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Green consumption and relative preferences in an international oligopoly

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Abstract

We consider an open to trade North-South two-country model with two vertically differentiated goods and relative preferences in consumption. Differentiation is along an environmental quality dimension. Analyzing the equilibrium configuration, we find that the green firm obtains higher profits under relative preferences than in their absence, whereas a brown firm is penalized by them if trade is sufficiently liberalized. Moreover, under relative preferences in both countries, trade liberalization is beneficial for the green producer but detrimental for the brown rival. Importantly, this finding does not hold when these preferences are only present in the developing country where the brown good is produced. In this case, the process of trade liberalization can be environmentally detrimental since it can favor the brown firm in terms of profits, while penalizing the green rival.

Keywords: relative preferences; green consumption; vertical differentiation; international oligopoly; trade liberalization.

JEL Classification Numbers: D11; F18; L13.

1 Introduction

> "There is strong agreement across the EU about the ethics of environmentally-friendly products: 95% of respondents agreed that using environmentally products is 'the right thing to do', 91% agreed that buying environmentally-friendly products sets a good example and *80% agreed that their family and friends would think it was a good thing if they used environmentally-friendly products.*" Eurobarometer, 2013 (italics added by the authors).

When buying green products, people advertise their worthy attitude with respect to the environment and this attitude is more valuable, the less responsible are their peers (Frey and Meier, 2004). Accordingly, the satisfaction of consuming environmentally friendly product depends not only on the intrinsic characteristics of the good but also on its *social content*: the comparison of one's own consumption and good's environmental quality to that of others.

In this paper, we wonder how the social content of green goods can affect green consumption and provide firms with an incentive to produce environmental-friendly goods in an open economy with trade. This research question seems critical in light of the current presidential race in US with so polarized positions with respect to environmental issues, and of the much debated TTIP, Transatlantic Trade and Investment Partnership, between the US and EU.

Three considerations inspire our analysis. First of all, green consumption is at least partially driven by social norms. They are intended as a set of shared *values, behaviours and beliefs* (Dietz *et al*, 2005; Steg and de Groot,

2012) and provide a social mechanism which sanctions any deviation from this set. Due to these norms, buying green goods provides the status of "good citizen" while purchasing brown product condemns to a social stigma. In 2007, the *New York Times* cited the main reasons why Toyota Prius owners bought their hybrid cars. It emerged that the buyers had "only a basic understanding of environmental issues or the ecological benefits of HEVs (hybrid electric vehicles)" and they purchased only because "it shows the world that its owner cares"[1] (Heffner *et al* 2007, p. 409).

An approach to this view passes through relative preferences. These preferences capture the idea that consumers strive for a relative position among peers thereby relating satisfaction from their own consumption to the consumption of the others. Under relative preferences, people are willing to pay different prices for functionally equivalent goods because of the conspicuous nature of some of them[2]. "Whether it is termed "status," "prestige," or "distinction," people sometimes seek - as an end in itself - relative position....and generally gain or lose satisfaction according to how well they do compared to others" (McAdams, 1992, 3).

Second, the green content of social norms differs according to the country where people live, their income, the behavior of their community *inter alia.* As documented by Litina *et al.* (2016), environmental culture that

[1] http://www.nytimes.com/2007/07/04/business/04hybrid.html?_r=0#addendums

[2] These ideas resemble those of Veblen (1899) in his seminal contribution "Theory of the Leisure Class", where conspicuous consumption is the means by which consumers affirm, promote and maintain their social status in the modern consumer society. Later Duesenderry (1949) exploits economic modelling to formalize the social content within the maximizing behavior in consumption choices and economic activities.

determines social norms is country-specific and it is furthermore intergeneretionally transmitted from parents to children. Authors argue that environmental attitudes, as the willingness to pay for environment, are a product of economic and environmental conditions in the country of residence but are also a product of cultural orientations. Additionally, individual perceptions about the causes of pollution seem quite different among people living in developing and developed countries as reported by The Health of the Planet Survey (Dunlap and Metig, 1995). People living in developed countries show much more awareness about the role of their individual green versus brown consumption on pollution in the country of residence. Hence, the responsibility with respect to the environment is more likely to be widespread, the richer is the country where people live and/or the higher their income level: feeling responsible w.r.t. environment belongs to a set of values arising after essential needs have been satisfied.

The aftermath of this literature is that people in developing countries have been doomed to be less involved so far in green issues than citizens in developed countries. In the latter, political and economic institutions have been traditionally concerned with environmental protection and there is still a hot debate among politicians about the rules to reduce gas emissions. Further, pollution damage deriving from unresponsible private behaviors gets always good press and often green consumption is subsidized. Rather, in the former countries, for a long time political institutions refused to be involved in international agreements for reducing the environmental damage and accepted pollution as a *natural* price of a fast economic growth. Informative campaigns failed to clarify the urgency of the environmental issue, and media

did not sensibilize people to a green behaviour. As a result, the problem of pollution is extremely severe in these areas and it is currently the unavoidable challenge for public authorities[3].

