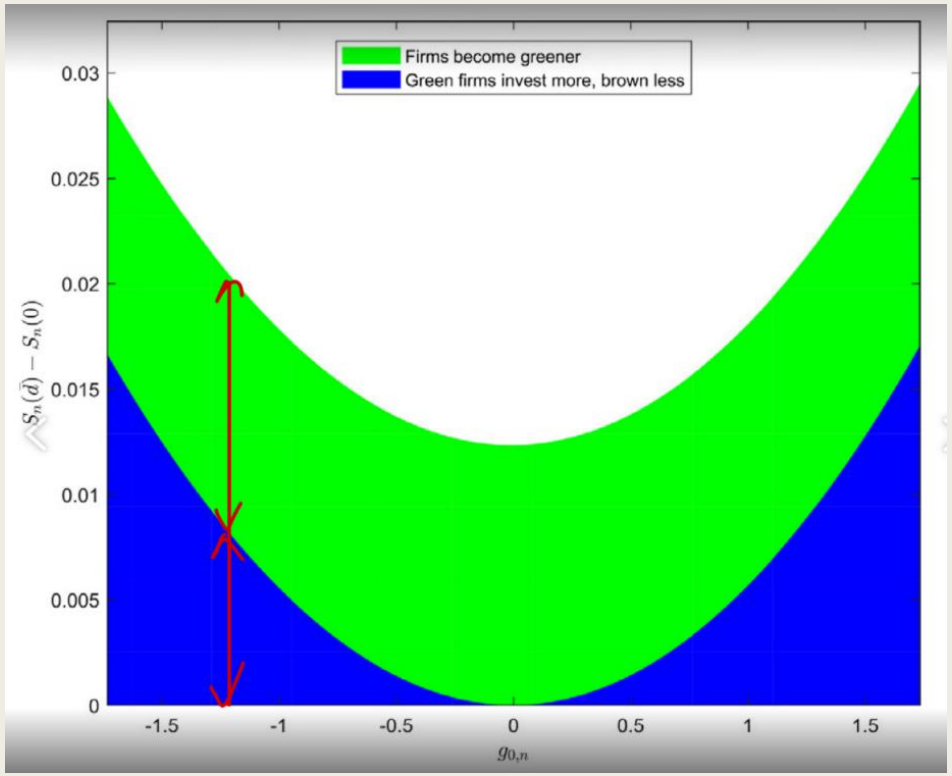
$$\mu = \mu_m\beta_m - \frac{\bar{d}}{a}g.$$

Implication:

When $\bar{d}$ > 0, expected returns decrease so firms' market values increase. Managers who wish to maximize market value therefore make their firms greener (i.e, g_n > 0)

3. Firms become greener (Social Impact)

$$S_n(\bar{d}) - S_n(0) = g_{0,n}\left(\Delta K_n(\bar{d}) - \Delta K_n(0)\right) + K_n(\bar{d})\,\Delta g_n(\bar{d})$$

