ESG: A Panacea for Market Power?*

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Preliminary

Abstract

We study the equilibrium effects of the "S" dimension of ESG in a model of imperfect competition in labor (and product) markets. All else equal, a profit maximizing firm can benefit from adopting ESG policies that give a competitive edge in attracting workers; "Doing Well by Doing Good" applies in our setting. ESG policies are strategic complements, and in equilibrium, they are adopted by all firms resulting with higher worker welfare but lower shareholder value. Thus, profit maximizing firms benefit from coordinating on low impact ESG policies, raising anti-trust concerns from the adoption of industry-wide ESG standards. A purposeful firm (lead by a socially conscious board) benefits from such ESG policies, and imperfect competition between purposeful firms obtains the first best in equilibrium. Thus, the social purpose of the corporation is a panacea to excessive marker power. More broadly, our analysis relates the adoption of ESG policies to the nature of competition between firms and their model of corporate governance.

Keywords: ESG, Shareholder Primacy, Stakeholder Capitalism, Corporate Social Responsibility, Corporate Governance, Market Power

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1 Introduction

There is a long-running debate in academic and policy circles over whether the purpose of the corporation is or, should be, to maximize value for shareholders or, instead, to operate in the interest of all of its various stakeholders. These questions have far-reaching implications, including whether and how companies and boards take into account Environmental, Social and Governance (ESG) considerations when developing and delivering products and services, making business decisions, managing risk, developing long-term strategies, recruiting and retaining talent and investing in the workforce, implementing compliance programs, and crafting public disclosures. A growing number of empirical studies have examined whether firms indeed pursue ESG policies, whether these policies achieve their putative aims, and whether equity markets reward such policies. Theoretical studies have also examined whether and how shareholder actions incentivize firms to behave in socially responsible ways. However, largely absent from the literature is an examination of how firms' ESG policies affect equilibrium outcomes in the real input and output markets that they operate in. Our paper aims to fill this gap.

We develop a benchmark model of the equilibrium effects of corporate social responsibility, thereby focusing on the "S" component of ESG in labor and product markets. In our framework, multiple oligopolistic firms interact in either the labor or product markets. Imperfect competition and constrained regulation leave room for meaningful corporate social responsibility. We model an ESG policy as a constraint that the firm's board of directors places on the firm's manager to treat workers/customers well. The firm's manager chooses the hiring strategy that maximizes the profits of the firm (i.e., the shareholder value) subject to satisfying the constraints imposed by the ESG policies of the firm. For example, in the context of labor markets, an ESG policy is a commitment to pay employees above market wages, provide generous benefits, invest in worker training, and create a friendly work environment. In the context of product markets, an ESG policy is a commitment to offer products with low environmental impact, high safety standards, protection of customer privacy, cybersecurity, etc. For concreteness, we focus on the labor market application of the model.

We start by characterizing the equilibrium in labor markets, taking the firms' ESG policies as given. Since ESG policies force managers to be more generous to workers than they would otherwise be at the hiring stage, the firm obtains a competitive edge in attracting workers in the labor market. The effect of this ESG-induced competitive edge on the shareholder value and the worker welfare depends on the aggressiveness of the adopted ESG policies. In particular, moderate ESG policies mitigate an oligopolist's incentive to underhire in the labor market. Indeed, due to the constraint imposed by the firm's ESG policy, the profit maximizing manager faces a locally perfectly elastic supply curve, which weakens the ability to exercise monopsony power. Effectively, moderate ESG policies commit a firm to compete more aggressively in the labor market. Such commitment is valuable in oligopolies, since it enables the firm to gain market share by deterring competitors from hiring. We show that moderate ESG policies increase an adopting firm's shareholder value at the expense of total industry profits (i.e., the profitability of other firms decreases), and at the same time increase the welfare both of a firm's own workers, and also of other firms' workers. In contrast, sufficiently aggressive ESG policies are so "expensive" that they deter managers from hiring, leading the firm to compete less aggressively in the labor market (i.e., hire fewer workers than it would otherwise do), thereby raising other firms' profits at the expense of the firm's own profits, and hurting all workers other than those associated with the aggressive-ESG firm.

This first set of equilibrium results illustrates several key points. First, firms can benefit from adopting moderate ESG policies even absent any "warm glow" social preferences. Put differently: no matter the reason behind an adoption of ESG policies, we should not be surprised to see that such policies sometimes increase profits. Second, ESG policies that target a firm's stakeholders, spill-over and affect other firms' stakeholders also, and hence have broader welfare implications. Third, the non-monotonic relationship between the strength of a firm's ESG policies and their impact on social welfare underscores that more isn't necessarily better when it comes to ESG, and an externally imposed one-size-fits-all ESG standard could be counter-productive. Fourth, our analysis highlights a novel strategic benefit to firms from publicizing their ESG policies (or pretending to adopt such policies, i.e., social-washing); it gives them a competitive advantage in input and output markets. Finally, the benefit from adopting and advertising an ESG policy depends on the firm's market power and the competitiveness of the markets in which it operates.

Next, we build on our characterization of the labor market equilibrium to study which ESG policies firms adopt and how a firm's ESG choices respond to those of its competitors. We first consider the shareholder primacy model in which a firm's board of directors sets

ESG policy with the objective of maximizing shareholder value. We show that at moderate levels of ESG, firms' choices are strategic complements. Intuitively, each firm benefits from at least marginally outdoing its competitors' ESG policies, as a means of attracting workers and gaining market share. However, as ESG policies become more extreme, the cost to a firm of being more generous to workers than its competitors is too high, and firms' ESG choices are instead strategic substitutes. Specifically: Although a firm increases its profits by marginally outdoing its competitors' ESG policies, it does even better by instead abandoning ESG policies so that it can compete in an unconstrained way. In equilibrium, profit maximizing firms adopt ESG policies that result in higher wages, higher employment, and higher social welfare, but lower total shareholder value. While the unintended consequences of profit-motivated ESG policies are socially beneficial, the equilibrium adopted ESG policies are too moderate to fully remove market power distortions, and equilibrium social surplus falls short of the first best. Importantly, profit maximizing firms would benefit from coordinating on low impact ESG policies, raising anti-trust concerns related to the adoption of industry-wide ESG standards.

Nothing that we have said so far requires either shareholders or board members to have preferences that extend beyond the traditional assumption of profit maximization. But in practice, such concerns are likely to lie behind at least some ESG-adoption decisions, and be driven in part by socially conscious investors and/or directors. We conclude our analysis by asking: If a firm sets ESG policies to maximize its total surplus—that is, the sum of profits and employee surplus—then what policy does it set? We label such firms as "purposeful" firms, as their objectives internalize the effect of their policies on other stakeholders, in our case, workers. Importantly, we maintain the assumption that at the firm makes hiring decisions to maximize profits; as such, we distinguish between corporate decision makers who set the firm's ESG policies (i.e., the board of directors) and those who execute them (i.e.,managers).

Loosely speaking, purposeful firms want to be large, and as one might expect, they adopt more aggressive ESG policies than profit-maximizing firms. When a purposeful firm competes against profit-maximizing firms, its optimal ESG policy also benefits its own shareholders. Thus, "Doing Well by Doing Good" applies in our setting. Nevertheless, a purposeful firm adopts excessively aggressive ESG policies, and grows too large relative to other firms, both from the perspective of total industry surplus. Intuitively, purposeful firms do not internalize how their ESG policies affect the hiring decisions and the surplus of other firms. In this case, a purposeful firm would do more social good (i.e., generate a labor-market equilibrium with higher industry surplus) if it were less purposeful, that is, if it weighted shareholder value more heavily than worker welfare, for example, by changing the composition of the company's board of directors. In some cases, the industry surplus created by a profit-maximizing firm can even be higher than the one created by a purposeful firm.

Alternatively, the distortions introduced by a purposeful firm are also mitigated by competition with other purposeful firms. We show that ESG policies are always strategic complements for purposeful firms. Intuitively, and similar to profit-maximizing firms, a purposeful firm always benefits from at least marginally outdoing its competitors' ESG policies. Unlike profit-maximizing firms, however, a purposeful firm is never tempted to undercut its competitors by abandoning ESG policies. In this case, we obtain a striking welfare theorem: Competing purposeful firms pick equilibrium ESG policies that lead to the first-best outcome in labor markets. In other words, competition in ESG policies between purposeful firms entirely eliminates the oligopolistic distortion and maximizes industry surplus. This is true even though each individual firm aims only to maximize only its own surplus, which as discussed above, can have adverse welfare effects when only a subset of firms are purposeful.

We have discussed our model's predictions in terms of labor markets. But we re-emphasize a point that we noted early, namely that our analysis applies equally to ESG policies in imperfectly competitive product markets, and generates a parallel collection of implications for that setting.

Overall, the social purpose of the corporation is a panacea to excessive marker power. More broadly, our analysis relates the adoption of ESG policies to the nature of competition between firms and their model of corporate governance.

Related literature

At an abstract level, the idea of firms' ESG choices affecting subsequent equilibrium outcomes under imperfect competition is related to literature studying the effects of other types of firm decisions, including, for example, Brander and Lewis (1986)'s analysis of debt choices and Sklivas (1987)'s analysis of managerial contracts. A central theme in much of this literature is that firms can effectively commit to compete more aggressively via decisions made prior to product market interactions, and that doing so is a potential source of advantage. Perhaps surprisingly, this same effect operates in our setting also—after all, it isn't obvious whether committing to pay workers more leads a firm to compete more or less aggressively. More generally, the application of the idea that commitment helps in imperfect competition settings to the specific context of ESG yields numerous insights, including the extent to which competition in ESG firms pushes the equilibrium outcome towards the socially optimal one.

The literature on the consequences of ESG policies for the equilibria of the real markets in which firms operate, and in turn for the ESG choices of competing firms, is relatively small. Closest to our paper is the recent working paper of Stoughton et al (2020), which similarly characterizes the consequences of firms committing to ESG policies before interacting in imperfectly competitive product or labor markets, and shows that profit-maximizing firms typically individually benefit from this commitment. Relative to Stoughton et al we model ESG as a clear commitment to deliver a minimum level of utility to worker or customers, as opposed to committing the manager to the more diffuse objective of putting weight on worker or customer surplus. This difference in how we conceptualize ESG policies has important implications for our analysis, including, for example, the observations that aggressive ESG policies hurt stakeholders in other firms; that there is a strong force pushing each firm to marginally out-do the ESG policies of its competitors; and that a firm's best response to its competitors adopting aggressive ESG policies is to abandon ESG altogether. Moreover, this distinction allows to investigate differences in optimal ESG policies adopted by purposeful and profit maximizing firms.

Xiong and Yang (2022) explore a different motive for ESG policies by profit-maximizing firms that operates for network goods, namely that since each customer benefits from an increase in the total number of customers, an ESG policy can increase a firms' profits by incentivizing a firm to charge lower prices, thereby attracting more customers.

Albuquerque et al (2018) conceptualize ESG very differently, and in particular, as a characteristic that directly impacts consumer demand by decreasing consumers' elasticity of substitution. As such, ESG policies raise profit margins, and reduces exposure to shocks.

In a non-ESG setting, Rey and Tirole (2019) study the use of price caps by firms selling complementary goods, and show that such price caps can alleviate double-marginalization problems for firms. In their analysis, firms collectively agree to price-cap arrangements

A sizeable literature has addressed the topic of a firm's objectives. See, for example, Tirole (2001); or for a recent survey, Gorton et al (2022). Allcott et al (2022) quantitatively estimate the relative importance of firm's profits, consumer surplus, worker surplus, and a subset of externalities including carbon emissions.

While the theoretical literature on the effects of ESG policies on product and labor market is small, a larger theoretical literature considers responsible investing. Heinkel, Kraus, and Zechner (2001) show that, when some investors automatically exclude a brown stock, this lowers its number of shareholders, meaning that each individual shareholder has to bear more risk, in turn reducing its stock price. Davies and Van Wesep (2018) demonstrate that the resulting lower price raises the number of shares granted to the manager if his equity-based pay is fixed in dollar terms, paradoxically rewarding him. Oehmke and Opp (2020) show that responsible investing is only effective if responsible investors are affected by externalities regardless of whether they own the emitting companies, and if they can co-ordinate. Pedersen, Fitzgibbons, and Pomorski (2021) focus on the asset pricing implications of responsible investing and solve for the ESG-efficient frontier. Goldstein et al. (2022) show that responsible investors can increase the cost of capital, because their trades reflect ESG rather than financial performance, thus making the stock price less informative about financials. Pastor, Stambaugh, and Taylor (2021) model how greater taste for green companies increases their valuation and reduces equilibrium expected returns. Edmans, Levit, and Schneemeier (2022) study the optimal socially responsible divestment strategy and show that a tilting strategy whereby a responsible investor holds only the best-in-class brown firm, can be superior to a blanket exclusion strategy whereby all brown firms are sold, as the former gives brown firms incentives to reform. Landier and Lovo (2020) find that the more money investors put into ESG funds, the more important it is for an industry to reduce its externalities to obtain financing. Green and Roth (2021) show that investors targeting social welfare should consider how other commercially-focused investors will react to their portfolio decisions. Chowdhry et al (2019) study co-investment by "impact" and profit-motivated investors.

2 Set-up

There are $N \geq 2$ firms. Each firm i deploys labor $l_i \geq 0$ to produce $f(l_i)$, where f is strictly increasing and strictly concave. To ensure interior solutions, we impose the Inada condition $f'(0) = \infty$ and $f'(1) = 0$. Write L for total labor employed at all firms:

$$L \equiv \sum_i l_i. \tag{1}$$

There is a continuum of workers, with a measure normalized to 1, and ordered on $[0,1]$ by outside option $W(l)$ for worker $l \in [0,1]$. Hence the inverse labor supply curve is $W(L)$. We assume

$$W''(L)\,L + W'(L) > 0, \tag{2}$$

which ensures both that firms' reaction functions to other firms' hiring decisions slope down (see formal result below) and that the employment cost $W(L)\,L$ faced by a monopsonist is convex (i.e., $W''(L)\,L + 2W'(L) > 0$). For example, this assumption holds if $W(L) = KL^{\frac{1}{\epsilon}}$, where $K > 0$ and $\epsilon > 0$ are constants. In this example, the supply curve $\left(\frac{W}{K}\right)^{\epsilon}$ has constant elasticity, where ϵ is the elasticity of labor supply.

Firms compete in Cournot fashion. That is, each firm simultaneously announces employment l_i and the market wage is determined by $W(L)$. There is significant evidence that employers enjoy market power in labor markets; see, for example, Lamadon et al (2022).

Firms can adopt ESG policies, and commit to pay a minimum level ω_i, that is, an ESG policy is a ω_i. A firm that has adopted such a policy pays its workers $\min\{\omega_i, W(L)\}$. Notice that ω_i may also include non-pecuniary benefits to employees, as long as they are contractible. We discuss non-contractible benefits when firms are purposeful.

3 Preliminaries

In this section we state several basic results and definitions that will be used in the core analysis.

3.1 First-best benchmark

Industry surplus is defined by the firms' output net of the outside options of the workers that are employed. It is given by

$$S(l_1,\ldots,l_N) \equiv \sum_i f(l_i) - \int_0^{\sum_i l_i} W(l)\,dl. \tag{3}$$

The first best allocation is $l_i = l^{**}$ such that

$$f'(l^{**}) = W^{**} \equiv W(Nl^{**}). \tag{4}$$

Notice that the first best allocation would be the outcome if all firms were controlled by a single owner whose objective was to maximize surplus rather than profit. It is also immediate that the first best allocation would be achieved if the labor market was fully competitive, so that each firm acts as a price-taker. Indeed, let

$$\lambda(W) \equiv \arg\max_l \; f(l) - Wl \tag{5}$$

be firm i's profit-maximizing employment decision if facing a constant wage W. Then, $l^{**} = \lambda(W^{**})$. We will use this notation in our analysis below.

Notice l^{**} decreases in N. Intuitively, a larger number of firms for a given supply requires each firm to produce less at a higher marginal productivity.

3.2 No-ESG benchmark

Suppose firms cannot commit to an ESG policy of any sort. Firms compete in Cournot fashion. Define the employment of all firms other than firm i as

$$L_{-i} \equiv \sum_{j\neq i} l_j. \tag{6}$$

Firm i takes employment decisions of other firms as given and solves

$$\max_{l_i} \; f(l_i) - W(l_i + L_{-i})\,l_i. \tag{7}$$

Write $r(L_{-i};0)$ for the the reaction function of firm i to other firm's decisions. Here, the 0 denotes no ESG policy ($\omega_i = 0$). All omitted proofs are in the Appendix.

Lemma 1 *The reaction function $r(L_{-i};0)$ is well-defined, strictly decreasing in L_{-i}; and $r(L_{-i},0) + L_{-i}$ is strictly increasing in L_{-i}.*

Lemma 1 shows that if other firms increase employment, firm i will optimally reduce its own employment since wages are expected to be higher, but by a lower amount. To see the latter point, notice that if firm i had reduced its employment by the same amount that the other firms increased it in aggregate, then the marginal cost of labor would not change (since overall employment remains the same), however, the marginal productivity of labor in firm i would be higher (since f is concave) and hence firm i will benefit from increasing its employment. That is, overall employment increases.