Third consideration, it is not clear whether this social content of green consumption will spread worldwide. At least two key drivers will affect it: *(i)* the willingness of policy makers to empower the social content of green goods, *(ii)* the process of trade liberalization among countries that makes available globally green and brown products. As far as driver *(i)*, since 2009 Obama has shown a constructive interest on climate change and environmental issues[4]. In China a green attitude is only recently emerging: in a 2011 editorial, environment Minister Zhou Shengxian said the "depletion, deterioration, and exhaustion of resources and the worsening ecological en-

[3] To give an idea of the matter, 16 of the world's 20 most polluted cities are in China and rising pollution in the developing world is ranked as the sixth most significant global trend this year – and in Asia it's the third. China became the largest greenhouse gas emitter in 2005 and remains in this position, followed by the United States and the European Union, according to the World Resources Institute. Brazil and India are the fifth and the eighth biggest.

[4] Cornerstones of the inclusive environmental policy pursued by Obama were government incentives for electric vehicles, for supporting R&D in sustainable technologies and for communities investing in electric vehicles infrastructure. Since U.S. are a consumer-driven economy, efforts were made also to ensure and protect american consumers while imposing higher efficiency standards for energy consumption (e.g. the so called "Lightbulb law" which increased efficiency standards ensuring monetary savings on energy consumption for american consumers. The light bulb law of Obama administration was strongly defeated by Republicans and in 2011 they proposed and unsuccessfully voted a bill to withdraw that more stringent standards. (http://www.nytimes.com/2011/07/13/business/energy-environment/republicans-fail-to-annul-new-light-bulb-law.html)

vironment have become bottlenecks and grave impediments to the nation's economic and social development" and in September 2016 the Chinese President Xi Jinping the Paris Agreement and Xi committed to cooperate with Barack Obama on two other global environmental agreements this year — an amendment to the Montreal Protocol to phase down air-conditioning refrigerants and on a market-based measure to reduce carbon emissions from aviation. Nevertheless, in recent years, Donald Trump stated on Twitter that "the concept of global warming was created by and for the Chinese in order to make U.S. manufacturing non-competitive" and rejected the position taken by scientists about man-made global warming, saying that climate change is a "total hoax". Further, in May 2016, in one of his speeches and in contrast with the position taken by Hillary Clinton on environmental issues, he said to be willing to cancel the Paris climate agreement. Since the set of values embodied by social norms is dramatically affected by politicians and media, in US consumers' involvement in environmental protection is mainly depending on the presidential race[5].

As far as driver *(ii)*, liberalizing trade enables firms to export at relatively lower costs, thereby making available worldwide goods, regardless of the place where they are produced. Due to trade liberalization, consumers get familiar with green and brown good, that they would not know in absence of trade. When interiorizing social norms, they may express relative preferences with respect to these goods. Typically, the more liberalized the

[5]It is worth remarking that since the Paris agreement needs to be ratified by 55 countries, representing 55% of global emissions, in order to come into effect, the role of US turns out to be crucial even for this.

trade, the lower the equilibrium prices and the larger the quantities of traded goods[6]. Nonetheless, if green goods are viewed as a means to get a socially worthy position whereas brown consumption becomes a blameworthy practice, the reduction in prices of green goods, which could be induced by trade liberalization, can be dampened. This in turn can have an impact on the traded quantity of goods. The empirical literature testifying that high quality goods (in our analysis, this is the green good) do have a higher price even in presence of trade and trade policy (Baldwin and Harrigan, 2011, Fajgebaum *et al*, 2011) abounds.

The basic framework

The model developed hereafter combines in a unified frame the above ingredients. It analyses the effects of relative preferences on the equilibrium configuration of an international oligopoly consisting of two (sets of) countries: developing and developed countries. The former produces a dirty good while the latter specialize in the production of a clean good[7]. Each firm exports its product thereby facing an iceberg cost which is lower, the more liberalized is trade. Introducing this cost in the model enables to consider how the profitability to produce green versus brown goods changes with the process of trade liberalization.

[6] A good survey of the industrial organisation models nested with international trade is Krugman (1989).

[7] This assumption is in line with the traditional view of a North-South model of production where dirty productions are relegated in less developed countries, the green ones being rather in the more advanced groups of nations (in trade models for instance in Fajgebaum et al, 2011).

When defining consumption behaviour in a country, we do not depart from the well-known concept of *homo economicus*, a rational and self-interested agent who traditionally maximizes his/her utility. Rather, borrowing from the literature on relative preferences, we reconcile the traditional approach with the idea that human beings are (at least partially) affected by social interaction and driven in their behaviour by some precise group norms whose content is affected by several factors such as education, income and political institutions of a country. Accordingly, we assume that goods are valued along two dimensions: intrinsic quality and social component. The former, in line with the traditional model of vertical differentiation *à la* Mussa and Rosen, is such that the absolute quality of a variant determines its utility. So, the green good is the high quality variant along the *quality ladder* since it dominates the competing and low-quality alternative from an environmental viewpoint. The latter, inspired to the approach of relative preferences, induces consumers to value a variant depending on its relative environmental quality, namely the quality gap between the variant itself and the alternative one. The quality gap between variants determines the social satisfaction obtained by each good and thus fixes its place along a *social ladder*.

