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RESEARCH ARTICLE

Globalization of markets and consumption home bias: new insights for the environment

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Abstract
We propose a model of international oligopoly with two countries, two vertically-differentiated goods, and heterogeneous consumers in terms of their willingness to pay for quality. Various sources of pollution are taken into account: consumption, production and the transportation of goods between the two countries. Green persuaded consumers display *consumption home bias*: they derive additional satisfaction when consuming a domestic good because buying locally abates transportation pollution. We investigate whether consumption home bias effectively curbs global emissions. Finally, we uncover the environmental role played by the globalization of markets.

Keywords: environmental damage; home bias; international trade; relative preferences; vertically-differentiated model

JEL classification: D43; F10; F15; Q56

1. Introduction

> "Protection. For free traders, this word represents the consummate evil. For environmentalists, it is the ultimate good."
>
> (Esty, 2001)

The process of globalization has facilitated easier access to geographically dispersed markets and has made transportation faster and more affordable. This ongoing interconnectedness between different regions and people has resulted in two distinct outcomes. Firstly, there has been a significant increase in the volume of traded goods over the past few decades, leading to a rise in emissions from transportation and other sources. However, the long-term effects of globalization and trade on carbon dioxide (CO_2) emissions have been largely overlooked. Consequently, the transportation sector has not observed the same gradual decline in emissions seen in other areas. According to estimates from the International Transport Forum (ITF), approximately 30 per cent of all transport-related CO_2 emissions from fuel combustion can be attributed to international trade-related freight transport, accounting for over 7 per cent of global emissions (ITF Transport Outlook, 2015).

On the other hand, numerous movements have emerged in several countries with the aim of preserving local niche economies. For example, there is a growing global trend of "Buy local" campaigns, which serve as a response to the patterns of consumption driven by globalization. These campaigns strive to support local businesses and protect domestic jobs. In his address to the United Nations General Assembly, Donald Trump emphasized the importance of prioritizing the well-being of one's own people and country, promoting his "America First" policies.[1] Similar campaigns, such as "the one who insists wins" (or ο επιμενων ελληνικα), "Compras made in Spain," or "Buy Irish," have also emerged in the so-called PIIGS countries (Portugal, Italy, Ireland, Greece, and Spain).

Many environmental movements have embraced these campaigns, incorporating them into a broader concept of "buy local, be cleaner." They advocate for the consumption of local goods as a means to reduce emissions generated by transportation. These environmental movements not only raise consumer awareness about the polluting nature of consumption, but also serve as drivers of green persuasion.[2] Through labeling and other information schemes, they disseminate knowledge about the negative environmental impacts associated with unsustainable consumption choices, aiming to influence rational consumers. In this context, green persuasion establishes a connection between intangible benefits (or penalties) and local (or foreign) consumption.[3] Green-persuaded consumers experience a non-monetary sense of being virtuous when they purchase domestically produced goods. This feeling goes beyond fulfilling a material need and becomes an additional benefit incorporated into their utility function, regardless of the emissions generated during production and consumption. Conversely, these consumers also experience a non-monetary feeling of shame when buying foreign goods, regardless of the ecological footprint involved in their production and consumption, as emissions are still generated through transportation (Glaeser, 2014: 209).[4] This preference for local products is known as *consumption home bias.*[5]

Although consumption home bias is a widely recognized and extensively studied phenomenon in the existing empirical literature, its implications for global emissions have largely been overlooked. While encouraging consumers to prefer domestic goods can have a direct positive impact on global emissions by reducing transportation-related emissions (see Lambertini, 2013), the situation is more complex. It is important to acknowledge that goods often vary along an environmental quality spectrum, resulting in non-uniform per-unit emissions from consumption. Additionally, producers can

[1] America First has changed buying U.S.-made products into a sign of loyalty to the U.S. rather than a consumption choice.

[2] *Green persuasion* is a term we borrow from Glaeser (2014).

[3] Benefit and penalty can have both an internal and an external motivation. For this distinction, Glaeser refers the reader to Kandel and Lazear (1992) on the difference between shame and guilt. Whereas shame is linked to "external sanction, guilt operates internally".