By symmetry, in equilibrium each firm hires l_B^*, given by the solution of

$$f'(l_B^*) = W'(Nl_B^*)\, l_B^* + W(Nl_B^*). \tag{8}$$

Notice l_B^* satisfies

$$r((N-1)\, l_B^*; 0) = l_B^*, \tag{9}$$

which has a unique solution. Moreover, the usual monopsony distortion arises,

$$f'(l_B^*) > W_B^* \equiv W(Nl_B^*), \tag{10}$$

so that employment and wages are both lower than in the first best benchmark,[1]

$$l_B^* < l^{**}. \tag{11}$$

Forcing the firm to pay wages modestly higher moves the economy closer to efficiency. Regulators who aim to maximize social welfare would be tempted to impose a minimum wage on the industry. However, tailoring such a policy would require industry specific information such as elasticity of labor supply, which cannot be easily observed or estimated. By contrast,

[1]Notice Nl_B^* increases in N, while l_B^* decreases in N. To see the latter, notice $W'(Nl)\,l + W(Nl)$ is increasing in N for a given l by assumption (2).

firms have a better knowledge of the industry in which they operate, which motivate our interest in studying their incentives to self impose ESG policies.

3.3 ESG firm's reaction function

Suppose that before hiring, firm i commits to pay a minimum level ω_i. A firm that has adopted such a policy pays its workers $\min\{\omega_i, W(L)\}$. Given the announced ESG policies, firm i chooses l_i to maximize its profits. Intuitively, the board of directors of the firm sets a minimum wage policy that can be monitored and enforced (wages are observable and verifiable), but the hiring decision is made by managers who have incentives to maximize profit. The goal of this section is to characterize the optimal hiring decision of firm i given ω_i and other firms' hiring decisions.

Define firm i's profits given employment decisions l_i and L_{-i} and firm i's ESG policy ω_i by

$$\begin{aligned}\pi(l_i, L_{-i}; \omega_i) &\equiv f(l_i) - \max\{W(l_i + L_{-i}), \omega_i\} l_i \\ &= \min\{f(l_i) - W(l_i + L_{-i}) l_i, f(l_i) - \omega_i l_i\}.\end{aligned} \tag{12}$$

Notice that profits $\pi(l_i, L_{-i}; \omega_i)$ are concave in l_i since it is the lower envelope of two concave functions. Importantly, other firms' ESG policies affect firm i's profits only via L_{-i}. Therefore, the characterization of an ESG firm's reaction function holds even when other firms also adopt ESG policies. Given L_{-i}, firm i's reaction function is

$$r(L_{-i}; \omega_i) \equiv \arg\max_{l_i} \pi(l_i, L_{-i}; \omega_i). \tag{13}$$

To characterize $r(L_{-i}; \omega_i)$, we first define $\Lambda(\omega)$ as the solution to

$$\Lambda + r(\Lambda; 0) = W^{-1}(\omega). \tag{14}$$

Note that the LHS is strictly increasing in Λ by Lemma 1, so at most one solution exists. Define $\Lambda(\omega) = 0$ if $W(r(0;0)) > \omega$ and $\Lambda(\omega) = \infty$ if $W(\Lambda + r(\Lambda; 0)) < \omega$ for all Λ. Intuitively, $\Lambda(\omega_i)$ is the total demand for labor by the other $N-1$ firms such that the market wage is ω_i given that firm i has no minimum wage policy and it reacts optimally to other firms' demand.

Notice $\Lambda(\cdot)$ is strictly increasing by Lemma 1.

Lemma 2 *A firm's best response function is given by*

$$r(L_{-i};\omega_i) = \begin{cases} \lambda(\omega_i) & \text{if } L_{-i} \le W^{-1}(\omega_i) - \lambda(\omega_i) \\ W^{-1}(\omega_i) - L_{-i} & \text{if } L_{-i} \in (W^{-1}(\omega_i) - \lambda(\omega_i), \Lambda(\omega_i)) \\ r(L_{-i};0) & \text{if } L_{-i} \ge \Lambda(\omega_i) \end{cases} \tag{15}$$

$$= \min\left\{\lambda(\omega_i), \max\left\{W^{-1}(\omega_i) - L_{-i}, r(L_{-i};0)\right\}\right\}. \tag{16}$$

As one might expect, the best response function is weakly decreasing in L_{-i}. In the first region, where $L_{-i} \le W^{-1}(\omega_i) - \lambda(\omega_i)$, we have $r(L_{-i};\omega_i) = \lambda(\omega_i)$ and $W(r(L_{-i};\omega_i) + L_{-i}) \le \omega_i$. Since the demand by other firms is low, the market wage is below firm $i's$ self-imposed minimum wage. Hence, firm i pays it employees above the market wage as if it faces a perfectly elastic supply at ω_i. We label it as the "*competitive*" region.

In the second region, where $L_{-i} \in (W^{-1}(\omega_i) - \lambda(\omega_i), \Lambda(\omega_i))$, we have $r(L_{-i};\omega_i) = W^{-1}(\omega_i) - L_{-i}$, which implies $W(r(L_{-i};\omega_i) + L_{-i}) = \omega_i$. That is, the market wage is equal to firm $i's$ self-imposed minimum wage. In this region, the demand by other firms is higher, and if firm i where to hire as if it faces a perfectly elastic supply at ω_i, the resulted market wage would have been higher than its self-imposed minium wage, which in turn, would incentivize firm i to hire less, as if it faces no minimum wage constraint. However, since the demand by other firms is not so high, if firm i were to hire as if it has no constraints, that is $l_i = r(L_{-i};0)$, then the resulted market wage would have been lower than its self-imposed minimum wage, which in turn, would incentivize it to hire more aggressively, as if it has a perfectly elastic supply at ω_i. Therefore, the best response of the firm is to choose the residual level of demand such that the resulted market wage is exactly equal to its self-imposed minimum wage. While firm i is not paying above the market wage, its ESG policy increases the market wage above the rate that would have emerged if it were to set $\omega_i = 0$. We label it as the "*residual*" region.

In the third region, where $L_{-i} > \Lambda(\omega_i)$, we have $r(L_{-i};\omega_i) = r(L_{-i};0)$. Notice $L_{-i} > \Lambda(\omega_i)$ implies $W(L_{-i} + r(L_{-i};0)) \ge \omega_i$. Since the demand by other firms is high, the market wage is above firm $i's$ self imposed minimum wage and it is forced to pay them that market price. Essentially, in this case, the ESG policy does not bind and has no effect on the outcome. We label it as the "*non-binding*" region. Figure 1 depicts the three regions.

Finally, notice that if $\lambda(\omega_i) \geq r(0;0)$, then $r(L_{-i};\omega_i) \geq r(L_{-i};0)$, with strict inequality whenever $L_{-i} < \Lambda(\omega_i)$. This can be seen in Figure 1 as the dashed gray line is below the solid black line. The condition $\lambda(\omega_i) \geq r(0;0)$ requires the competitive hiring given wage ω_i to be higher than the level of hiring under pure monopsony. Therefore, if ω_i is not too high,[2] the hiring policy of firm i is more aggressive when it self-imposes a minimum wage policy. Intuitively, the commitment to pay a minimum wage incentivizes the profit-maximizing manager of the firm to hire more aggressively, as if the firm faces a perfectly elastic supply at that minimum wage. Indeed, this force weakens the incentives of the firm to lower hiring in an attempt to keep wages below their competitive level. In other words, it mitigates the monopsony distortion. As we shall see below, firms can in fact benefit from adopting such policies even when their objective is profit maximization.

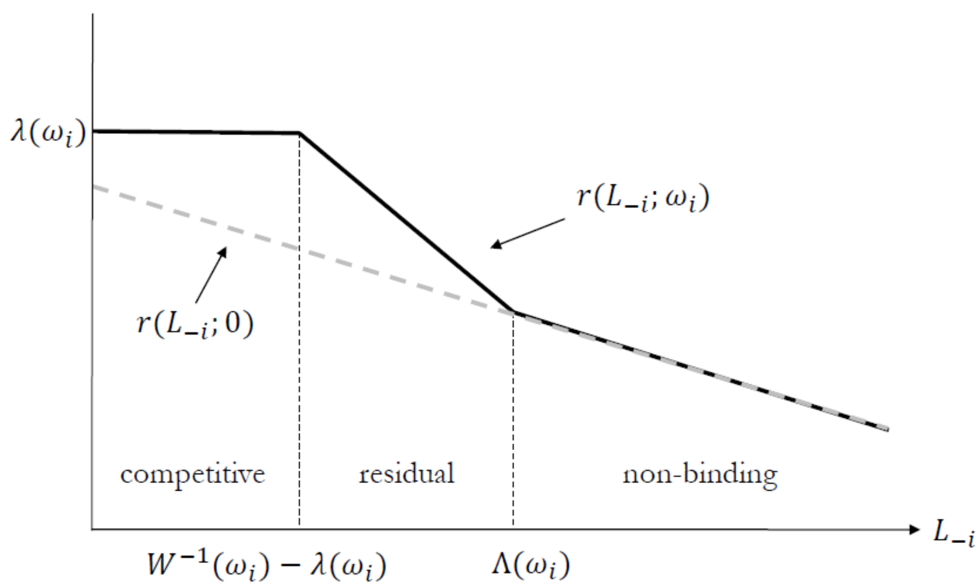

Figure 1 - ESG firm's reaction function

[2]If $\lambda(\omega_i) < r(0;0)$, then there is $L'_{-i} \in (0, W^{-1}(\omega_i) - \lambda(\omega_i)]$ such that if $L_{-i} < L'_{-i}$ then $r(L_{-i};\omega_i) < r(L_{-i};0)$. Intuitively, a very high self-imposed minimum wage constraints the firm and forces the profit maximizing manager to reduce hiring.

4 Labor market equilibrium

In this section, we characterize the labor market equilibrium that follows an arbitrary vector of ESG policies. In equilibrium, $l_i^* = r\left(L_{-i}^*; \omega_i\right)$ for all i, and firm i pays its workers $W_i^* = \max\left\{W\left(l_i^* + L_{-i}^*\right), \omega_i\right\}$. For tractability, we assume $N = 2$,[3] and without the loss of generality, we assume $\omega_2 \leq \omega_1$.

The next result characterizes the labor market equilibrium.

Proposition 1 *An equilibrium always exists.*

(i) If $\omega_1 \leq W_B^*$ then in any equilibrium, $l_1^* = l_2^* = l_B^*$ and $W_1^* = W_2^* = W_B^*$.

(ii) If $\omega_2 \geq W^{**}$ then in any equilibrium, $l_i^* = \lambda(\omega_i)$ and firm $W_i^* = \omega_i$.

(iii) If $\omega_2 = \omega_1 \in (W_B^*, W^{**})$ then for any

$$l^* \in \left[W^{-1}(\omega_1) - \min\{\Lambda(\omega_1), \lambda(\omega_1)\}, \min\{\Lambda(\omega_1), \lambda(\omega_1)\}\right]$$

there is an equilibrium in which $l_1^* = l^*$, $l_2^* = W^{-1}(\omega_1) - l^*$, and $W_1^* = W_2^* = \omega_1$. No other equilibrium exists.

(iv) If $\omega_1 > \omega_2$, $\omega_1 > W_B^*$ and $\omega_2 < W^{**}$ then in any equilibrium $l_1^* = \min\{\Lambda(\omega_1), \lambda(\omega_1)\}$, $l_2^* = r(l_1^*; \omega_2)$, $W_1^* = \omega_1$ and $W_2^* = \max\{\omega_2, W(l_1^* + r(l_1^*; \omega_2))\}$. Moreover, $l_1^* > l_2^*$.

Proposition 1 has several important takeaways. First, according to part (i), if both firms adopt an ESG-policy with a minimum wage that is lower than W_B^*, then the labor market equilibrium obtains the No-ESG benchmark outcome. Intuitively, low minimum wage policies are non-binding and do not alter the labor market equilibrium.

Second, according to part (ii), if both firms adopt an ESG-policy with a minimum wage that is higher than the first best wage W^{**}, then in the labor market equilibrium each firm pays its self-imposed minimum wage and hires as if it faces a perfectly elastic supply at that level. In those cases, the market wage is lower than the minium wage imposed by both firms. An immediate implication of this result is that if both firms commit to a minimum wage equal to W^{**}, then the first best is obtained.

[3] In the Appendix, we analyze cases with $N > 2$ in which only one firm adopts ESG policy.

Third, according to part (iii), if both firms adopt the same ESG-policy then multiple equilibria exist. In all of these equilibria, both firms pay the market wage, which is equal to their identical self-imposed minimum wage, and total employment equals $W^{-1}(\omega_1)$. Although firms pay the market wage, the paid wage and total employment are both higher than their counterpart in the No-ESG benchmark. The only difference between different equilibria is the number of employees that each firm hires. The multiplicity stems from the fact that the best response functions always intersect at the "residual" demand region, which has a slope of -1. There, both firms have incentives to hire just enough workers such that the market wage equals to the self-imposed minimum wage. Indeed, no firm has incentives to hire more employees, which would increase the wage it has to pay its employees, due to the monopsony distortion. At the same time, no firm has incentives to hire fewer employees, which would push the market wage below its self-imposed minimum wage, since in this case it will face a (locally) perfectly elastic supply curve which incentivizes the manager to hire more.

Last, according to part (iv), the firm with the more aggressive ESG-policy hires more workers in equilibrium. Notice that it is possible that $\omega_1 < W^{**}$ and yet $l_1^* > l^{**}$.[4] That is, firms can adopt ESG policies that commit them to pay less than the first best wage, and nevertheless, end up hiring more than the first best level.

5 ESG equilibrium

In this section we consider the optimal choice of ESG policies by the firms. In Section 5.1, we start by analyzing the case in which only firm 1 adopts an ESG policy. We ask what is the optimal ω_1 given that $\omega_2 \equiv 0$. In Section 5.2, we allow firm 2 to respond to firm 1's ESG policy by optimally choosing ω_2, and given the anticipated best response of firm 2, we analyze firm 1's optimal decision. For this purpose, we assume that the ESG policy of the firm are decided with the objective of maximizing profit, i.e., the shareholder value. In Section 6, we relax this assumption and instead assume that the objective of the firm when setting its ESG policy is to maximize its surplus rather than profit. We analyze this case and then compare the outcomes under these two different objectives.

[4] If $\omega_1 = \hat{W}$, where $\hat{W} \in (W_B^*, W^{**})$ is defined by (17), then $l_1^* = \min\{\Lambda(\hat{W}), \lambda(\hat{W})\} = \lambda(\hat{W}) > \lambda(W^{**}) = l^{**}$.

The following auxiliary result will be useful when characterizing optimal ESG policies.

Lemma 3 *Let $\hat{W}$ be a cutoff such that*

$$\lambda(\hat{W}) + r(\lambda(\hat{W}); 0) = W^{-1}(\hat{W}). \tag{17}$$

Then, $\hat{W}$ is well-defined, $\hat{W} \in (W_B^*, W^{**})$, and $\Lambda(\omega) < \lambda(\omega)$ if and only if $\omega < \hat{W}$.

5.1 Shareholder value maximizing ESG policy

If firm 2 does not adopt any ESG policy then a corollary of Proposition 1 describes the labor outcome equilibrium that follows from any ESG policy adopted by firm 1.

Corollary 1 *Suppose $\omega_2 \equiv 0$. Then, in the unique equilibrium the following holds.*

(i) If $\omega_1 \leq W_B^*$ then the No-ESG benchmark is obtained.

(ii) If $\omega_1 > W_B^*$ then $l_1^* = \min\{\Lambda(\omega_1), \lambda(\omega_1)\}$, $l_2^* = r(l_1^*; 0)$, $W_1^* = \omega_1$, and $W_2^* = W(l_1^* + r(l_1^*; 0))$.

Since $\Lambda(\omega_1) < \lambda(\omega_1)$ if and only if $\omega_1 < \hat{W}$, and $\Lambda(\cdot)$ is an increasing function but $\lambda(\cdot)$ is a decreasing function, l_1^* increases with ω_1 if and only if $\omega_1 < \hat{W}$. According to Lemma 1, this also implies that l_2^* increases with ω_1 if and only if $\omega_1 > \hat{W}$, and total industry employment increases with ω_1 if and only if $\omega_1 < \hat{W}$. Notice that the maximum total employment is obtained when $\omega_1 = \hat{W}$. However, also observe that this maximum level of employment is still lower that the first best employment level, and hence, the first best cannot be obtained through firm 1's ESG policy.[5]

Let $\varphi_{SH}(\omega)$ be the ESG policy that maximizes the shareholder value of the firm given that its opponent adopted ESG policy ω. The next result characterizes $\varphi_{SH}(0)$.