Under the assumption of country-specific relative preferences, we characterize the equilibrium configuration of the oligopoly and study how it would change with trade liberalization.

In order to incorporate the above considerations we consider different scenarios. After presenting the model (Section 2), we provide the description of the setup without relative preferences (Section 3); then, we characterize in Section 4 a scenario where consumers in both developed and developing

countries display relative preferences. Inhere, we advance the hypothesis that under Hillary Clinton' s administration consumers in US would be strongly concerned with environmental issues thereby attributing to green goods some social content. Along the same rationale, China will keep its commitment to reduce pollution and sensibilize people to responsible behavior so that green consumption will become a conspicuous practice.

Then, in Section 5 we assume that relative preferences emerge only in one country. In particular, we consider first the case when green awareness is widespread among consumers living in developing countries while being absent in developed areas (Section 5.1). In this scenario, we contrast the green pattern undertaken by Chinese Government and the possible consumers' attitude in US under Trump administration. On this, it is worth remarking that in US not only the candidates' viewpoint on environmental issues are poles apart but also the voters' opinion on climate change. Back in 2008, surveys highlighted how democrats and republicans voters had different perception with respect on environmental issues. For questions on the effect of global warming, the exacerbated views of media or the human responsibility on climate change, democrats and republicans gap was quite wide and it will certainly increase if Trump will be the new President of US. Finally, in Section 5.2 we assume consumers in developed countries display relative preferences for environmental quality thereby getting from green goods a social and psychological benefit behind the needs they can satisfy. These relative preferences do not emerge in the developing counterparts. This scenario captures the current political agenda of Barack Obama in US as counterposed to the weak China's commitment to green issues. These political trends are

leading consumers in US to interiorize some environmental norms and those in China to attribute to green goods no social content.

Our main results concern the effect of trade liberalization on good prices and on pollution. The presence of relative preferences in both countries is beneficial for the green firm and this benefit can be boosted by trade liberalization. Importantly, these findings cannot be extended to the case when relative preferences are relegated to the less advanced country where the brown good is produced. In this case, the process of trade liberalization can be environmentally detrimental since it can favor the brown firm in terms of profits, while penalizing the green rival who faces lower price and quantity. This result emerges when citizens in the developed economies do not attribute a social content to green consumption.

Our analysis complements the recent theoretical literature on social norms and pro-environmental behavior (see e.g., Stern, 2000; Brekke *et al.*, 2003) thereby contributing to the debate on the impact of environmentally friendly behavior on market equilibrium (Conrad, 2005; Eriksson, 2004; Garcia-Gallego and Georgantzs, 2009; Moraga-Gonzalez and Padron-Fumero, 2002; Nyborg *et al.*, 2006; Rodriguez-Ibeas 2007). More specifically, we extend this literature and consider the effects of *social norms* on environment in an *open economy* when *trade is liberalized.* Our modeling framework is directly inspired by Ben Elhadj and Tarola (2015) where the social component of consumption is formalized by relative preferences and introduced in a model of vertical differentiation. Nesting their analysis in an international oligopoly has many and fruitful implications. First, it enables to characterize the equilibrium configuration of an open economy depending on the differences between trading

countries (i.e. income and sociocultural development). Further, it allows to consider how this configuration change with trade liberalization.

2 The Model

Consider a North-South two-country model with two vertically differentiated goods along an environmental quality dimension. Each country is populated by a single firm. We label Green and Brown each country and the corresponding firm within the country. The Green (resp. Brown) firm produces the high (resp. low) environmental variant q_G (resp. q_B)[8]. The range of quality is in the interval $\left[\bar{q}, \underline{q}\right]$ where $\bar{q}$ is the highest quality level which are technologically feasible and $\underline{q} > 0$ is the lowest one. Each firm can serve both countries. When serving the foreign market, it incurs iceberg trade costs τ, $1 \geq \tau \geq 0$. Trade costs are related not only to the geographical distance between countries but also and mainly to cultural barriers, tariffs and administrative costs. This distance determines a gap between the quantity produced to serve the foreign market and the one actually arrived at destination. More specifically, from the firms viewpoint, this distance creates a

[8] In our analysis, like in Rodriguez-Ibeas (2007) and Andre et al. (2009), the meaning of the variable q_i, $i = G, B$ is in line with the traditional approach in vertical differentiation as in Mussa and Rosen (1978) and Gabszewicz and Thisse (1979). In other models, it is related to the abatement effort of firms affecting the emission intensity of goods. Typically, the lower the emission intensity per unit of production, the higher the environmental quality of the product. See, for example, Moraga-Gonzalez and Padro-Fumero (2002) and Lombardini-Riipinen (2005). In a further strand of literature, different levels of social responsibility of producers determine vertical differentiation between products (see, e.g., Garcia-Gallego and Georgantzıs, 2009).

gap between the quantity produced to serve the foreign market and the one generating profits. When τ is closer to 1, trade costs are relatively low and the quantity produced to serve the foreign market is similar to the one determining profits. When τ is close to 0, then trade barriers erode a significant amount of quantity targeted to the foreign market with a negative effect on profits, *ceteris paribus*.

