ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

ARCHIVIO ISTITUZIONALE
DELLA RICERCA

Alma Mater Studiorum Università di Bologna
Archivio istituzionale della ricerca

Green monopoly and downward leapfrogging

This is the final peer-reviewed author's accepted manuscript (postprint) of the following publication:

Published Version:
Lambertini L., Mantovani A., Vergari C. (2021). Green monopoly and downward leapfrogging. ECONOMIA E POLITICA INDUSTRIALE, 48(1), 93-103 [10.1007/s40812-020-00154-x].

Availability:
This version is available at: https://hdl.handle.net/11585/842814 since: 2021-12-22

Published:
DOI: http://doi.org/10.1007/s40812-020-00154-x

Terms of use:

Some rights reserved. The terms and conditions for the reuse of this version of the manuscript are specified in the publishing policy. For all terms of use and more information see the publisher's website.

This item was downloaded from IRIS Università di Bologna (https://cris.unibo.it/).
When citing, please refer to the published version.

(Article begins on next page)

12 October 2024

This is the final peer-reviewed accepted manuscript of:

Lambertini, L., Mantovani, A., & Vergari, C. (2021). Green monopoly and downward leapfrogging. *Journal of Industrial and Business Economics*, *48*, 93-103.

The final published version is available online at:

https://doi.org/10.1007/s40812-020-00154-x

Terms of use:

Some rights reserved. The terms and conditions for the reuse of this version of the manuscript are specified in the publishing policy. For all terms of use and more information see the publisher's website.

This item was downloaded from IRIS Università di Bologna (https://cris.unibo.it/)

When citing, please refer to the published version.

Green Monopoly and Downward Leapfrogging*

Luca Lambertini[†], Andrea Mantovani[‡], and Cecilia Vergari[§]

February 10, 2020

Abstract

In this paper we show that environmental consciousness may act as a substitute for environmental regulation. We consider a vertically differentiated duopoly in which the high quality firm pollutes more than the low quality rival. Consumers attach a positive value to the green firm, while stigmatizing the brown one. For relatively high values of this environmental concern, only the green firm is active in the market. When this happens, a downward leapfrogging mechanism takes place, leading to a recursive race to the bottom. At equilibrium, polluting emissions can be reduced to the level established by environmental agencies.

Keywords: Environmental consciousness; relative preferences; downward leapfrogging.

JEL Classification: D62; L13; H13.

*We would like to thank the Guest Editors Jean Gabszewicz and Ornella Tarola, and two anonymous referees for their valuable suggestions and comments. We are also grateful to seminar participants at the First Annual Workshop on Circular Economy, Innovation and SMEs (Ferrara, 2019) for helpful discussion. The usual disclaimer applies.

[†]Department of Economics, University of Bologna, Strada Maggiore 45, 40125 Bologna, Italy; email: luca.lambertini@unibo.it.

[‡]Department of Economics, University of Bologna, Strada Maggiore 45, 40125 Bologna, Italy; email: a.mantovani@unibo.it.

[§]Department of Economics and Management, University of Pisa, Via Cosimo Ridolfi 10, 56124 Pisa, Italy, email: cecilia.vergari@unipi.it

1 Introduction

Climate change represents one of the most relevant issues of the last decades. At the climate conference held in Paris in 2015, 195 countries reached for the first time a comprehensive global climate deal that aims at reducing greenhouse gas emissions and limit the rise in global average temperature. Each country committed to adopt common methodologies accepted by the Intergovernmental Panel on Climate Change (IPCC) in order to estimate sources that produce greenhouse gas emissions.[1] The final aim was to establish standards and emissions limits for a number of pollutants to be achieved in the coming years. For example, actions were supposed to be taken in order not to surpass the symbolic milestone of 400 parts per million (ppm) CO2.[2] For higher values, the global temperature is predicted to rise even faster. For this reason, the Paris Agreement aimed to limit the emissions below 400 to keep the global temperature increase below two degrees Celsius. In plain words, driving the global economic system towards a green growth path does not require attaining a zero emission target, but rather a set of technologies whose impact must be compatible with the planet's carbon sinks in the long run. This crucial feature of UNO's Sustainable Development Goals and also the Paris Agreement has been repeatedly stressed (see, among many others, Pacala and Socolow, 2004) and, as we shall see below, plays an explicit role also in the model we are going to illustrate.