Proposition 2 *Suppose $\omega_2 \equiv 0$. The shareholder value maximizing ESG policy of firm 1 satisfies $\varphi_{SH}(0) = \varphi^* \in (W_B^*, \hat{W})$. Relative to the No-ESG benchmark, under firm 1's optimal policy, the total industry employment, total surplus, and firm 1's profits are all higher; total*

[5] Indeed, notice that if $\omega_1 = \hat{W}$ then $l_1^* = \lambda(\hat{W})$. Thus, $l_1^* + l_2^* = \lambda(\hat{W}) + r(\lambda(\hat{W}); 0)$. By definition if $\hat{W}$, $l_1^* + l_2^* = W^{-1}(\hat{W})$. Since $\hat{W} < W^{**}$, we have $l_1^* + l_2^* = W^{-1}(\hat{W}) < W^{-1}(W^{**}) = 2l^{**}$.

profits and firm 2's profit are lower. Moreover, both firms pay the same wage φ^* to their employees, which is higher than the No-ESG benchmark.

Proposition 2 establishes that even a shareholder value maximizing firm can benefit from committing to pay its employees an above the market minimum wage. Intuitively, a commitment to pay high wages is a credible way to commit to hire more aggressively in the labor market. Indeed, managers of ESG firms face a perfectly elastic labor supply at to those high minimum wage levels, and hence, do not limit hiring due to the monopsony distortion. In turn, such commitment deters hiring by the competitors of those firms since they anticipate higher market wages. This enables ESG firms to hire more employees at lower wages than they would have had to pay if their competitors had kept their employment at the No-ESG benchmark level. Overall, an employee-friendly ESG policy gives the firm a competitive edge at the labor market, and thereby, benefits its shareholders.

While shareholders of firm 1 benefit from their firm's ESG policy at the expense of the shareholders of firm 2, the employees of both firms benefit from firm 1's ESG policy. Indeed, in equilibrium, both firms pay their employees a wage of $\varphi^* > W_B^*$.[6] This implies that there is no pay difference in equilibrium between ESG and non-ESG firms.[7] Also notice that while the employment of firm 1 increases at the expense of firm 2's employment (i.e., $l_1^* > l_B^* > l_2^*$), total employment increases (i.e., $l_1^* + l_2^* > 2l_B^*$). That is, firm 1 increases its employment by more than what firm 2 reduces it.

Finally, Proposition 2 implies that the total surplus increases when firm 1 adopts an ESG policy, even though the motivation behind such adoption is to increase the firm's profits. Thus, the unintended consequences of a profit-motivated ESG policy is socially beneficial.

5.2 Competition in ESG policies

In this section, we allow firm 2 to respond to firm 1's ESG policy. We start by characterizing the best response ESG policy of firm 2.

[6] Since $W_2^* = W(\Lambda(\omega_1) + r(\Lambda(\omega_1); 0))$, by the definition of $\Lambda(\cdot)$, $W_2^* = \omega_1$.

[7] Notice that the ESG firm is larger than the non-ESG firm since it employs more workers. However, if firms were asymmetric, it would be hard to identify which one is the ESG firm, e.g., less productive firms can adopt ESG policy and still hire less.

Lemma 4 *Suppose firm 1 adopts ESG policy ω_1. There exists $\check{W} \in (\hat{W}, W^{**})$ such that the best response ESG policy of firm 2 satisfies*

$$\varphi_{SH}(\omega_1) = \begin{cases} \varphi^* & \text{if } \omega_1 < \varphi^* \\ \omega_1 + \varepsilon & \text{if } \omega_1 \in [\varphi^*, \check{W}) \\ 0 & \text{if } \omega_1 \geq \check{W}. \end{cases} \tag{18}$$

Lemma 4 shows that ESG policies are strategic complements when the policies are moderate and strategic substitutes when they are extreme. Indeed, if $\omega_1 < \varphi^*$, then firm 2 has incentives to choose $\omega_2 = \varphi^*$, which according to Proposition 2 is the optimal profit-maximizing ESG policy when the other firm does not adopt an ESG policy. Indeed, any "soft" ESG policy $\omega_1 < \varphi^*$ has the same strategic impact as the No-ESG policy, $\omega_1 = 0$. If instead firm 1 adopts a moderate ESG policy, $\omega_1 \in [\varphi^*, \check{W})$, then firm 2 has incentives to "top" firm's ESG policy and choose $\omega_2 = \omega_1 + \varepsilon$, where parameter $\varepsilon > 0$ is arbitrarily small.[8] Intuitively, given a fixed total employment, firm 2 obtains a higher profit when it hires more employees at the expense of firm 1. The most profitable way to gain such market share is by topping firm 1's ESG policy. Firm 2 does not adopt a more aggressive ESG policy than ω_1, since it benefits from staying as close as possible to the optimal ESG policy φ^*. In other words, firm 2 chooses the least aggressive ESG policy that would maintain her advantage in the labor market. However, if ω_1 is sufficiently high, that is, $\omega_1 > \check{W}$, then topping firm 1's aggressive ESG policy is too costly, and firm 2's best response is to adopt the no-ESG policy, $\omega_2 = 0$, and let firm 1 hire aggressively in the labor market. Indeed, $\check{W}$ is the value of ω_1 such that firm 2 is indifferent between ESG policies $\omega_2 = \check{W} + \varepsilon$ and $\omega_2 = 0$.

The next result characterizes the equilibrium.

Proposition 3 *The shareholder value maximizing ESG policy of firm 1 is $\omega_1^* = \varphi^*$ and of firm 2 is $\omega_2^* = \varphi^* + \varepsilon$. Relative to the No-ESG benchmark, the total industry employment, total surplus, and firm 2's profits are all higher; total profits and firm 1's profit are lower. Moreover, both firms pay the same wage $\varphi^* + \varepsilon$ to their employees, which is higher than the No-ESG benchmark.*

[8] In the Appendix we show that there is a discontinuity in firm 2's profitability, and it has incentives to be arbitrarily close from above to ω_1.

The comparison between Propositions 2 and 3 is striking: the ability of firm 2 to respond to firm 1's ESG policy gives the advantage to firm 2. To understand the intuition, observe that firm 1 anticipates firm 2's best response as described by Lemma 4. In particular, it realizes that firm 2 will top its ESG policy as long as $\omega_1 < \check{W}$. Therefore, if $\omega_1 \in (0, \check{W})$ then adopting a more aggressive ESG policy only reduces firm 1's profitability. Indeed, it can not deter the hiring decision of firm 2. Firm 1 can deter firm 2 only by adopting a sufficiently aggressive ESG policy, that is, $\omega_1 > \check{W}$. At this high level of minimum wage, firm 2 prefers the no-ESG policy over topping firm 1. Recall that at $\omega_1 = \check{W}$, firm 2 is indifferent between topping firm 1's ESG policy and choosing the no-ESG policy $\omega_2 = 0$. However, since the firms are symmetric, it also implies that deterring firm 2 by adopting ESG policy $\check{W}$ is just as profitable to firm 1 as adopting the no-ESG policy and being deterred by firm 2. In fact, in the Appendix we show that if $\omega_2 > \varphi^*$ then firm 1 is indifferent between all ESG policies in the interval $[0, \varphi^*]$ (since it's being deterred either way). According to Proposition 2, φ^* is the only policy in this interval that is robust to a perturbation of the model in which firm 2 does not adopt an ESG policy (i.e., $\omega_2 = 0$) with an arbitrarily small probably.[9] Therefore, in equilibrium, $\omega_1 = \varphi^*$ and firm 2 responds by topping firm 1 and choosing the optimal ESG policy, $\omega_2 = \varphi^* + \varepsilon$.

Finally, recall that according to Proposition 2, the total profits of shareholders in both firms in such equilibrium is lower than in the No-ESG benchmark. If there is ex-ante uncertainty about which firm will be the first-mover to adopt an ESG policy, then both firms have incentives to coordinate and commit not to adopt any ESG policy to pay workers a minimum wage. Without such coordination, however, firms' temptation to deter hiring by their competitors results with a lower shareholder value but higher employees' welfare and social surplus.

6 ESG equilibrium of purposeful firms

In this section we relax the assumption that firms choose the ESG policy that maximizes their profits, that is, their shareholder value. Instead, we assume the firm chooses the ESG policy that maximizes its individual surplus. Similar to industry surplus, a individual firm's surplus is its output net of the outside options of the workers that it employs. We label such firms as

[9] Assuming this tie-breaking rule can also be justified if firm 1 benefits from being perceived as employee-friendly by outsiders.

"purposeful," since their objectives internalize the effect of its policies on other stakeholders, in our case, employees. Importantly, we continue to assume that the firm's hiring decision is aimed to maximize its profit, and hence, we distinguish between the decision makers who set the firm's ESG policy (i.e., the board of directors) and the decision makers who execute the firm's policies in the labor market (i.e., managers). While the manager of the firm abides by the firm's ESG policy, her incentives remain profit maximization subject to the constraints put forwards by the board.[10] Thus, a purposeful firm can be considered a firm whose investors/directors are socially conscious.

Calculating the outside options of the workers that the firm employs requires assumptions on how workers are allocated across firms. The minimum possible value of the combined outside options of firm i's workers is $\int_0^{l_i} W(l)\,dl$ while the maximum possible value is $\int_{L_{-i}}^{l_i+L_{-i}} W(l)\,dl$. We define firm i's surplus by

$$S_i(l_i, L_{-i}) = f(l_i) - \mu \int_0^{l_i} W(l)\,dl - (1-\mu) \int_{L_{-i}}^{l_i+L_{-i}} W(l)\,dl, \tag{19}$$

for some fixed $\mu \in [0,1]$.[11]

In Section 6.1, we analyze the case in which only purposeful firm 1 adopts an ESG policy, and in Section 6.2, we allow firm 2 to respond to the ESG policy of firm 1 by optimally choosing its own ESG policy. In both sections we compare the equilibrium outcomes of purposeful firms to the outcome of profit maximizing firms.

6.1 Optimal ESG policy of a purposeful firm

Suppose $\omega_2 \equiv 0$. Since the hiring decision of the purposeful firm's manager is aimed to maximize profit, the hiring subgame equilibrium that follows from any ESG policy of firm 1 is as described by Corollary 1. The key difference from our analysis in Section 5 is that a purposeful firm sets its ESG policy not to maximize its profits, but rather, to maximize its individual surplus. We let $\varphi_P(\omega)$ be the ESG policy that maximizes the surplus of the firm given that its opponent adopted ESG policy ω. The next result characterizes $\varphi_P(0)$.

[10] Effectively, we assume the board of the firm (or its investors) cannot directly alter the incentives of the manager to internalize the welfare of the firm's employees.

[11] Our results hold for any $\mu \in [0,1]$. Notice that if $\mu = \frac{1}{2}$ then $S_i(l_i, l_j) + S_j(l_j, l_i) = S(l_i, l_j)$, that is, the sum of individual firms' surplus equals the industry surplus.

Proposition 4 *Suppose $\omega_2 \equiv 0$. The optimal ESG policy of purposeful firm 1 is $\varphi_P(0) = \hat{W}$. Relative to the No-ESG benchmark, under the optimal purposeful ESG policy, the total employment, total surplus, and firm 1's profits are all higher; total profits and firm 2's profit are lower. Moreover, both firms pay the same wage $\hat{W}$ to their employees, which is higher than the No-ESG benchmark.*

Proposition 4 is similar to Proposition 2, with the exception of $\varphi_P(0) > \varphi_{SH}(0)$, that is purposeful firms adopt more aggressive ESG policies, which is intuitive. Importantly, Proposition 4 implies that the optimal ESG policy of a purposeful firm also benefits its own shareholders relative to the No-ESG policy. Thus, "Doing Well by Doing Good" applies in our setting as well. Recall that firm 1's employment and total industry employment are both maximized when $\omega_1 = \hat{W}$, where as firm 2's employment is minimized when $\omega_1 = \hat{W}$. Therefore, relative to the optimal ESG policy of a profit maximizing firm, total employment is higher under the optimal purposeful ESG policy, and since the wage that both firms pay is also higher, employees of both companies benefit more from this ESG policy.

Notice, however, that relative to the optimal ESG policy of a profit maximizing firm, the profits of both companies are lower under the optimal ESG policy of a purposeful firm. In fact, as the next result shows, the optimal ESG policy of a purposeful firm does not maximize the industry surplus.

Corollary 2 *The optimal purposeful ESG policy of firm* 1 *does not maximize industry surplus. The industry-surplus maximizing ESG policy of firm* 1 *leads to less employment at firm* 1 *and more employment at firm 2, relative to ESG policy $\varphi_P(0)$.*

Intuitively, purposeful firms do not fully internalize how their ESG policies affect the hiring decisions of other firms. In particular, since under the optimal ESG policy of firm 1 we have $l_1 > l_2$, the marginal productivity of its employees is lower than the firm 2's employees. Therefore, industry surplus can increase if firm 1 hires fewer employees while firm 2 higher more employees. However, since $\varphi_P(0)$ only maximizes the surplus of firm 1, it do not account for this welfare gain. In this respect, the ESG policy of a purposeful firm is too aggressive from a social perspective. Recall that profit maximizing firms adopt a less aggressive ESG policy (i.e., $\varphi_{SH}(0) < \varphi_P(0)$). Thus, to maximize industry surplus, a purposeful firm must overweight shareholders relative to other stakeholders of the firm, for example, by giving shareholders larger representation on the company's board of directors.

6.2 Competition in ESG policies between purposeful firms

In this section, we allow firm 2 to react to firm 1's ESG policy by adopting its own ESG policy. We start by characterizing the best response ESG policy of firm 2.

Lemma 5 *Suppose firm* 1 *adopts ESG policy* ω_1. *Then, the best response ESG policy of firm* 2 *is*

$$\varphi_P(\omega_1) = \begin{cases} \hat{W} & \text{if } \omega_i < \hat{W} \\ \omega_1 + \varepsilon & \text{if } \omega_1 \in [\hat{W}, W^{**}) \\ W^{**} & \text{if } \omega_1 \geq W^{**}. \end{cases} \tag{20}$$

Lemma 5 shows that ESG policies are always strategic complements for purposeful firms. To understand why, note that if $\omega_1 < \hat{W}$, then firm 2 has incentives to choose $\omega_2 = \hat{W}$, which is the optimal ESG policy of a purposeful firm when the other firm does not adopt an ESG policy. Indeed, any "soft" ESG policy $\omega_1 < \hat{W}$ has the same strategic impact as the No-ESG policy, $\omega_1 = 0$. Thus, it is optimal for firm 2 to choose $\omega_2 = \hat{W}$ as we show in Proposition 4. If instead $\omega_1 \in [\hat{W}, W^{**})$, then firm 2 has incentives to top firm 1's ESG policy and choose $\omega_2 = \omega_1 + \varepsilon$. Intuitively, to increase its surplus, firm 2 needs to hire a large number of employees. If it chooses $\omega_2 < \omega_1$, then firm 2's managers will be deterred form hiring aggressively in the labor market since they anticipate an even more aggressive policy by firm 1's managers. Thus, to provide its managers incentives to be more aggressive than firm 1's managers, firm 2 tops firm 1's ESG policy. Firm 2 does not adopt a more aggressive ESG policy than that, since it has incentives to stay as close as possible to the optimal ESG policy $\hat{W}$. Finally, if $\omega_1 \geq W^{**}$, firm 2 does not have incentives to top firm 1's ESG policy, since beyond this point the marginal productivity of its employees is lower than the wages it pays them, and hence, its surplus will necessarily decrease.

The next result characterizes the equilibrium that results from competition in ESG policies by purposeful firms.

Proposition 5 *In the unique equilibrium, both purposeful firms adopt ESG policy* $\omega_i = W^{**}$, *leading to the first-best outcome.*

Proposition 5 is striking: competition in ESG policies between purposeful firms entirely eliminates the monopsony distortion and results with the maximum industry surplus. This is true even though each individual firm's objective is to maximize only its own surplus, which as we demonstrate in Corollary 2, can have adverse welfare effects.

To understand the intuition behind this result, observe that firm 1 anticipates firm 2's best response. Similar to firm 2, firm 1 has incentives to adopt an ESG policy that incentivizes its managers to be more aggressive in the labor market. However, it also realizes it cannot be more aggressive than firm 2. Thus, the best firm 1 can do is to adopt an ESG policy that would maximize its employment. Recall that if $\omega_1 \geq \hat{W}$, then firm 2 will choose $\hat{W} + \varepsilon$, and in this region, firm 2 will hire $\lambda(\hat{W} + \varepsilon)$ employees, as if it faces a perfectly elastic supply curve at a wage of $\hat{W} + \varepsilon$. Thus, by adopting a more aggressive ESG policy (i.e., larger ω_1), firm 1 forces firm 2 to reduce its hiring in the labor market (recall $\lambda'(\cdot) < 0$), which in turn enables firm 1 to increase its own employment. Firm 1 has incentives to push through this aggressive ESG policy and increase its employment (at the expense of firm 2) as long as its marginal productivity is higher than expected wage, that is, all the way through to the first best wages.