As for the demand side, in each country, consumers are characterized by their willingness to pay for environmental quality indexed by θ, uniformly distributed in the interval $[0, \Theta_i]$ $i = G, B$, with density $1/\Theta_i$ and $\Theta_G > \Theta_B$[9]. Each consumer is assumed to buy at most one unit of the good.

3 The baseline scenario: absence of relative preferences

In this section, we define a baseline scenario where consumers display the same preferences with respect to variants, so that their indirect utility function $U(\theta)$ writes as

$$U_j(\theta) = \begin{cases} \theta q_G - p_G & \text{if she buys G} \\ \theta q_B - p_B & \text{if she buys B} \\ 0 & \text{otherwise} \end{cases} .$$

[9] Since the lowest willingness to pay in each country is 0, changing the highest willingness to pay, namely highest level of income, also determines a change in the average income of the country.

Thus, demand function of each firm can be written as follows

$$x_G(p_G, p_B) = \tau(\Theta_B - \frac{p_G - p_B}{q_G - q_B}) + \left(\Theta_G - \frac{p_G - p_B}{q_G - q_B}\right)$$
$$x_B(p_G, p_B) = \frac{p_G - p_B}{q_G - q_B} - \frac{p_B}{q_B} + \tau(\frac{p_G - p_B}{q_G - q_B} - \frac{p_B}{q_B})$$

In this setting, the maximization of the profits of the firms given simply by $p_i x_i(p_i, p_j)$, $i, j = B, G$, $i \neq j$, yield the candidate equilibrium prices

$$p_G^* = (q_G - q_B)\,\frac{(\Theta_G + \Theta_B\tau)2q_G}{(4q_G - q_B)(\tau+1)}$$
$$p_B^* = (q_G - q_B)\,\frac{(\Theta_G + \Theta_B\tau)q_B}{(4q_G - q_B)(\tau+1)}\ .$$

The corresponding demands at equilibrium write as

$$x_G^* = \frac{(\Theta_G + \Theta_B\tau)2q_G}{4q_G - q_B} \text{ and } x_B^* = q_G\frac{(\Theta_G + \Theta_B\tau)}{(4q_G - q_B)}.$$

In this framework the typical effects of trade on the equilibrium configuration emerge so that the equilibrium prices of the variants decrease and the corresponding demands raise as the trade gets more and more liberalized.

4 Relative preferences in both countries

We assume in this section that consumers in both countries, namely the developed and developing one, display relative preferences. Accordingly, they benefit from a social/psychological premium if they buy the higher quality variant or suffer a penalty if they buy the dirty product. We characterize the equilibrium configuration and consider the effect of trade liberalization on it.

Formally, the indirect utility function in country i, with $i = G, B$ writes

as follows:

$$U_i(\theta) = \begin{cases} \theta q_G - p_G + \gamma_i(q_G - q_B) & \text{if she buys G} \\ 0 & \text{otherwise} \end{cases}$$

and

$$U_i(\theta) = \begin{cases} \theta q_B - p_B - \gamma_i(q_G - q_B) & \text{if she buys B} \\ 0 & \text{otherwise.} \end{cases}$$

In the above formulation, we add to the traditional utility function a social driver $\gamma_i(q_G - q_B)$ capturing the existence of relative preferences. This term defines the social benefit (or the social punishment) which is obtained (or suffered) by the consumer when purchasing the green (or the brown) variant of the good. *Ceteris paribus*, this social component increases with the gap between environmental qualities: the higher the environmental quality of the green variant with respect to the dirty product, the stronger the social rewards or the fiercer the social punishment for the consumers[10]. The intensity of the relative preferences is given by the parameter γ_i. It is assumed $\gamma_G > \gamma_B$ and thus in the more developed country, namely country G, social drivers attached to the environmental quality are more significant than those in the less developed country, namely country B. This is in line with the idea that green norms are interiorized after the basic needs have been satisfied[11]. Thus, the indifferent consumer between buying the green variant and the

[10]Interestingly, the introduction of these relative preferences determines a correspondence between the relative position of a variant along a quality ladder (namely its quality compared with the quality made available by the competing firm) and the relative position (a social status) of the consumer buying that variant along a social ladder.

[11]See on this Ben-Elhadj and Tarola (2014).

brown one in country G and country B, $\bar{\theta}_G$ and $\bar{\theta}_B$, respectively write as

$$\bar{\theta}_G(p_G, p_B) = \frac{p_G - p_B - 2\gamma_G(q_G - q_B)}{q_G - q_B}$$
$$\bar{\theta}_B(p_G, p_B) = \frac{p_G - p_B - 2\gamma_B(q_G - q_B)}{q_G - q_B},$$

while the indifferent consumer between buying the low quality variant and not buying at all, namely $\tilde{\theta}_G, \tilde{\theta}_B$ in country G and country B, write as

$$\tilde{\theta}_G(p_B) = \frac{p_B + \gamma_G(q_G - q_B)}{q_B} \text{ and } \tilde{\theta}_B(p_B) = \frac{p_B + \gamma_B(q_G - q_B)}{q_B} .$$