[4] Although these internal and external motivations are not mutually exclusive, consumers buying green goods become socially worthy citizens when external motivation is the main driver of a green action. They can show "a kind of green pride" when preferring an environmentally friendly product over an ordinary variant (Barringer, 2008), thereby obtaining a *reputational payoff* (Bénabou and Tirole, 2006). Rather, the internal motivation is linked to a Kantian model of behavior: a consumer chooses a green good because this is moral and provides the consumer with a positive self-image.

[5] Discussing the source of benefit/penalty goes beyond the goal of our analysis. We use the expression of social condemnation, in line with an external motivation and to avoid a cumbersome terminology. Nonetheless, we could also claim that "it deserves social/moral condemnation".

employ different production techniques, leading to varying per-unit emissions. Therefore, even if the demand for domestic products increases at the expense of foreign products, home bias can indirectly and undesirably affect global emissions. For instance, if there is a rise in demand for a product with higher per-unit emissions from consumption, while a cleaner alternative is neglected, global emissions will only decrease if the corresponding per-unit emissions from production, in combination with transportation emissions, decrease sufficiently so as to offset this increase. Otherwise, the anticipated benefits of local consumption will be so minimal that home bias will exacerbate the adverse impact on global pollution.

In our research, we aim to address this issue by presenting an international duopoly model that incorporates both international trade and consumption home bias. We consider a scenario where products are differentiated based on their environmental quality, and pollution is generated not only through consumption and production but also during the transportation of goods. Within this framework, our objective is to investigate whether home bias can sustain the preference for a local product with a poor environmental footprint in either consumption or production, while neglecting a foreign alternative with better environmental performance in one of these two dimensions. Furthermore, we analyze the overall impact of home bias on global emissions by simultaneously considering the three sources of pollution: consumption, production and transportation. By doing so, we seek to gain a comprehensive understanding of the net effect of home bias on global emissions within this context.

Formally, we present a model featuring two countries and two vertically-differentiated goods: a high-quality environmentally friendly good (referred to as "green") and a low-quality environmentally damaging good (referred to as "brown"). Each country is home to a firm producing one of these goods. Firms engage in exporting their products, which incurs trade costs and results in pollution from transportation, in addition to pollution from production. Final consumers contribute to pollution through their consumption activities. Firms are characterized by varying levels of environmental efficiency in production and transportation. As a benchmark, we consider environmentally conscious consumers within each country, with differing willingness to pay for environmental quality. With this setup, we introduce the concept of home bias and analyze the market equilibrium when firms compete based on prices.

Our findings reveal that consumption home bias has unforeseen effects on equilibrium prices and quantities. It consistently raises the prices of domestic goods while reducing the prices of foreign alternatives. The impact on profits is ambiguous and depends on transportation costs. In situations where market integration is limited, home bias benefits firms by sustaining their market power in the domestic market through trade barriers generated by high transportation costs. In terms of environmental damage, intriguingly, when the green firm exhibits high environmental efficiency in production, strong green persuasion among consumers proves globally beneficial for the environment. However, when the green firm's environmental efficiency is moderate, any degree of green persuasion is consistently detrimental.

These findings have two important implications. Firstly, they suggest that policies promoting local consumption should be carefully examined as they may yield unintended consequences. Many environmental campaigns encourage the consumption of local goods, arguing that it reduces the pollution associated with transportation, one of the most environmentally harmful activities. However, our study questions the theoretical basis of this argument and highlights the need for caution, as phenomena such as home bias can potentially increase pollution instead of reducing it. Secondly, our

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findings underscore the price effects of consumption home bias. Specifically, it can lead to unwarranted price increases that contradict the anticipated effects of international trade.

The roadmap of the paper is as follows. In section 2, we place our paper in the context of the relevant literature. In section 3, the model is developed in the absence and presence of consumption home bias. Section 4 develops the analysis in the presence of asymmetric home bias. Section 5 offers some concluding remarks.

2. Related literature

The key ingredients of our setting are: (i) green persuasion expressed as consumption home bias; and (ii) a comprehensive analysis of environmental damage, including pollution from consumption, production and transportation under international trade—accordingly, our contribution to prior literature branches into these two different research areas.