7 Concluding remarks

In this paper we study the equilibrium effects of the "S" dimension of ESG in a model of imperfect competition in labor (and product) markets. All else equal, a profit maximizing firm can benefit from adopting ESG policies that give a competitive edge in attracting workers; "Doing Well by Doing Good" applies in our setting. ESG policies are strategic complements, and in equilibrium, they are adopted by all firms resulting with higher worker welfare but lower shareholder value. Thus, profit maximizing firms benefit from coordinating on low impact ESG policies, raising anti-trust concerns from the adoption of industry-wide ESG standards. A purposeful firm (lead by a socially conscious board) benefits from such ESG policies, and imperfect competition between purposeful firms obtains the first best in equilibrium. Thus, the social purpose of the corporation is a panacea to excessive marker power. More broadly, our analysis relates the adoption of ESG policies to the nature of competition between firms and their model of corporate governance.

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A Appendix

A.1 Proofs for Section 3

Proof of Lemma 1. It is convenient to rewrite firm i's maximization problem as

$$\max_L f(L - L_{-i}) - W(L)(L - L_{-i}).$$

We first note that $W(L)(L - L_{-i})$ is strictly convex. If W is weakly convex then this is immediate. Otherwise, consider any L such that $W''(L) < 0$, and note that

$$\frac{\partial^2 W(L)(L - L_{-i})}{\partial L^2} = W''(L)(L - L_{-i}) + 2W'(L) > W''(L)L + 2W'(L) > 0,$$

where the final inequality follows from (2). It follows that the firm's objective is strictly concave, and hence has a unique maximizer.

Next, we establish that $r(L_{-i}, 0)$ is decreasing. This follows from the FOC

$$f'(l_i) = W'(l_i + L_{-i})\, l_i + W(l_i + L_{-i}).$$

The derivative of the RHS with respect to L_{-i} is

$$W''(l_i + L_{-i})\, l_i + W'(l_i + L_{-i}) = W''(L)(L - L_{-i}) + W'(L),$$

which is strictly positive: this is immediate if $W''(L) \geq 0$, and follows from (2) if $W''(L) < 0$. The result follows.

Finally, we establish that $r(L_{-i}, 0) + L_{-i}$ is strictly increasing in L_{-i}. This follows from the single-crossing property applied to firm i profits $f(L - L_{-i}) - W(L)(L - L_{-i})$. Specifically, consider L and $\tilde{L} > L$ such that

$$f(\tilde{L} - L_{-i}) - W(\tilde{L})(\tilde{L} - L_{-i}) \geq f(L - L_{-i}) - W(L)(L - L_{-i}).$$

Then for any $\tilde{L}_{-i} > L_{-i}$, we claim

$$f(\tilde{L} - \tilde{L}_{-i}) - W(\tilde{L})(\tilde{L} - \tilde{L}_{-i}) > f(L - \tilde{L}_{-i}) - W(L)(L - \tilde{L}_{-i}).$$

This holds because

$$\begin{aligned} f(\tilde{L} - \tilde{L}_{-i}) - f(L - \tilde{L}_{-i}) &> f(\tilde{L} - L_{-i}) - f(L - L_{-i}) \\ &\geq W(\tilde{L})(\tilde{L} - L_{-i}) - W(L)(L - L_{-i}) \\ &> W(\tilde{L})(\tilde{L} - \tilde{L}_{-i}) - W(L)(L - \tilde{L}_{-i}), \end{aligned}$$

where the first inequality follows from the concavity of f, and the third inequality follows from W being strictly increasing.[12] ■

[12] Local argument: Recall $r(L_{-i}; 0)$ satisfies $f'(r) = W'(r + L_{-i})\, r + W(r + L_{-i})$. By the implicit function

Proof of Lemma 2. Let

$$\pi_c(l_i;\omega_i) \equiv f(l_i) - \omega_i l_i.$$

We can write

$$\pi(l_i, L_{-i};\omega_i) = \min\{\pi(l_i, L_{-i};0), \pi_c(l_i;\omega_i)\}.$$

We make two useful observations:

1. Recall $\lambda(\omega_i) = \arg\max_{l_i} \pi_c(l_i;\omega_i)$ and $r(L_{-i};0) = \arg\max_{l_i} \pi(l_i, L_{-i};0)$.

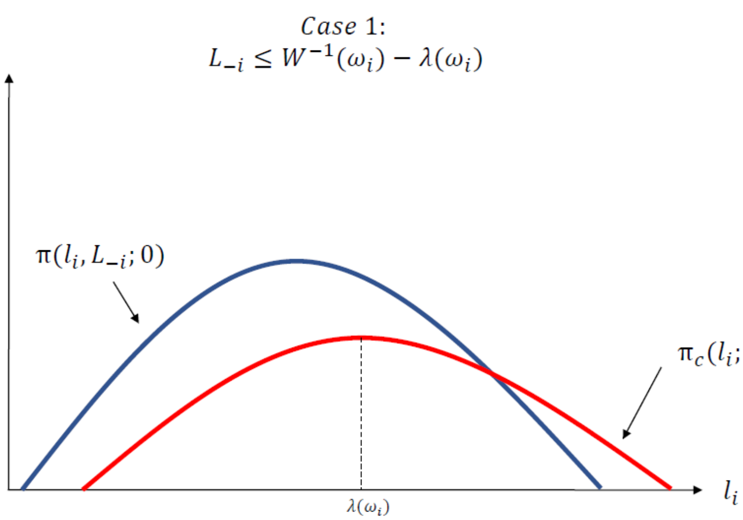
2. Note that $\pi_c(l_i;\omega_i) > \pi(l_i, L_{-i};0) \Leftrightarrow W(l_i + L_{-i}) > \omega_i$. If $W(l_i + L_{-i}) = \omega_i$ then $\pi(l_i, L_{-i};0) = \pi_c(l_i;\omega_i)$ and at this point,

$$\begin{aligned}\frac{\partial \pi(l_i, L_{-i};0)}{\partial l_i} &= f'(l_i) - W(l_i + L_{-i}) - W'(l_i + L_{-i})\, l_i \\ &< f'(l_i) - W(l_i + L_{-i}) = \frac{\partial \pi_c(l_i;\omega_i)}{\partial l_i}.\end{aligned}$$

Hence $\pi(l_i, L_{-i};0)$ crosses $\pi_c(l_i;\omega_i)$ from above.

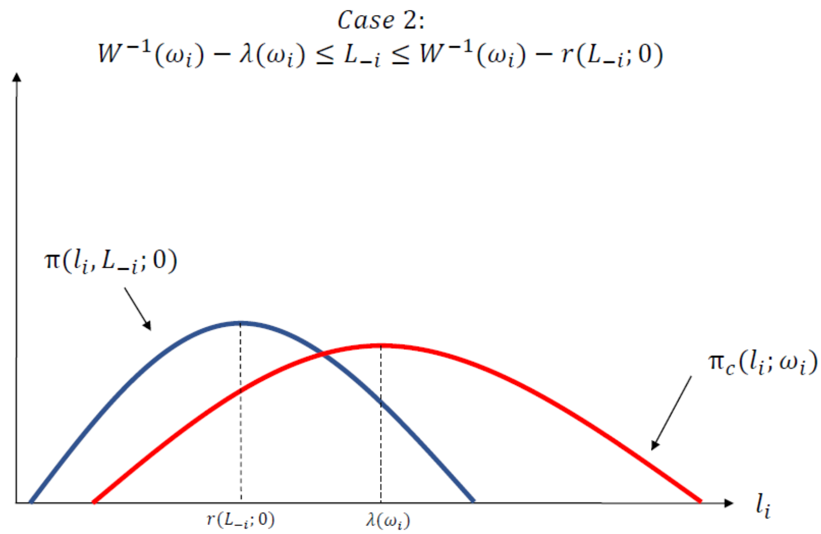
There are three cases to consider:

1. Suppose $W(\lambda(\omega_i) + L_{-i}) \le \omega_i$, which holds if and only if $L_{-i} \le W^{-1}(\omega_i) - \lambda(\omega_i)$. At $l_i = \lambda(\omega_i)$, $W(l_i + L_{-i}) \le \omega_i$ and so $\pi_c(l_i;\omega_i) \le \pi(l_i, L_{-i};0)$. So $\pi(l_i, L_{-i};0)$ crosses $\pi_c(l_i;\omega_i)$ from above to the right of $\lambda(\omega_i)$, which is the maximizer of $\pi_c(l_i;\omega_i)$. Hence the maximum of $\pi(l_i, l_{-i};\omega_i)$ is $l_i = \lambda(\omega_i)$.



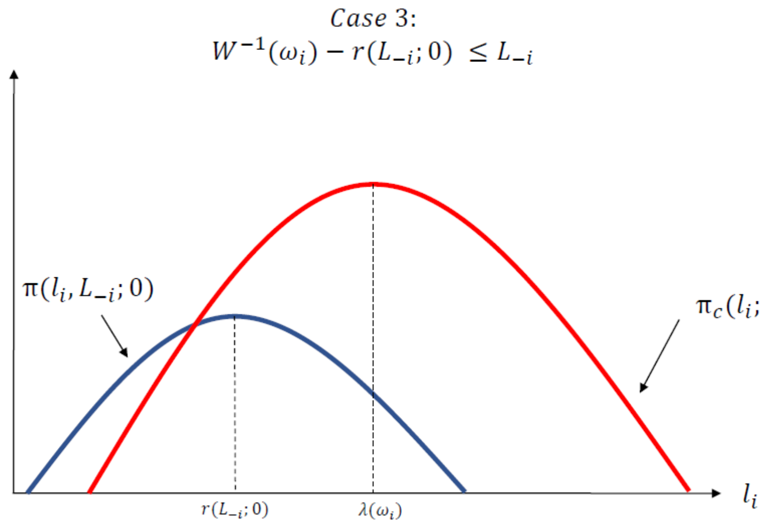
theorem, $\frac{\partial r}{\partial L_{-i}} = \frac{W''(r+L_{-i})r + W'(r+L_{-i})}{f''(r) - W''(r+L_{-i})r - W'(r+L_{-i}) - W'(r+L_{-i})}$. The assumption $W''(L)L + W'(L) > 0$ implies the denominator is negative and the numerator is positive. Notice $\frac{\partial r}{\partial L_{-i}} > -1 \Leftrightarrow f''(r) < W'(r + L_{-i})$, which holds given $f'' < 0 < W'$.

2. Suppose $W(r(L_{-i};0)+L_{-i}) \leq \omega_i \leq W(\lambda(\omega_i)+L_{-i})$, which holds if and only if $W^{-1}(\omega_i)-\lambda(\omega_i) \leq L_{-i} \leq W^{-1}(\omega_i)-r(L_{-i};0)$. Note that, in this case, $r(L_{-i};0) \leq \lambda(\omega_i)$. At $l_i = r(L_{-i};0)$, $W(l_i+L_{-i}) \leq \omega_i$ and so $\pi_c(l_i;\omega_i) \leq \pi(l_i,L_{-i};0)$. At $l_i = \lambda(\omega_i)$, $\omega_i \leq W(\lambda(\omega_i)+L_{-i})$, and so $\pi(l_i,L_{-i};0) \leq \pi_c(l_i;\omega_i)$. Hence the crossing point of the functions $\pi_c(l_i;\omega_i)$ and $\pi(l_i,L_{-i};0)$ occurs in the interval $[r(L_{-i};0), \lambda(\omega_i)]$, with $\pi_c(l_i;\omega_i) \leq (\geq) \pi(l_i,L_{-i};0)$ to the left (right) of the crossing point. Hence $\min\{\pi_c(l_i;\omega_i), \pi(l_i,L_{-i};0)\}$ is strictly increasing up to the crossing point, and strictly decreasing after the crossing point, and so is maximized at the crossing point. The crossing point l_i satisfies $W(l_i+L_{-i}) = \omega_i$, i.e., $l_i = W^{-1}(\omega_i) - L_{-i}$.



3. Suppose $\omega_i \leq W(r(L_{-i};0)+L_{-i})$, which holds if and only if $L_{-i} \geq W^{-1}(\omega_i)-r(L_{-i};0)$. At $l_i = r(L_{-i};0)$, $\omega_i \leq W(l_i+L_{-i})$, and so $\pi(l_i,L_{-i};0) \leq \pi_c(l_i;\omega_i)$. If $\pi(l_i,L_{-i};0) \leq \pi_c(l_i;\omega_i)$ for all l_i, it is immediate that the maximizer of $\min\{\pi_c(l_i;\omega_i), \pi(l_i,L_{-i};0)\}$ is $r(L_{-i};0)$. Otherwise, $\pi(l_i,L_{-i};0)$ crosses $\pi_c(l_i;\omega_i)$ from above at a point to the left of $r(L_{-i};0)$. Hence $\pi_c(l_i;\omega_i)$ is increasing up to this crossing point, and the maximizer of

$\min\{\pi_c(l_i;\omega_i), \pi(l_i, L_{-i};0)\}$ is again $r(L_{-i};0)$.



Observe that it cannot be $W(\lambda(\omega_i) + L_{-i}) \leq \omega_i \leq W(r(L_{-i};0) + L_{-i})$. If it did, then $W(\lambda(\omega_i) + L_{-i}) \leq W(r(L_{-i};0) + L_{-i})$ implies $\lambda(\omega_i) < r(L_{-i};0)$, $W(\lambda(\omega_i) + L_{-i}) \leq \omega_i$ implies $\pi_c(\lambda(\omega_i);\omega_i) \leq \pi(\lambda(\omega_i), L_{-i};0)$, and $\omega_i \leq W(r(L_{-i};0) + L_{-i})$ implies $\pi_c(r(L_{-i};0);\omega_i) > \pi(r(L_{-i};0), L_{-i};0)$. Since $\pi_c(r(L_{-i};0);\omega_i) \leq \pi_c(\lambda(\omega_i);\omega_i)$, the above implies $\pi(r(L_{-i};0), L_{-i};0) < \pi(\lambda(\omega_i), L_{-i};0)$, which contradicts the observation that $r(L_{-i};0)$ is the maximizer of $\pi(l_i, L_{-i};0)$.

Finally, we rewrite the condition on L_{-i} from the second case. Note that

$$\pi\left(\lambda(\omega_i), W^{-1}(\omega_i) - \lambda(\omega_i);0\right) = \pi_c(\lambda(\omega_i);\omega_i) = \max_{l_i} \pi_c(l_i;\omega_i),$$

implying $r(W^{-1}(\omega_i) - \lambda(\omega_i);0) < \lambda(\omega_i)$. Hence

$$W^{-1}(\omega_i) - \lambda(\omega_i) + r\left(W^{-1}(\omega_i) - \lambda(\omega_i);0\right) < W^{-1}(\omega_i),$$

i.e., at $L_{-i} = W^{-1}(\omega_i) - \lambda(\omega_i)$,

$$L_{-i} + r(L_{-i};0) < W^{-1}(\omega_i).$$

Hence

$$W^{-1}(\omega_i) - \lambda(\omega_i) < \Lambda(\omega_i).$$

Hence the condition on L_{-i} is equivalent to

$$L_{-i} \in \left[W^{-1}(\omega_i) - \lambda(\omega_i), \Lambda(\omega_i)\right].$$

This completes the proof of the first equality in the statement of the result. The second equality follows from the property (Lemma 1) that $r(L_{-i},0) + L_{-i}$ is strictly increasing. ■

A.2 Proofs for Section 4

The next sequence of auxiliary results will be used for the proof of Proposition 1.

Lemma 6 *If $\omega_1 \neq \omega_2$ then there is at most one labor market equilibrium.*

Proof. Note that (l_1, l_2) is a labor market equilibrium if and only if l_2 is a solution to

$$r\left(r\left(l_2;\omega_1\right);\omega_2\right) = l_2.$$

and $l_1 = r\left(l_2;\omega_1\right)$. From Lemma 2, it is immediate that the function $r\left(r\left(\cdot;\omega_1\right);\omega_2\right)$ has the following properties: It is continuous and weakly increasing. It is differentiable at all but at most four points. The set of points at which the function has slope 1 is an interval. Everywhere outside this interval the slope is strictly less than 1. And finally, if the slope is 1 then

$$\begin{aligned} r\left(l_2;\omega_1\right) &= W^{-1}\left(\omega_1\right) - l_2 \\ r\left(r\left(l_2;\omega_1\right);\omega_2\right) &= W^{-1}\left(\omega_2\right) - r\left(l_2;\omega_1\right). \end{aligned}$$

From these properties, equilibrium multiplicity occurs only if

$$W^{-1}\left(\omega_2\right) - \left(W^{-1}\left(\omega_1\right) - l_2\right) = l_2,$$

has more than one solution, i.e., only if $\omega_1 = \omega_2$. ■

Lemma 7 *If $\omega_2 \leq \omega_1 \leq W_B^*$ then in any equilibrium, $l_1^* = l_2^* = l_B^*$ and $W_1^* = W_2^* = W_B^*$.*

Proof. Certainly, $l_1 = l_2 = l_B^*$ is an equilibrium, since $\lambda\left(W_B^*\right) > l_B^* = W^{-1}\left(W_B^*\right) - l_B^* = r\left(l_B^*;0\right)$ and so if firm $-i$ picks $l_{-i} = l_B^*$ then firm i's best response is $r\left(l_B^*;\omega_i\right) = l_B^*$.