The aim of this paper is to show that ambitious goals in terms of reducing emissions can be reached even without direct environmental regulation. Indeed, we demonstrate that a sufficiently high degree of environmental concern can induce brown firms to reduce their emissions levels in order to remain in the market. We analyze a scenario in which consumers are environmentally concerned and there are two vertically differentiated firms producing one quality each (Gabszewicz and Thisse, 1979; Shaked and Sutton, 1982). In line with Mantovani *et al.* (2016), the two goods are differentiated along two dimensions that are in conflict with each other: hedonic (or intrinsic) quality and environmental quality. In particular, the high (hedonic) quality is considered as brown as it leads to a higher degree of pollution, whereas the low (hedonic) quality is less polluting and it is therefore considered as green. This is supported by the observation that brown goods often have higher performance than green alternatives (*e.g.*, Weatherell *et al.*, 2003; Gupta and Ogden, 2009).[3] Examples can be found

[1] In 2019, the IPCC revised the 2006 Guidelines for National Greenhouse Gas Inventories.

[2] For environmental scientists, this symbolic target served as a precise red line into a danger zone of climate change. For more information, please visit: https://e360.yale.edu/features/how-the-world-passed-a-carbon-threshold-400ppm-and-why-it-matters

[3] This is in contrast with part of the literature, which considers the opposite case in which the green good

in several industries which may largely differ in terms of the technological features of the goods involved. For instance, a tradeoff between environmental and hedonic quality exists for vehicles powered by internal combustion engine, which are dominated by elctric cars as far as polluting emissions are concerned, and yet remain frequently superior when it comes to pure performance. Analogous considerations holds for recycled paper and plastic. The energy saving cycles characterising the latest generation of dishwashers and washing machines take a lot longer than standard cycles.

Moreover, as producing green products often implies an additional (and costly) effort, we assume the presence of a cost differential that favors the brown producers. Consumers, however, attach a positive value to the less polluting product, while at the same time they penalize the brown one. More precisely, consumers display *relative preferences* for the environmental quality, such that consumption of green (resp., brown) goods induces some extra-reward (resp., stigma) as a result of social approval (resp., disapproval). We thus consider a warm glow effect that is in line with the literature on impure altruism and moral motivation as a source of pro-social behavior (see Andreoni, 1988, 1990 and more recently, among others, Nyborg *et al.*, 2006).

We focus on the case in which the environmental driver is so strong that consumers are willing to buy only the green good. Hence, we conjecture the existence of a monopoly in the hands of the firm supplying the lower hedonic quality, which is however the greener of the two. Moreover, depending on the intensity of this driver, the market can be covered or uncovered. Regarding the stability properties of this market configuration, an interesting result arises at the equilibrium. Indeed, each firm is aware that it must produce the cleaner of the two goods in order to have a positive demand. It follows that a downward "leapfrogging" (Motta *et al.*, 1997) process may take place, in which the firm that produces the high (but more polluting) quality reacts to the quality choice of its rival by setting a lower (and even less polluting) quality level. The mechanism at work is a reminiscent of the undercutting process leading to the Bertrand equilibrium in which, in the presence of asymmetric costs, the only firm active in the market is the one endowed with a lower marginal cost. Here the dynamic is similar but the mechanism is different, as the only active firm is the one that bears the additional cost that allows it to become the greener one. Another important difference is related to the "limit to the bottom" imposed by the mechanism itself. In Bertrand the final price is equal to the higher of the two marginal costs, whereas here the "quality undercutting" only ends when it reaches the target imposed by the environmental standard. If consumers are aware of such standard, they will consider as green the firm reaching the target.

is of high quality and the polluting brown good is of low quality (*e.g.*, Moraga-Gonzalez and Padron-Fumero, 2002; Lombardini-Riipinen, 2005).