First, our research contributes to analyzing home-bias drivers of economic choices. We focus on consumption home bias for environmental reasons, expressed by consumers' awareness that close-substitute goods may have very different ecological footprints. The theoretical literature on pro-environmental behaviors and their effect on market equilibria has rapidly increased (Lombardini-Riipinen, 2005; Brecard, 2013; Ben Elhadj and Tarola, 2015; Mantovani *et al.*, 2016; Ceccantoni *et al.*, 2018, among others). The entry point of this literature is that environmentally aware consumers differentiate goods concerning their environmental impact and are willing to pay a premium for products of higher environmental quality (Sartzetakis *et al.*, 2012; Marini *et al.*, 2022). Some of this literature pushes forward the hypothesis that consumption choices are not exclusively driven by the desire to satisfy material needs but also by other considerations such as altruism (Andreoni, 1990), reputation payoff (Bénabou and Tirole, 2006), or simply social norms (e.g., Ostrom, 2000). These norms state that consumers shall reduce their ecological footprint to save the planet and their children's future (Nyborg, 2000; Brekke *et al.*, 2003; Nyborg *et al.*, 2006). Our modelling strategy embraces this view.

In particular, we follow Glaeser (2014) and consider a consumer who is not only environmentally aware but also green-persuaded such that they have "a nonpecuniary feeling of being a good person" when contributing to minimizing emissions. In contrast, they suffer "a nonpecuniary feeling of shame" otherwise. A simple and concrete application of the norm, "reduce your ecological footprint", is buying local products to reduce pollution from transportation. Consumption home bias follows as a by-product of this persuasion. The idea that consumers may be reluctant to buy foreign products is old. It was first mentioned by Schooler (1965), who stated that "foreignness" is a feature of a good that consumers may not appreciate. Shimp and Sharma (1987) rationalized these consumption preferences using the notion of ethnocentrism. In their seminal paper, they emphasize the role of in-group affiliation and belief in the morality of domestic consumption.

The reflection of this demand side of consumption bias on the supply side is the famous home-market effect (Krugman, 1980), namely the tendency of differentiated product industries to concentrate in large countries, making these countries net exporters and thus crucially shaping international trade flows. Beyond consumption, however, home bias is manifested in many other settings and, accordingly, it has been investigated in various branches of the economics literature. Equity home bias appears to be a crucial determinant of individuals' financial decisions and equity portfolios (see French and Poterba, 1991; Ardalan, 2019 for a survey). Individuals strongly prefer domestic stocks of locally headquartered firms rather than following the suggestion of diversification based on optimal portfolio theory. An explanation offered by the behavior finance literature is the information asymmetry of investors for foreign capital markets. In addition, home attachment appears in the migration economics literature as a driver for the propensity to migrate (Stark, 1991). Individuals have an embedded preference for their country (social capital, patriotism, preferences for national amenities, and so on) that affects their cost of migrating and, therefore, the intention or the decision to quit their homeland. In this paper, we focus on the effect of consumption home bias on the environment in the presence of international trade. To do so, we nest preferences à la (Mussa and Rosen, 1978; Gabszewicz and Thisse, 1979, 1980), with consumption home bias determining the perceived quality distance between national and foreign goods. In doing so, we link home bias theories to environmental issues mediated by international trade forces.

Second, we contribute to the debate on the environmental impact of international trade and transport. The literature on international trade and the environment is vast and develops along many different research lines with empirical and theoretical contributions, reaching contrasting conclusions. Trade is associated with better environmental outcomes in Antweiler *et al.* (2001), Copeland and Taylor (2004), and McAusland and Millimet (2013). In contrast, the theoretical pollution-haven argument and the empirical work by Ederington *et al.* (2005) and Taylor (2005), *inter alia*, attribute adverse environmental effects to international trade. A common finding is that trade affects the environment through three mechanisms: a domestic environmental effect is generated by the consumption of imported products; an ecological spillover comes from the production of export goods; and finally, a third environmental effect is caused by transportation (Veen-Groot van and Nijkamp, 1999). Transportation activities have environmental footprints ranging from noise to the emission of pollutants and climate change. In our paper, we concentrate on the direct impact of commodity transportation on the environment. These, namely carbon monoxide emissions, are known to have an immediate harmful effect on air quality. Our key assumption is that consumers buy locally to minimize emissions; therefore, this treatment of pollution from transportation appears the most consistent for our setting.