Finally $\hat{\theta}_G(p_G) = \dfrac{p_G - \gamma_G(q_G - q_B)}{q_G}$ and $\hat{\theta}_B(p_G) = \dfrac{p_G - \gamma_B(q_G - q_B)}{q_G}$, with $\hat{\theta}_i(p_G) > 0$, iff $p_G > \gamma_G(q_G - q_B)$ represent the indifferent consumer between buying the high quality green variant and not buying at all in country G and country B, respectively. In this framework, the demand functions faced by firms G and B write, respectively, as:

$$x_G(p_G, p_B) = \tau(\Theta_B - K) + \Theta_G - k$$
$$x_B(p_G, p_B) = K - \frac{p_B + \gamma_B (q_G - q_B)}{q_B} + \tau(k - \frac{p_B + \gamma_G (q_G - q_B)}{q_B})$$

where $K = \dfrac{p_G - p_B - 2\gamma_B (q_G - q_B)}{(q_G - q_B)}$ and $k = \dfrac{p_G - p_B - 2\gamma_G (q_G - q_B)}{(q_G - q_B)}$.
Given the profit function $\pi_i(p_i, p_j) = p_i x_i(p_i, p_j)$, $i, j = B, G$, $i \neq j$, the pair of equilibrium prices is easily found

$$p_G^{**} = \frac{(q_G - q_B)((2\Theta_G + 4\gamma_G + 2\tau\Theta_B + 4\tau\gamma_B)q_G - (\gamma_B + \tau\gamma_G)(q_G + q_B))}{(4q_G - q_B)(\tau + 1)}$$
$$p_B^{**} = \frac{(q_G - q_B)((\Theta_G + 2\gamma_G + \tau\Theta_B + 2\tau\gamma_B)q_B - (q_G + q_B)(2\tau\gamma_G + 2\gamma_B))}{(4q_G - q_B)(\tau + 1)}.$$

The corresponding demands at equilibrium are then

$$x_G^{**} = \frac{(2\Theta_G + 4\gamma_G + 2\tau\Theta_B + 4\tau\gamma_B)q_G - (\gamma_B + \tau\gamma_G)(q_G + q_B)}{4q_G - q_B}$$
$$x_B^{**} = q_G \frac{((\Theta_G + 2\gamma_G + \tau\Theta_B + 2\tau\gamma_B)q_B - (q_G + q_B)(2\tau\gamma_G + 2\gamma_B))}{q_B(4q_G - q_B)}.$$

Notice that $p_G^{**} > 0$ and $x_G^{**} > 0$ always hold whereas p_B^{**} and x_B^{**} are strictly positive iff $\Theta_B \geq \check{\Theta}_B = \frac{(2\gamma_B+2\tau\gamma_G)(q_B+q_G)-q_B(\Theta_G+2\gamma_G+2\tau\gamma_B)}{\tau q_B}$. Since the social penalty reduces the price of the brown good, for its price to be positive, the average income of the less advanced country has to be sufficiently high.

Denoting by $\breve{\tau} = \frac{\gamma_B q_B+\gamma_B q_G-\gamma_G q_B}{\gamma_B q_B-\gamma_G q_B-\gamma_G q_G}$, we observe that

Proposition 1 *Under relative preference, whatever the level of trade liberalization, the equilibrium price and quantity of the green variant are higher than those in the baseline scenario. On the contrary, when the international trade is sufficiently liberalized ($\tau > \breve{\tau}$), the equilibrium price and the corresponding quantity of the brown good are lower than those in absence of relative preferences.*

Proof. *From direct comparison of the expressions.* ■

In the case when $\tau > \breve{\tau}$, our finding on the equilibrium price of the brown variant is in line with that emerging in Ben-Elhadj and Tarola (2014) where firms produce and sell in their home market and exports are not contemplated. Indeed, when trade liberalization is very significant, it is as if the two areas would collapse to a single market. In this circumstance, one can isolate two drivers of equilibrium prices: a *price competition driver* and a *social driver.* The former driver, which is typically observed in a vertically differentiated, is such that the larger the quality gap between variants, the less fierce the price competition in the market and thus the higher the equilibrium prices. The latter is rather linked to the social component of consumption so that the social benefit of buying green raises the equilibrium price of the green variant like so the social punishment reduces the equilibrium price of the competing and dirty product. Notice that

Remark $\breve{\tau} < 0 \Leftrightarrow q_G > \breve{q}_G$ with $\breve{q}_G = \frac{1}{\gamma_B}(\gamma_G q_B - \gamma_B q_B)$

Thus, the condition $\tau > \breve{\tau}$ is always met when $\breve{\tau} < 0$, namely when the green variant has a very high environmental quality ($q_G > \breve{q}_G$). In this case, the price competition driver moves upward the price of the brown good, while the social driver emphasizes the social frustration of buying the brown good thereby reducing its corresponding price. This latter force prevails over the former so that the equilibrium price of the brown product under relative preferences is lower than in the baseline scenario.

We investigate now the role of trade liberalization on the equilibrium configuration.