All in all, our paper shows that a virtuous circle may arise when consumers highly value the consequences of their consumption habits on the environment, and are willing to reward those firms that undertake environmentally friendly investments. Notice that, in our simple model, at equilibrium the level of polluting emission may still be positive. However, it would be compatible with long-run goal of the environmental policies, thereby enabling society to reach the target set by the environmental agency without a direct intervention. In a certain way, we provide an interesting example in which the Porter hypothesis (Porter, 1991; Porter and van der Linde, 1995) holds even in the absence of an environmental regulation which may induce efficiency and encourage innovations.[4]

2 The Model

We consider a vertically differentiated market with two variants of the same product. As in standard models of vertical differentiation in the tradition of Mussa and Rosen (1978), the intrinsic performance of variant $i = H, L$ determines its *hedonic quality*, q_i, and we assume that $q_H > q_L > 0$. However, variant L is considered as green because it pollutes less than variant H. It follows that the *environmental quality* of L is higher than that of H.

There exists a continuum of consumers indexed by θ and uniformly distributed in the interval $[0, b]$ with density $1/b$. Parameter θ represents consumers' valuation of the hedonic quality. Each consumer willing to buy purchases either one unit of variant H or one unit of variant L. The indirect utility of consumer type θ writes as follows:

$$U(\theta) = \begin{cases} \theta q_H - p_H - \gamma (q_H - q_L), \text{ if she buys the high (hedonic) quality good,} \\ \theta q_L - p_L + \gamma (q_H - q_L), \text{ if she buys the low (hedonic) quality good,} \\ 0, \text{ if she does not buy.} \end{cases} \tag{1}$$

Following the theory of *relative preferences*, (Ghazzai, 2008; Alexopoulos and Sapp, 2006; Ben Elhadj and Tarola, 2015; Mantovani *et al.*, 2016), (1) illustrates a scenario in which consumers attach an extra positive value to the green good while at the same time stigmatizing the consumption of the brown one. This is captured by adding the component $\gamma (q_H - q_L)$, with $i \neq j$, meaning that the utility of buying a variant of the product can be either increased or diminished by the environmental factor. By an appropriate choice of units, we are implicitly assuming that consumers associate pollution level $e_H = q_H$ to the high quality variant, and $e_L = q_L$ to the low quality one. Parameter $\gamma \geq 0$ measures the intensity of the relative dimension of consumption: the higher the value of γ, the stronger the relative (or social)

[4]See, among others, André *et al.* (2009) and Lambertini and Tampieri (2012) for the Porter hypothesis in a vertically differentiated duopoly. For an overview of the related debate, see Ambec *et al.* (2013) and Lambertini (2013, 2017).

preferences with respect to the hedonic ones.[5]

The consumer that is indifferent between buying the low quality good and not buying at all is identified by:

$$\theta_L = \frac{p_L - \gamma(q_H - q_L)}{q_L}. \tag{2}$$

It is worth stressing that imposing an environmental standard $q_L = 0$ would invalidate the demand structure. However, this is not the requirement appearing in any of IPCC's reports or the bulk of scientific discussion on the matter. Hence, we may stipulate that a plausible target can be defined as $q_G > 0$, where subscript G stands for *green*. Accordingly, henceforth we assume $q_L \in [q_G, q_H)$. Also note that, as soon as θ_L is not positive, the market is fully covered, that is also consumer type $\theta = 0$ is willing to buy, and it is worth noting that this is solely due to the warm glow effect associated with the environmental concern.[6] The consumer that is indifferent between buying the low quality good and the high quality good is at:

$$\theta_H = 2\gamma + \frac{p_H - p_L}{q_H - q_L}. \tag{3}$$

Thus, the demand functions faced by firms are, respectively:

$$x_H = \frac{1}{b}\left(b - \theta_H\right), \; x_L = \frac{1}{b}\left(\theta_H - \theta_L\right).$$

We assume that the profit functions of firms H and L, respectively, write as:

$$\pi_H = x_H \cdot p_H, \tag{4}$$

$$\pi_L = \left(p_L - c\right) x_L, \tag{5}$$

where $c > 0$ is the cost per unit of green production and it represents the *cost differential* between producing the green and the brown product, *i.e.*, $c_L - c_H = c > 0$, where we pose $c_H = 0$ without further loss of generality. This cost differential might well account for the increase in marginal cost associated with emissions abatement.

3 The equilibrium analysis

We consider a duopoly with uncovered market. Profit maximization yields the following equilibrium prices:

$$p_L^* = \frac{2cq_H + (q_H - q_L)(2\gamma q_H + bq_L)}{4q_H - q_L}, \tag{6}$$

$$p_H^* = \frac{cq_H + (q_H - q_L)\left[2bq_H - \gamma(3q_H - q_L)\right]}{4q_H - q_L}. \tag{7}$$

[5]The extreme case $\gamma = 0$ reduces the model to the traditional vertical differentiation framework with hedonic preferences as the unique drivers for consumption.