Carbon emissions from European international air and maritime transport grew by 72.9 per cent between 1990 and 2006 (European Commission, 2009). Despite this acceleration, the environmental damage associated with transportation has been vastly overlooked by the theoretical and empirical literature, with few exceptions (e.g., Cristea *et al.*, 2013). This literature is predominantly empirical. The main contributions are related to different ways of allocating carbon emissions to firms and final consumers. Munksgaard and Pedersen (2001) define the consumer responsibility principle in the following terms: consumers are responsible for pollution. Hence the total emissions of a country must sum emissions from production (net of exports) and emissions from consumption generated by domestic and imported final goods. This debate has led to a detailed analysis of the impact of international trade and consumption patterns on a country's polluting emissions, frequently using input-output tables. From a methodological point of view, our paper provides a microeconomic foundation for different sources of pollution when consumers are not only aware of the environment but also express consumption home bias. In fact, by explicitly modelling domestic production, exports and consumption, we can theoretically tackle the role of each activity in total pollution when consumers display consumption home bias.[6]

We characterize production and transportation to answer the question: Does consuming foreign goods despite having consumption home bias increase or lower total pollution? In the vein of Wiedmann *et al.* (2007), to build an appropriate theoretical setting to analyze different sources of pollution, we consider heterogeneous goods. Consequently, pollution intensity is different for imports and domestic production.

3. The model

Consider a two-country model with two firms, each supplying a vertically-differentiated product. As for the demand side, in each country, consumers are assumed to be environmentally aware that consumption is a polluting activity. For this reason, they differentiate products along an environmental-quality dimension; hence, they link the environmental quality of a good to its environmental footprint of consumption. Linking the environmental quality to emissions from consumption without including production emissions can be seen as restrictive. However, ample evidence suggests that consumers cannot always gather information about the ecological footprint of production processes (e.g., 2019 Global Consumer Insights Survey). Also, in some cases they suffer from a problem of misinformation, and differentiated variants belonging to the same category of goods can be perceived as homogeneous.[7]

The high environmental quality good, called *green*, generates lower per-unit emissions when consumed by the final customers than the *brown* or *dirty* one. The ranking of products reflects this environmental awareness: a green good is unanimously ranked higher by consumers than the brown one. This hypothesis is supported by evidence suggesting consumers are willing to pay a price premium to purchase cleaner goods (Farhar and Houston, 1996; Sundt and Rehdanz, 2015).

Consumers are characterized by their willingness to pay for environmental quality. They are indexed by θ and uniformly distributed over the interval $[a, b]$. Parameter b denotes the highest willingness to pay for environmental quality, with $b > 2a$ and a sufficiently high. These conditions guarantee that the market in both countries is covered at equilibrium.

A single firm populates each country. We label the countries h and l and assume that each of the two firms offers a single variant of an environmentally differentiated good. The firm located in country h produces the variant of high-environmental quality g, i.e., a green variant, whereas the firm located in country l produces a variant of low-quality d, i.e., a brown or dirty good. We denote by u_j the quality level of variant $j = g, d$, with

[6] A companion question asks whether a cleaner environment enhances international trade. We refer the interested reader to Pantelaiou *et al.* (2020) for a recent analysis of this issue.

[7] Take the example of electric vehicles. No doubt consumers know that these vehicles produce lower tailpipe emissions than conventional vehicles do. Nonetheless, tailpipe emissions are only one of the sources of pollution, and a vehicle's life cycle emissions are higher by far than tailpipe emissions. In order to know the actual ecological footprint of an electric vehicle, thereby choosing the greener one among the set of electric cars, a consumer should be able to estimate both fuel-cycle emissions and vehicle-cycle emissions (material and vehicle production as well as end-of-life). A similar problem occurs when considering organic and conventional beef. Typically, organic food is provided with ecolabels guaranteeing its health and safety. Still, when organic and conventional beef production are compared by carbon footprint, it is found that the conventional system has lower greenhouse gas emissions.

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$u_g > u_d$. Production costs are assumed to be nil. This assumption enables us to identify the pure effect of the home bias on the equilibrium configuration while narrowing down its effect to the demand side of the problem: absent costs, the only component affecting the competition mode is the new approach to consumers' preferences.[8]

For simplicity and without loss of generality, we assume $2u_d > u_g$.[9] Each firm can serve both countries because markets are open to international trade. When serving the foreign market, a firm incurs a trade cost t, $t \geq 0$. From the firms' viewpoint, this trade cost creates a gap between the price to serve the foreign market and the one generating profits. When t is close to 0, the gap between the price that could generate profits and the one targeted to the foreign market is small, and trade costs are negligible for the firms.[10]

We first describe the market equilibrium when firms compete in price. Then, we determine and investigate the environmental damage that firms and consumers generate.

