Green Investors and Corporate Investment

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Abstract

Green investing, or socially responsible investing (SRI), which refers to making investment decisions according to both financial and ethical criteria, has become increasingly popular in recent years. This paper explores the effects of ethical screening on the investment decisions of firms that fail the screen (‘polluting’ firms) and on their decisions to reform so as to pass the screen. The paper also analyzes the impact that short selling polluting firms by green investors would have on these firms. These issues are examined in an equilibrium setting with endogenous investment decisions and endogenous future outputs. We find that green investors can induce polluting firms to reform and that screening results in under-investing by polluting firms and over-investing by clean firms. We also find that short selling polluting firms by green investors can significantly increase polluting firms’ cost of capital and that it can leverage the effect on polluting firms’ decisions to reform.

1 Introduction

Green investing, or socially responsible investing (SRI), refers to making investment decisions according to both financial and ethical criteria. SRI has become increasingly popular in recent years. According to the Social Investing Forum, an association dedicated to promoting the concept of green investing, the amount of money involved in SRI reached a level of $2.3 trillion in 2001, accounting for about 10-12 percent of all managed funds in the US.

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The Social Investing Forum defines three strategies that are used by investors who wish to promote socially and environmentally responsible business practices: screening, shareholder activism and community investing.

Screening is the practice of including or excluding publicly traded securities from investment portfolios or mutual funds based on social and/or environmental criteria. A typical exclusionary screening practice would be to use all firms included in the S&P 500 as the initial opportunity set and exclude from it firms in the tobacco, weapons and gambling businesses. On the other hand, an inclusionary screening approach involves selecting companies based on their positive contributions to society such as outstanding employer-employee relations, excellent environmental practices, and so on. Shareholder activism refers to the actions that socially aware investors can take in their role as owners of corporations. These efforts include discussing issues of concern with companies, as well as filing, co-filing, and voting proxy resolutions aimed at influencing corporate behavior toward a more responsible level of corporate citizenship. Community investing refers to investments which provide low interest rate loans to people in low-income communities, who would otherwise have difficulty gaining access to loan capital.

This paper focuses on exclusionary screening, which is by far the most popular SRI practice, accounting for over $2.0 trillion of the $2.3 trillion mentioned above. Heinkel, Kraus and Zechner (2001) analyzed the effect of exclusionary screening to raise a polluting firm’s cost of capital to the point where maximizing share value supports paying a fixed cost to reform, allowing the firm’ shares to be held by the investors applying the screen. However, in that model investment by firms was held constant. In this paper, we endogenize investment and examine the impact that exclusionary screening has on total economy-wide investment.

In our model, risk-neutral entrepreneurs have projects that they wish to implement and sell to risk-averse investors. The entrepreneur chooses an investment amount $K$ and sells the firm to investors for $P$, earning the project’s net present value, $P - K$. The projects belong to a set of two types. Half of the projects have a clean technology ($N_c = .5$) and half of the
projects have a *polluting* technology \( (N_p = .5) \). The expected returns and variances of the two technologies are identical, but the correlation between the returns is less than 1.0, thus offering diversification benefits to investors.

Risk-averse investors are composed of two types of individuals: *neutral* investors, who do not practice exclusionary screening, and *green* investors, who do. Green investors refuse to hold the shares of firms with polluting technologies. The fraction of green investors in the economy, \( \frac{I_g}{I} \), is set exogenously between 0 and 1. Both green and neutral investors have the same level of risk aversion. The entrepreneurs can, before selling their stock to the public, spend \( C \) and become *reformed*. Reformed firms retain their polluting technology (the mean, variance and correlation with the clean technology), but they are now acceptable to green investors. The number of firms with polluting technologies that switch from polluting to reformed is endogenous \( (N_r \) varies from 0 to .5) to satisfy the equilibrium condition \( P_r - K_r - C = P_p - K_p \). Green investors hold clean and reformed firms and neutral investors hold clean and polluting firms. Neutral investors will not hold reformed firms because of the higher price of reformed firms.\(^1\) Among each of the three firm categories, all firms are identical and they operate as a cartel.