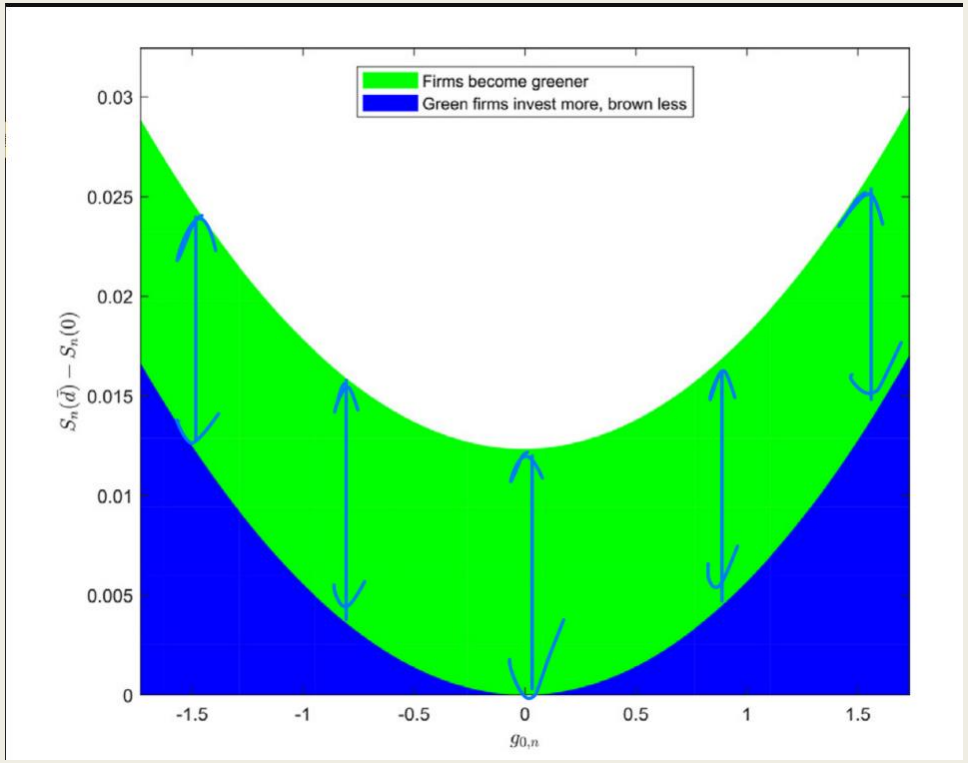


Implication:

- Social impact Comes from two parts, the first part is the extra investment of greener firms (Higher NPV), and the second part is the firm additional investment in order to going green (Increasing Firm value)

3. Firms become greener (Social Impact)

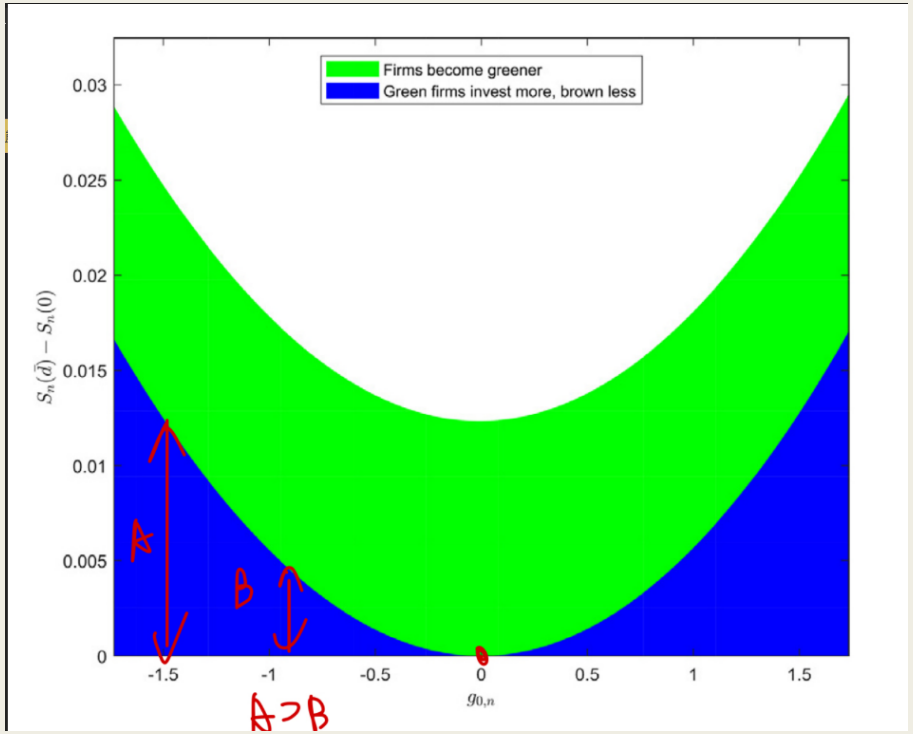
$$S_n(\bar{d}) - S_n(0) = g_{0,n}\left(\Delta K_n(\bar{d}) - \Delta K_n(0)\right) + K_n(\bar{d})\,\Delta g_n(\bar{d})$$



Implication:

- Social impact brought by firms willingness to become greener is roughly the same