3.1. The equilibrium configuration in the absence of consumption home bias

Consider as a baseline scenario a framework of two open economies with firms competing in an international duopoly and serving both the domestic market and, through export, the foreign one. We assume that consumers are immobile; each buys at most one unit of the good, either green or brown. Moreover, markets are segmented, and firms price discriminate between countries. Depending on their location, the indirect utility function $U_i(\theta)$ of a consumer residing in country i, $i = h, l$, is written as

$$U_i(\theta) = \begin{cases} \theta u_g - p_{ig} & \text{if she buys } g \\ \theta u_d - p_{id} & \text{if she buys } d \end{cases}, \quad i = h, l, \tag{1}$$

where p_{ig} and p_{id}, $i = h, l$, are the country-specific prices for the green and the brown good, respectively. In line with the traditional model of vertical product differentiation *à la* Mussa and Rosen (1978), the indifferent consumer $\theta_i\left(p_{ig}, p_{id}\right)$, between buying the environmentally high quality variant or the low one in country $i = h, l$, derives from the indifference condition

$$\theta_h u_g - p_{hg} = \theta_h u_d - p_{hd} \text{ and } \theta_l u_g - p_{lg} = \theta_l u_d - p_{ld}.$$

Therefore, the expressions for the two marginal consumers in each country are

$$\theta_h(p_{hg}, p_{hd}) = \frac{p_{hg} - p_{hd}}{u_g - u_d} \text{ and } \theta_l\left(p_{hd}, p_{ld}\right) = \frac{p_{lg} - p_{ld}}{u_g - u_d}.$$

[8]The absence of costs hypothesis is widely shared in the literature. The pioneering works by Gabszewicz and Thisse (1979), Shaked and Sutton (1983), and also Choi and Shin (1992) and Wauthy (1996), analyze competition in a vertically-differentiated market when each firm sells its variant at no cost to get insights into the role of demand in the market. With a focus on environmental quality, Wang and Yang (2001), Bacchiega and Minniti (2009), Bacchiega *et al.* (2016) and Ceccantoni *et al.* (2018) use the same assumption, *inter alia.*

[9]The model can be solved for the alternative condition $u_d > 2u_g$ with no major changes in the results. Calculations are available upon request from the authors.

[10]Bacchiega and Minniti (2009), Bacchiega *et al.* (2016) and Picard and Tampieri (2021) use a similar approach to model trade costs.

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Then, the demand functions for the two goods $x_g(p_{hg}, p_{hd})$ and $x_d(p_{hd}, p_{ld})$ can be written as follows:

$$x_g(p_{hg}, p_{hd}) = b - \theta_h(p_{hg}, p_{hd}) + b - \theta_l\left(p_{hg}, p_{hd}\right),$$
$$x_d(p_{hd}, p_{ld}) = \theta_l\left(p_{hd}, p_{ld}\right) - a + \theta_h\left(p_{hd}, p_{ld}\right) - a.$$

As mentioned previously, goods can be shipped across countries at a constant unit trade cost t, borne by firms and independent of the direction of trade. The firms' profits are written as:

$$\Pi_g\left(p_{hg}, p_{lg}\right) = \left(b - \frac{p_{hg} - p_{hd}}{u_g - u_d}\right) p_{hg} + \left(b - \frac{p_{lg} - p_{ld}}{u_g - u_d}\right)(p_{lg} - t),$$
$$\Pi_d\left(p_{ld}, p_{hd}\right) = \left(\frac{p_{lg} - p_{ld}}{u_g - u_d} - a\right) p_{ld} + \left(\frac{p_{hg} - p_{hd}}{u_g - u_d} - a\right)\left(p_{hd} - t\right).$$

Maximizing the above profits yields the equilibrium prices:

$$p^*_{hg} = \frac{t}{3} + \frac{(2b - a)\left(u_g - u_d\right)}{3} \text{ and } p^*_{lg} = \frac{2t}{3} + \frac{(2b - a)\left(u_g - u_d\right)}{3}, \quad (2)$$
$$p^*_{ld} = \frac{t}{3} + \frac{(b - 2a)\left(u_g - u_d\right)}{3} \text{ and } p^*_{hd} = \frac{2t}{3} + \frac{(b - 2a)\left(u_g - u_d\right)}{3}. \quad (3)$$

All optimal prices are positively signed due to condition $b > 2a$. Notice that the equilibrium prices of domestically traded and exported goods depend on trade costs due to strategic price complementarity.