Our interest is in how varying the fraction of green investors from 0 to 1 alters the prices and investment levels of clean, polluting and reformed (if they exist) firms. For expositional reasons, we describe this process as though \( \frac{I_g}{I} \) were increasing. However, since we have a single-period model, the analysis is actually that of comparative statics. The two extreme cases that we analyze are one in which \( C \) is very high and one in which \( C \) is positive but very low. We argue that every intermediate case is a combination of the two extreme cases.

Suppose \( C \to \infty \). As investors change from neutral to green \( (\frac{I_g}{I} \) goes from 0 to 1), firms with polluting technologies will never find it optimal to reform since the cost of doing so is too large. This results in the price and investment level of the polluting firms dropping, as the demand for their shares decreases. Since the demand for the shares of the clean firms is

\(^1\)As in Heinkel, Kraus and Zechner (2001), we rule out short-selling by neutral investors. Our arguments for doing so are the same as those in Heinkel, Kraus and Zechner (2001). See also the discussion there about eliminating the short-selling constraint.
relatively constant, because both the green and neutral investors hold shares of clean firms, total investment in the economy also falls. In this extreme case the green investors have the largest negative impact on total investment in the economy.

The other extreme case is the one in which $C \to 0$. Then, when reforming costs are very small but positive, firms with polluting technologies will start switching to reformed, making them acceptable to green investors, when $I_q$ is very small. As long as some cost of reforming exists, the number of reformed firms is convex, that is, the rate of reforming increases as $I_q$ goes from 0 to 1.

Reformed firms are very valuable to green investors because by holding them they can gain access to the polluting technology. Since only green investors hold reformed firms, the convexity of the reformation means that at a low level of $I_q$, the rate at which investors are switching from neutral to green is greater than the rate at which firms are switching from polluting to reformed. This creates a shortage in supply of reformed firms, which results in a higher price for their shares and greater investment. Since the rate of reforming increases as $I_q$ goes from 0 to 1, green investors are willing to pay the highest price for the first firm that reforms.

On the polluting firms’ side, the opposite process takes place. Again, since the rate at which investors are switching from neutral to green is greater than that in which firms are reforming, an over supply of polluting firms is created. This supply effect decreases their price and investment level.

Total investment in the case where $C \to 0$ exhibits a maximum for some $0 < I_q^m < I$ ($I_q^m$ is around $\frac{1}{2}$) and is higher than when $I_q = 0$ or when $I_q = 1$. It is also the case that total investment is the same whether $I_q = 0$ or $I_q = 1$. The intuition for total investment having a maximum has to do with the fact that the three sectors (clean, reformed and polluting) are formed as cartels. When $I_q = 0$, there are only two sectors in the economy, clean and polluting, each equals one half of the total supply of firms ($N_c = N_p = \frac{1}{2}$). At this stage, the two cartels have the largest market power and they keep their output at a low level in order to maximize profits. As the reformation process begins, firms are switching from
the polluting sector to the reformed sector and the cartel of polluting firms is losing market power while the cartel of reformed firms is gaining one.

As the process continues further, it reaches a stage where the size of the two sectors is equal \((N_r = N_p = \frac{1}{4})\). This is the stage in the economy when the competition between the three sectors is the largest and the reformed and polluting cartels have the least total market power. This increased competition encourages a larger amount of total investment and results in lower firms’ profits. As \(\frac{I_g}{T}\) increases from this point, the reformed sector is gaining market power until at \(\frac{I_g}{T} = 1\), its size and impact are similar to those of the polluting sector when \(\frac{I_g}{T} = 0\).

