

The Socially Responsible Choice in a Duopolistic
Market: a dynamic model of “ethical product”
differentiation

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Abstract

The increasing attention of profit maximising corporations to corporate social responsibility (CSR) is a new stylized fact of the contemporary economic environment. In our theoretical analysis we model CSR adoption as the optimal response of a profit maximising firm to the competition of a not for profit corporate pioneer in presence of a continuum of consumers with heterogeneous preferences toward the social and environmental features of the final good. CSR adoption implies a trade-off since, on the one side, it raises production costs but, on the other side, it leads to accumulation of ethical capital. We investigate conditions under which the profit maximising firm switches from price to price and CSR competition by comparing monopoly and duopoly equilibria and their consequences on aggregate social responsibility and consumers welfare. Our findings provide a theoretical background for competition between profit maximising incumbents and not for profit entrants in markets such as fair trade, organic food, ethical banking and ethical finance.

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JEL Classification Numbers: L33; L21; L13.

1 Introduction

Corporate social responsibility (from now on, CSR) is rapidly emerging as a new relevant competitive factor in product markets. If before globalisation the interaction between profit maximising corporations and benevolent local institutions ensured the joint pursuit of economic growth and social cohesion, the global integration of product and labour markets, and the heterogeneity of social and environmental domestic rules in different productive environments generated a bottom-up reaction of concerned stakeholders asking global corporations to avoid a "race to the bottom" on social and environmental rules. In parallel, due to its emerging importance, CSR is gaining increasing attention from academic research (see among others Kitzmüller and Shimsack, 2012 and Benabou and Tirole, 2010).

CSR implies a move from the maximisation of shareholder wealth to the satisfaction of a more complex objective function in which interests of other stakeholders are taken into account¹ and it must not be confused with philanthropy, since it is becoming part of the core business strategies.²

¹The EU Commission (2001) defines CSR as a "*concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis*". According to Sacconi (2012, pag.10) "*CSR is a model of extended corporate governance whereby those who run firms (entrepreneurs, directors, managers) have responsibilities that range from fulfillment of their fiduciary duties towards the owners to fulfillment of analogous fiduciary duties towards all the firm's stakeholders*".

²"*It is not some separate activity that companies do on the side, a corner of corporate life reserved for virtue. It is just good business*" (The Economist, 19 January, 2008, p. 3, Special Report).

Since profit maximising companies are more and more adopting CSR practices there must be pecuniary benefits arising from them.

As we document in detail in this paper with reference to the existing literature (see section 2.3), CSR has the potential to generate several value increasing effects by attracting better employees, enhancing their intrinsic motivations and loyalty, reducing turnover rates, improving efficiency and reducing operating costs (Nun and Tan, 2010). In the same way CSR may improve firm reputation reducing business risk, boosting sale revenues, customer goodwill and increasing rivals' costs.

CSR also affects corporate profits because of its impact on the demand side due to the growing interest in socially responsible practices among consumers (who are firms' stakeholders, too). According to the 2003 Corporate Social Responsibility Monitor³, the Corporate perception by consumers (90 percent of respondents) is by far the most selected item (against ethical values of managers, tax incentives and relationship with stakeholders) when a sample of interviewed socially responsible companies is asked about reasons for their socially responsible behavior. The 2010 Corporate Social Responsibility Perception Survey finds that 77% of consumers say it is important for companies to be socially responsible, while in 2012 a Nielsen survey on 28,000 individuals from 56 different countries documents that 48 percent of respondents are willing to pay more for the socially and environmentally responsible features of products⁴. Even though, as we know, contingent claim survey answers tend to be upward biased,⁵ the phenomenon remains relevant and contributes to explain why CSR is becoming a new competitive dimension with many companies being accustomed to advertise and communicate not only price and quality, but also their socially responsible actions. In the year 2005, KPMG reports that 52 percent of the largest corporations published a CSR report, while, at present, more than 8,000 businesses around the world do it by signing the UN Global Compact.⁶ According to data released by Net Impact on May 2012, 65% of MBAs surveyed aim to promote sustainability to help businesses, and they want to make a social or environmental difference through their jobs. Along this path companies are devising new CSR models. In this respect many companies are launching fair trade products⁷ to tap into growing demand among consumers. For instance, since the 2005, one

³Downloadable at <http://www.bdgglobal.com/issues/sr.asp>.

⁴Downloadable from the website:

<http://www.fi.nielsen.com/site/documents/NielsenGlobalSocialResponsibilityReportMarch2012.pdf>.

⁵For the traditional contingent claim literature on survey answers' upward bias see Carson et al. (2001). The bias here is also due to the fact that in the virtual survey question there is no uncertainty, as it occurs in real life, for the ethical features of the product.

⁶The UN Global Compact engages companies in good global citizenship in the areas of human rights, labor standards and environmental protection, see: <http://business.time.com/2012/05/28/why-companies-can-no-longer-afford-to-ignore-their-social-responsibilities>.

⁷Fair trade products are food and textile products which obtain the fair trade label when their production processes follow a given set of social and environmental sustainability criteria established by the movement

of the world's biggest players in the coffee market, the US consumer good company Procter & Gamble, announced it would begin offering Fair Trade certified coffee through one of its specialty brands. Following Procter & Gamble's decision to start selling a Fair Trade coffee, also Kraft Foods, another coffee giant, committed itself to purchasing sustainable grown coffee (EFTA, 2003). It is worth noting as well that Chiquita Rainforest alliance's standard may also be seen as a response to the diffusion of fair trade bananas which now account for around 25 percent of the market in the UK and 55 percent in Switzerland.

The economy of social and environmental sustainability plays a very important role in the European Union, where it accounts for more than 10% of the total European Economy (in terms of GDP), with more than 11 millions of workers (6% of total employment). This may explain why on October 2011 the European Commission has adopted a Social Business Initiative action plan as part of a package of measures entitled the "Responsible Business Initiative" (see IP/11/1238) which will help this emerging sector to fulfill its potential. This initiative is complemented by an ambitious strategy for Corporate Social Responsibility to generate a higher level of trust and consumer confidence and improve companies' contribution to societal well-being. The aim of the Social Business Initiative is to support those social businesses whose mission is to generate significant social, environmental and community impacts for a more sustainable economic growth. When launching the initiative the EU remarked that one out four new firms in Europe are "social business".⁸

All the above mentioned findings motivate the basic hypothesis of this paper that ethical imitation is today a relevant competitive feature in product markets. Based on this point we develop a theoretical model in which we focus on some key theoretical features of CSR competition. First, we assume that the above mentioned CSR benefits, can be seen as a sort of "ethical capital", whose accumulation nevertheless implies paying additional costs. Second, we model consumers' heterogeneity toward social and environmental responsibility with a horizontal differentiation model in which geographical distance is reinterpreted as ethical distance between consumers' sensitivity and seller's engagement toward CSR.

With our work we aim to contribute to the stream of literature which considers CSR as a strategic tool to differentiate a firm's product in markets with imperfect competition. A firm achieves a competitive advantage through CSR by targeting customers with a higher willingness to pay as firms supporting CSR are seen as more reliable, trustworthy, and their products are of higher quality.

Among the earliest papers to introduce this view of CSR into the classical economic framework are Baron (2001) and McWilliams and Siegel (2002). In the first, it is assumed that consumers are willing to pay a higher price for the products sold by firms which undertake

of fair trade importers and retailers. For the related theoretical literature see, among others, Maseland and De Vaal (2002) and LeClair (2002).

⁸For more information see also http://ec.europa.eu/internal_market/smact/index_en.htm and http://ec.europa.eu/internal_market/social_business/index_en.htm.

activities to protect the environment. The firms invest in improving the environment until they reach the level at which marginal benefits equal marginal costs. McWilliams and Siegel (2002) analyse the impact of CSR on firms' interaction in the market, depending on the products' characteristics and the types of competition.

Most of the other models in literature look at the CSR as a strategic variable in a differentiation strategy, to exploit the increasing sophistication of consumers' demand (Chen, 2001; Becchetti, Giallonardo and Tessitore, 2010; Becchetti, Federico and Solferino, 2011; Manasakis, Mitrokostas and Petrakis, 2007; Evangelios and Petrakis, 2007; Kannianen and Pietarila, 2006), Toolsema, 2009, Garcia-Gallego and Georgantzis, 2009).