At these equilibrium prices, the indifferent consumers θ^*_h and θ^*_l in each country at equilibrium are:

$$\theta^*_h = \frac{a + b}{3} - \frac{t}{3\left(u_g - u_d\right)} \text{ and } \theta^*_l = \frac{a + b}{3} + \frac{t}{3\left(u_g - u_d\right)},$$

and both expressions lie within the admissible interval $[a, b]$ if, and only if, $t < t' \equiv \left(u_g - u_d\right)(b - 2a)$, which we assume hereafter. If $t > t'$, then trade costs are so high that international trade stops.

The corresponding total quantities x^*_g and x^*_d produced at equilibrium for both markets are written as

$$x^*_g = \frac{2\,(2b - a)}{3} \text{ and } x^*_d = \frac{2\,(b - 2a)}{3},$$

with $x^*_g > x^*_d$, and where x^*_g and x^*_d include both the domestic and foreign consumption of variants g and d, respectively.

3.2. Environmental damage

From the *firm side*, we contemplate two sources of environmental pollution: *production* and *transportation*. In particular, we assume that when producing a good, firms generate emissions. Firms generate emissions when transporting goods from one country to

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another. To the best of our knowledge, our analysis is the first to disentangle the effect of different sources of pollution on the environment using a vertically-differentiated goods model. To this aim, we do not distinguish between local and transboundary pollution, as this distinction refers to where emissions occur. Instead, our crucial reference is the source of pollution, namely the level of emissions generated by a good when it is produced, traded and consumed.

Formally, the environmental damage generated by the brown firm at equilibrium, E_d^*, is written as

$$E_d^* = \phi_p x_d^* + \phi_t(\theta_h^* - a).$$

The first component, $\phi_p x_d^*$, captures pollution from *production*. This component is more prominent, the larger is the amount of the goods targeted to the domestic market $(\theta_l^* - a)$ and the foreign market $(\theta_h^* - a)$, and the higher is the *emissions coefficient of the production activity* ϕ_p. This coefficient captures the environmental impact of the production activity, i.e., the per-unit emissions generated by the brown firm when producing its variant. The second component, $\phi_t(\theta_h^* - a)$, captures pollution from the *transportation* of the exported quantity of good d. It increases with the amount of transported goods and the *emissions coefficient of transportation*, ϕ_t. This coefficient summarizes the environmental characteristics of the transportation undertaken by the brown firm, i.e., it measures the per-unit emissions of the transported goods.[11] For the sake of simplicity, and to better highlight the possible differences between the green and the brown goods, we normalize $\phi_p = \phi_t = 1$.

The equilibrium environmental damage associated with the green firm E_g^* is given by:

$$E_g^* = \mu_p x_g^* + \mu_t \left(b - \theta_l^*\right), \tag{4}$$

where the parameter $\mu_p \gtreqless 1$ is the production emissions coefficient of green good g. The production process of variant g can be highly polluting even if the per-unit consumption-based emissions of this variant are very low (e.g., the production of batteries for electric bicycles is a very polluting activity, irrespective of the fact that using a bicycle is more environmentally friendly than a car). Whenever $\mu_p < 1$, then the green good has a lower environmental footprint in terms of consumption and unit production. The parameter μ_t measures the transportation emissions coefficient. Since the environmental impact of transportation is not a by-product of cleaner quality, the transportation of the high quality good can be more, less, or equally polluting compared to the transportation of the brown good. Formally, $\mu_t \gtreqless 1$. Given $\left(b - \theta_l^*\right)$, a high value of μ_t (e.g., $\mu_t > 1$) magnifies pollution generated by exporting the green good, whereas a low value of the parameter (e.g., $\mu_t < 1$) diminishes the environmental impact of transportation. Hence, in the range where both $\mu_p < 1$ and $\mu_t < 1$, the green good has a smaller environmental footprint in unit production, transportation and consumption ($u_g > u_d$). Nevertheless, it must be noted that this does not imply that the total level of emissions from the green good is necessarily smaller than the total level of emissions from the brown. When