3. Firms become greener (Social Impact)

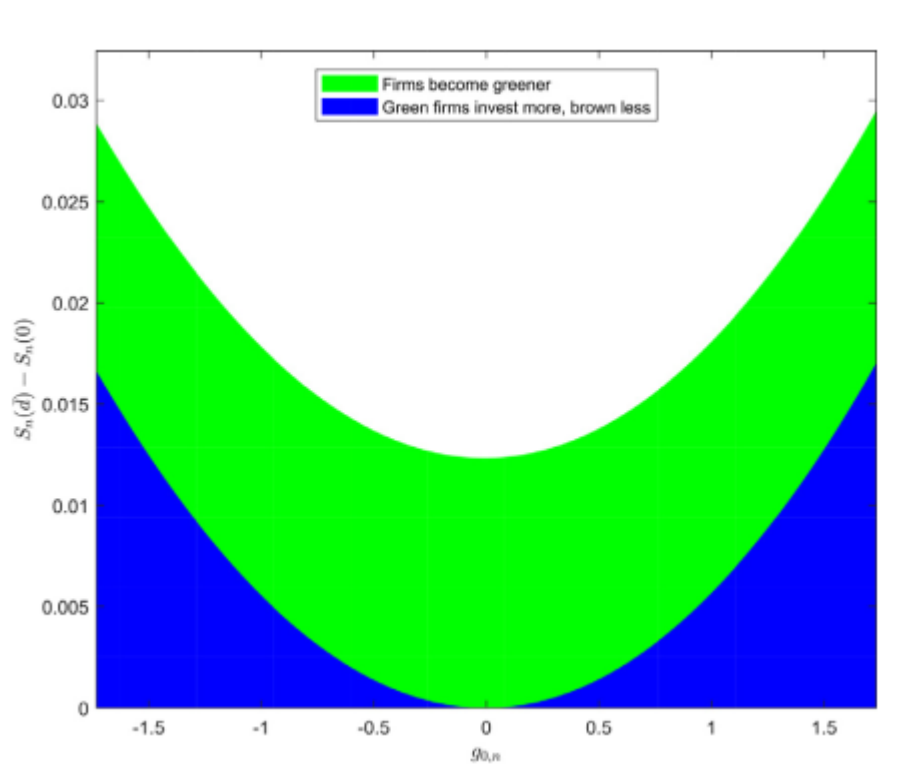


$$S_n(\bar{d}) - S_n(0) = g_{0,n}\left(\Delta K_n(\bar{d}) - \Delta K_n(0)\right) + K_n(\bar{d})\,\Delta g_n(\bar{d}).$$

Implication:

- tilting investment toward green firms, is zero for an ESG-neutral firm, but it is large for very green or very brown firms, which experience the largest shifts in investment (bottom blue region)

3. Firms become greener (Social Impact)

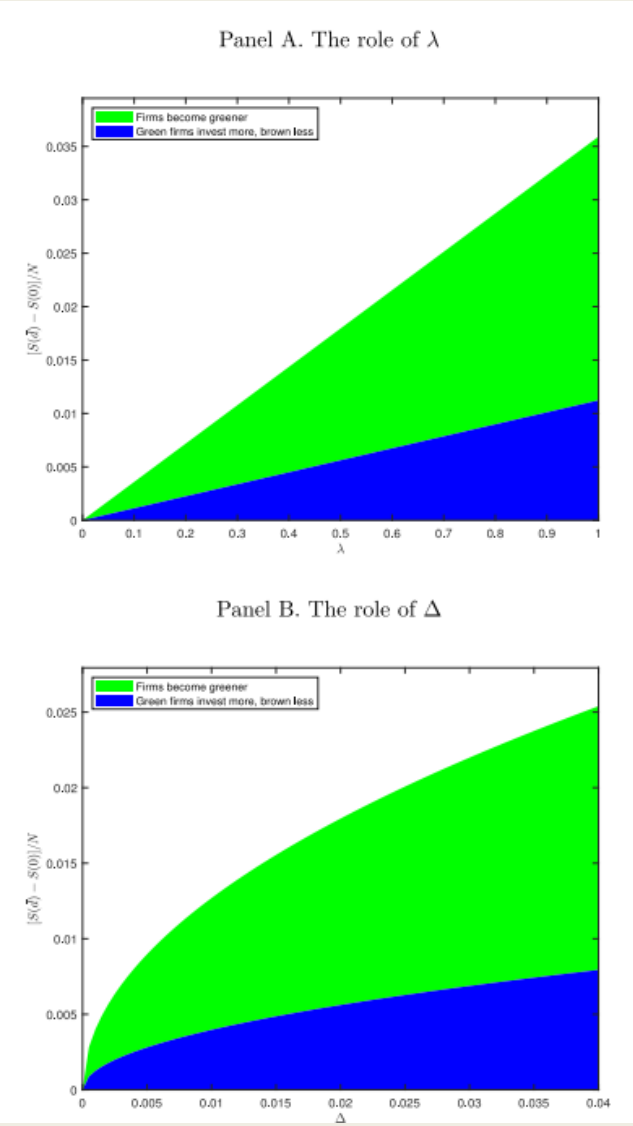


$$S_n(\bar{d}) - S_n(0) = g_{0,n}\left(\Delta K_n(\bar{d}) - \Delta K_n(0)\right) + K_n(\bar{d})\,\Delta g_n(\bar{d})$$

Implication:

- A larger dispersion ($g_{0,n} \neq 0$) deepens the cost-of capital differentials between green and brown firms, leading to larger investment differentials. With green firms investing more and brown firms investing less, aggregate social impact increases.

3. Firms become greener



Implication:

Social impact increases as ESG taste increases