In order to discuss less extreme cases we first define \(I_g^*\) as the level when the first polluting firm switches to reformed. \(N_r = 0\) for \(I_g \leq I_g^*\) and then \(N_r\) rises to \(N_r = .5\) when \(\frac{I_g}{T} = 1\). Intermediate cases are those with reforming costs \(C (0 < C < \infty)\), such that \(I_g^* < 1\). We argue that every intermediate case is a combination of the two extreme cases described above.

The first phase of an intermediate case resembles the \(C \rightarrow \infty\) phase. In this phase, since the benefits of avoiding being boycotted by the green investors do not compensate for the reforming costs, no firm reforms. Consequently, the price and investment level of the polluting firms and the total investment in the economy drop.

At \(I_g^*\), firms start to reform and the situation resembles the \(C \rightarrow 0\) regime. A convex reformation rate begins, until at \(\frac{I_g}{T} = 1\) all firms reform. In order to answer the question at what level of \(I_g\) does the economy exhibit its maximum total investment, we need to observe the level of \(I_g^*\).

In the intermediate cases where \(\frac{I_g}{T} < 1\), if reformation costs are large, maximum investment occurs at the extremes when \(\frac{I_g}{T} = 0\) or \(\frac{I_g}{T} = 1\). The reason is that the \(C \rightarrow \infty\) phase lasts long enough that total investment cannot recover above its initial level.

For more modest reformation costs, the \(C \rightarrow \infty\) regime is relatively short, the reformation process begins at an early stage and once we switch to the \(C \rightarrow 0\) regime, total investment rebounds and exceeds its level at \(\frac{I_g}{T} = 0\). In this case the largest investment occurs at an interior value for \(\frac{I_g}{T}\), but total investment is less than in the case where \(C \rightarrow 0\).
2 The Model

2.1 Firms

There are three categories of firms: clean, reformed and polluting, denoted c, r and p, respectively; there are \( N_i \) firms of type \( i, \ i \in \{c,r,p\} \) and \( N \) firms in total. A polluting firm that reforms switches to a reformed class at a fixed cost of \( C \). This means that it will retain its polluting technology, but will be acceptable for investment by green investors\(^2\).

Firm’s \( i \) output is given by the following production technology: \( \tilde{Y}_i = F_i \tilde{X}_i \) where \( F_i = K_i^{\gamma_i} \) (\( \gamma_i < 1 \)) and \( \tilde{X}_i \sim N(\mu_i, V_i) \). The fact that reformed firms retain their polluting technologies, implies: \( \gamma_r = \gamma_p \). The covariance between \( \tilde{X}_i \) and \( \tilde{X}_j \) is denoted by \( V_{i,j} \) and the correlation by \( \rho_{i,j} \). We assume that the outputs of firms of the same type are perfectly correlated with each other.

There are three types of entrepreneurs in the economy, having access to the different production technologies. An entrepreneur of type \( i, \ i \in \{c,r,p\} \) chooses an investment level \( K_i \), that maximizes his net present value, \( \{P_i - K_i\} \).

2.2 Investors and Green Screening

There are two types of investors: neutral and green, denoted \( n \) and \( g \), respectively. There are \( I_k \) investors of type \( k \) and \( I \) investors in total. Neutral investors are willing to invest in all types of firms but green investors refuse to hold shares in polluting firms. Each investor has constant absolute risk aversion (CARA) preferences (i.e., negative exponential utility function) with risk tolerance parameter denoted by \( \tau \).