Along this path the aim of our paper is to provide a theoretical background for this emerging form of competition and give more specific answers to some questions related to the contagion effects of not for profit enterprises on profit maximising entrants as historically occurred in fields such as fair trade, ethical finance, organic food and ethical banking.⁹

More specifically, we focus our attention on an issue unexplored in the existing literature, that is, the relation between CSR actions and firm performance which is known to be affected by several socio-economic and organizational variables. To take into consideration the inter-relationship among these dimensions and variables, which may enrich our understanding of the strategic nature of CSR, we develop a dynamic model where alongside the traditional effects of product differentiation on profits through the price/quantity changes, a very important role is also played by the "ethical capital". This last affects in various additional ways firms' profit maximisation (as specified in the next section), when the CSR practices adopted become an important part of the firms' core business activities.

The remainder of the paper is organized as follows. In Section 2 we dedicate specific attention to motivate the effects of CSR on ethical capital accumulation by documenting in depth the existing literature and empirical evidence on the potential benefits of corporate social responsibility. Section 3 summarizes the main assumptions and features of our model. The choices of the best competitive strategy by a profit maximizing firm, under the assumption of consumers' linear and quadratic costs of buying products under their preferred standards of social responsibility, are investigated in sections 4 and 5 respectively. In these sections we compare the mixed duopoly equilibrium with the profit maximising producer monopolistic optimum, thereby evaluating the net contribution of an "ethically" concerned producer to the competitor's socially responsible behavior, consumers' welfare and aggregate social responsibility in the market. Section 6 contains some concluding remarks.

⁹In this sense our paper aims to answer to questions such as "What pushes large transnational companies such as Kraft, Nestle' or Procter & Gamble, Coca-Cola, etc. to introduce new lines of socially responsible products? Why they voluntarily reduce their profit margins to increase their costly social and environmental sustainability practices? What pushes firms to adopt CSR practices?"

2 How CSR positively affects corporate performance: the meaning of "ethical capital"

Our assumptions on the positive impact of CSR on the accumulation "ethical capital" may be supported by at least nine potential sources of CSR benefits well documented in the literature (Nun and Tan, 2010):

1. **Reputation.** Firms with higher CSR involvement have better reputation than firms with little or no involvement. Such reputation allows them to become more efficient and productive (Orlitzky et al., 2003, Fombrun and Shanley, 1990; Read, 2004) or to obtain more favourable terms of trade when negotiating with various stakeholders (Cornell and Shapiro, 1987; Bowen *et al.*, 1995; Jones, 1995). Reputation benefits are empirically documented by Minor (2010) showing on a sample of 184 events that product recalls generate significantly less negative abnormal returns (3 percent gain) for firms with higher social rating. The rationale is that recalls are more likely to be interpreted as accidents not depending on corporate negligence (and with lower consequences on future unobserved product quality). Considering the median market value of sample firms (23 billions) the net CSR gain per event is 600 million dollars.
2. **Information quality.** High CSR firms are subject to stronger informational requirements and provide more information to stakeholders. This implies that they tend to have lower informational asymmetries (Schuler and Cording, 2006) with positive effects on analysts' forecasts and reduction of risk (Becchetti and Ciciretti, 2012).
3. **Learning.** Investments in CSR help firms to develop new capabilities, resources, and competencies (Orlitzky *et al.*, 2003) which show up in the firm structure, technology, culture and human resources (Barney, 1991; Russo and Fouts, 1997; Wernerfelt, 1984). In this perspective CSR is also identified as a vehicle for innovation (Husted, 2005) and opportunity recognition (Maxfield, 2008);
4. **Attracting Better Employees.** There is some empirical support that socially responsible firms attract better employees (Backhouse *et al.*, 2002; Greening and Turban, 2000; Turban and Cable, 2003; Turban and Greening, 1996; Grahame, 2004). Frank (1996) surveys four separate case studies showing that employees were willing to accept lower compensation when working for SR employers. Edmans (2011) documents that top firms in terms of employee satisfaction in the United States earn a risk adjusted abnormal return (four-factor alpha) of 4 percent per year from 1984 to 2005, while the EU in its Social Business Enterprise initiative (see footnote 8) claims that social firms reduce by far workers' absenteeism rates.

5. **Commitment.** Freeman (1984) considers that CSR may be an optimal choice to minimize transaction costs and potential conflicts with stakeholders. Sacconi (2006a,b and 2012) discusses potential profit maximising firm inefficiencies, due to the fact that non controlling stakeholders will be ex ante discouraged from investing at an optimal level, whereas ex post they will resort to conflicting or disloyal behaviour. This is because they believe to be subject to the abuse of authority associated with governance solutions based on the mere allocation of property rights to a single party. This problem may be reduced in a model of corporate governance based on CSR, which implies a stronger individual's identification and involvement in a particular organization.¹⁰ Hence, there is a wide empirical support that CSR practices in firms will induce higher organizational commitment in employees (Backhause et al., 2002; Greening and Turban, 2000; Turban and Cable, 2003; Turban and Greening, 1996).¹¹
6. **Reduced Operating Costs.** More CSR may translate into cost savings which increase internal efficiency (Holliday *et al.*, 2002) due to the more efficient use of resources, and more efficient processes helping companies to reduce their operating costs in the long run. As well, the increased firm efficiency arising from learning on the job and higher-quality employees may lead to higher revenues and/or reduced costs.
7. **Trust and social capital.** According to Grahame (2004) a good corporate reputation reinforces trust in the company. Sacconi and Degli Antoni (2011) identify a virtuous circle between the level of social capital and the implementation of CSR practices that foster the creation of cooperative networks between the firm and all its stakeholders.
8. **CSR and Intrinsic Motivations.** An increasing strand of the literature emphasizes that workers productivity is affected not just by wages, but also by (other-regarding and self-regarding) intrinsic motivations which may in turn be enhanced by the higher consonance between corporate goals and workers' ideals generated by CSR (Agell and Lundberg, 1995; Bewley, 1995). Becchetti *et al.* (2012) find empirical evidence of an

¹⁰Conceptually, workers involvement can be characterized by at least three factors: i) a strong belief in and acceptance of the organization's goals and values; ii) a willingness to exert considerable effort; iii) "an emotional and intellectual bond with employees" (Grahame, 2004).

¹¹Empirical research also suggests that firm CSR matters to its employees (Albinger and Freeman, 2000; Backhause et al., 2002; Greening and Turban, 2000; Peterson, 2004; Turban and Greening, 1997). In line with this, Davis (1973), Hodson (2001) and McGuire et al. (1988) also argue that employees would display more "goodwill" toward an employer with greater CSR and, because of increased task motivation and organizational commitment, demonstrate greater organizational citizenship behaviors and produce better results. This may in turn lead to a reduced turnover rate since employees who are committed to their organization will have "a strong desire to maintain membership in the organization" (Mowday *et al.*, 1982).

intrinsic motivation-productivity effect, that is, highly SR firms attract intrinsically motivated workers who are more productive and are willing to accept relatively lower wages (donate part of their wages) when working for these firms.

9. **Eco-sustainable innovation.** The pursuit of environmental sustainability implies investment in energy saving and emission and waste reducing technologies. This may generate a technological leadership for CSR firms which meet consumer tastes for environmental sustainability or anticipate regulatory changes in direction of more severe environmental rules (see among others Asongu, 2007 and Jones and Maurrasse, 2003).

3 The setup of the model

In what follows we describe our theoretical framework starting from preliminary and basic assumptions (section 3.1), outlining the model structure (section 3.2).

3.1 Preliminaries and basic assumptions

Most of the hypotheses in the model which follows are standard assumptions in the product differentiation literature. A few of them are original and are introduced due to the specific nature of ethical competition¹². A profit maximizing monopolist sells a good to a continuum of consumers with inelastic, unit demands who are uniformly distributed across the line segment $[0,1]$ according to their concerns for social responsibility. The monopolist activity consists in transforming an intermediate input into a final consumption good with a production cost denoted by $w > 0$. The monopolist has two choice variables to maximize profits: the price $P_A > 0$ of her final good and her location $a \in [0, 1]$ on the ethical segment, that is, the intensity of her SR practices which translate into additional production costs but contribute to ethical capital accumulation¹³.