It remains to show that this is the unique equilibrium. Suppose to the contrary there is a second equilibrium $(\tilde{l}_1, \tilde{l}_2)$. By Lemma 6 it must be $\omega_2 = \omega_1 = \omega$ for some $\omega \leq W_B^*$, and by its proof, it must be $\tilde{l}_1 + \tilde{l}_2 = W^{-1}\left(\omega\right)$. Since $r\left(\cdot;\omega\right)$ is weakly decreasing, it follows that $\tilde{l}_i > l_B^*$ for some firm i. Observe

$$W^{-1}\left(\omega\right) = \tilde{l}_1 + \tilde{l}_2 = \tilde{l}_i + r(\tilde{l}_i;\omega) \geq l_B^* + r\left(l_B^*;\omega\right) = W^{-1}\left(W_B^*\right).$$

Indeed, the second equality follows from the definition of equilibrium, the first inequality follows from the observation that $l + r\left(l;\omega\right)$ is a weakly increasing function of l, and the third equality follows from the observation that (l_B^*, l_B^*) is an equilibrium. Therefore, it must be $\omega = W_B^*$. But notice that $\Lambda\left(W_B^*\right) = l_B^*$. And thus, $\tilde{l}_i > l_B^*$ implies $\tilde{l}_i > \Lambda\left(W_B^*\right)$, and hence, $r(\tilde{l}_i;W_B^*) = r(\tilde{l}_i;0)$ by (15). Therefore,

$$W^{-1}\left(W_B^*\right) = \tilde{l}_i + r(\tilde{l}_i;W_B^*) = \tilde{l}_i + r(\tilde{l}_i;0) > l_B^* + r\left(l_B^*;0\right) = W^{-1}\left(W_B^*\right),$$

where the strict inequality follows from Lemma 1, a contradiction. ■

Lemma 8 *If $\omega_i \geq W^{**}$ then $l_i = \lambda\left(\omega_i\right)$.*

Proof. For specificity, set $i = 2$. For use at various points in the proof, note that

$$2\lambda(\omega_2) \leq 2\lambda(\omega^{**}) = W^{-1}(W^{**}) \leq W^{-1}(\omega_2) \tag{21}$$

and that, if $l \leq l_B^*$ and $W \geq W_{B^*}$ then by Lemma 1,

$$l + r(l;0) \leq l_B^* + r(l_B^*;0) = W^{-1}(W_B^*) \leq W^{-1}(W),$$

i.e., $l \leq l_B^*$ and $W \geq W_{B^*}$ then

$$r(l;0) \leq W^{-1}(W) - l. \tag{22}$$

First, we show that in any equilibrium $l_2 = \lambda(\omega_2)$. It suffices to show that

$$r(\lambda(\omega_2);\omega_1) \leq W^{-1}(\omega_2) - \lambda(\omega_2), \tag{23}$$

because in this case,

$$\begin{aligned} \lambda(\omega_2) &\leq W^{-1}(\omega_2) - r(\lambda(\omega_2);\omega_1) \\ &\leq \max\left\{W^{-1}(\omega_2) - r(\lambda(\omega_2);\omega_1), r(r(\lambda(\omega_2);\omega_1);0)\right\} \end{aligned}$$

thereby implying that $r(r(\lambda(\omega_2);\omega_1);\omega_2) = \lambda(\omega_2)$.

To establish (23): If $\omega_1 \geq \omega_2$ then the inequality is immediate from the combination of $r(\cdot;\omega_1) \leq \lambda(\omega_1) \leq \lambda(\omega_2)$ and (21). If instead $\omega_1 < \omega_2$ then recall

$$r(\lambda(\omega_2);\omega_1) \leq \max\left\{W^{-1}(\omega_1) - \lambda(\omega_2), r(\lambda(\omega_2);0)\right\}.$$

The inequality (23) follows from the combination of $W^{-1}(\omega_1) - \lambda(\omega_2) < W^{-1}(\omega_2) - \lambda(\omega_2)$ and $r(\lambda(\omega_2);0) \leq W^{-1}(\omega_2) - \lambda(\omega_2)$,[13] which together ensure

$$\max\left\{W^{-1}(\omega_1) - \lambda(\omega_2), r(\lambda(\omega_2);0)\right\} \leq W^{-1}(\omega_2) - \lambda(\omega_2),$$

and hence $r(\lambda(\omega_2);\omega_1) \leq W^{-1}(\omega_2) - \lambda(\omega_2)$, as required.

If $\omega_1 \neq \omega_2$ then the equilibrium is unique by Lemma 6, and the proof is complete. For $\omega_1 = \omega_2 \geq W^{**}$, simply note that $l_{-i} \leq \lambda(\omega_1)$, and so

$$\begin{aligned} r(l_{-i};\omega_i) &= \min\left\{\lambda(\omega_1), \max\left\{W^{-1}(\omega_1) - l_{-i}, r(l_{-i};0)\right\}\right\} \\ &= \min\left\{\lambda(\omega_1), W^{-1}(\omega_1) - l_{-i}\right\} \\ &= \lambda(\omega_1), \end{aligned}$$

where the first and second equalities follow from (22) and (21), respectively. Hence the unique equilibrium in this case is $l_1 = l_2 = \lambda(\omega_1)$. ■

Lemma 9 *If $\omega_1 \in (W_B^*, \hat{W}]$ and $\omega_2 \leq \omega_1$ then $l_1^* = \Lambda(\omega_1)$, $l_2^* = W^{-1}(\omega_1) - \Lambda(\omega_1)$, and $W_1^* = W_2^* = \omega_1$ is an equilibrium; and is the unique equilibrium if $\omega_2 < \omega_1$.*

[13] Notice that $\underline{W}_2 \geq W^{**} > \hat{\underline{W}}$ ensures $\Lambda(\underline{W}_2) > \underline{l}(\underline{W}_2)$ and hence $r(\underline{l}(\underline{W}_2);0) + \underline{l}(\underline{W}_2) \leq W^{-1}(\underline{W}_2) \Rightarrow r(\underline{l}(\underline{W}_2);0) \leq W^{-1}(\underline{W}_2) - \underline{l}(\underline{W}_2)$.

Proof. We start by arguing that the best response of firm 2 to $l_1 = \Lambda(\omega_1)$ is $l_2 = W^{-1}(\omega_1) - \Lambda(\omega_1)$. Firm 2's best response is

$$r(\Lambda(\omega_1);\omega_2) = \min\left\{\lambda(\omega_2), \max\left\{W^{-1}(\omega_2) - \Lambda(\omega_1), r(\Lambda(\omega_1);0)\right\}\right\}.$$

Using the definition of $\Lambda(\omega)$ and $\omega_2 \leq \omega_1$, we have $W^{-1}(\omega_2) - \Lambda(\omega_1) \geq r(\Lambda(\omega_1);0)$. Indeed,

$$\begin{aligned} W^{-1}(\omega_2) - \Lambda(\omega_1) &\geq r(\Lambda(\omega_1);0) \Leftrightarrow \\ \omega_2 &\geq W(\Lambda(\omega_1) + r(\Lambda(\omega_1);0)) \Leftrightarrow \\ \omega_2 &\geq \omega_1. \end{aligned}$$

Thus,

$$r(\Lambda(\omega_1);\omega_2) = \min\{\lambda(\omega_2), r(\Lambda(\omega_1);0)\}.$$

Note that $\omega_1 > W_B^* \Rightarrow \Lambda(\omega_1) > \Lambda(W_B^*)$ and $\Lambda(W_B^*) = l_B^*$, thus, $\Lambda(\omega_1) > l_B^*$. Hence

$$\lambda(\omega_2) \geq \lambda(\omega_1) > \lambda(W^{**}) = l^{**} > l_B^* = r(l_B^*;0) > r(\Lambda(\omega_1);0),$$

establishing

$$r(\Lambda(\omega_1);\omega_2) = r(\Lambda(\omega_1);0) = W^{-1}(\omega_1) - \Lambda(\omega_1),$$

as required.

Next, we argue that the best response of firm 1 to $l_2 = W^{-1}(\omega_1) - \Lambda(\omega_1)$ is $l_1 = \Lambda(\omega_1)$. Firm 1's best response is

$$r\left(W^{-1}(\omega_1) - \Lambda(\omega_1);\omega_1\right) = \min\left\{\lambda(\omega_1), \max\left\{\Lambda(\omega_1), r\left(W^{-1}(\omega_1) - \Lambda(\omega_1);0\right)\right\}\right\}.$$

Because $\Lambda(\omega_1) > \Lambda(W_B^*) = l_B^*$,

$$W^{-1}(\omega_1) - \Lambda(\omega_1) = r(\Lambda(\omega_1);0) < r(\Lambda(W_B^*);0) = \Lambda(W_B^*) < \Lambda(\omega_1).$$

Since $W^{-1}(\omega_1) - \Lambda(\omega_1) < \Lambda(\omega_1)$, Lemma 1 and the definition of $\Lambda(\omega_1)$ then implies

$$W^{-1}(\omega_1) - \Lambda(\omega_1) + r\left(W^{-1}(\omega_1) - \Lambda(\omega_1);0\right) < \Lambda(\omega_1) + r(\Lambda(\omega_1);0) = W^{-1}(\omega_1),$$

and so

$$r\left(W^{-1}(\omega_1) - \Lambda(\omega_1);0\right) < \Lambda(\omega_1)$$

and

$$r\left(W^{-1}(\omega_1) - \Lambda(\omega_1);\omega_1\right) = \min\{\lambda(\omega_1), \Lambda(\omega_1)\}.$$

Since $\omega_1 \leq \hat{W}$, we have $\Lambda(\omega_1) \leq \lambda(\omega_1)$, and $r(W^{-1}(\omega_1) - \Lambda(\omega_1);\omega_1) = \Lambda(\omega_1)$ as required.

Hence $(l_1, l_2) = (\Lambda(\omega_1), W^{-1}(\omega_1) - \Lambda(\omega_1))$ is an equilibrium. Uniqueness when $\omega_2 < \omega_1$ follows from Lemma 6. Finally notice that

$$W(l_1^* + l_2^*) = W(\Lambda(\omega_1) + W^{-1}(\omega_1) - \Lambda(\omega_1)) = \omega_1 \geq \omega_2,$$

and hence, $W_1^* = W_2^* = \omega_1$. ■

Lemma 10 *Suppose $\omega_1 \in (\hat{W}, W^{**}]$ and $\omega_2 \leq \omega_1$. Then,*

(i) There is an equilibrium in which, $l_1^* = \lambda(\omega_1)$, $l_2^* = r(\lambda(\omega_1); \omega_2) \leq W^{-1}(\omega_1) - \lambda(\omega_1)$, and $W_1^* = \omega_1$.

(ii) If $\omega_2 < \omega_1$ then the equilibrium in part (i) is the unique equilibrium and $l_2^* < W^{-1}(\omega_1) - \lambda(\omega_1)$. Moreover:

(a) If $W^{-1}(\omega_2) - \lambda(\omega_1) \geq r(\lambda(\omega_1); 0)$ then $l_2^* = W^{-1}(\omega_2) - \lambda(\omega_1)$ and $W_2^* = \omega_2$.

(b) If $W^{-1}(\omega_2) - \lambda(\omega_1) < r(\lambda(\omega_1); 0)$ then $l_2^* = r(\lambda(\omega_1); 0)$ and $W_2^* = W(\lambda(\omega_1) + r(\lambda(\omega_1); 0))$.

(iii) If $\omega_2 = \omega_1$ then $l_2^* = W^{-1}(\omega_1) - \lambda(\omega_1)$ and $W_2^* = \omega_1$.

Proof. First, we show that if $l_2 \leq W^{-1}(\omega_1) - \lambda(\omega_1)$ then firm 1's best response is $r(l_2; \omega_1) = \lambda(\omega_1)$. This follows directly from $\lambda(\omega_1) \leq W^{-1}(\omega_1) - l_2 \leq \max\{W^{-1}(\omega_1) - l_2, r(l_2; 0)\}$.

Second, we show firm 2's best response to firm 1 picking $\lambda(\omega_1)$ is $r(\lambda(\omega_1); \omega_2) \leq W^{-1}(\omega_1) - \lambda(\omega_1)$. It is sufficient to establish that $\max\{W^{-1}(\omega_2) - \lambda(\omega_1), r(\lambda(\omega_1); 0)\} \leq W^{-1}(\omega_1) - \lambda(\omega_1)$. This is indeed the case since $W^{-1}(\omega_2) - \lambda(\omega_1) \leq W^{-1}(\omega_1) - \lambda(\omega_1)$ and, by $\omega_1 > \hat{W} \Rightarrow \lambda(\omega_1) < \Lambda(\omega_1)$ and Lemma 1,

$$\lambda(\omega_1) + r(\lambda(\omega_1); 0) < \Lambda(\omega_1) + r(\Lambda(\omega_1); 0) = W^{-1}(\omega_1),$$

and so

$$r(\lambda(\omega_1); 0) < W^{-1}(\omega_1) - \lambda(\omega_1).$$

Therefore, $r(\lambda(\omega_1); \omega_2) \leq W^{-1}(\omega_1) - \lambda(\omega_1)$.

Third, note that

$$W^{-1}(\omega_1) \leq W^{-1}(W^{**}) = 2\lambda(W^{**}) \leq 2\lambda(\omega_1),$$

and so

$$W^{-1}(\omega_1) - \lambda(\omega_1) \leq \lambda(\omega_1). \tag{24}$$

Hence $l_2 = r(\lambda(\omega_1); \omega_2) = \max\{W^{-1}(\omega_2) - \lambda(\omega_1), r(\lambda(\omega_1); 0)\}$.

Fourth, if $\omega_2 < \omega_1$ then the above steps establish $r(\lambda(\omega_1); \omega_2) < W^{-1}(\omega_1) - \lambda(\omega_1)$; and equilibrium uniqueness follows from 6. The wage statements follow from the construction of the best response function.

Finally, if $\omega_2 = \omega_1$ then the above inequalities directly imply $r(\lambda(\omega_1); \omega_2) = W^{-1}(\omega_1) - \lambda(\omega_1)$. ■

Proof of Proposition 1. Part (i) follows from Lemma 7. Part (ii) follows from Lemma 8. Consider part (iii). Suppose $\omega_2 = \omega_1 = \omega \in (W_B^*, W^{**})$. As in the proof of Lemma 6, the function $r(r(\cdot; \omega); \omega)$ has a slope 1 only if $r(l_2^*; \omega) = W^{-1}(\omega) - l_2^*$ and $r(l_1^*; \omega) = W^{-1}(\omega) - l_1^*$. Therefore, $l_1^* + l_2^* = W^{-1}(\omega)$ and it must be $W_1^* = W_2^* = \omega$. Based on Lemma

2, $r\left(l_2^*;\omega\right) = W^{-1}\left(\omega\right) - l_2^*$ requires $l_2^* \in \left(W^{-1}\left(\omega\right) - \lambda\left(\omega\right), \Lambda\left(\omega\right) \Leftrightarrow W^{-1}\left(\omega\right) - \lambda\left(\omega\right) < l_2^* < \Lambda\left(\omega\right)\right.$. Similarly, $r\left(l_1^*;\omega\right) = W^{-1}\left(\omega\right) - l_1^*$ requires $W^{-1}\left(\omega\right) - \lambda\left(\omega\right) < l_1^* < \Lambda\left(\omega\right)$. Therefore $W^{-1}\left(\omega\right) - \lambda\left(\omega\right) < l_2^* < \Lambda\left(\omega\right)$ implies $W^{-1}\left(\omega\right) - \lambda\left(\omega\right) < W^{-1}\left(\omega\right) - l_1^* < \Lambda\left(\omega\right)$, which implies $W^{-1}\left(\omega\right) - \Lambda\left(\omega\right) < l_1^* < \lambda\left(\omega\right)$. Similarly, $W^{-1}\left(\omega\right) - \Lambda\left(\omega\right) < l_2^* < \lambda\left(\omega\right)$. Combined,

$$W^{-1}\left(\omega\right) - \min\left\{\Lambda\left(\omega\right), \lambda\left(\omega\right)\right\} < l_1^*, l_2^* < \min\left\{\Lambda\left(\omega\right), \lambda\left(\omega\right)\right\}.$$

Thus, the set of equilibria is composed of $l^* \in \left[W^{-1}\left(\omega\right) - \min\left\{\Lambda\left(\omega\right), \lambda\left(\omega\right)\right\}, \min\left\{\Lambda\left(\omega\right), \lambda\left(\omega\right)\right\}\right]$ such that $l_1^* = l^*$ and $l_2^* = W^{-1}\left(\omega\right) - l^*$. Finally, if $\omega \leq \hat{W}$ then based on Lemma 3 $\Lambda\left(\omega\right) \leq \lambda\left(\omega\right)$. Recall, by definition, $\Lambda\left(\omega\right) + r\left(\Lambda\left(\omega\right), 0\right) = W^{-1}\left(\omega\right)$. Notice $\omega > W_B^*$ implies $\Lambda\left(\omega\right) > l_B^*$ and hence $\Lambda\left(\omega\right) > l_B^* > r\left(\Lambda\left(\omega\right), 0\right)$, which implies $W^{-1}\left(\omega\right) - \Lambda\left(\omega\right) < \Lambda\left(\omega\right)$, that is, the interval $\left[W^{-1}\left(\omega\right) - \Lambda\left(\omega\right), \Lambda\left(\omega\right)\right]$ is non-empty. If $\omega > \hat{W}$ then based on Lemma 3 $\Lambda\left(\omega\right) > \lambda\left(\omega\right)$. Recall $2\lambda(W^{**}) = W^{-1}\left(W^{**}\right)$. Since $\lambda' < 0$, then $\omega < W^{**}$ implies $2\lambda(\omega) > W^{-1}\left(\omega\right)$, that is, the interval $[W^{-1}\left(\omega\right) - \lambda(\omega, \lambda(\omega]$ is non-empty.