Based on the assumptions of normally distributed output and CARA preferences, a typical neutral investor has the following expected utility function (see Heinkel, Kraus and Zechner (2001)):

\(^2\)We solved three different cases for the reformed firms. In the first one, the reformed firms retain their polluting technology, in the second, the reformed firms switch to a clean technology and in the third, the reformed firms adopts a reformed technology that is somewhere between the clean and polluting technologies. In this paper we present the case in which the reformed firms retain their polluting technology in order to avoid diversification benefits to both the green and the neutral investors.
\[ U_n = x_{nc}F_{c}\mu_c + x_{np}F_{p}\mu_p + x_{nr}F_{r}\mu_p - \frac{x_{nc}^2F_c^2V_c + x_{np}^2F_p^2V_p + x_{nr}^2F_r^2V_p}{2\tau} \]
\[-\frac{[2x_{nc}x_{np}F_cF_pV_{cp} + 2x_{nc}x_{nr}F_cF_rV_{cp} + 2x_{nr}x_{np}F_rF_pV_{p}]}{2\tau} \]
\[-(x_{nc} - \omega_{nc})P_c - (x_{nr} - \omega_{nr})P_r - (x_{np} - \omega_{np})P_p \]

A typical green investor has the following expected utility function (with \( x_{gp} = 0 \)):

\[ U_g = x_{gc}F_{c}\mu_c + x_{gr}F_{r}\mu_p - \frac{[x_{gc}^2F_c^2V_c + x_{gr}^2F_r^2V_p + 2x_{gc}x_{gr}F_cF_rV_{cp}]}{2\tau} \]
\[-(x_{nc} - \omega_{nc})P_c - (x_{nr} - \omega_{nr})P_r \]

Where, \( x_{ij}, i \in \{n, g\}, j \in \{c, r, p\} \) is the number of shares of firm \( j \) held by investor \( i \); and \( \omega_{ij}, i \in \{n, g\}, j \in \{c, r, p\} \) is the number of shares of firm \( j \) endowed to investor \( i \).

### 2.3 Equilibrium

The market clearing conditions are:

\[ I_n x_{nc}^* + I_g x_{gc}^* = N_c \]  (3)
\[ I_n x_{nr}^* + I_g x_{gr}^* = N_r \]  (4)
\[ I_n x_{np}^* = N_p \]  (5)

In order to have no arbitrage we must prohibit short selling of reformed shares. Otherwise, the neutral investors could short the reformed firms and buy the polluting firms; since the latter use exactly the same technology but their share price is lower (when there are positive reforming costs), neutral investors could earn a riskless arbitrage profit. Therefore, in equilibrium \( x_{nr}^* = 0 \).

The resulting equilibrium prices are:

\[ P_c = K_c^{\gamma_c} \left[ \mu_c - \frac{1}{(I_g + I_n)\tau} \left( K_c^{\gamma_c} N_c V_c + K_r^{\gamma_r} N_r V_{c,p} + K_p^{\gamma_p} N_p V_{c,p} \right) \right] \]  (6)
\[ P_r = K_r^{\gamma_r} \left[ \mu_p - \frac{1}{(I_g + I_n) \tau} \left( K_c^{\gamma_c} N_c V_{c,p} + K_r^{\gamma_r} N_r V_p + K_p^{\gamma_p} N_p \frac{V_{c,p}^2}{V_c} + K_r^{\gamma_r} N_r \frac{I_n}{I_g} \phi \right) \right] \]  
\[ P_p = K_p^{\gamma_p} \left[ \mu_p - \frac{1}{(I_g + I_n) \tau} \left( K_c^{\gamma_c} N_c V_{c,p} + K_p^{\gamma_p} N_p V_p + K_r^{\gamma_r} N_r \frac{V_{c,p}^2}{V_c} + K_p^{\gamma_p} N_p \frac{I_g}{I_n} \phi \right) \right] \]

Where \( \phi = V_c V_p - V_{c,p}^2 \)

A Nash equilibrium is a solution that satisfies the following four conditions:

1. \( \partial P_i / \partial K_i = 1, \quad i \in \{c, r, p\} \) (first order condition for maximizing net present value)
2. \( (P_p - K_p^*) = (P_r - K_r^*) - C \) (gain from reforming just covers fixed reforming cost)

The solutions to these four equations give the optimal investment levels \( \{K_c^*, K_r^*, K_p^*\} \) and the number of polluting firms that reform in equilibrium, \( N_r^* \).