Let us denote $\bar{\gamma}_G = \frac{(2\Theta_B q_G + 4\gamma_B q_G)}{q_B + q_G}$ and $\gamma_G^{'} = \frac{(\Theta_B q_B + 2\gamma_B q_B)}{2q_B + 2q_G}$, with $\gamma_G^{'} < \bar{\gamma}_G$. Then,

Proposition 2 *Trade liberalization*

(i) increases the quantity sold by each firm iff the social driver of consumption is weak ($\gamma_G < \gamma_G^{'}$). It increases the quantity sold by firm G while it reduces the quantity of firm B iff the social component is moderate ($\gamma_G^{'} < \gamma_G < \bar{\gamma}_G$). Finally, it decreases the quantity sold by each firm iff this component is strong ($\gamma_G > \bar{\gamma}_G$);

(ii) reduces both equilibrium prices.

Proof. As far as the effect of trade liberalization on equilibrium quantity, from standard computations we find that

$$\frac{\partial x_G^{**}}{\partial \tau} = \frac{2\Theta_B q_G + 4\gamma_B q_G - \gamma_G q_G - \gamma_G q_B}{4q_G - q_B} \gtreqless 0 \Leftrightarrow_B \gamma_G \lesseqgtr \bar{\gamma}_G \equiv \frac{(2\Theta_B q_G + 4\gamma_B q_G)}{q_B + q_G}$$

$$\frac{\partial x_B^{**}}{\partial \tau} = q_G \frac{\Theta_B q_B + 2\gamma_B q_B - 2\gamma_G q_G - 2\gamma_G q_B}{q_B(4q_G - q_B)} \gtreqless 0 \Leftrightarrow \gamma_G \lesseqgtr \gamma_G^{'} \equiv \frac{(\Theta_B q_B + 2\gamma_B q_B)}{2q_B + 2q_G}$$

Proving the effect on price is straightforward. **Q.E.D.** ■

This finding sounds surprising: trade liberalization can reduce the equilibrium quantities while decreasing their price. In particular, this effect emerges when the intensity of social preferences in country G is relevant.

Traditionally liberalizing the trade determines a reduction of the equilibrium prices with a corresponding increase of the traded quantity.

The rationale for our result can be captured as follows. Due to trade liberalization, the equilibrium price of both variants decreases. Since the social component in country G driven by $\gamma_G(q_G - q_B)$ is very significant, the price of the green variant decreases proportionally less than the price of the brown good. This reduction in prices has a cross-effect: the quantity of the variant i reduces as a consequence of the price reduction of the competing variant j. Still, the reduction of x_B^{**} is less significant than that of x_G^{**}: the high intensity of the social component γ_G in country G magnifies the benefit (resp. punishment) of buying the green (resp. dirty) good thereby restraining the reduction of its price p_G^{**} while increasing that of the corresponding demand.

Of course, the less relevant this social component (namely the lower γ_G), the less significant the gap in price reductions and thus the lower the reduction in the demand of the green good. In line with this, one can observe that there exists a value of γ_G under which x_G^{**} ceases to decrease: since the reduction of its equilibrium price is not dampened by the social component γ_G, it turns out to be so attractive with respect to the competing good that its demand does not decrease. Finally, for an extremely low value of γ_G, the social component of consumption ceases to be significant and the traditional effects of trade liberalization with reduction in prices and increases in demand are observed.

Interestingly, $\bar{\gamma}_G$ increases with q_G while $\gamma_G^{'}$ decreases with q_G. Accordingly, the higher the value of q_G, the larger the set of parameters such that $\gamma_G^{'} < \gamma_B < \bar{\gamma}_G$ holds. So, a product innovation increasing the environmental quality of the green good makes the green firm better off, while making worse off the brown rival, *ceteris paribus*.

5 Relative preferences in one country

We assume now that relative preferences are in only one of two countries. First, we consider the scenario where consumers in developing country have relative preferences, those in more advanced country having the traditional utility function. Then, we move to the case in which consumers' preferences and firms production are aligned: the green (resp. brown) firm is located where consumers displays more (resp. less) sensitivity for the environment. In both these scenarios the role of trade cost is crucial.

5.1 Relative preferences in country B

In this scenario, we assume that relative preferences emerge in the less developed country B where the more pollutant production activity of the brown firm is located. The pair of equilibrium prices $\check{p}_i$, $i = G, B$ writes as

$$\check{p}_G = (q_G - q_B)\,\frac{(\Theta_G+\Theta_B\tau+2\tau\gamma_B)2q_G-\gamma_B(q_G+q_B)}{(4q_G-q_B)(\tau+1)}$$
$$\check{p}_B = (q_G - q_B)\,\frac{(\Theta_G+\Theta_B\tau+2\tau\gamma_B)q_B-2\gamma_B(q_G+q_B)}{(4q_G-q_B)(\tau+1)}$$

with the corresponding demand at equilibrium being:

$$\check{x}_G = \frac{(\Theta_G+\Theta_B\tau+2\tau\gamma_B)2q_G-\gamma_B(q_G+q_B)}{4q_G-q_B}$$
$$\check{x}_B = q_G\frac{(\Theta_G+\Theta_B\tau+2\tau\gamma_B)q_B-2\gamma_B(q_G+q_B)}{q_B(4q_G-q_B)}.$$