[6]Early examples of this kind, inserting a similar element into consumer preferences, can be found in Eriksson (2004), Conrad (2005) and Lombardini-Riipinen (2005).

By plugging (6) and (7) into (2) and (3), we simplify the expressions of the levels of marginal willingness to pay of the critical consumers as follows:

$$\theta_H^* = \frac{(q_H - q_L)\left[(2b+3\gamma)q_H - (b+\gamma)q_L\right] - cq_H}{(4q_H - q_L)(q_H - q_L)}, \tag{8}$$

$$\theta_L^* = \frac{2cq_H - (q_H - q_L)\left[2\gamma q_H - (b+\gamma)q_L\right]}{(4q_H - q_L)\, q_L}. \tag{9}$$

The above expressions show that, in correspondence of prices (6-7), the market is only partially covered if and only if $\theta_L^* > 0$, which holds for all

$$\gamma \in (0, \widehat{\gamma})\ ;\ \widehat{\gamma} \equiv \frac{2cq_H + b\,(q_H - q_L)\, q_L}{(2q_H - q_L)(q_H - q_L)} \tag{10}$$

Conversely, for $\gamma > \widehat{\gamma}$, the market is fully covered as the poorest consumer is still able to buy the low quality good by virtue of the warm glow effect. This implies:

Lemma 1 *Full market coverage obtains for all $\gamma \geq \widehat{\gamma}$. Any value of γ below this threshold implies that some consumers in the right neighbourhood of $\theta = 0$ are priced out.*

Note also that

$$p_L^* \geq c \text{ and } x_L \geq 0 \iff \gamma \geq \frac{c\,(2q_H - q_L) - bq_L\,(q_H - q_L)}{2q_H(q_H - q_L)} \equiv \underline{\gamma}. \tag{11}$$

This condition plainly says that if the weight of the warm glow effect is excessively high, the price set by the green firm drops to marginal cost and its demand becomes nil, whereby π_L is also equal to zero. It can be easily proved that $\widehat{\gamma} > \underline{\gamma}$ since

$$\widehat{\gamma} - \underline{\gamma} = \frac{(4q_H - q_L)\, q_L\left[c + b\,(q_H - q_L)\right]}{2q_H\,(q_H - q_L)\,(2q_H - q_L)} > 0. \tag{12}$$

Having said that, both firms have positive demands provided that $0 < \theta_L^* < \theta_H^* < b$. In particular, the necessary and sufficient condition for $\theta_H^* < b$ is

$$\gamma < \frac{q_H[2b(q_H - q_L) + c]}{(3q_H - q_L)(q_H - q_L)} \equiv \overline{\gamma}, \tag{13}$$

which immediately implies:

Lemma 2 *The demand of the high-quality brown firm is zero for all $\gamma \geq \overline{\gamma}$. For all γ beyond this level, we also have $p_H^* = 0$.*

To complete the picture, one may also check that

$$\widehat{\gamma} > \overline{\gamma} \iff c > \widehat{c} \equiv \frac{b\,(q_H - q_L)^2}{q_H} \tag{14}$$

and

$$\underline{\gamma} > \overline{\gamma} \iff c > \widetilde{c} \equiv b\left(q_H + q_L\right) \tag{15}$$

with $\widetilde{c} > \widehat{c}$ everywhere.

The foregoing analysis produces the following landscape, with three alternative scenarios depending on the level of the cost differential:

S1 $c \in (0, \widehat{c})$: here, $\overline{\gamma} > \widehat{\gamma} > \underline{\gamma}$;

S2 $c \in (\widehat{c}, \widetilde{c})$: here, $\widehat{\gamma} > \overline{\gamma} > \underline{\gamma}$;

S3 $c > \widetilde{c}$: here, $\widehat{\gamma} > \underline{\gamma} > \overline{\gamma}$.

The identification of these areas allows us to formulate the following.