An interesting observation is that an economy that has no green investors \( (I_g = 0) \) and an economy that has only green investors \( (I_g = 1) \) have the same investment levels and share prices. Formally, \( P_c(I_g = 0) = P_c(I_g = 1) \), and \( P_p(I_g = 0) = P_r(I_g = 1) \). The reason for this symmetry is the following: at \( I_g = 0 \), there are only neutral investors in the economy and two types of firms, clean and polluting. At \( I_g = 1 \), there are only green investors in the economy and two types of firms, clean and reformed. Since the reformed firms and the polluting firms are using the same technology (polluting), the two economies described above are essentially the same. This implies similar outcomes in terms of prices and investment levels in the two economies.

Another interesting observation is that the price and investment level of the clean firms, \( P_c \) and \( K_c \) are relatively insensitive to the number of green investors, that is, \( \frac{\partial P_c}{\partial I_g} \approx 0 \), \( \frac{\partial K_c}{\partial I_g} \approx 0 \). The reason for that is that in the price equation of the clean firms, equation (6), \( I_g \) does not appear as a direct parameter. Therefore, \( P_c \) depends on \( I_g \) only at a second order effect through \( N_r, N_p \) and \( K_r, K_p \). Using numerical simulations we verified that this secondary effect is indeed very small. This result is also similar to HKZ (2001) where the price of the clean firms is completely independent of \( I_g \).
2.4 Time Line of Events

Although our model is a one period model, it is useful to imagine the actions taking place in the following sequence of events. At the first period, the polluting firms decide whether they reform or not and the entrepreneurs sell their firms to the investors. After raising the funds the entrepreneurs invest $K_c, K_r, K_p$ (the amount that they were committed to) using the capital that was raised by issuing shares. In the second period, future outputs $\hat{Y}_c, \hat{Y}_r, \hat{Y}_p$ are revealed and distributed to the investors.

3 Three Different Cases

The complexity of the equilibrium conditions does not allow us to get an analytical solution for the optimal investment levels and for $N_r^*$, the number of firms that reform in equilibrium. Therefore, in order to explore the model’s predictions we need to calibrate it and solve it numerically. We present two extreme cases and two intermediate cases. The two extreme cases that we analyze are one in which $C$ is very high ($C \to \infty$) and one in which $C$ is very low ($C \to 0$).

3.1 Calibration

We present three cases in which reforming costs vary from 0% to 10% of the investment levels $\{K_c^*, K_r^*, K_p^*\}$ as well as a case with infinite reforming costs. The resulting cost of capital in equilibrium in the zero and intermediate cases is in the range of 4% to 12% for each type of firm.

Parameters:

- Technology: $\gamma_c = \frac{1}{2}; \quad \gamma_p = \frac{1}{2};$
- Random shocks means: $\mu_c = 1; \quad \mu_p = 1$
- Random shocks variances: $V_c = 1; \quad V_p = 1$
- Correlation and covariance: $\rho_{c,p} = 0.70; \quad \Rightarrow V_{c,p} = \rho_{c,p}\sqrt{V_c}\sqrt{V_p} = 0.7$

Note that in the three examples described in this section, the green investors have zero holdings in the polluting firms. Later, we discuss the effects of short selling polluting firms by green investors.
Risk tolerance: $\tau = 5$

Initial proportion of firms$^4$: $N_c = 0.5, \ N_p = 0.5$

Investors: $I = I_g + I_n = 1$

### 3.2 Infinite Reforming Costs ($C \to \infty$)

When there are infinite reforming costs, there is no option for polluting firms to reform. This is the case in which the green investors’ impact is the largest. As there are more green investors, the number of investors who boycott the polluting firms increases, the demand for polluting firms falls and their price drop. An alternative way to describe it would be from the side of the neutral investors. As there are less neutral investors, and since polluting firms never reform, a smaller group of neutral investors is forced to hold the fixed supply of polluting firms. As this group gets smaller, the price of the polluting firms must get sufficiently lower in order to compensate that group for the extra risk that it is bearing.