Consider part (iv). If $\omega_2 < \omega_1$ then the equilibrium is unique based on Lemma 6. Based on Lemma 9, if $\omega_1 \in (W_B^*, \hat{W}]$ then $l_1 = \Lambda\left(\omega_1\right)$ and $W_1^* = \omega_1$. Based on Lemma 10 part (i), if $\omega_1 \in (\hat{W}, W^{**}]$ then $l_1^* = \lambda\left(\omega_1\right)$ and $W_1^* = \omega_1$. Based on Lemma 3, $\Lambda\left(\omega\right) < \lambda\left(\omega\right)$ if and only if $\omega < \hat{W}$. Therefore, $l_1^* = \min\left\{\Lambda\left(\omega_1\right), \lambda\left(\omega_1\right)\right\}$ and $W_1^* = \omega_1$ as required. Notice l_2^* and W_2^* follow from the definition of equilibrium, and their explicit characterization is given in Lemmas 9 and 10. ■

Proof of Lemma 3. Observe $\hat{W}$ is well-defined since $\lambda'\left(\cdot\right) < 0$ and by Lemma 1, the LHS of 17 is decreasing in $\hat{W}$. Note that $l_B^* = r\left(l_B^*, 0\right) < \lambda\left(W_B^*\right)$ and $W^{-1}(\hat{W}) = l_B^* + r\left(l_B^*, 0\right)$, so by Lemma 1,

$$\lambda\left(W_B^*\right) + r\left(\lambda\left(W_B^*\right), 0\right) > l_B^* + r\left(l_B^*, 0\right) = W^{-1}\left(W_B^*\right).$$

Therefore, $W_B^* < \hat{W}$. Moreover, since $r\left(l_B^*, 0\right) = l_B^*$ and $\lambda\left(W^{**}\right) = l^{**} > l_B^*$, we have $r\left(\lambda\left(W^{**}\right), 0\right) < \lambda\left(W^{**}\right)$. Since $\lambda\left(W^{**}\right) + \lambda\left(W^{**}\right) = W^{-1}\left(W^{**}\right)$, we have

$$\lambda\left(W^{**}\right) + r\left(\lambda\left(W^{**}\right), 0\right) < \lambda\left(W^{**}\right) + \lambda\left(W^{**}\right) = W^{-1}\left(W^{**}\right).$$

Therefore, $\hat{W} < W^{**}$. Last, by definition $\Lambda(\hat{W})$ is the unique solution of

$$\Lambda + r\left(\Lambda; 0\right) = W^{-1}(\hat{W}),$$

and therefore, it must be $\Lambda(\hat{W}) = \lambda(\hat{W})$. Since $\Lambda\left(\cdot\right)$ is strictly increasing and $\lambda\left(\cdot\right)$ is strictly decreasing, then $\Lambda\left(\omega\right) < \lambda\left(\omega\right)$ if and only if $\omega < \hat{W}$, as required. ■

A.3 Proofs for Section 5.1

The results of Section 5.1 are proved for a general $N \geq 2$. We assume firm N adopts ESG policy ω_N, while $\omega_i = 0$ for all $i < N$. We focus on subgame equilibria in which all other (non-ESG) firms make the same labor market choice. So an equilibrium is a pair (l_N, l_{-N}).

Lemma 11 *The equilibrium is unique.*

Proof. An equilibrium is (l_N, l_{-N}) such that $l_N = r((N-1)\,l_{-N};\omega_N)$ and $l_{-N} = r(l_N + (N-2)\,l_{-N};0)$, or equivalently,

$$\begin{aligned} l_{-N} &= r\left(r\left((N-1)\,l_{-N};\omega_N\right) + (N-2)\,l_{-N};0\right) &(25)\\ l_N &= r\left((N-1)\,l_{-N};\omega_N\right). &(26)\end{aligned}$$

Suppose that, contrary to the claimed result, there exist two distinct equilibria, (l_N, l_{-N}) and $(\tilde{l}_N, \tilde{l}_{-N})$, where without loss $\tilde{l}_{-N} > l_{-N}$. (The case $\tilde{l}_{-N} = l_{-N}$ cannot arise because it implies $\tilde{l}_N = l_N$, in which case the two equilibria aren't distinct.)

By (25), $\tilde{l}_{-N} > l_{-N}$ implies that

$$r(r((N-1)\,\tilde{l}_{-N};\omega_N) + (N-2)\,\tilde{l}_{-N};0) > r\left(r\left((N-1)\,l_{-N};\omega_N\right) + (N-2)\,l_{-N};0\right)$$

Recall that by Lemma 1 $r(\cdot;0)$ is a decreasing function. This implies that

$$r((N-1)\,\tilde{l}_{-N};\omega_N) + (N-2)\,\tilde{l}_{-N} < r\left((N-1)\,l_{-N};\omega_N\right) + (N-2)\,l_{-N}.$$

Also from Lemma 1, $r(L_{-N};0) + L_{-N}$ is an increasing function of L_{-N}. It then follows that

$$\begin{aligned} & r((N-1)\,\tilde{l}_{-N};\omega_N) + (N-2)\,\tilde{l}_{-N} + r(r((N-1)\,\tilde{l}_{-N};\omega_N) + (N-2)\,\tilde{l}_{-N};0) \\ < \; & r\left((N-1)\,l_{-N};\omega_N\right) + (N-2)\,l_{-N} + r\left(r\left((N-1)\,l_{-N};\omega_N\right) + (N-2)\,l_{-N};0\right). \end{aligned}$$

Substituting in (25), this inequality is equivalent to

$$r\left((N-1)\,\tilde{l}_{-N};\omega_N\right) + (N-1)\,\tilde{l}_{-N} < r\left((N-1)\,l_{-N};\omega_N\right) + (N-1)\,l_{-N}.$$

But, since $\tilde{l}_{-N} > l_{-N}$, this contradicts the combination of Lemmas 1 and 2 that $r(L_{-N};\omega_N) + L_{-N}$ is a weakly increasing function. ■

To characterize equilibrium outcomes, first define $\rho(l_N)$ by

$$\rho(l_N) = r\left(l_N + (N-2)\,\rho(l_N);0\right). \tag{27}$$

That is: if firm N hires l_N in equilibrium, then $\rho(l_N)$ is the equilibrium hiring of firms $1,\ldots,N-1$. Note that since $r(\cdot;0)$ is strictly decreasing (Lemma 1) it follows that $\rho(l_N)$ is well-defined, and moreover is strictly decreasing in l_N. Moreover:[14]

Lemma 12 *$l_N + (N-1)\,\rho(l_N)$ is strictly increasing in l_N.*

Proof. Consider l_N and $\tilde{l}_N > l_N$. Since $\rho(\tilde{l}_N) < \rho(l_N)$ it follows that

$$\tilde{l}_N + (N-2)\,\rho(\tilde{l}_N) > l_N + (N-2)\,\rho(l_N).$$

[14] It can be shown that $[l_N + (N-1)\,\rho(l_N)]' \in (0,1)$. Indeed, $\rho'(l_N) = \frac{r'(l_N+(N-2)\rho;0)}{1-(N-2)r'(l_N+(N-2)\rho;0)}$ and $[l_N + (N-1)\,\rho(l_N)]' = \frac{1+r'(l_N+(N-2)\rho;0)}{1-(N-2)r'(l_N+(N-2)\rho;0)} \in (0,1)$

Hence by Lemma 1,

$$\begin{array}{rl} & \tilde{l}_N + (N-2)\,\rho(\tilde{l}_N) + r(\tilde{l}_N + (N-2)\,\rho(\tilde{l}_N);0) \\ > & l_N + (N-2)\,\rho\,(l_N) + r\,(l_N + (N-2)\,\rho\,(l_N)\,;0)\,, \end{array}$$

or equivalently,

$$\tilde{l}_N + (N-2)\,\rho(\tilde{l}_N) + \rho(\tilde{l}_N) > l_N + (N-2)\,\rho\,(l_N) + \rho\,(l_N)\,,$$

establishing the result. ■

Lemma 13 *Define $\hat{W}$ by*

$$\hat{W} = W(\lambda(\hat{W}) + (N-1)\,\rho(\lambda(\hat{W}))). \tag{28}$$

Then, $\hat{W}$ is well-defined, and lies in the interval (W_B^*, W^{**}). Moreover, $\lambda(\hat{W}) > l^{**} > l_B^*$

Proof. Observe $\hat{W}$ is well-defined since by Lemma 12, $W\,(\lambda\,(\cdot) + (N-1)\,\rho\,(\lambda\,(\cdot)))$ is a decreasing function. Note that $\rho\,(l_B^*) = l_B^* < \lambda\,(W_B^*)$, so by Lemma 12,

$$l_B^* + (N-1)\,l_B^* < \lambda\,(W_B^*) + (N-1)\,\rho\,(\lambda\,(W_B^*))\,,$$

and so

$$W_B^* < W\,(\lambda\,(W_B^*) + (N-1)\,\rho\,(\lambda\,(W_B^*)))\,,$$

implying $\hat{W} > W_B^*$. Moreover, $\lambda(\hat{W}) > l_B^*$, since if instead $\lambda(\hat{W}) \leq l_B^*$ then (28) and Lemma 12 imply $\hat{W} \leq W\,(l_B^* + (N-1)\,\rho\,(l_B^*)) = W\,(Nl_B^*) = W_B^*$, contradicting $\hat{W} > W_B^*$.

Notice $\lambda\,(W^{**}) = l^{**}$ and $\rho\,(l^{**}) < l^{**}$. Indeed, if on the contrary $\rho\,(l^{**}) \geq l^{**}$ then $r\,(l^{**} + (N-2)\,\rho\,(l^{**})\,;0) = \rho\,(l^{**}) \geq l^{**}$ and $L_{-N} \equiv l^{**} + (N-2)\,\rho\,(l^{**}) \geq (N-1)\,l^{**}$. Notice $r\,(L_{-N}, 0)$ uniquely solves

$$f'\,(r) - W\,(r + L_{-N}) - rW'\,(r + L_{-N}) = 0.$$

However,

$$\begin{aligned} f'\,(l^{**}) - W\,(l^{**} + L_{-N}) - l^{**}W'\,(l^{**} + L_{-N}) &= W\,(Nl^{**}) - W\,(l^{**} + L_{-N}) - l^{**}W'\,(l^{**} + L_{-N}) \\ &< W\,(Nl^{**}) - W\,(Nl^{**}) - l^{**}W'\,(l^{**} + L_{-N}) \\ &= -l^{**}W'\,(l^{**} + L_{-N}) < 0. \end{aligned}$$

Therefore, $r\,(L_{-N}, 0) < l^{**}$, a contradiction. Since $\lambda\,(W^{**}) = l^{**}$ and $\rho\,(l^{**}) < l^{**}$, we have $\lambda\,(W^{**}) + (N-1)\,\rho\,(\lambda\,(W^{**})) = l^{**} + (N-1)\,\rho\,(l^{**}) < Nl^{**}$ and

$$W^{**} > W\,(\lambda\,(W^{**}) + (N-1)\,\rho\,(\lambda\,(W^{**})))$$

implying $\hat{W} < W^{**}$. Notice $\lambda(\hat{W}) > \lambda\,(W^{**}) = l^{**}$. ■

Lemma 14 *If $\omega_N \leq W_B^*$ then firm N's ESG policy has no effect, and the equilibrium coincides with the No-ESG benchmark, $(l_N, l_{-N}) = (l_B^*, l_B^*)$. If $W_B^* < \omega_N \leq \hat{W}$ then the equilibrium l_N is determined by the solution to $W(l_N + (N-1)\rho(l_N)) = \omega_N$, while if $\omega_N \geq \hat{W}$ the equilibrium $l_N = \lambda(\omega_N)$. In all cases, $l_{-N} = \rho(l_N)$.*

Proof. There are three cases:

1. $\omega_N \leq W_B^*$: Intuitively, this is a non-binding ESG policy, and has no effect, i.e., the equilibrium is $(l_N, l_{-N}) = (l_B^*, l_B^*)$. Formally: $\Lambda(\omega_N) \leq \Lambda(W_B^*) = (N-1) l_B^*$. Hence $r((N-1) l_B^*; \omega_N) = r((N-1) l_B^*; 0) = l_B^*$, establishing that (l_B^*, l_B^*) is the (unique) equilibrium.

2. $W_B^* < \omega_N \leq \hat{W}$: In this case, the equilibrium is determined by the solution to

$$W(l_N + (N-1)\rho(l_N)) = \omega_N$$

along with $l_{-N} = \rho(l_N)$. To establish that this is indeed the equilibrium, we must show $r((N-1)\rho(l_N); \omega_N) = l_N$, i.e.,

$$r((N-1)\rho(l_N); \omega_N) = W^{-1}(\omega_N) - (N-1)\rho(l_N).$$

From Lemma 2, this is equivalent to showing

$$\lambda(\omega_N) \geq W^{-1}(\omega_N) - (N-1)\rho(l_N) \geq r((N-1)\rho(l_N); 0).$$

We first show that

$$l_N \in (l_B^*, \lambda(\omega_N)].$$

To establish the upper bound, suppose to the contrary that $l_N > \lambda(\omega_N)$. By Lemma 12,

$$\omega_N = W(l_N + (N-1)\rho(l_N)) > W(\lambda(\omega_N) + (N-1)\rho(\lambda(\omega_N))),$$

implying $\hat{W} > W(\lambda(\hat{W}) + (N-1)\rho(\lambda(\hat{W})))$, contradicting the definition of $\hat{W}$. To establish the lower bound, simply note that

$$W(l_B^* + (N-1)\rho(l_B^*)) = W(N l_B^*) = W_B^* < \omega_N,$$

so by Lemma 12 it follows that $l_N > l_B^*$.

To establish the required pair of inequalities: From the definition of $\hat{W}$,

$$W^{-1}(\hat{W}) = \lambda(\hat{W}) + (N-1)\rho(\lambda(\hat{W})),$$

and hence

$$\begin{aligned} W^{-1}(\omega_N) &\leq \lambda(\omega_N) + (N-1)\rho(\lambda(\omega_N)) \\ &\leq \lambda(\omega_N) + (N-1)\rho(l_N). \end{aligned}$$

Finally, $l_N > l_B^*$ implies $\rho(l_N) < \rho(l_B^*) = l_B^*$ and so

$$\begin{aligned}(N-1)\rho(l_N) + r((N-1)\rho(l_N);0) &< (N-1)l_B^* + r((N-1)l_B^*;0) \\ &= Nl_B^* = W^{-1}(W_B^*) < W^{-1}(\omega_N).\end{aligned}$$

3. $\omega_N \geq \hat{W}$: In this case, the equilibrium is $l_N = \lambda(\omega_N)$ along with $l_{-N} = \rho(l_N)$. To establish that this is indeed the equilibrium, we must show $r((N-1)\rho(\lambda(\omega_N));\omega_N) = \lambda(\omega_N)$, for which it in turn suffices to show that

$$\lambda(\omega_N) \leq W^{-1}(\omega_N) - (N-1)\rho(\lambda(\omega_N)).$$

This inequality indeed follows from $\omega_N \geq \hat{W}$ and the definition of $\hat{W}$.

■

Proof of Proposition 2. For $\omega_N \in [W_B^*, \hat{W}]$, firm N's profits are

$$f(l_N) - l_N W(l_N + (N-1)\rho(l_N)), \tag{29}$$

where l_N is as characterized in Lemma 14. In this range, l_N is strictly increasing in ω_N. The derivative of (29) with respect to l_N is

$$f'(l_N) - W(l_N + (N-1)\rho(l_N)) - (1 + (N-1)\rho'(l_N))W'(l_N + (N-1)\rho(l_N)). \tag{30}$$

At $\omega_N = W_B^*$ we know $l_N = \rho(l_N) = l_B^*$, and so (30) reduces to

$$f'(l_B^*) - W(Nl_B^*) - (1 + (N-1)\rho'(l_B^*))W'(Nl_B^*) = -(N-1)\rho'(l_B^*)W'(Nl_B^*),$$

where the equality follows from the firm N's optimality condition in the non-ESG benchmark. Since ρ is strictly decreasing, it follows that firm N's profits are strictly increasing in the ESG policy ω_N in the neighborhood to above W_B^*.