The candidate equilibrium price $\check{p}_B$ is positive iff

$$\Theta_G > \bar{\Theta} \text{ with } \bar{\Theta} = \frac{2\gamma_B(q_G+q_B)-2\tau\gamma_B q_B}{q_B} - \Theta_B\tau.$$

Since $\bar{\Theta} > \breve{\Theta}$, then $\check{p}_B > 0 \Leftrightarrow \check{p}_G > 0$. The price of the green variant $\check{p}_G$ is positive iff the more advanced country has a sufficiently high average income, namely $\Theta_G > \breve{\Theta}$ where $\breve{\Theta} = \frac{\gamma_B(q_B+q_G)-4\tau\gamma_B q_G}{2q_G} - \Theta_B\tau$ with $\breve{\Theta} \geq 0$ for $\Theta_B \leq \frac{1}{2\tau q_G}\left(\gamma_B\left(q_B+q_G\right)-4\tau\gamma_B q_G\right)$. In the general analysis with relative preferences in both countries, the positivity of the price of the green variant was met, regardless of the average income in country G. This is due to the fact that now the social rewards from buying the green variant is weaker than in this setting. As immediate consequence, the green price is lower under relative preferences in country B than under relative preferences in both countries.

In particular, denoting by $\dot{\tau} = \frac{(q_B+q_G)}{4q_G}$, we find that

Proposition 3 *Under relative preferences only in the brown market, (i) both the equilibrium price and demand of the green variant are higher than those in the baseline iff trade is sufficiently liberalized ($\tau > \dot{\tau}$); (ii) the equilibrium price and the corresponding demand of the brown good are lower than those in absence of relative preferences.*

Proof. *From direct comparison of the expressions.* ■

Accordingly, when the social component of consumption holds only in the less advanced country, the brown firm is penalized by the existence of relative preferences, regardless of trade costs: the social penalty suffered by consumers when buying the dirty product moves downward its price. Along the same rationale, the green firm benefits from these preferences only under a sufficiently high liberalization: when trade costs are not relevant, the social rewards emerging in the less developed country turns out to be significant thereby moving upward the willingness to pay for the green good.

Nonetheless, it gets higher than in the baseline where the social component does not play any role, namely $p_G^{**} > \check{p}_G > p_G^*$.

We investigate now the role of trade liberalization on the equilibrium configuration, under the assumption of relative preferences in country B. Typically, as a natural consequence of trade liberalization, equilibrium prices of the traded goods tend to reduce while demand of products to increase. This phenomenon determines a positive effect on consumers' surplus and possibly on firms' profits if the increase in quantity can countervail the reduction in prices.

Let us define $\check{\gamma} = \frac{2\Theta_G q_G - 2\Theta_B q_G}{q_B + 5q_G}$ and $\hat{\gamma} = \frac{\Theta_G q_B - \Theta_B q_B}{4q_B + 2q_G}$. We claim the following proposition:

Proposition 4 *Trade liberalization*

(i) increases (resp. decreases) both prices whenever the intensity of relative preferences is high (resp. low), namely iff $\gamma_B > \check{\gamma}$ (resp. $\gamma_B < \hat{\gamma}$). For any $\check{\gamma} > \gamma_B > \hat{\gamma}$, it increases the price of the brown variant and decreases the one of the green firm.

(ii) always increases the quantity produced by both firm.

Proof. $\frac{\partial \check{p}_G}{\partial \tau} = (q_G - q_B)\,\frac{\gamma_B q_B + 5\gamma_B q_G + 2\Theta_B q_G - 2\Theta_G q_G}{(4q_G - q_B)(\tau+1)^2} \gtreqless 0 \Leftrightarrow \gamma_B \gtreqless \check{\gamma} = \frac{2\Theta_G q_G - 2\Theta_B q_G}{q_B + 5q_G}$

$\frac{\partial \check{p}_B}{\partial \tau} = (q_G - q_B)\,\frac{4\gamma_B q_B + 2\gamma_B q_G + \Theta_B q_B - \Theta_G q_B}{(4q_G - q_B)(\tau+1)^2} \gtreqless 0 \Leftrightarrow \gamma_B \gtreqless \hat{\gamma} = \frac{\Theta_G q_B - \Theta_B q_B}{4q_B + 2q_G}$.

Finally notice that $\check{\gamma} > \hat{\gamma}$ always holds. **Q.E.D.** ■

The rationale underlying the above Proposition can be expressed as follows. When the social component of consumption is very significant, trade liberalization benefits both firms: the green producer takes advantage from the social rewards for consumers in country B which moves upward their willingness to pay for the environmentally friendly good; the price of the brown variant is rather positively affected by the relatively higher willingness to pay of consumers in country G. When the social component is low, the traditional findings emerge with trade liberalization reducing prices and increasing the corresponding traded quantities. Finally, for intermediate values of the social component, on one hand the social punishment penalizing the dirty product is weak so that the brown firm can get benefit from exporting to the more advanced (and richer) country and selling to consumers who disregard the social content of the goods. On the other hand, the price of the green variant is moved downward by the low willingness to pay of consumers in country B, for which the social rewards of buying socially worthy goods play a minor role.