The decrease in the price of the polluting firms is accompanied by a decrease in the investment level of these firms and as a result, a decrease in the total investment of the economy. Note that in this case of infinite reforming costs, there is no symmetry between the two end points $I_g = 0$ and $I_g = 1$. When $I_g = 0$, there are two technologies in the economy, held by the neutral investors, whereas when $I_g = 1$, there is only a clean technology held by the green investors. Therefore, the total investment in the economy when $I_g = 0$ is higher than when $I_g = 1$.

Figure 1 shows the total investment in the economy as a function of $I_g$ for the infinite reforming costs case.

### 3.3 Negligible Reforming Cost ($C \to 0$)

We define $I_g^*$ to be the critical level of green investors at which the first firm reforms. When reforming costs are very small but positive, the reformation process starts at a very early

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$^4$KLD (Kinder, Lydenberg, Domini and Co.) have constructed the Domini 400 Social Index, which is a portfolio of 400 ethically screened stocks. Out of the 500 stocks that compose the S&P 500 index, 252, or about 50%, have passed the KLD ethical screening.
Figure 1: Total investment in the economy as a function of $I_g$ when $C \to \infty$

Figure 2: The number of reformed firms, $N_R$, as a function of $I_g$ when $C \to 0$

stage, that is, $I_g^*$ is very close to $I_g = 0$.

In the absence of reforming costs, there is a frictionless flow of firms between the polluting and the reformed categories. As soon as some green investors appear, some polluting firms find it beneficial to reform, at a negligible cost, and avoid being boycotted by the green investors. As reflected in figure 2, the reforming process starts as soon as some neutral investors become green ($I_g^* = \varepsilon > 0$), and continues, at an almost linear rate, until all investors are green and all polluting firms have reformed.

We focus on the analyzes of the investment levels (see figure 3). As investors become green, they divest their holdings in the polluting firms. By doing so, they lose the diversification benefit of holding both technologies. But since the reformation process begins as soon
Figure 3: Total investment in the economy (sum of the three sectors) when \( C \to 0 \), as a function of \( I_g \)

as the first green investor appears, the green investors have a big demand for shares in the reformed firms because these shares offer them the polluting technology. This is the reason why the price and investment level of the reformed firms, \( P_r \) and \( K_r \), starts at a higher point than that of the polluting firms.

As described above, we view the three sectors as cartels. It is as if firms in each sector decide simultaneously about the investment level for the whole industry and enforce this decision. In the beginning of the reformation process the size of the reformed industry is very small, therefore its effect on the total investment in the economy is also small. But as more investors switch to green and more firms reform, the size and impact of that industry increases.

At a point around \( I_g = 0.5 \) the green and neutral investors are equally numerous and the number of reformed and polluting firms equals 0.25. The two cartels of reformed and polluting have least total market power when they are equal in size \( (N_r = N_p = 0.25) \). At this point the profits of firms in each of the the three cartels is the lowest as firms are facing the largest competition.

This increased competition is reflected in the overall investment in the economy, defined as \( \sum_{i=c,r,p} N_i K_i \). As figure 3 shows, there is a maximum to total investment around \( I_g = 0.5 \).
3.4 Intermediate Cases

When reforming is costly, polluting firms do not find it optimal to reform as soon as the first green investor appears. The aggregate effect of green investors boycotting the polluting firms on their share price has to be large enough to compensate for paying the reforming costs. In the previous subsections we discussed two extreme cases. One, when reforming cost are infinite and firms never find it optimal to reform and second, when reforming costs are very low and firms start to reform as soon as some green investors appear in the market. Here, we discuss intermediate cases in which reforming costs are positive but not so high that firms never reform. Then, there will be a critical mass of green investors, $I_g^*$, at which the first firm reforms.