At $\omega_N = \hat{W}$ we know $l_N = \lambda(\omega_N)$, or equivalently, $f'(l_N) = W(l_N + (N-1)\rho(l_N))$. Hence (30) reduces to

$$-(1 + (N-1)\rho'(l_N))W'(l_N + (N-1)\rho(l_N)),$$

which is strictly negative by Lemma 12. So firm N's profits are strictly decreasing in the ESG policy ω_N in the neighborhood below $\hat{W}$.

For $\omega_N \geq \hat{W}$, firm N hires $l_N = \lambda(\omega_N)$, or equivalently, firm N's profits are

$$\max_{\tilde{l}_N} f(\tilde{l}_N) - \omega_N \tilde{l}_N,$$

and so are strictly decreasing in ω_N, completing the proof. ■

A.4 Proofs for Section 5.2

Proof of Proposition 3. Defining ω. Firm 2's profits from ESG profile $(\hat{W}, 0)$ are strictly lower than firm 2's profits from $(\hat{W}, \hat{W}+\epsilon)$, $\epsilon > 0$ sufficiently small. This follows because moving from $(\hat{W}, 0)$ to $(\hat{W}, \hat{W}+\epsilon)$ moves the equilibrium from firm 2's least-preferred member of the equilibrium set at $(\hat{W}, \hat{W})$ to an outcome that is arbitrarily close firm 2's most-preferred member. Firm 2's profits from $(W^{**}, 0)$ are strictly greater than firm 2's profits at $(W^{**}, W^{**}+\epsilon)$.

Define

$$\omega = \inf\left\{\omega_1 > \hat{W} : \text{firm 2's profits at } (\omega_1, 0) > \text{firm 2's profits at } (\omega_1, \omega_1+\epsilon) \text{ for all } \epsilon > 0\right\}.$$

In words: By choosing $\omega_1 = \omega$, the leader firm 1 induces the follower firm 2 to respond with $\omega_2 = 0$.

For use below: the two firms' profits are equal to each other under $(\omega, 0)$. To see this, note first that firm 1's profits under $(\omega, 0)$ match firm 2's profits under the limit of $(\omega, \omega+\epsilon)$ as $\epsilon > 0$ approaches 0. (This is true for any $\omega \in (\hat{W}, W^{**})$). Second, note that by the definition of ω, firm 2's profits in this limit equal firm 2's profits under $(\omega, 0)$.

To avoid open-set issues, we assume that firms choose policies from a large finite set, which includes $W_B^*, \varphi_{SH}(0), \hat{W}, \omega, W^{**}$. The set of feasible choices is fine grid.

By backwards induction, firm 1's equilibrium profits are a function of its choice ω_1. Write $g(\omega_1)$ for this function. First, it is immediate from prior analysis that if $\omega_1 < \varphi_{SH}(0)$ then

$$g(\omega_1) = \max_{\tilde{l}_1} f(\tilde{l}_1) - W(\tilde{l}_1 + \Lambda(\varphi_{SH}(0)))\tilde{l}_1.$$

The heart of the proof is to show that if $\omega_1 \in [\varphi_{SH}(0), W^{**}]$ then

$$g(\omega_1) \leq \tilde{g}(\omega_1) \equiv \max_{\tilde{l}_1} f(\tilde{l}_1) - W(\tilde{l}_1 + \min\{\Lambda(\omega_1), \lambda(\omega_1)\})\tilde{l}_1. \tag{31}$$

Inequality (31) implies the result because

$$g(\varphi_{SH}(0)) < \tilde{g}(\varphi_{SH}(0)) = \max_{\tilde{l}_1} f(\tilde{l}_1) - W(\tilde{l}_1 + \Lambda(\varphi_{SH}(0)))\tilde{l}_1,$$

and, for any $\omega_1 \in (\varphi_{SH}(0), W^{**}]$, the facts that $\Lambda(\cdot)$ is increasing, $\lambda(\cdot)$ is decreasing, and $\lambda(W^{**}) = l^{**} > \Lambda(\varphi_{SH}(0))$ imply

$$\min\{\Lambda(\omega_1), \lambda(\omega_1)\} > \Lambda(\varphi_{SH}(0))$$

and hence

$$\tilde{g}(\omega_1) < \tilde{g}(\varphi_{SH}(0)).$$

It remains to establish (31). There are three cases, of which the first two are straightforward.

1. First, if $\omega_1 \in [\varphi_{SH}(0), \hat{W})$ then firm 2 responds by picking a slightly higher ω_2 leading to firm 2 hiring (close to) $\Lambda(\omega_1)$ in equilibrium. Firm 1's profits are then bounded above by firm 1's best response to $\Lambda(\omega_1)$.

2. Second, if $\omega_1 \in [\hat{W}, \omega)$ then firm 2 responds by picking a slightly higher ω_2 leading to firm 2 hiring (close to) $\lambda(\omega_1)$ in equilibrium. Firm 1's profits are then bounded above by firm 1's best response to $\lambda(\omega_1)$. Moreover, recall that $\Lambda(\omega_1) \leq \lambda(\omega_1)$ if and only if $\omega_1 \leq \hat{W}$.

3. Third, if $\omega_1 \in [\omega, W^{**}]$ then firm 2 chooses $\omega_2 = 0$. So firm 1's profits are bounded above by profits at $\omega_1 = \omega$. Firm 1's profits at ω equal firm 1's profits under the pair of policies $(0, \omega)$. Hence if $\omega_1 \in [\omega, W^{**}]$ then

$$g(\omega_1) \leq g(\omega) = \tilde{g}(\omega) \leq \tilde{g}(\omega_1),$$

where the final inequality follows because $\lambda(\omega_1)$ is decreasing.

■

Proof of Lemma 4. The proof follows from the arguments in the proof of Proposition 3. ■

A.5 Proofs for Section 6.1

Similar to Section 5.1, we prove the results of Section 6.1 for a general $N \geq 2$. We assume firm N adopts ESG policy ω_N, while $\omega_i = 0$ for all $i < N$. We focus on subgame equilibria in which all other (non-ESG) firms make the same labor market choice. So an equilibrium is a pair (l_N, l_{-N}).

Proof of Proposition 4. Firm N's surplus is

$$f(l_N) - \mu \int_0^{l_N} W(l)\, dl - (1-\mu) \int_{(N-1)\rho(l_N)}^{l_N + (N-1)\rho(l_N)} W(l)\, dl, \tag{32}$$

where l_N is as characterized in Proposition 14. The derivative of (32) with respect to l_N is

$$\begin{aligned} & f'(l_N) - \mu W(l_N) - (1-\mu) W(l_N + (N-1)\rho(l_N)) \\ - & (1-\mu)(N-1)\rho'(l_N)\left(W(l_N + (N-1)\rho(l_N)) - W((N-1)\rho(l_N))\right) \\ \geq & f'(l_N) - W(l_N + (N-1)\rho(l_N)), \end{aligned} \tag{33}$$

where the inequality follows because ρ is decreasing.

First, consider $\omega_N \in [W_B^*, \hat{W})$. Increasing ω_N corresponds to increasing l_1. In this case, $l_N < \lambda(\omega_N)$, or equivalently, $f'(l_N) > \omega_N$; and $\omega_N = W(l_N + (N-1)\rho(l_N))$. Hence (33) is strictly positive. It follows that $\omega_N = \hat{W}$ delivers higher firm surplus than any choice in $[W_B^*, \hat{W})$.

Second, consider $\omega_N > \hat{W}$. Decreasing ω_N corresponds to increasing l_N. In this case, $l_N = \lambda(\omega_N)$, or equivalently, $f'(l_N) = \omega_N$; and $\omega_N > W(l_N + (N-1)\rho(l_N))$. Hence (33) is strictly positive. It follows that $\omega_N = \hat{W}$ delivers higher firm surplus than any choice in $\omega_N > \hat{W}$. ■

Proof of Corollary 2. Industry surplus is

$$f(l_N) + (N-1) f(\rho(l_N)) - \int_0^{l_N+(N-1)\rho(l_N)} W(l)\, dl, \tag{34}$$

where l_N is as characterized in Proposition 14. The derivative of (34) with respect to l_N is

$$\begin{aligned} & f'(l_N) - W(l_N + (N-1)\rho(l_N)) \\ + \quad & (N-1)\rho'(l_N)(f'(\rho(l_N)) - W(l_N + (N-1)\rho(l_N))). \\ < \quad & f'(l_N) - W(l_N + (N-1)\rho(l_N)), \end{aligned}$$

where the inequality follows from the monopsony distortion in non-ESG firms' hiring decisions, $f'(\rho(l_N)) > W(l_N + (N-1)\rho(l_N))$, along with the fact that ρ is decreasing.

From Proposition 4, the ESG policy that maximizes firm N's surplus is $\hat{W}$, and the associated employment level l_N is such that $f'(l_N) = \hat{W} = W(l_N + (N-1)\rho(l_N))$. Hence the derivative of (34) with respect to l_N is strictly negative at this point, implying that the ESG policy that maximizes industry surplus must induce strictly lower employment at firm N. (No ESG policy can induce strictly more employment.)

Finally, observe that for any ESG policy $\omega_N \in (W_B^*, \hat{W})$, there is an alternative ESG policy $\omega_N > \hat{W}$ that leads to the same hiring by firm N, l_N, and hence to the same hiring by other firms, $\rho(l_N)$, and the same industry surplus. ■

A.6 Proofs for Section 6.2

Proof of Lemma 5. We prove that if firm 1 (leader) chooses $\omega_1 \in [W_B^*, W^{**}]$, then firm 2's (follower) best response is $\max\{\hat{W}, \omega_1 + \varepsilon\}$ for an arbitrarily small $\varepsilon > 0$.

The surplus of firm i is given by

$$S_i(l_i, l_{-i}) = f(l_i) - \mu \int_0^{l_i} W(l)\, dl - (1-\mu) \int_{l_{-i}}^{l_i+l_{-i}} W(l)\, dl. \tag{35}$$

We divide the proof to two cases:

1. Suppose $\omega_1 \in (W_B^*, \hat{W}]$.

   (a) If $\omega_2 < \omega_1$ then based on Lemma 9, $l_1 = \Lambda(\omega_1)$, $l_2 = W^{-1}(\omega_1) - \Lambda(\omega_1)$, and the wage is ω_1. Then, firm 2 surplus is invariant to ω_2.

   (b) If $\omega_2 = \omega_1$ then based on Lemma 9, there is an equilibrium with $l_1 = \Lambda(\omega_1)$, $l_2 = W^{-1}(\omega_1) - \Lambda(\omega_1)$, the same surplus it obtains when $\omega_2 < \omega_1$. However, based on the argument in the proof of Lemma 15, firm 2 could benefit from preempting and choosing $\omega_2 = \omega_1 + \varepsilon$, where $\varepsilon > 0$ is arbitrarily small.

   (c) If $\omega_2 \in (\omega_1, \hat{W}]$ then based on Lemma 9, $l_2 = \Lambda(\omega_2)$, $l_1 = W^{-1}(\omega_2) - \Lambda(\omega_2)$, and the wage is ω_2. The surplus of firm 2 is

$$S_2(\omega_1,\omega_2) = f(\Lambda(\omega_2)) - \mu \int_0^{\Lambda(\omega_2)} W(l)\,dl - (1-\mu)\int_{W^{-1}(\omega_2)-\Lambda(\omega_2)}^{W^{-1}(\omega_2)} W(l)\,dl. \quad (36)$$

Observe

$$\begin{aligned}
\frac{\partial S_2(\omega_1,\omega_2)}{\partial \omega_2} &= \Lambda'(\omega_2) f'(\Lambda(\omega_2)) - \mu \Lambda'(\omega_2) W(\Lambda(\omega_2)) \\
&\quad - (1-\mu)\left[\begin{array}{c} (W^{-1})'(\omega_2)\,\omega_2 \\ -\left((W^{-1})'(\omega_2) - \Lambda'(\omega_2)\right) W\left(W^{-1}(\omega_2) - \Lambda(\omega_2)\right) \end{array}\right] \\
&= \Lambda'(\omega_2)\left[f'(\Lambda(\omega_2)) - \mu W(\Lambda(\omega_2)) - (1-\mu) W\left(W^{-1}(\omega_2) - \Lambda(\omega_2)\right)\right] \\
&\quad - (1-\mu)\left(W^{-1}\right)'(\omega_2)\left[\omega_2 - W\left(W^{-1}(\omega_2) - \Lambda(\omega_2)\right)\right]
\end{aligned}$$

Notice $\omega_2 - W(W^{-1}(\omega_2) - \Lambda(\omega_2)) > 0$. Also, by definition

$$\Lambda(\omega_1) + r(\Lambda(\omega_1);0) = W^{-1}(\omega_1),$$

so that

$$\Lambda'(\omega_1)\left(\frac{\partial}{\partial \tilde{l}}\left(\tilde{l} + r\left(\tilde{l};0\right)\right)\Big|_{\tilde{l}=\Lambda(\omega_1)}\right) = \left(W^{-1}\right)'(\omega_1),$$

implying (since $\frac{\partial\left(\tilde{l}+r\left(\tilde{l};0\right)\right)}{\partial \tilde{l}} \in (0,1)$)

$$\Lambda'(\omega_1) > \left(W^{-1}\right)'(\omega_1). \quad (37)$$

Combined, we have:

$$\begin{aligned}
\frac{\partial S_2(\omega_1,\omega_2)}{\partial \omega_2} &> \Lambda'(\omega_2)\left[f'(\Lambda(\omega_2)) - \mu W(\Lambda(\omega_2)) - (1-\mu) W\left(W^{-1}(\omega_2) - \Lambda(\omega_2)\right)\right] \\
&\quad - (1-\mu)\Lambda'(\omega_2)\left[\omega_2 - W\left(W^{-1}(\omega_2) - \Lambda(\omega_2)\right)\right] \\
&= \Lambda'(\omega_2)\left[f'(\Lambda(\omega_2)) - \mu W(\Lambda(\omega_2)) - (1-\mu)\omega_2\right]
\end{aligned}$$

Since $W(\Lambda(\omega_2)) < W(\Lambda(\omega_2) + l_1) = \omega_2$ and $f'(\Lambda(\omega_2)) > \omega_2$, we have $\frac{\partial S_2(\omega_1,\omega_2)}{\partial \omega_2} > 0$.

(d) Suppose $\omega_1 \in (W_B^*, \hat{W}]$ and $\omega_2 \in (\hat{W}, W^{**}]$. Then, based on Lemma 10, $l_2 = \lambda(\omega_2)$ and firm 2 pays ω_2. There are two subcases:

i. If $W^{-1}(\omega_1) - \lambda(\omega_2) \geq r(\lambda(\omega_2);0)$ then $l_1 = W^{-1}(\omega_1) - \lambda(\omega_2)$ and firm 1 pays ω_1. The surplus of firm 2 is

$$S_2(\omega_1,\omega_2) = f(\lambda(\omega_2)) - \mu \int_0^{\lambda(\omega_2)} W(l)\,dl - (1-\mu)\int_{W^{-1}(\omega_1)-\lambda(\omega_2)}^{W^{-1}(\omega_1)} W(l)\,dl,$$

and

$$\begin{aligned}\frac{\partial S_2(\omega_1,\omega_2)}{\partial\omega_2} &= \lambda'(\omega_2)\,f'(\lambda(\omega_2))-\mu\lambda'(\omega_2)\,W(\lambda(\omega_2))\\ &\quad -(1-\mu)\,\lambda'(\omega_2)\,W\left(W^{-1}(\omega_1)-\lambda(\omega_2)\right)\\ &= \lambda'(\omega_2)\left[f'(\lambda(\omega_2))-\mu W(\lambda(\omega_2))-(1-\mu)\,W\left(W^{-1}(\omega_1)-\lambda(\omega_2)\right)\right]\end{aligned}$$

which is negative given that $\lambda'(\omega_2)<0$ and $f'(\lambda(\omega_2))>\omega_2>\omega_1>\mu W(\lambda(\omega_2))+(1-\mu)\,W\left(W^{-1}(\omega_1)-\lambda(\omega_2)\right)$. Thus, in this range, $\frac{\partial S_2(\omega_1,\omega_2)}{\partial\omega_2}<0$.

ii. If $W^{-1}(\omega_1)-\lambda(\omega_2)<r(\lambda(\omega_2);0)$ then $l_1=r(\lambda(\omega_2);0)$ and firm 1 pays $W(\lambda(\omega_2)+r(\lambda(\omega_2);0))>\omega_1$.The surplus of firm 2 is

$$S_2(\omega_1,\omega_2)=f(\lambda(\omega_2))-\mu\int_0^{\lambda(\omega_2)}W(l)\,dl-(1-\mu)\int_{r(\lambda(\omega_2);0)}^{\lambda(\omega_2)+r(\lambda(\omega_2);0)}W(l)\,dl,$$

and

$$\begin{aligned}\frac{\partial S_2(\omega_1,\omega_2)}{\partial\omega_2} &= \lambda'(\omega_2)\,f'(\lambda(\omega_2))-\mu\lambda'(\omega_2)\,W(\lambda(\omega_2))\\ &\quad -(1-\mu)\left[\begin{array}{c}(\lambda(\omega_2)+r(\lambda(\omega_2);0))'\,W(\lambda(\omega_2)+r(\lambda(\omega_2);0))\\ -(r(\lambda(\omega_2);0))'\,W(r(\lambda(\omega_2);0))\end{array}\right]\\ &= \lambda'(\omega_2)\left[\begin{array}{c}f'(\lambda(\omega_2))-\mu W(\lambda(\omega_2))\\ -(1-\mu)\left[\begin{array}{c}(1+r'(\lambda(\omega_2);0))\,W(\lambda(\omega_2)+r(\lambda(\omega_2);0))\\ -r'(\lambda(\omega_2);0)\,W(r(\lambda(\omega_2);0))\end{array}\right]\end{array}\right]\end{aligned}$$

Recall $\omega_2>W(\lambda(\omega_2)+r(\lambda(\omega_2);0))$ and notice

$$\begin{aligned}\left[\begin{array}{c}(1+r'(\lambda(\omega_2);0))\,W(\lambda(\omega_2)+r(\lambda(\omega_2);0))\\ -r'(\lambda(\omega_2);0)\,W(r(\lambda(\omega_2);0))\end{array}\right] &< W(\lambda(\omega_2)+r(\lambda(\omega_2);0))\Leftrightarrow\\ W(\lambda(\omega_2)+r(\lambda(\omega_2);0)) &> W(r(\lambda(\omega_2);0))\end{aligned}$$

Thus,

$$\mu W(\lambda(\omega_2))+(1-\mu)\left[\begin{array}{c}(1+r'(\lambda(\omega_2);0))\,W(\lambda(\omega_2)+r(\lambda(\omega_2);0))\\ -r'(\lambda(\omega_2);0)\,W(r(\lambda(\omega_2);0))\end{array}\right]<\omega_2$$

and since $f'(\lambda(\omega_2))>\omega_2$, we have $\frac{\partial S_2(\omega_1,\omega_2)}{\partial\omega_2}<0$.