Rather surprisingly, it emerges that when a social driver moves consumers only in less advanced countries producing dirty product, the process of trade liberalization risks to favor the brown producer, while penalizing the green firm.

This effect is never found in the scenario with relative preferences in

both countries: in that case, we prove that both equilibrium prices decrease with trade liberalization. Further, when the social component is extremely significant, the equilibrium quantities decrease as well with a negative effect on profits of both producer. Still, when this component is not so relevant, it may happen that the equilibrium quantity of the green good increase with trade liberalization, while that of the brown product decreases. When this happens, it may hold that the green producer takes advantage from the liberalization of the trade, while the brown producer is penalized from it.

5.2 Relative preferences in country G

In this setting with relative preferences arising only in country G, we observe the same qualitative findings emerging when relative preferences arise in both countries. For clarity of exposition, we relegate to the Appendix the formal details of this scenario. We find that the price and the quantity of the brown variant at equilibrium are lower than in the baseline when the international market is free enough, while the equilibrium price and quantity of the green product are always higher, irrespective of trade cost.

Further, in line with the general analysis, we observe that whenever the intensity of relative preferences is relatively low (resp. high), trade liberalization raises (resp. decreases) the equilibrium demand of both brown and green goods. For intermediate values of this intensity, the demand of the green good increases while that of the brown good decreases. Both equilibrium prices decrease with trade liberalization. Nevertheless, it is interesting to notice that:

Proposition 5 *Trade liberalization favors the green producer more when*

consumers in both countries display relative preferences than in the case when these preferences arise only in country G.

Proof. See Appendix. ■

Clearly, the larger the number of countries, in which consumers show relative preferences, the stronger the incentive for firms to produce green goods in the light of the increasing liberalization process.

6 Conclusions

In this paper, we investigate the effect of relative preferences and trade liberalization on the equilibrium outcome of an open economy of two countries and two firms. To this aim, we have analyzed a North-South model with a green firm located in the more advanced area and a brown rival producing a dirty good in the less developed country. Our main results concern the effect of trade liberalization on good prices and on pollution. We find that lowering trade costs may lead to an increase in prices and in the level of production of brown goods. This result emerges when citizens in the developed economies do not attribute a social content to green consumption.

We believe that environmental attitudes, dictated by relative preferences, are a product of economic and environmental conditions in the country of residence but are also a product of cultural orientations. As such, they can be strongly affected by the institutional setting of the country. Embracing this view, the current US presidential race may have strong impact on the position of US with respect to environmental issues within US and worldwide.

Appendix

Relative preferences in country G

In this section, we provide the details for the scenario in which relative preferences appear in country G. We find that the equilibrium prices are given by

$$p_G^{***} = (q_G - q_B)\,\frac{(\Theta_G+\Theta_B\tau+2\gamma)2q_G-\gamma\tau(q_G+q_B)}{(4q_G-q_B)(\tau+1)}$$
$$p_B^{***} = (q_G - q_B)\,\frac{(\Theta_G+\Theta_B\tau+2\gamma)q_B-2\gamma\tau(q_G+q_B)}{(4q_G-q_B)(\tau+1)}$$

Notice that $p_G^{***} > 0$ always holds while the positivity of the equilibrium price p_B^{**} is met iff $\Theta_B \geq \dot{\Theta}_B$ where $\dot{\Theta}_B = \frac{2\tau\gamma(q_B+q_G)-q_B(2\gamma+\Theta_G)}{\tau q_B}$.

The corresponding equilibrium market shares are then:

$$x_G^{***} = \frac{(\Theta_G + 2\gamma + \Theta_B\tau)2q_G - \gamma\tau(q_G+q_B)}{4q_G - q_B}$$
$$x_B^{***} = q_G\frac{(\Theta_G + 2\gamma + \Theta_B\tau)q_B - 2\gamma\tau(q_G+q_B)}{q_B\,(4q_G - q_B)}.$$

For the positivity of the market share x_B^{***}, the same argument used about p_B^{***} applies so that $x_B^{***} > 0$ iff $\Theta_B \geq \dot{\Theta}_B$.

Proof of Proposition 5

From standard computations, $\frac{\partial x_G^{**}}{\partial\tau} = \frac{\Theta_B q_B-2\gamma q_B-2\gamma q_G}{q_B(4q_G-q_B)} \gtreqless 0 \Leftrightarrow \gamma \lesseqgtr \dot{\gamma}$ and $\frac{\partial x_B^{**}}{\partial\tau} = \frac{\gamma q_B+\gamma q_G-2\Theta_B q_G}{q_B-4q_G} \gtreqless 0 \Leftrightarrow \gamma \lesseqgtr \ddot{\gamma}$. Notice that $\ddot{\gamma} < \dot{\gamma} < \gamma_G^{'}$ always holds. Accordingly, when $\ddot{\gamma} < \dot{\gamma} < \gamma < \gamma_G^{'}$, then the equilibrium demand of the green goods increases with trade liberalization in the general setting with relative preferences in both countries. Still, it reduces in the particular case where relative preferences arise only in country G.

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