In this framework, we want to investigate the effects on the incumbent profit maximizing strategy of the entry of a socially concerned producer which takes a "socially responsible" position on the ethical segment and fixes a price P_B for her product. We call the latter socially responsible producer (SRP) and assume her not to be a profit maximizer since the SRP's goal is that of maximizing transfers devoted exclusively to socially responsible

¹²We use the term CSR alongside to that of "ethics", since CSR may be seen as a model of sustainable responsible business through an active compliance with the ethical standards and values shared by consumers, employees, local communities and all other members of the public sphere who may also be considered as stakeholders, on which the CSR is aimed to have a positive impact.

¹³As is well known, most CSR activities such as higher care for employees, local communities and environment are in principle cost increasing.

practices in order to increase stakeholders' welfare.¹⁴

The socially responsible features of the entrant therefore consist in selling her product at zero profit¹⁵ and transferring a "free margin" s to finance the investment required to increase stakeholders' welfare. The SRP's zero profit condition is: $P_B = w(1 + s)$, where the amount of her transfer made to implement CSR, determines her position on the segment. After the SRP's entry consumers may choose between two final goods which differ in price and socially responsible features. The qualifying difference with respect to the traditional product differentiation models is that different locations in the consumers' interval do not imply differences in physical distances, product taste or standard product quality, but in the psychological perception of the ethical value of the good¹⁶. The consideration of ethical instead of physical distance makes an important difference. Consistently with our concept of ethical distance, the cost of moving along the ethical segment is assumed to be positive only for those going from a more ethical to a less ethical point. As a consequence, consumers incur in costs proportional to the "ethical" distance anytime they move to the left¹⁷. In

¹⁴Our assumption can be easily applied to the case of fair trade. In this market segment history tells us that non-profit maximising socially responsible producers (fair trade importing organisations) entered traditional textile and food industry with the goal of improving the wellbeing of commodity producers in low income countries by transferring resources to be invested in local public goods and job training in order to improve their future market opportunities. A similar reasoning may be applied to organic food competition, microfinance and ethical banking (even though competition between CSR and non-CSR actors in banking and financial industry would require proper ad hoc modeling). Our goal is however to provide a more general case which may give insights for any new similar competitive case. For the related literature see Becchetti et al. (2010) and Becchetti and Solferino (2011)

¹⁵Our model of competition between a profit maximizing and a zero profit producer falls in the mixed duopoly literature (Cremer, Marchand and Thisse, 1991; Grilo, 1994) with the qualifying difference that our zero profit entrant is a private (and not a state-owned) producer which is concerned with stakeholders' welfare.

¹⁶In this model we abstract from considerations of asymmetric information and divergences between consumers' and sellers' perception of the ethical value of the good by assuming that they coincide. For a specific analysis of this point see Becchetti and Gianfreda (2011) and Becchetti *et al.* (2012).

¹⁷This is because when the consumer moves to the left she chooses a product below her own ethical standards (which is psychologically costly), whereas when she moves to the right, a product above her own ethical standards (and therefore we reasonably assume that the move does not bring any psychological cost to her). To justify the assumption consider that a large number of empirical findings document the existence of a nonzero share of consumers who are not willing to pay extra money for social or environmental features of the product. Descriptive evidence from the World Value Survey database, with 65,660 (15,443) individuals interviewed between 1980 and 1990 (1990 and 2000) in representative samples of 30 (7) different countries, shows that around 45 (49) percent of sample respondents are not willing to pay in excess for environmentally responsible features of a product. These consumers are either indifferent (thereby supporting our view of asymmetric costs of SR distance) or even find a disutility in buying a product above their ethical standards (i.e., they may believe that this money is wasted supporting the view of symmetric costs of distance). Even though we believe that the chosen one is the most faithful formalization of consumers' preferences on SR, the symmetry/asymmetry of distance costs may be an issue deserving further discussion. Namely, a choice of symmetric costs of ethical distance would have definitely located the model into the horizontal differentiation

order to consider a wider class of possible ethical distances, we will take into consideration powers of the above distance such as $(x - a)^\gamma$, where $\gamma > 0$.

We assume that consumers' utilities are decreasing in product price and also in the distance between consumers' ethical distance and the ethical value incorporated in the purchased product. The psychological cost of buying a product which is below one's own ethical standards is f times the ethical distance so that the welfare W_c of a consumer satisfying her unit demand is:

$$W_c = \begin{cases} R_p - P_i - f(x - a)^\gamma, & \text{if } x - a \geq 0 \\ R_p - P_i, & \text{if } x - a < 0 \end{cases},$$

where P_i is the price of the product sold by the i -th seller, R_p is the "conditional" reservation price, that is, the maximum price consumers are willing to pay in case of zero costs of ethical distance, while x indicates the generic consumer location on the ethical segment. Consider that, with the specification of the SRP's behavior and consumers' position on the segment, the cost of ethical distance has a clear monetary counterpart. For a consumer who locates at the right of the purchased product this cost represents the distance in monetary terms between the transfer which is considered fair by the consumer (indicated by her location on the segment) and the transfer chosen by the producer (indicated by producer's location on the segment). The coefficient $f \in]0, \infty[$ ¹⁸ maps this objective measure into subjective consumers' preferences indicating whether its impact on consumers' utility is proportional ($f = 1$), more than proportional ($f > 1$) or less than proportional ($f < 1$) than its amount in monetary terms. After SRP's entry the consumers' indifference condition is equal to

$$\begin{cases} P_A + f(x - a)^\gamma = P_B, & \text{if } x - a \geq 0 \\ P_A = P_B, & \text{if } x - a < 0 \end{cases}$$

field, whereas our choice of asymmetric costs of ethical distance puts our analysis in the vertical differentiation literature. Benchmark references in the horizontal product differentiation literature are Hotelling (1929), D'Aspremont, Gabsewicz and Thisse (1979), Economides (1984), Dasgupta and Maskin (1986), whereas Shaked and Sutton (1983) is the seminal paper for vertical product differentiation. In a synthesis between the two perspectives, Craemer and Thisse (1991) show that location horizontal differentiation models can be considered as special cases of vertical differentiation models.

¹⁸If we allow for the possibility of a negative f we would imply that ethical distance increases consumer's utility (the more ethically unacceptable the product to him, the happier the consumer) which does not make sense. As well, f cannot be zero otherwise there would not be ethical concern in the model. Hence, it is reasonable to introduce the assumption that f needs to be strictly positive.

Consequently, the PMP has a nonzero market share when $f(x-a)^\gamma > P_B - P_A$. In general, the market share for the incumbent reads as follows:

$$x^* = \left(\frac{P_B - P_A}{f} \right)^{\frac{1}{\gamma}} + a. \quad (1)$$

3.2 The structure of the model

We can finally outline the structure of our model relying on the above framework and on the following assumptions:

- We consider the circumstance under which the SRP chosen location is the most ethically-concerned possible. In this case the SRP locates herself at the right-hand boundary of the ethical segment ($s = 1$) under the zero profit condition. Her optimal price, which is constrained to the location s , is equal to $w(1 + s)$, that is $P_B = 2w$. Notice that, for a successful SRP's entry, we are also implicitly assuming that the consumers' reservation price is $R_p \geq 2w$.
- The PMP has two different strategic variables: the location $a \in (0, 1)$ and the price P_A . Since she is a profit maximizer, this price is supposed to exceed the marginal cost w , whereas competition in price with the new entrant located at the extreme ethical position implies that the PMP cannot establish a price higher than the SRP's price (P_B). Hence we will consider $(w, 2w]$ as the domain for P_A .
- The state variable $E(t)$ represents the evolution of ethical capital accumulation and is positively affected by the variables indicating players' location, at the same time being subject to depreciation with a decay rate $\delta > 0$. The variable enters PMP's profits increasing her payoff depending on her location.

Based on these assumptions the PMP maximizes her profit flow with respect to a and P_A :

$$\int_0^\infty e^{-\rho t} \left([P_A - w(1 + a)] \left[\left(\frac{2w - P_A}{f} \right)^{\frac{1}{\gamma}} + a \right] + \alpha E \right) dt, \quad (2)$$

where α is the multiplicative coefficient measuring the effect of $E(t)$ on total profit, which is here given by the traditional profit (depending on the firm's market share and mark-up) plus an additional part measuring the tangible/intangible benefits due to the ethical capital accumulation.