Overall, $\frac{\partial S_2(\omega_1,\omega_2)}{\partial\omega_2}>0$ if and only if $\omega_2<\hat{W}$, and hence, the best response of firm 2 is $\omega_2=\hat{W}$.

2. Suppose $\omega_1\in(\hat{W},W^{**}]$. If $W_2>W_1$ then, the argument in (1.d) shows that firm 2 has incentives to get as close as possible to $\hat{W}$ from above (indeed, the conditions in Lemma 10 do not require the firm with the lower ESG policy to be above or below $\hat{W}$). If

$\omega_2 < \omega_1$ then based Lemma 10 $l_1 = \lambda(\omega_1)$ and firm 1 pays ω_1. There are two subcases:

(a) If $W^{-1}(\omega_2) - \lambda(\omega_1) \geq r(\lambda(\omega_1); 0)$ then $l_2 = W^{-1}(\omega_2) - \lambda(\omega_1)$ and firm 2 pays ω_2. The surplus of firm 2 is

$$S_2(\omega_1, \omega_2) = f\left(W^{-1}(\omega_2) - \lambda(\omega_1)\right) - \mu \int_0^{W^{-1}(\omega_2) - \lambda(\omega_1)} W(l)\, dl - (1-\mu) \int_{\lambda(\omega_1)}^{W^{-1}(\omega_2)} W(l)\, dl. \tag{38}$$

and

$$\begin{aligned} \frac{\partial S_2(\omega_1, \omega_2)}{\partial \omega_2} &= \left(W^{-1}\right)'(\omega_2) f'\left(W^{-1}(\omega_2) - \lambda(\omega_1)\right) \\ &\quad - \mu \left(W^{-1}\right)'(\omega_2) W\left(W^{-1}(\omega_2) - \lambda(\omega_1)\right) - (1-\mu)\left(W^{-1}\right)'(\omega_2)\,\omega_2 \\ &= \left(W^{-1}\right)'(\omega_2) \begin{bmatrix} f'\left(W^{-1}(\omega_2) - \lambda(\omega_1)\right) \\ -\mu W\left(W^{-1}(\omega_2) - \lambda(\omega_1)\right) - (1-\mu)\,\omega_2 \end{bmatrix} \end{aligned}$$

Since $\omega_1 < W^{**}$ then $2\lambda(\omega_1) > W^{-1}(\omega_1)$. Since $\omega_1 > \omega_2$, $2\lambda(\omega_1) > W^{-1}(\omega_2) \Rightarrow W^{-1}(\omega_2) - \lambda(\omega_1) < \lambda(\omega_1)$. Since $\omega_1 > \omega_2$, $\lambda(\omega_1) < \lambda(\omega_2)$, which implies $W^{-1}(\omega_2) - \lambda(\omega_1) < \lambda(\omega_2)$. Since $f'(\lambda(\omega_2)) = \omega_2$, we have

$$f'\left(W^{-1}(\omega_2) - \lambda(\omega_1)\right) > \omega_2 > \mu W\left(W^{-1}(\omega_2) - \lambda(\omega_1)\right) + (1-\mu)\,\omega_2.$$

Therefore, $\frac{\partial S_2(\omega_1, \omega_2)}{\partial \omega_2} > 0$.

(b) If $W^{-1}(\omega_2) - \lambda(\omega_1) < r(\lambda(\omega_1); 0)$ then $l_2 = r(\lambda(\omega_1); 0)$ and firm 2 pays $W(\lambda(\omega_1) + r(\lambda(\omega_1); 0)$ The surplus of firm 2 is

$$S_2(\omega_1, \omega_2) = f(r(\lambda(\omega_1); 0)) - \mu \int_0^{r(\lambda(\omega_1);0)} W(l)\, dl - (1-\mu) \int_{\lambda(\omega_1)}^{\lambda(\omega_1) + r(\lambda(\omega_1);0)} W(l)\, dl, \tag{39}$$

which is invariant to ω_2

Overall, $\frac{\partial S_2(\omega_1, \omega_2)}{\partial \omega_2} > 0$ if and only if $\omega_2 < \omega_1 + \varepsilon$, and hence, the best response of firm 2 is $\omega_2 = \omega_1 + \varepsilon$.

■

We prove the following three auxiliary results.

Lemma 15 *Consider a game in which each firm i simultaneously chooses policy ω_i to maximize its surplus then the unique equilibrium is that both firms set $\omega_i = W^{**}$, leading to the first-best outcome.*

Proof. As a preliminary observation: If $\omega_1 = \omega_2 < W^{**}$, the firm 2's surplus is increasing in l_2 over the equilibrium set. To see this, decompose surplus into firm 2's profits and worker surplus:

$$S(l_2, l_1) = f(l_2) - \omega_2 l_2 + \left(\omega_2 l_2 - \mu \int_0^{l_2} W(l)\, dl - (1-\mu) \int_{l_1}^{l_1+l_2} W(l)\, dl \right).$$

Aggregate labor $l_1 + l_2$ is constant over the equilibrium set. Firm 2 profits $f(l_2) - \omega_2 l_2$ are increasing in l_2, as established in the proof of Lemma 16. The derivative of worker surplus with respect to l_2 is

$$\omega_2 - \mu W(l_2) - (1-\mu) W(l_1),$$

which is strictly positive since $W(l_2), W(l_1) < W(l_1 + l_2) = \omega_2$.

So $\omega_1 = \omega_2 < W^{**}$ cannot be an equilibrium, by same argument as Lemma 16.

Similarly, there is no equilibrium with $\omega_2 < W^{**}$ and $\omega_1 \in (W_B^*, \hat{W}]$ by the same argument as in Lemma 17.

Next, consider $\omega_1 \in (\hat{W}, W^{**}]$ and $\omega_2 < \omega_1$. By Lemma 10, $l_1 = \lambda(\omega_1)$ both for ω_2 and any deviation to an alternative $\omega_2 < \omega_1$. Moreover, from the analysis in the proof of Lemma 10 we know that over the range $\omega_2 < \omega_1$: $l_2 < \lambda(\omega_1) < \lambda(\omega_2)$; $r(\lambda(\omega_1); \omega_2)$ is constant in ω_2 if $W^{-1}(\omega_2) - \lambda(\omega_1) < r(\lambda(\omega_1); 0)$; is strictly increasing in ω_2 if $W^{-1}(\omega_2) - \lambda(\omega_1) \geq r(\lambda(\omega_1); 0)$, and this case arises for ω_2 sufficiently close to ω_1.

The derivative of firm 2's surplus with respect to l_2 when $l_1 = \lambda(\omega_1)$ is

$$f'(l_2) - \mu W(l_2) - (1-\mu) W(\lambda(\omega_1) + l_2).$$

If l_2 is strictly increasing in ω_2, then $W(\lambda(\omega_1) + l_2) = \omega_2$ and so $f'(l_2) > \omega_2$ since $l_2 < \lambda(\omega_2)$. So firm 2 can increase its surplus by increasing ω_2.

This same argument also implies that neither firm would deviate downwards from $\omega_1 = \omega_2 = W^{**}$. ■

Lemma 16 *If $\omega_1 = \omega_2 \in (W_B^*, W^{**})$ then at least one firm i can profitably deviate to some $\omega_i > \omega_1 = \omega_2$.*

Proof. The above results, combined with symmetry, together imply: If $\omega_1 = \omega_2 \in (W_B^*, W^{**})$ that the equilibrium set consists of all convex combinations of

$$(l_1, l_2) = \left(\min\{\lambda(\omega_1), \Lambda(\omega_1)\}, W^{-1}(\omega_1) - \min\{\lambda(\omega_1), \Lambda(\omega_1)\}\right)$$

and

$$(l_1, l_2) = \left(W^{-1}(\omega_1) - \min\{\lambda(\omega_1), \Lambda(\omega_1)\}, \min\{\lambda(\omega_1), \Lambda(\omega_1)\}\right).$$

Because $\omega_1 < W^{**}$ it follows that

$$W^{-1}(\omega_1) < W^{-1}(W^{**}) = 2\lambda(W^{**}) < 2\lambda(\omega_1),$$

and because $\omega_1 > W_B^*$, $\Lambda(\omega_1) > \Lambda(W_B^*) = l_B^*$, and so

$$W^{-1}(\omega_1) - \Lambda(\omega_1) = r(\Lambda(\omega_1); 0) < r(\Lambda(W_B^*); 0) = \Lambda(W_B^*) < \Lambda(\omega_1).$$

Hence

$$W^{-1}(\omega_1) - \min\{\lambda(\omega_1), \Lambda(\omega_1)\} < \min\{\lambda(\omega_1), \Lambda(\omega_1)\},$$

and so the equilibrium set is continuum. For all members of the equilibrium set, the equilibrium wage is ω_1. Because both firms hire strictly less than $\lambda(\omega_1)$ at any equilibrium in the interior of the equilibrium set, firm i's profits are strictly increasing in l_i.

Take any equilibrium (l_1, l_2). At least one firm i has $l_i < \min\{\lambda(\omega_1), \Lambda(\omega_1)\}$. By choosing $\omega_i \in (\omega_1, W^{**})$ this firm i ensures the labor market equilibrium has $l_i = \min\{\lambda(\omega_1), \Lambda(\omega_1)\}$, and that it pays ω_1. By choosing ω_i sufficiently close to ω_1, firm i can achieve profits arbitrarily close to that which it would receive from hiring $l_i = \min\{\lambda(\omega_1), \Lambda(\omega_1)\}$ and paying ω_1, which in turn strictly exceed its equilibrium profits. ■

Lemma 17 *Consider a game in which each firm i simultaneously chooses policy ω_i to maximize its profit. There is no pure strategy equilibrium in which firms pick different ESG policies.*

Proof. Case: $\omega_2 < \omega_1$ and $\omega_1 \in (W_B^*, \hat{W}]$: By Lemma 9, firm 2's profits are the same as the profits in the equilibrium that is least profitable for firm 2 in the equilibrium set after the deviation $\omega_2 = \omega_1$. But then firm 2 would be strictly better off by deviating to ω_2 just above ω_1, by Lemma 16.

Case: $\omega_2 < \omega_1$ and $\omega_1 \in (\hat{W}, W^{**}]$: By Lemma 10, $l_1 = \lambda(\omega_1)$ and hence firm 1's profits are $\max_{\tilde{l}_1} f(\tilde{l}_1) - \tilde{l}_1\omega_1$. Also by Lemma 10, if firm 1 deviates to $\omega_1 < \omega_1$ such that $\omega_1 > \omega_2$ and $\omega_1 > \hat{W}$ then firm 1's profits are $\max_{\tilde{l}_1} f(\tilde{l}_1) - \tilde{l}_1\omega_1$, which is a strict improvement. ■

Proof of Propositoin 5. If $\omega_1 \in [W_B^*, \hat{W})$, then based on Lemma 5, firm 2 will choose $\omega_2 = \hat{W}$. Then, based on Lemma 9, $l_2 = \Lambda(\hat{W})$, $l_1 = W^{-1}(\hat{W}) - \Lambda(\hat{W})$, and the wage is $\hat{W}$. The surplus of firm 1 is

$$S_1(\omega_1, \omega_2) = f(W^{-1}(\hat{W}) - \Lambda(\hat{W})) - \mu \int_0^{W^{-1}(\hat{W})-\Lambda(\hat{W})} W(l)\, dl - (1-\mu) \int_{\Lambda(\hat{W})}^{W^{-1}(\hat{W})} W(l)\, dl. \quad (40)$$

which is independent of ω_1.

If $\omega_1 \in [\hat{W}, W^{**})$, then based on Lemma 5, firm 2 will choose $\omega_2 = \omega_1 + \varepsilon$. We show that $S_1(\omega_1, \omega_1 + \varepsilon)$ is increasing in ω_1. Based on Lemma 10, $l_2 = \lambda(\omega_2)$ and firm 2 pays ω_2. Since $\omega_1 > \hat{W}$ then $\Lambda(\omega_1) > \lambda(\omega_1)$, and

$$r(\lambda(\omega_1); 0) + \lambda(\omega_1) < r(\Lambda(\omega_1); 0) + \Lambda(\omega_1) = W^{-1}(\omega_1).$$

Since $\omega_2 = \omega_1 + \varepsilon$, $r(\lambda(\omega_2); 0) + \lambda(\omega_2) < r(\lambda(\omega_1); 0) + \lambda(\omega_1) < W^{-1}(\omega_1)$. Therefore, $W^{-1}(\omega_1) - \lambda(\omega_2) \geq r(\lambda(\omega_2); 0)$, and according to part (a) of Lemma 5, $l_1 = W^{-1}(\omega_1) - \lambda(\omega_2)$ and firm 1 pays ω_1. Overall, the equilibrium outcome is that

$$\begin{aligned} l_1 &= W^{-1}(\omega_1) - \lambda(\omega_1) \\ l_2 &= \lambda(\omega_1), \end{aligned}$$

and both firms pay ω_1. Firm 1's surplus is

$$f\left(l_1\right)-\mu\int^{l_1}W(\tilde{l})d\tilde{l}-(1-\mu)\int_{\lambda(\omega_1)}^{W^{-1}(\omega_1)}W\left(\tilde{l}\right)d\tilde{l}.$$

The derivative with respect to ω_1 is

$$\frac{\partial l_1}{\partial\omega_1}\left(f'\left(l_1\right)-\mu W\left(l_1\right)\right)-(1-\mu)\left(W^{-1}\right)'\left(\omega_1\right)\omega_1+(1-\mu)\lambda'\left(\omega_1\right)W\left(\lambda\left(\omega_1\right)\right),$$

which in turn equals

$$\left(\left(W^{-1}\right)'\left(\omega_1\right)-\lambda'\left(\omega_1\right)\right)\left(f'\left(l_1\right)-\mu W\left(l_1\right)\right)-(1-\mu)\left(W^{-1}\right)'\left(\omega_1\right)\omega_1+(1-\mu)\lambda'\left(\omega_1\right)W\left(\lambda\left(\omega_1\right)\right),$$

i.e.,

$$\left(W^{-1}\right)'\left(\omega_1\right)\left(f'\left(l_1\right)-\mu W\left(l_1\right)-(1-\mu)\omega_1\right)-\lambda'\left(\omega_1\right)\left(f'\left(l_1\right)-\mu W\left(l_1\right)-(1-\mu)W\left(\lambda\left(\omega_1\right)\right)\right),$$

which is positive since $\lambda'\left(\omega_1\right)$ is negative (recall $l_1,l_2\leq l^{**}$ implies $f'\left(l_1\right)\geq W\left(l_1+l_2\right)$).

Since firm 1 surplus is increasing in ω_1, it will chooses W^{**} as required. ■