![Figure 4: The number of reformed firms, $N_R$, as a function of $I_g$ in intermediate cases. Dashed line - reforming cost = 10%; Solid line - reforming cost = 6%](image)

Figure 4 demonstrates two examples of intermediate cases with different reforming costs that represent six and ten percent of the total investment. When reforming costs equal six percent of investment, $I_g^* \approx 0.15$ and when they are ten percent, $I_g^* \approx 0.5$.

We argue that every intermediate case can be divided into two different regimes; the first when $0 < I_g < I_g^*$ and the second when $I_g^* < I_g < I$.

The first phase is identical to the $C \to \infty$ case described above. As more investors switch from neutral to green, they divest their holdings in the polluting firms and increase their
demand for the clean firms. This drives down $P_p$ and $K_p$, the share price and investment of the polluting firms, and pushes up slightly the price and investment of the clean firms. Since the effect on the polluting firms is larger than that on the clean firms, total investment in the economy falls.

At some point in the process $(I_g^*)$, polluting firms start to reform and a third category of firms is created: the reformed firms that use the polluting technology. From here, we are moving to a phase that resembles the $C \to 0$ case. The actual effect of this phase on total investment depends on the size of the reforming costs which determines the level of $I_g^*$.

When reforming costs are high, $I_g^*$ is also high; for example, in the case presented here, reforming costs of 10 percent of investment result in $I_g^* \approx 0.5$. The high level of $I_g^*$ implies that the reformation process will be relatively fast. This happens because at $I_g = 1$ the number of polluting firms must equal 0, (as there are no neutral investors), and therefore, the number of reformed firms must change from 0 to $\frac{1}{2}$ as $I_g$ goes from $I_g^*$ to $I_g = 1$. This rate of reformation is higher than in a case where $I_g^*$ is closer to 0.

The intensity of the reformation rate is translated into an increase in the total investment in the economy. The reformed firms are very valuable to the green investors and therefore their price and investment level are higher than those of the polluting firms, which are less valuable to investors. In the reformation process, every polluting firm with low investment level is replaced with a reformed one with a high investment level and since the rate of reformation is high, the total investment goes up.

A lower reforming costs of approximately 6 percent of the initial investment, results in a lower value of $I_g^* \approx 0.15$. The prices and investment levels of the reformed and polluting firms exhibit similar behavior to the case of high reforming costs. With respect to the total investment, the behavior is a little bit more complicated. The first difference is that the total investment doesn’t increase immediately at $I_g^*$ as it did with higher reforming costs. This happens because around $I_g^*$, the rate of firms reforming is very low, and the supply of reformed firms is so small that every new green investor who divests his holding in the polluting firms creates mainly demand for the clean firms. Total investment eventually
Figure 5: Total investment for intermediate cases. Dashed line - reforming cost = 10%; Solid line - reforming cost = 6%

recovers, but only when the rate of reformation increases. A second interesting pattern is that around \( I_g = 0.85 \), total investment exhibits a maximum and reverses again (see figure 5). This maximum resembles the one in the case of \( C \to 0 \). It is as if the reformation process has started at an early stage such that we stayed long enough in the \( C \to 0 \) phase to observe a maximum.

In order to better understand why the change in total investment can be positive or negative when \( I_g > I_g^* \) we need to consider the marginal changes in each industry’s investment. Since the clean industry investment is almost constant, as we argued earlier, this means that the variation comes from industries \( r \) and \( p \), specifically from the sum of the changes in the two. The sum of the investments in industries \( r \) and \( p \) is simply \( S_{r,p} = N_rK_r + N_pK_p \). The term that we’re interested in is the total derivative of that sum, with respect to the number of green investors, \( \frac{dS_{r,p}}{dI_g} \). As the following sign calculation shows, the sign of the total derivative is not clear.