Proposition 1 *For all $\gamma \geq \overline{\gamma}$, firm L plays $p_L^* \geq c$ and is a monopolist. If $\gamma \geq \max\{\widehat{\gamma}, \overline{\gamma}\}$, firm L covers the entire market. If $\gamma \in \left[\max\left\{\underline{\gamma}, \overline{\gamma}\right\}, \widehat{\gamma}\right)$, it prices out all consumers indexed by $\theta \in [0, \theta_L^*]$.*

Figure 1

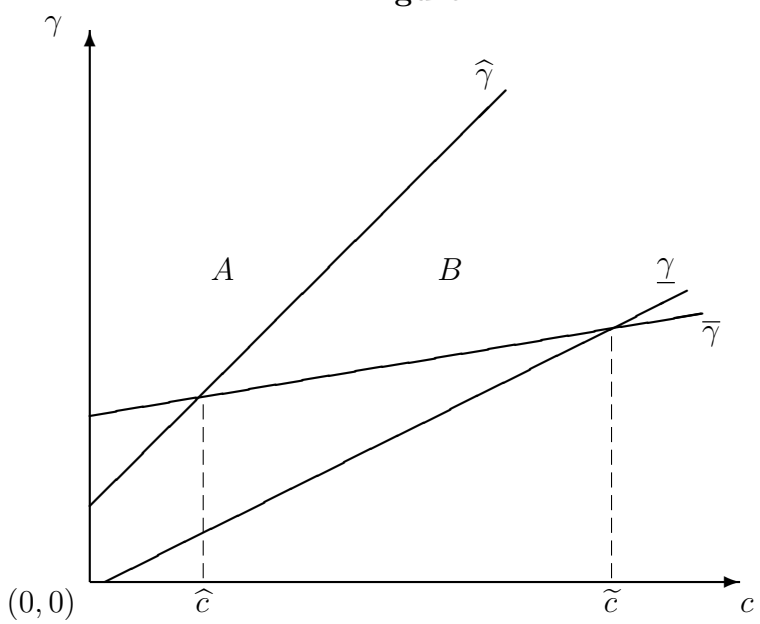

Figure 1 portrays this situation. In particular, the parameter regions mentioned in the above Proposition are areas A, where $\gamma \geq \max\{\widehat{\gamma}, \overline{\gamma}\}$, and B, where $\gamma \in \left[\max\left\{\underline{\gamma}, \overline{\gamma}\right\}, \widehat{\gamma}\right)$. If the weight attached to the warm glow effect satisfies either condition, it appears that we shall expect to observe the arising of a monopoly in the hands of the firm supplying the low (resp., high) quality as measured along the hedonic (resp., environmental) dimension. However, there remain to assess the stability properties of the market configuration we have described thus far.

4 Stability analysis

If the high-quality firm is out of the market, it is natural to imagine that it may want to reconsider its strategy, looking for an alternative one yielding positive profits. In this respect, we are about to outline a simple downward leapfrogging strategy that can be implemented by what is initially labeled as firm H. Recalling that qualities are exogenously given and c is a pure cost differential, it is not unreasonable to suppose that firm H has the possibility of producing $\underline{q}_L \in [q_G, q_L)$. At this quality level, the former firm H will have to bear the cost differential $\underline{c} > 0$, in the neighborhood of c, *i.e.*, $\underline{c} \in (0, c \pm \varepsilon)$, with ε positive but sufficiently small to ensure the positivity of $\underline{c} > 0$. Of course, by construction, variant $\underline{q}_L$ is greener than variant q_L.

This strategy can be adopted irrespective of the prevailing extent of market coverage performed by firm L in regions A and B. As soon as consumers detect the presence of $\underline{q}_L$, they will perceive the former q_L as the new q_H, and - all else equal - the foregoing argument goes through unmodified, with a new monopoly replacing the initial one. Each monopoly is *observationally equivalent* - although not entirely identical - to the other, in that qualities are exogenously given and what happens depends on the size of the warm glow effect, in combination with the gap in terms of productive efficiency or abatement costs. Intuitively, this mechanism may reproduce itself again, with firms changing their respective positions running down along the quality ladder.

This informal discussion produces the following:

Proposition 2 *The monopoly outcome arising for all* $\gamma \geq \max\{\widehat{\gamma}, \overline{\gamma}\}$ *and* $\gamma \in \left[\max\left\{\underline{\gamma}, \overline{\gamma}\right\}, \widehat{\gamma}\right)$ *is unstable, as it is subject to a downward leapfrogging mechanism whose nature is recursive. The race to the bottom ends as soon as either firm reaches the environmental standard* q_G.