The above mentioned maximization is subject to the kinematic equation for E , starting at $t = 0$:

$$\begin{cases} \dot{E}(t) = \frac{a(t) + 1}{2} - \delta E(t) \\ E(0) = E_0 > 0 \end{cases} . \quad (3)$$

Note that in (3) the quantity $\frac{a(t) + 1}{2}$ which positively affects ethical capital accumulation is described as the arithmetic mean between the two firms' locations¹⁹. If they were both playing using their respective locations as strategic variables, its numerator would be $a + s$.²⁰

In sections 4 and 5 we will take into consideration two distinct cases leading to different definitions of PMP's market share, $\gamma = 1$, implying linear costs of ethical distance and $\gamma = 2$, implying quadratic costs of ethical distance.

4 The case with linear consumers' costs of ethical distance

In what follows we outline the optimal PMP's price and location as reaction to the SRP's entry (section 4.1) and compare it with the same choice under monopoly (section 4.2) in order to evaluate the impact of the SRP on aggregate SR and consumer welfare.

¹⁹By introducing s , which is equal to one, in equation (3) we aim to take into account all the possible direct and indirect effects of the others' CSR practices including, alongside to the competitive constraints, also positive externalities, social benefits and spillover effects. In particular we model the fact that "companies which do not engage in CSR obviously do not bear the costs of CSR. Yet they still reap the societal benefits accruing from CSR activities of others"(Pani, 2009), as the common benefits of having a positive quantity of the public good available (for CSR identified with creation of public goods see among others Bagnoli and Watts, 2003, Besley and Ghatak, 2007). Nevertheless, our results do not substantially change if we remove s from the law of accumulation of the ethical capital.

²⁰To avoid excessive complexity and without loss of generality, we do not model capital accumulation of the new entrant, i.e. the SRP. This is because we assume that the SRP starts her activity by locating at the extreme ethical position of the segment. This may be considered a reasonable approximation of the strategy of fairtrade organisations. Hence, no further ethical gains and ethical accumulation is possible at this point while all PMP's capital accumulation is explained by gains generated by her departure from its previous zero-CSR stance which prevented her from reaping the CSR gains documented in section 2. Nevertheless we take into account also the possible negative externalities from SRP's ethics to PMP's capital accumulation by interpreting the decay factor δ also as a measure of this negative SRP's contribution.

4.1 The profit maximizing producer's optimal strategy in a duopolistic market

We investigate model findings under the assumption of linear consumers' costs of ethical distance, so that the PMP's market share is given by (1) with $\gamma = 1$, i.e. $x^* = \frac{2w - P_A}{f} + a$.

As a consequence, the PMP's dynamic optimization problem amounts to:

$$\max_{a, P_A} J(a, P_A, E) = \int_0^\infty e^{-\rho t} \left[(P_A - w(1+a)) \left(\frac{2w - P_A}{f} + a \right) + \alpha E \right] dt, \quad (4)$$

subject to (3).

Searching for the open-loop information structure, we write down the current-value Hamiltonian function $H_{PMP}(\cdot)$ (omitting time arguments whenever possible to simplify the notation):

$$H_{PMP}(a, P_A, E, \lambda, t) = [P_A - w(1+a)] \left[\frac{2w - P_A}{f} + a \right] + \alpha E + \lambda \left(\frac{a+1}{2} - \delta E \right), \quad (5)$$

where $\lambda(t)$ is the current-value costate variable associated to the dynamic constraint (3). Pontryagin's maximum principle yields the following necessary conditions:

- **FOCs:**

$$\frac{\partial H_{PMP}}{\partial a} = -w \left[\frac{2w - P_A}{f} + a \right] + P_A - w(1+a) + \frac{\lambda}{2} = 0, \quad (6)$$

$$\frac{\partial H_{PMP}}{\partial P_A} = \frac{2w - P_A}{f} + a - \frac{P_A - w(1+a)}{f} = 0. \quad (7)$$

- **Costate equation:**

$$\dot{\lambda}(t) = \rho \lambda(t) - \frac{\partial H_{PMP}}{\partial E} \implies \dot{\lambda}(t) = (\rho + \delta) \lambda(t) - \alpha. \quad (8)$$

- **Transversality condition:**

$$\lim_{t \rightarrow \infty} e^{-\rho t} \lambda(t) E(t) = 0. \quad (9)$$

Sufficient conditions for an internal maximum can be verified by taking into account the Hessian matrix \mathcal{H} of the Hamiltonian function:

$$\mathcal{H}(H_{PMP}) = \begin{pmatrix} \frac{\partial^2 H_{PMP}}{\partial a^2} & \frac{\partial^2 H_{PMP}}{\partial a \partial P_A} \\ \frac{\partial^2 H_{PMP}}{\partial P_A \partial a} & \frac{\partial^2 H_{PMP}}{\partial P_A^2} \end{pmatrix} = \begin{pmatrix} -2w & \frac{w}{f} + 1 \\ \frac{w}{f} + 1 & -\frac{2}{f} \end{pmatrix},$$

whose determinant is $\det(\mathcal{H}(H_{PMP})) = -\left(\frac{w}{f} - 1\right)^2 < 0$. Hence the unique stationary point is supposed to be a saddle point, meaning that no internal maximum is admitted.

Consequently, we must take into consideration the corner solutions, separately investigating the cases in which $a(t) \equiv 0$ and $a(t) \equiv 1$. Before proceeding, we can note that in both cases $a(t) = \bar{a} \in \{0, 1\}$, therefore we can insert this condition into the Cauchy problem (3) and solve it. This leads us to directly determine the optimal state $E^*(t)$:

$$E^*(t) = \frac{\bar{a} + 1}{2\delta} + \left(E_0 - \frac{\bar{a} + 1}{2\delta}\right) e^{-\delta t}. \quad (10)$$

Proposition 1. *Under the assumption of linear costs of consumers' ethical distance, the principle of maximum ethical product differentiation holds and the optimal location and price strategies for the PMP are*

$$a^{**} = 0, \quad P_A^{**} = \frac{3w}{2}.$$

Proof. By investigating the corner solutions we find two possible cases:

- If $a = 1$, we collapse to a single strategic variable problem and the FOC with respect to a does not make sense any longer. Plugging $\bar{a} = a^* = 1$ into (7), we find that $P_A^*(t)$ is constant as well, i.e. $P_A^* = 2w + \frac{f}{2}$, which is not feasible since $f > 0$ by assumption. Hence, this solution must be ruled out.
- If $\bar{a} = a^{**} = 0$, the optimal value for P_A is $P_A^{**} = \frac{3w}{2}$, and this is the only possible choice for the PMP.

□

Remark 2. *If Proposition 1 holds, then the optimal state variable is:*

$$E^*(t) = \frac{1}{2\delta} + \left(E_0 - \frac{1}{2\delta}\right) e^{-\delta t}.$$

and the payoff function amounts to:

$$\begin{aligned} J(a^{**}, P_A^{**}, E^*(t)) &= \int_0^\infty e^{-\rho t} \left[\frac{w^2}{4f} + \alpha \left(\frac{1}{2\delta} + \left(E_0 - \frac{1}{2\delta} \right) e^{-\delta t} \right) \right] dt = \\ &= \frac{w^2}{4\rho f} + \frac{\alpha}{\rho + \delta} \left(E_0 - \frac{1}{2\delta} \right) + \frac{\alpha}{2\rho\delta} = \frac{w^2}{4\rho f} + \frac{\alpha}{\rho + \delta} E_0 + \frac{\alpha}{2\rho\delta\rho + \delta}, \end{aligned}$$

which is positive for all $E_0 > 0$.