\[
\frac{dS_{r,p}}{dI_g} = (K_r - K_p) \frac{\partial N_r}{\partial I_g} + N_r \frac{\partial K_r}{\partial I_g} + N_p \frac{\partial K_p}{\partial I_g} \\
= (+) (+) (-) (-)
\]

(9)

When \( I_g < I_g^* \), the decline in the polluting firm’s investments has a major impact on
the total investment (see figure 5). Once firms start to reform, polluting firms with low
investment levels are replaced with reformed firms that invests much more, but this might
not be enough to push the total investment up again. As equation (9) shows, the sign of
the total derivative also depends on the intensity of the reformation rate, \( \frac{\partial N_r}{\partial I_g} \). If this rate
is very small around \( I^*_g \), as in the first intermediate case that we present here, then total
investment continues to drop in the beginning of the reformation process. On the other
hand, if the reformation process is intense around \( I^*_g \), as in the second intermediate case,
total investment increases as soon as the first firm reforms.

To summarize, the rate at which the reformed industry replaces the polluting industry
explains the patterns of the total investment in the economy. As we described earlier, since
the total investment must be equal at \( I_g = 0 \) and \( I_g = 1 \), if the total derivative of the sum
of changes in industries \( r \) and \( p \) crosses the zero line twice there exists an internal maximum
for the total investment.

4 Short Selling Polluting Firms by Green Investors

One of the major open issues in the area of SRI is the purpose of green investments. Bob
Walker, vice-president of SRI policy and research at Ethical Funds Inc., located in Vancouver,
has been quoted recently in *The Globe and Mail*, saying: ”The industry is shifting from a 'feel-
good' approach, where people feel good about the stocks in their portfolio, to an approach
that says the point of SRI is to make a difference in the world by making corporations better
corporate citizens.” If this is indeed the case, one puzzling question is why green funds don’t
use their significant presence in the market to leverage their effect by short selling polluting
firms?

Figure 6 presents the impact of such an action taken by green investors. In this example
we have replaced the boycott constraint, \( x_{g,p} = 0 \), with a short sale position, \( x_{g,p} = -0.25 \).
This means that every green investor sells short the polluting firms instead of merely boy-
cotting them. The result accelerates the process of reforming and, by pushing down the price
of the polluting firms further, increases the polluting firms’ cost of capital.
Figure 6: Short selling of polluting firms by green investors \((X_{g,p} = -.25)\) - dashed lines, no short selling - solid line

As shown above, short selling of polluting firms by green investors can significantly reduce the critical number of green investors that is needed to induce firms to reform (from \(I_{g}^{*} = 0.5\) to \(I_{g}^{*} = 0.25\) in the example presented in figure 6).

5 Conclusions

This paper explores the effects of ethical screening on firms' decisions to reform and on their investment level. These issues are examined in an equilibrium setting with endogenous investment decisions and endogenous future outputs. The effects on total investment are examined in the presence of various levels of reforming costs.

The results of our model indicate that if reformation costs are infinite, ethical screening reduces total investment in the economy significantly. When reforming costs are negligible, maximum total investment occurs around \(I_{p} = .5\) but changes in total investment are small relatively to the changes when reformation costs are infinite. In intermediate cases when reforming costs are positive but not so high that firms never reform, the maximum of total investment depends on the level of reforming costs. When reforming costs are low, total investment exhibits an interior maximum \(I_{g}^{m}\) \((0 < I_{g}^{m} < I)\), but when reforming costs are low total investment occurs when there are either no green investors \((I_{g} = 0)\) or when there
are only green investors \( (I_g = 1) \).

The paper also analyzes the impact that short selling polluting firms by green investors would have on these firms. We find that short selling polluting firms by green investors can significantly increase polluting firms’ cost of capital and that it can leverage the effect on polluting firms’ decisions to reform.

If we accept various estimates of the fraction of money in North America pursuing a green strategy as being around 10% to 12%, it appears that investment levels may be reduced by the pursuit of these strategies.

**Bibliography**


The Globe and Mail, March 8, 2003