Anyone accustomed with the discrete choice approach to product differentiation is familiar with the idea of leapfrogging (either upwards or downwards) as an integral part of a proof of existence of a pure-strategy equilibrium in the product space. So, in a sense, we may look at the above Proposition with some disappointment. Yet, this is not necessarily the case in the present model, for a simple reason, which can be spelled out in the following terms.

Consumers care about products' greenness (or lack thereof), and this is the fundamental reason for the recursive *race to the bottom* which is the subject of this section. The fact that this jeopardizes stability, however, is a lesser evil, or rather a blessing, because the race will end as soon as the low quality reaches the standard q_G. At that point, the industry will fix itself into an equilibrium at which per unit and aggregate emission levels are minimized given the best technology in use (measured by the cost differential prevailing in correspondence of

that regime).[7]

In this respect, two remarks are in order:

- the mechanism illustrated above closely resembles the analogous one operating in a Bertrand duopoly with homogeneous good and asymmetric constant marginal costs. In both cases, the mechanism is an auction in which firms bid for monopoly and the one with a structural advantage outbids the other. In Bertrand, the advantage is associated with the difference in marginal costs, here it is associated with the warm glow, which more than offsets productive efficiency considerations;

- at equilibrium, the extant level of CO_2-equivalent ppm in the atmosphere may still be very far from nil, and yet compatible with long-run environmental standards (for instance, lower than 400 ppm, in accordance to the Paris Agreement).

The latter remark brings us to the final step of our paper. This consists in bridging between this setup, which relates to choosing an angle to appreciate the difference between hedonic and environmental quality, and the Porter hypothesis, in particular its strong form. According to the latter, environmental regulation, rather than compromising firms' performance, might spur green innovation in such a way that firms end up attaining higher profits and also delivering a higher social welfare. This is also known as the *win-win solution*. In a nutshell, the Porter hypothesis relies on the idea that a tough environmental policy must be adopted to become inoperative (or, more explicitly, obsolete) as quickly as possible. In the model we have illustrated here, such a policy is altogether absent, and the outcome is entirely driven by consumers' preferences. In both cases, but in particular in the regime in which the final outcome is a recursive green monopoly with full coverage, one might want to read this result as a *win-win solution without regulation*.

5 Concluding remarks

In a vertically differentiated duopoly, we have considered consumers environmental concern modeled as a warm glow effect coming from the consumption of the low hedonic but less pollutant good. Whenever this concern is sufficiently important, all consumers willing to buy prefer the cleaner good over the brown alternative. The consequence is a zero demand for the high (brown) quality firm, that, in turn, induces a recursive race to the bottom that ends as soon as the low quality reaches the minimal admissible level compatible with the best available

[7]Note that once either firm has reached the standard q_G, the rival firm has no incentive to set the same highest environmental quality as price competition would lead to a Bertrand paradox.

technology as well as with the long-run environmental standards. This can be regarded as a *win-win solution without regulation*.

The crucial role of consumers' environmental concern in determining this result calls for the following policy implication. The government should promote environmental campaigns and invest in environmental education in order to raise consumers' awareness about the impact of their consumption choices on the ecosystem in which they live. Yet, all of this should be taken with some caution, because shaping an environmental culture requires a farsighted investment, and it may involve a long-run and costly process of instilling the respect for the environment. Performing this task involves coordinating the behaviour of countless atomistic agents, which poses a problem along at least two dimensions: one is obviously the size of the population of consumers involved, the other is the time that a process like this would realistically require. This is an example of a more general issue affecting the evolution of cultural attitudes (see Giavazzi *et al.*, 2019, *inter alia*). Hence, although the message conveyed by the model is that the consumption pattern of consumers may in principle act as a net substitute of the policy maker's action, a more conservative assessment of this and many other analyses of green consumerism can be summarised by saying that consumers' environmental awareness may complement - possibly to a very effective extent - the *panoplia* of environmenal policy tools.

References

[1] Alexopoulos, M. and Sapp, S. (2006). Exploring the Behavior of Economic Agents: the role of relative preferences. *Economics Bulletin*, **12**, 1-7.