Proposition 1 and Remark 2 seem apparently to contradict each other since the PMP chooses to compete only in prices after the SRP's entry even though her profits are increasing in ethical capital accumulation. The main rationale is that investment in ethical capital requires prices which are not competitive in presence of the zero profit entrant price competition. According to Remark 2, investing in CSR practices might in fact be convenient for the PMP for sufficiently high values of f and/or for sufficiently strong effects in terms of ethical capital accumulation measured by the parameter α . However, in a duopolistic market, the SRP competition and the constraint $P_A \leq 2w$, rule out this occurrence. In fact, positive profits with CSR adoption imply very high prices which are not feasible given the SRP's price competition and may not even be feasible in a monopolistic condition when consumers' reservation price is low. Therefore, if we assume linear costs of ethical distance, the PMP will find it optimal to keep the share of the less ethical consumers by selling them products at a price $P_A = 3w/2$, lower than P_B (generating the maximum ethical product differentiation result). In other words, since profits depend on both the market share and the mark-up, and since the effects of becoming ethical on the market share are not sufficiently large with the implied cost structure of ethical distance, the PMP concentrates strategically on maintaining a high mark-up. On the other side, by ruling out CSR, the PMP can make profits by preserving her niche of not SR consumers and at the same time she can take advantage from the positive externalities on E (such as generalized trust, environmental quality improvement, just to mention a few) created by the ethical producer, without supporting additional costs for that. Therefore the only possible PMP's best ethical location choice turns out to be $a = 0$.

4.2 The optimal choice in a monopolistic market

In this section we try to assess the impact of the SRP on the PMP's ethical stance. This can be done by comparing the latter in the duopoly after SRP's entry with the counterfactual, that is, the ethical stance that the PMP would adopt as a monopolist, by simply being aware of consumers' distribution on the ethical segment.²¹ In order to do so, we must consider a monopolistic market where the PMP can fix a price allowing her to recover CSR costs and accomplish maximum profits under the constraint of the consumers' reservation price.

In fact, if we consider the case of a monopolistic market, the state dynamics changes in that we only take into account the unique agent's ethical location affecting the ethical

²¹It may be argued that SRP's entry helps the PMP to discover consumers' ethical tastes. The history of the fair trade diffusion makes this assumption not implausible. Our model therefore illustrates the impact of SRP in a perfect information scenario and may be considered as the lower bound of the SRP's effect on PMP's ethical imitation.

accumulation, and the PMP's dynamic optimization problem amounts to:

$$\max_{a, P_A} J(a, P_A, E) = \int_0^\infty e^{-\rho t} \left[(P_A - w(1+a)) \left(\frac{R_p - P_A}{f} + a \right) + \alpha E \right] dt, \quad (11)$$

subject to

$$\begin{cases} \dot{E}(t) = a(t) - \delta E(t) \\ E(0) = E_0 > 0 \end{cases}.$$

If we assume that the monopolistic PMP is fully informed about the distribution of consumer tastes along the ethical segment, we can prove the following:

Proposition 3. *If $R_p > 2w + f$ and if $f > w$, a monopolistic PMP always chooses to locate at the upper bound of the the ethical segment $a^* = 1$, setting the price $P_A^* = \frac{R_p + 2w + f}{2}$.*

*Else, if $2w < R_p < 2w + f$ a monopolistic PMP always chooses to locate at the lower bound of the the ethical segment $a^{**} = 0$, setting the price $P_A^{**} = \frac{R_p + w}{2}$.*

Proof. Repeating the same analysis carried out in the duopolistic market, the Hessian matrix is exactly the same as in that case, confirming that no internal maximum is admitted. Hence, we must take into consideration the corner solutions and the two possible occurrences are:

$$(a^*, P_A^*) = \left(1, \frac{R_p + 2w + f}{2} \right), \quad (a^{**}, P_A^{**}) = \left(0, \frac{R_p + w}{2} \right).$$

Both solutions are feasible if $P_A < R_p$, that is, if $R_p > 2w + f$. Under this condition on consumers' reservation price, we can calculate the optimal state variable in both cases:

$$E^*(t) = \frac{1}{2\delta} (1 - (1 - 2\delta E_0) e^{-\delta t}), \quad E^{**}(t) = E_0 e^{-\delta t},$$

and subsequently the related payoffs as follows:

$$J(a^*, P_A^*, E^*(t)) = \frac{1}{\rho} \left[\frac{(R_p - 2w + f)^2}{4f} + \frac{\alpha}{2\delta} \right] - \frac{\alpha(1 - 2\delta E_0)}{2\delta(\rho + \delta)},$$

$$J(a^{**}, P_A^{**}, E^{**}(t)) = \frac{1}{\rho} \frac{(R_p - w)^2}{4f} + \frac{\alpha E_0}{\rho + \delta},$$

. Comparing the payoffs yields:

$$J(a^*, P_A^*, E^*(t)) - J(a^{**}, P_A^{**}, E^{**}(t)) = \dots = \frac{(f - w)^2}{4f\rho} + \frac{2}{f\rho} \frac{(R_p - w)(f - w)}{2} + \frac{\alpha}{2\rho(\rho + \delta)},$$

which is always positive if $f > w$. On the other hand, if $2w < R_p < 2w + f$, then P_A^* is not feasible because $P_A^* > R_p$. Hence, this solution must be ruled out. \square

The above proposition tells us that without SRP's competition the PMP has no more constraints (as she had in the duopolistic competition) to raise her price in order to accommodate ethical capital accumulation, provided that consumers' reservation price and ethical concerns are high enough. On the contrary, for low levels of consumers' reservation price, not being an ethically-concerned producer is still the best choice for a profit maximizing firm.

The comparison of this result with that in the duopoly allows us to make several interesting considerations. First, the SRP's entry in the market raises aggregate social responsibility (due to her own contribution) only when $2w < R_p < 2w + f$, that is, when consumers' reservation prices are relatively low (since in this case the PMP would not be socially responsible even if she were the monopolist in the market). Second, the SRP's entry never triggers ethical imitation (that is, it never increases the PMP's ethical stance) with linear costs of distance, while she actually reduces the PMP's ethical position when the above mentioned inequalities are reversed (high enough reservation price). In such case the SRP's entry produces market segmentation with a low-price, non-socially-responsible product and a high-price, socially-responsible product.

As a consequence, SRP's entry increases aggregate social responsibility in the market for low consumer reservation prices ($2w < R_p < 2w + f$), whereas it lowers it when the inequality is reversed and $f > w$ since in this case the ethical choice of the monopolistic PMP would produce stronger aggregate effect than the below unit market share of the SRP in the duopolistic equilibrium does.

Note as well that, in spite of these controversial effects on aggregate social responsibility, consumers' welfare is always higher after SRP's entry. In fact, from a consumer's welfare point of view, the SRP's entry reduces aggregate consumers' ethical distance vis-a-vis the monopolistic situation (the maximum ethical distance becomes $1/2$ while it was 1 under monopoly). Moreover, in terms of prices, it triggers a PMP's price reduction thereby increasing satisfaction of consumers placed at the low extreme of the segment. Hence consumers' welfare is definitely higher. More specifically, by looking at the two cases, with $2w < R_p < 2w + f$, the PMP has the same location and lower prices in the duopoly vis-à-vis the monopoly. As a consequence the entry (since $R_p > 2w$ by definition) of an additional producer with nonnegative market share makes by definition better off those consumers who switch from the PMP to the SRP. Hence consumers' welfare improves. Analogously, if $R_p > 2w + f$ and if $f > w$, under the duopoly the PMP lowers its price and moves to the left, while more ethical consumers are now served by the new SR producer located at the ethical extreme who sets lower prices than those set by the PMP monopolist located at the same extreme, the difference being given by $(R_p + f)/2$. Again consumers' welfare improves.

5 The case with quadratic consumers' costs of ethical distance

In this section we analyze the case in which the consumers' costs of buying a product behind their ethical standards increase more than proportionally as this distance increases, that is we consider (1) with $\gamma = 2$, leading to a square-quadratic expression of the market share. This implicitly means that ethical concerns are more serious than in the linear case as they grow in distance more than proportionally.

The assumption of quadratic costs allows us to analyse how our results change when consumers become more responsive to social responsibility by suffering an increasingly higher disutility with respect to the linear case for any level of ethical distance. In this respect we investigate whether shifting from a society with a low level of social responsibility concerns to one where SR norms and attitudes are more interiorized (so we can also take into account for instance the effects of society more oriented in promoting and educating towards SR) may affect the ethical companies' strategic choice in a different way. As it is shown in the analysis which follows, when the costs of ethical distance have a more than proportional negative effect on consumers' welfare, the ethical imitation becomes the most likely choice unlike in the linear case where, in a duopolistic competition, we found that PMP never chooses it.