[2] Ambec, S., M. Cohen, S. Elgie and P. Lanoie (2013), The Porter Hypothesis at 20: Can Environmental Regulation Enhance Innovation and Competitiveness?, *Review of Environmental Economics and Policy*, **7**, 2-22.

[3] André, F.J., P. González and N. Porteiro (2009), Strategic Quality Competition and the Porter Hypothesis, *Journal of Environmental Economics and Management*, **57**, 182-94.

[4] Andreoni, J. (1988). Privately Provided Public Goods in a Large Economy: The Limits of Altruism. *Journal of Public Economics*, **35**, 57-73.

[5] Andreoni, J. (1990). Impure Altruism and Donations to Public Goods: A Theory of Warm-Glow Giving. *The Economic Journal*, **100**, 464-77.

[6] Ben Elhadj, N. and O. Tarola (2015). Relative Quality-Related (Dis)utility in Vertically Differentiated Oligopoly with an Environmental Externality. *Environment and Development Economics*, **20**, 354-79.

[7] Conrad K. (2005). Price Competition and Product Differentiation When Consumers Care for the Environment. *Environmental and Resource Economics*, **31**, 1-19.

[8] Eriksson, C. (2004). Can Green Consumerism Replace Environmental Regulation? a Differentiated Products Example. *Resource and Energy Economics*, **26**, 281-93.

[9] Gabszewicz, J.J. and J.F. Thisse (1979). Price competition, quality and income disparities. *Journal of Economic Theory*, **20**, 340-359.

[10] Ghazzai, H. (2008). Multi-product strategies and relative preferences for quality. *Economics Bulletin*, **34**, 1-10.

[11] Giavazzi, F., I. Petkov and F. Schiantarelli (2019). Culture: Persistence and Evolution. *Journal of Economic Growth*, **24**, 117-54.

[12] Gupta, S. and G. T. Ogden (2009). To Buy or Not to Buy? A Social Dilemma Perspective on Green Buying. *Journal of Consumer Marketing*, **26**, 376-91.

[13] Lambertini, L. (2013). *Oligopoly, the Environment and Natural Resources*, London, Routledge.

[14] Lambertini, L. (2017). Green Innovation and Market Power, *Annual Review of Resource Economics*, **9**, 231-52.

[15] Lambertini, L. and A. Tampieri (2012). Vertical Differentiation in a Cournot Industry: The Porter Hypothesis and Beyond, *Resource and Energy Economics*, **34**, 374-80.

[16] Lombardini-Riipinen C. (2005). Optimal Tax Policy under Environmental Quality Competition. *Environmental and Resource Economics*, **32**, 317-36.

[17] Mantovani, A., Tarola, O. and C. Vergari (2016). Hedonic and Environmental Quality: A Hybrid Model of Product Differentiation. *Resource and Energy Economics*, **45**, 99-123.

[18] Moraga-Gonzalez, J. L. and N. Padron-Fumero (2002). Environmental Policy in a Green Market. *Environmental and Resource Economics*, **22**, 419-47.

[19] Motta, M., Thisse, J., and A. Cabrales (1997). On the Persistence of Leadership or Leapfrogging in International Trade, *International Economic Review*, **38**, 809-24.

[20] Mussa, M. and S. Rosen (1978). Monopoly and Product Quality. *Journal of Economic Theory,* **18**, 301-17.

[21] Nyborg, K., Howarth R.B. and K.A. Brekke (2006). Green Consumers and Public Policy: On Socially Contingent Moral Motivation. *Resource and Energy Economics,* **28**, 351-66.

[22] Pacala, S. and R. Socolow (2004). Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies. *Science*, **305**, 968-72.

[23] Porter, M. (1991). America's Green Strategy. *Scientific American*, **264**, 96.

[24] Porter, M.E. and C. van der Linde (1995). Toward a New Conception of the Environment-Competitiveness Relationship. *The Journal of Economic Perspectives* **9**, 97-118.

[25] Shaked, A. and J. Sutton (1982). Relaxing Price Competition through Product Differentiation. *Review of Economic Studies*, **49**, 3-13.

[26] Weatherell, C., Tregear, A. and J. Allinson (2003). In Search of the Concerned Consumer: UK Public Perceptions of Food, Farming and Buying Local. *Journal of Rural Studies,* **19**, 233-44.