Throughout this change the dynamic optimization problem takes the following form:

$$\max_{a, P_A} J(a, P_A, E) = \int_0^\infty e^{-\rho t} \left[(P_A - w(1 + a)) \left(\sqrt{\frac{2w - P_A}{f}} + a \right) + \alpha E \right] dt, \quad (12)$$

subject to (3).

The new problem allows us to enunciate and prove the following:

Proposition 4. *If $\frac{\alpha}{2(\rho + \delta)} < w < \frac{4}{3}f$, the problem (12) subject to (3) admits a steady state (\hat{a}, \hat{P}_A) , where $\hat{P}_A \in \left(\frac{5w}{3}, 2w\right)$ and $\hat{a} = \frac{3\hat{P}_A - 5w}{2\sqrt{f(2w - \hat{P}_A)} + w} \in (0, 1)$.*

Proof. See Appendix. □

First of all, we may notice that, for $P_A = \frac{5w}{3}$, the optimal PMP location choice is $\hat{a} = a^{**} = 0$. Therefore the price corresponding to a non SR PMP location is slightly higher than in the case with linear consumers' costs of ethical distance, where it was equal to $\frac{3w}{2}$. This may seem counter-intuitive, because when consumers' costs are quadratic social

responsibility matters more for consumers. Therefore, it might be reasonable to think that in this case the PMP would try to become more competitive with the SRP by lowering her price, and even more than in the linear case. The apparently counter-intuitive strategy is however due to the lower chance that the PMP has in attracting ethical consumers through a price reduction. If consumers' preferences are strongly ethical, the price reduction that the PMP should practice to induce them to buy her products, would be too high. Nevertheless this will probably make it not profitable at all for a profit maximizing firm to sell products. Therefore the PMP will keep on selling only to the less ethically concerned consumers and let them paying a higher price (but obviously lower than the SRP's price). That is, to recover the profit loss in terms of market share, the PMP will focus her strategy on the gains that can be achieved through a higher mark-up by offering products at a sufficiently profitable price. On the contrary, in the linear case, the PMP could more easily act on the market share and attract more ethical consumers with a price reduction. In other words, the PMP's strategy under quadratic costs of ethical distance consists in drawing the maximum surplus from the the unethical consumers, due to the fact that she cannot attract a relevant share of ethical consumers through an even profitable price reduction. The consequence is that the less ethical consumers will suffer a welfare loss with respect to the linear cost of distance benchmark.

In addition to it, Proposition 4 points out that, if the PMP jointly chooses price and ethical location after the SRP's entry, the equilibrium is characterized by partial ethical imitation when consumers' marginal costs of ethical distance are higher than producers' costs of ethical imitation, i.e. $w < \frac{4f}{3}$. This analysis also tells us that when the PMP opts for ethics she can also set a price higher than when she is located at the left-hand extreme of the segment (no SR), that is $5w/3$, provided that ethical consumers are willing to pay the extra money, but obviously less than the constraint price imposed by the presence of SRP. This will probably help the PMP to recover additional costs for ethics at a positive mark-up. Nevertheless, the condition for an internal maximum also implies that costs must be higher than benefits from ethical capital accumulation, which justifies why the PMP does not chose full ethical imitation. Therefore we are supposed to check what happens when the PMP strategies are boundary solutions. First of all we investigate a sufficient condition in order to rule out the case of internal solutions:

Proposition 5. *If the following condition holds:*

$$0 < w < \min \left\{ \frac{25f}{3}, \frac{\alpha}{2(\rho + \delta)}, f + \frac{\sqrt{4f^2(\rho + \delta)^2 + 2\alpha f(\rho + \delta)}}{2(\rho + \delta)} \right\}, \quad (13)$$

then no steady state (\tilde{a}, \tilde{P}_A) exists with $\tilde{P}_A \in \left(\frac{5w}{3}, 2w \right)$.

Proof. See Appendix. □

We have seen that under condition (13) the optimal control problem (12)–(3) admits boundary solutions, now we analyze how the PMP picks the optimal ones,

Proposition 6. *If the following condition holds*

$$0 < w < \min \left\{ \frac{25f}{3}, \frac{\alpha}{2(\rho + \delta)}, f + \frac{\sqrt{4f^2(\rho + \delta)^2 + 2\alpha f(\rho + \delta)}}{2(\rho + \delta)}, \frac{3}{2} \sqrt[3]{\frac{\alpha^2 f}{2(\rho + \delta)^2}} \right\}, \quad (14)$$

then the optimal location and price strategies for the PMP are

$$a^* = 1, \quad P_A^* = 2w.$$

Else, if

$$\frac{3}{2} \sqrt[3]{\frac{\alpha^2 f}{2(\rho + \delta)^2}} < w < \min \left\{ \frac{25f}{3}, \frac{\alpha}{2(\rho + \delta)}, f + \frac{\sqrt{4f^2(\rho + \delta)^2 + 2\alpha f(\rho + \delta)}}{2(\rho + \delta)} \right\},$$

then the optimal location and price strategies for the PMP are

$$a^{**} = 0, \quad P_A^{**} = \frac{5w}{3}.$$

Proof. It suffices to compare the two payoff functions:

$$J(a^*, P_A^*, E^*(t)) = J\left(1, 2w, \frac{1}{\delta} [1 - (1 - \delta E_0)e^{-\delta t}]\right) = \frac{\alpha}{\rho\delta} - \frac{\alpha(1 - \delta E_0)}{\delta(\rho + \delta)},$$

$$J(a^{**}, P_A^{**}, E^{**}(t)) = J\left(0, \frac{5w}{3}, \frac{1}{2\delta} [1 - (1 - 2\delta E_0)e^{-\delta t}]\right) = \frac{2w}{3\rho} \sqrt{\frac{w}{3f}} + \frac{\alpha}{2\rho\delta} - \frac{\alpha(1 - 2\delta E_0)}{2\delta(\rho + \delta)}.$$

$$J(a^*, P_A^*, E^*(t)) > J(a^{**}, P_A^{**}, E^{**}(t)) \iff \dots \iff w < \frac{3}{2} \sqrt[3]{\frac{\alpha^2 f}{2(\rho + \delta)^2}}.$$

□

Proposition 6 confirms that the optimal location shifts on the constraint $a = 1$ when the PMP may benefit also from ethical capital accumulation.²² In particular, Proposition 5 tells

²²It's worth noticing that the condition on ethical imitation, i.e. $w < 4f/3$, is the same as in the static analysis in Becchetti and Solferino (2011). Therefore in a dynamical context the additional function of the ethical capital accumulation represents another superior incentive to foster PMP's social responsibility.

us that when the cost w is sufficiently offset by at least one of the following: i) high benefits from sales to ethical consumers $\frac{25f}{3}$, ii) the ethical capital accumulation $\frac{\alpha}{2(\rho + \delta)}$, or iii)

the joint effect of both of them measured by $f + \frac{\sqrt{4f^2(\rho + \delta)^2 + 2\alpha f(\rho + \delta)}}{2(\rho + \delta)}$, the PMP's

strategies are different from a choice consisting in an interior solution and precisely the producer is led to consider what she would earn by adopting a more extreme behaviour on the constraints $a = 0$ or $a = 1$. In addition, Proposition 6 tells us that, if ethics is convenient and the earnings exceed those that would be obtained if the PMP does not adopt CSR, i.e.

$w < \frac{3}{2} \sqrt[3]{\frac{\alpha^2 f}{2(\rho + \delta)^2}}$, then the latter chooses the maximum ethical location: $a = 1$.

In other words, in this case investing in CSR is absolutely the most convenient choice for the profit maximising producer who can earn both from the consumers' ethical preferences and from the ethical capital accumulation leading that producer to fully recover costs supported for ethics concerns and benefit from all the possible advantages explained in subsection 2.3.

On the contrary, even if the individual effects of f , E , or their joint effect, are high compared to the cost w , when the increase in additional costs which are not adequately offset so that the condition $J(a^*) < J(a^{**})$ holds, for that producer it is more convenient to keep the niche along with the possible benefits from the positive externality of the ethics made by the SRP which involves higher earnings.

The fact that this is true also when $w < \min \left\{ \frac{25f}{3}, \frac{\alpha}{2(\rho + \delta)}, f + \frac{\sqrt{4f^2(\rho + \delta)^2 + 2\alpha f(\rho + \delta)}}{2(\rho + \delta)} \right\}$

is not contradictory, because high values of α and f under quadratic costs of ethical distance do not necessarily translate in an incentive to be ethical. In fact, the high value of f implies for the PMP a trade-off between the gains that can be achieved in conquering ethical consumers and the high level of consumers' ethical concerns. Stronger ethical preferences would imply greater sacrifice in terms of cost increases required to adopt CSR, so that in the end it might just be better sell only to the less ethically concerned consumers by charging them with a much higher price P_A . The same applies for α : it measures both benefits from the ethical capital accumulation that the PMP may enjoy by behaving ethically by herself, but also those coming from the positive externalities due to the ethical behaviour of her competitor. In the quadratic costs of distance framework, high values of α could also imply that the second effect prevails on the first one. Therefore to assess which one of the two trade-off effects prevails obviously it is necessary to compare the functionals $J(a^*)$ e $J(a^{**})$.

We can finally compare duopoly results with the PMP optimal choice in a monopolistic

market with a square-quadratic market share²³. By substantially repeating the same analysis but without the SRP competitor, we find that the PMP's feasible solution is $\hat{a}^* > 0$ iff $P_A \in \left(\frac{w}{3} + \frac{2Rp}{3}, Rp\right)$, while $\hat{a}^* < 1$ iff $P_A < \frac{2w}{3} + \frac{2Rp}{3}$, hence we may conclude that for $P_A \in \left(\frac{w}{3} + \frac{2Rp}{3}, Rp\right)$ a non maximal ethical differentiation is still convenient and the best choice is $a \in (0, 1)$. We may notice that in monopoly both the lower and upper boundaries of the interval for a feasible optimal price corresponding to an internal maximum, are larger than in the case with a SRP entrant. This is because without price competition, the PMP can opt for an ethical location but pushing her price to a highest level, depending only on the consumers' reservation price. In terms of ethical location this implies that it is more likely that, under less convenient parametric conditions, the PMP opts for some SR in monopoly than under the duopoly while it is as well more likely that, under more convenient parametric conditions, the PMP does not choose maximum ethical location as in the duopoly. This makes the comparison of aggregate SR between the duopoly and monopoly depending on such conditions. When they are convenient (i.e. low marginal cost of CSR, high consumer costs of ethical distance) the duopoly definitely produces more CSR since to the additional contribution of the SRP we must add a more preferable CSR stance of the PMP. On the contrary, when parametric conditions are not convenient, the effect is uncertain since the PMP ethical stance tends to be stronger under monopoly and this effect counterbalances the positive one of the SRP's entry.

In particular, if we compare

$$\begin{aligned} & J(a^*, P_A^*, E^*(t)) - J(a^{**}, P_A^{**}, E^{**}(t)) = \\ & = \frac{1}{\rho} \left((R_p - 2w) - \left(\frac{2R_p - 2w}{3} \right) \left(\sqrt{\frac{R_p - w}{3f}} \right) \right) + \frac{\alpha}{2\rho(\rho + \delta)} > 0, \end{aligned}$$

we find that the condition for having maximal ethics is stronger than in the duopoly, in the sense that it is more difficult that the PMP prefers $a = 1$. This still depends on the fact that, if the PMP wants to conquer ethical consumers under the assumption of quadratic ethical distance, she must make a lot of ethics, and this increases costs more than in the linear case. Then if the reservation price is high, for PMP could be more convenient not to support these additional costs and to earn from higher price by loyal unethical consumers.

²³More details on these results are available upon request.

6 Concluding remarks

Our theoretical model aims at providing insights for the widely observed phenomenon of the proliferation of more and more for-profit companies interested in the adoption of SR practices. To this purpose we devise a mixed horizontal differentiation duopoly in which a profit maximising incumbent reacts in price and (ethical) location to the entry of a not for profit ethical pioneer. This feature of the model closely resembles what happened in several food and textile markets where a not for profit ethical entrant (a fair trade organisation) starts competing with a traditional profit maximising producer. The model aims to investigate whether and under which conditions the profit maximising producer finds it optimal to imitate partially or in full the not for profit maximising entrant (an example can be the adoption of the rainforest alliance standards in Chiquita's plantations which very closely resemble fair trade standards). The novelty of this model with respect to the previous literature is in the definition of a function of ethical capital accumulation which takes into account in a parsimonious way the various potentially profit enhancing effects of CSR adoption. Our findings document that, if consumers' care for social responsibility does not grow enough with ethical distance (linear and non quadratic costs of ethical distance), the profit maximising producer limits herself to price competition and no CSR after the SRP's entry, so that the principle of maximum ethical product differentiation ever holds. In such case the PMP just offers her products at a discount with respect to the socially responsible producer, with the discount varying according to the consumers' costs of ethical distance.

The comparison of the duopoly and of the monopoly counterfactual in the linear case allows us to make interesting considerations about the effects of the entry of the socially responsible producer. When consumers' reservation prices are relatively low the SRP's entry definitely increases aggregate CSR in the market (even if it does not generate ethical imitation) and also produces a price undercut reaction of the PMP. The consequence is a strong product segmentation with a low-price, no-CSR product and a high-price, high-CSR product. However, when consumers' reservation prices are relatively high, the SRP's entry may reduce aggregate CSR in the market by reducing the ethical stance of the PMP. Since it is reasonable to assume that reservation prices are affected by the business cycle our findings document that the impact of CSR competition are quite dependent on it. Note as well that, in spite of the controversial effects of the SRP's entry on aggregate social responsibility, we demonstrate in the paper that consumers' welfare is always higher in the duopoly than in the monopoly due to price competition and to the lower aggregate ethical distance.

On the contrary, when consumers' concerns grow more than proportionally (quadratically and not linearly) with ethical distance, the profit maximising incumbent finds it optimal either to imitate partially the socially responsible producer or to locate herself in the same position of the SRP producer, depending on the value of consumers' costs of ethical distance and on the effects of the ethical capital accumulation. This implies that

what produces PMP's imitation is a combination of the above mentioned accumulation with quadratic consumers' concerns for ethical distance and the SRP's entry. What must be finally considered is that what documented in our model is a lower bound perfect information benchmark of the potentially contagious effects of the SRP's entry in the market since what we assume here is the absence of an ex ante PMP's information gap on consumers' ethical tastes which can be actually revealed by the same SRP's entry. A theoretical analysis which incorporates such elements and those of asymmetric information on CSR between consumers and producers, and compares its findings to those of our perfect information benchmark, is left to future research.

Appendix

6.1 Proof of Proposition 4

The current-value Hamiltonian function $H_{PMP}(\cdot)$ is given by:

$$H_{PMP}(a, P_A, E, \lambda, t) = [P_A - w(1+a)] \left[\sqrt{\frac{2w - P_A}{f}} + a \right] + \alpha E + \lambda \left(\frac{a+1}{2} - \delta E \right), \quad (15)$$

where $\lambda(t)$ is the costate variable associated to the dynamic constraint (3). In this case, the necessary conditions for maximization are the following FOCs:

$$\frac{\partial H_{PMP}}{\partial a} = -w \left[\sqrt{\frac{2w - P_A}{f}} + a \right] + P_A - w(1+a) + \frac{\lambda}{2} = 0, \quad (16)$$

$$\frac{\partial H_{PMP}}{\partial P_A} = \sqrt{\frac{2w - P_A}{f}} + a - \frac{1}{2f} \frac{P_A - w(1+a)}{\sqrt{\frac{2w - P_A}{f}}} = 0, \quad (17)$$

and the costate equation and the transversality condition are respectively

$$\dot{\lambda}(t) = \rho\lambda(t) - \frac{\partial H_{PMP}}{\partial E} \implies \dot{\lambda}(t) = (\rho + \delta)\lambda(t) - \alpha, \quad (18)$$

and

$$\lim_{t \rightarrow \infty} e^{-\rho t} \lambda(t) E(t) = 0. \quad (19)$$

Consider the condition in which λ does not appear, i.e. (17). Isolating a we obtain:

$$2f \sqrt{\frac{2w - P_A}{f}} \sqrt{\frac{2w - P_A}{f}} + 2fa \sqrt{\frac{2w - P_A}{f}} - P_A + w(1+a) = 0 \iff$$

$$\begin{aligned}
&\Leftrightarrow a \left(w + 2f \sqrt{\frac{2w - P_A}{f}} \right) = P_A - w - 2(2w - P_A) \Leftrightarrow \\
&\Leftrightarrow a^* = \frac{3P_A - 5w}{2\sqrt{f(2w - P_A)} + w}. \tag{20}
\end{aligned}$$

It is immediate to check that $a^* > 0$ if and only if $P_A \in \left(\frac{5w}{3}, 2w\right)$. In this case, we have to check whether $a^* < 1$ as well:

$$\frac{3P_A - 5w}{2\sqrt{f(2w - P_A)} + w} < 1 \Leftrightarrow P_A < \frac{1}{3} \left(6w + 2\sqrt{f(2w - P_A)} \right) = 2w + \frac{2}{3}\sqrt{f(2w - P_A)},$$

which holds because $P_A < 2w$ by assumption.

The remaining FOC takes the following form:

$$-w \left[\sqrt{\frac{2w - P_A}{f}} + \frac{3P_A - 5w}{2\sqrt{f(2w - P_A)} + w} \right] + P_A - w \left(1 + \frac{3P_A - 5w}{2\sqrt{f(2w - P_A)} + w} \right) + \frac{\lambda}{2} = 0,$$

from which we can obtain the expression for λ , depending on P_A :

$$\lambda^* = -2 \left[P_A - w - 2w \left(\frac{3P_A - 5w}{2\sqrt{f(2w - P_A)} + w} \right) - w \sqrt{\frac{2w - P_A}{f}} \right]. \tag{21}$$

Differentiating (21) with respect to time yields:

$$\begin{aligned}
\dot{\lambda} &= -2 \left[\dot{P}_A - 2w \frac{3\dot{P}_A \left(2\sqrt{f(2w - P_A)} + w \right) - (3P_A - 5w) \frac{\sqrt{f}(-\dot{P}_A)}{\sqrt{2w - P_A}}}{\left(2\sqrt{f(2w - P_A)} + w \right)^2 \sqrt{2w - P_A}} + \frac{w\dot{P}_A}{2\sqrt{f(2w - P_A)}} \right] = \\
&= -2\dot{P}_A \left[\frac{w}{2\sqrt{f(2w - P_A)}} + 1 - 2w \frac{3\sqrt{2w - P_A} \left(2\sqrt{f(2w - P_A)} + w \right) + (3P_A - 5w)\sqrt{f}}{\left(2\sqrt{f(2w - P_A)} + w \right)^2 \sqrt{2w - P_A}} \right] = \\
&= -2\dot{P}_A \left[\frac{w}{2\sqrt{f(2w - P_A)}} + 1 - 2w \frac{3w\sqrt{2w - P_A} + (7w - 3P_A)\sqrt{f}}{\left(2\sqrt{f(2w - P_A)} + w \right)^2 \sqrt{2w - P_A}} \right],
\end{aligned}$$

hence the costate equation becomes:

$$\begin{aligned} \dot{P}_A & \left[\frac{w}{2\sqrt{f(2w-P_A)}} + 1 - 2w \frac{3w\sqrt{2w-P_A} + (7w-3P_A)\sqrt{f}}{\left(2\sqrt{f(2w-P_A)} + w\right)^2 \sqrt{2w-P_A}} \right] = \\ & = (\rho + \delta) \left[P_A - w - 2w \left(\frac{3P_A - 5w}{2\sqrt{f(2w-P_A)} + w} \right) - w \sqrt{\frac{2w-P_A}{f}} \right] + \frac{\alpha}{2}, \end{aligned}$$

from which we can determine the steady state by positing $\dot{P}_A = 0$, which leads to the following equation:

$$P_A - w - 2w \left(\frac{3P_A - 5w}{2\sqrt{f(2w-P_A)} + w} \right) - w \sqrt{\frac{2w-P_A}{f}} + \frac{\alpha}{2(\rho + \delta)} = 0. \quad (22)$$

In order to solve (22), it is convenient to employ the change of variable $y = \sqrt{2w-P_A}$, meaning that $P_A = 2w - y^2$, and that, since $P_A \in \left(\frac{5w}{3}, 2w\right)$ the new variable y must belong to the interval $\left(0, \sqrt{\frac{w}{3}}\right)$ to ensure the positivity of (20).

Now we are going to prove that (22) has at least one solution belonging to $\left(0, \sqrt{\frac{w}{3}}\right)$. Let F be the following function:

$$F(y) := w - y^2 - 2w \left(\frac{w - 3y^2}{2\sqrt{f}y + w} \right) - \frac{w}{\sqrt{f}}y + \frac{\alpha}{2(\rho + \delta)}, \quad (23)$$

then

$$F(0) = -w + \frac{\alpha}{2(\rho + \delta)}$$

and

$$F\left(\sqrt{\frac{w}{3}}\right) = w \left(\frac{2}{3} - \sqrt{\frac{w}{3f}} \right) + \frac{\alpha}{2(\rho + \delta)}.$$

Hence if we impose

$$w > \frac{\alpha}{2(\rho + \delta)} \quad \text{then} \quad F(0) < 0,$$

whereas if we require

$$w < \frac{4}{3}f \quad \text{then} \quad F\left(\sqrt{\frac{w}{3}}\right) > 0.$$

Since F is a continuous function in $\left(0, \sqrt{\frac{w}{3}}\right)$, we can conclude that, if w satisfies

$$\frac{\alpha}{2(\rho + \delta)} < w < \frac{4}{3}f, \quad (24)$$

then (22) admits a solution $\widehat{y} \in \left(0, \sqrt{\frac{w}{3}}\right)$, corresponding to a price level $\widehat{P}_A \in \left(\frac{5w}{3}, 2w\right)$.

6.2 Proof of Proposition 5

Referring to Proposition 4, in order not to have internal solutions for the equation $F(y) = 0$, if we assume positivity of $F(0)$, i.e.

$$F(0) > 0 \iff w < \frac{\alpha}{2(\rho + \delta)}, \quad (25)$$

then we must impose positivity for $F\left(\sqrt{\frac{w}{3}}\right)$ as well to obtain suitable parametric conditions:

$$F\left(\sqrt{\frac{w}{3}}\right) = w\left(\frac{2}{3} - \sqrt{\frac{w}{3f}}\right) + \frac{\alpha}{2(\rho + \delta)} > w\left(\frac{2}{3} - \sqrt{\frac{w}{3f}}\right) + w = w\left(\frac{2}{3} - \sqrt{\frac{w}{3f}} + 1\right),$$

which is positive if and only if

$$\frac{5}{3} - \sqrt{\frac{w}{3f}} > 0 \iff \sqrt{\frac{w}{3f}} < \frac{5}{3} \iff \frac{w}{3f} < \frac{25}{9},$$

hence if

$$0 < w < \min\left\{\frac{25f}{3}, \frac{\alpha}{2(\rho + \delta)}\right\}, \quad (26)$$

then $F(0)$ and $F\left(\sqrt{\frac{w}{3}}\right)$ are both positive. In order to show that F cannot vanish in $\left(0, \sqrt{\frac{w}{3}}\right)$ we rewrite F as

$$F(y) = \frac{-Ay^3 + By^2 + Cy + D}{Ay + w},$$

where $A = 2\sqrt{f}$, $B = 3w$, $C = 2\sqrt{f}w + \frac{\alpha\sqrt{f}}{2(\rho + \delta)} - \frac{w^2}{\sqrt{f}}$ and $D = \frac{\alpha w}{2(\rho + \delta)} - w^2$.

If we require that $C > 0$, that is if and only if

$$0 < w < f + \frac{\sqrt{4f^2(\rho + \delta)^2 + 2\alpha f(\rho + \delta)}}{2(\rho + \delta)}, \quad (27)$$

then Descartes Theorem ensures that F can have at most one intersection point y^* with the horizontal axis, where $y^* > 0$, so the conclusion follows by imposing conditions (26) and (27) on w .

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