[11] This coefficient can also be affected by the geographical space where transportation develops, i.e., conditions of the routes or distance between markets. Given that we consider a two-country model, we neglect the geographical characteristics of the routes along which transportation takes place and the distance between the two markets since these components affect with the same intensity firms' environmental efficiency of transportation.

the effects of trade are taken into account, it is possible that, in the setting of a closed economy, the emissions generated by the green good will increase, while those flowing from the brown one will decrease. Whenever the former rise overcompensates the latter reduction, total emissions increase. This is known as the *product mix effect*.[12]

Then, the level of environmental damages generated by the green and the brown firm at the market solution in the absence of home bias is obtained as

$$E_g^* = \frac{2b-a}{3}\left(2\mu_p + \mu_t\right) - \frac{t}{3\left(u_g - u_d\right)}\mu_t \text{ and } E_d^* = (b-2a) - \frac{t}{3\left(u_g - u_d\right)}. \quad (5)$$

The consumption-based damage from consumers buying variant j, $j = g, d$, is written as

$$E_{j,c} = \beta_j x_j,$$

where β_j is the consumption emissions coefficient when consumers choose variant j, i.e., it measures the per-unit emissions of good j when it is consumed. Since $u_g > u_d$, we assume that $\beta_g < \beta_d$. At the equilibrium, we obtain:

$$E_{g,c}^* = \frac{2\beta_g\,(2b-a)}{3} \text{ and } E_{d,c}^* = \frac{2\beta_d\,(b-2a)}{3}.$$

Although the green good has a higher environmental quality than the dirty variant, whenever the emissions coefficient of consumption β_g is not sufficiently low, the more considerable demand the green variant faces generates more significant emissions than the competing good.

We denote by $\breve{\mu}_t$ and $\breve{\beta}_g$ the values of the transportation and of the consumption coefficients such that $E_g^* = E_d^*$ and $E_{g,c}^* = E_{d,c}^*$, respectively. Then, comparing the environmental damage associated with each variant, we find the following:

Proposition 1. *If the transportation emissions coefficient is low (i.e., $\mu_t < \breve{\mu}_t$), the green firm emits a lesser quantity of pollutants in comparison to the brown firm. Conversely, if the pollution intensity in transportation surpasses a certain threshold (i.e., $\mu_t > \breve{\mu}_t$), the green firm generates a higher level of emissions relative to the brown firm. Furthermore, if the emissions coefficient of consumption is not adequately low ($\beta_g > \breve{\beta}_g$), consumers exacerbate the adverse environmental impact associated with the green alternative.*

Proof : Comparing E_g^* and E_d^*, we find

$$E_g^* - E_d^* \gtreqless 0 \Leftrightarrow \mu_t \gtreqless \breve{\mu}_t \equiv \frac{3\,(b-2a)\left(u_g - u_d\right) - t}{(2b-a)\left(u_g - u_d\right) - t} - \mu_p \frac{2\,(2b-a)\left(u_g - u_d\right)}{(2b-a)\left(u_g - u_d\right) - t},$$

whereas, considering the consumption-based damages $E_{g,c}^*$ and $E_{d,c}^*$, we obtain

$$E_{g,c}^* - E_{d,c}^* \gtreqless 0 \Leftrightarrow \beta_g \gtreqless \breve{\beta}_g \equiv \frac{(b-2a)\beta_d}{2b-a}$$

that concludes the proof. □

[12]This effect is reminiscent of the *composition effect* and *the technique effect* introduced into the literature by Copeland and Taylor (2004).

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Notice that the threshold $\breve{\mu}_t \gtreqless 1$ and recall that $x_g^* > x_d^*$. Accordingly, emissions generated by the green firm may exceed those generated by the brown rival firm due to a *quantity driver* and an *emissions intensity driver* playing a role in production and transportation. When $\mu_p < 1$ and $\mu_t < 1$, the green good undoubtedly has a greener per-unit footprint than the brown variant. The green good has an emissions-intensity driver that is environmentally friendly not only in terms of consumption ($u_g > u_d$), but also in terms of production (since $\mu_p < 1$), and transportation ($\mu_t < 1$). Nonetheless, the quantity driver hurts the environment due to the larger market share of the green firm in both the domestic and foreign markets. Whenever $\mu_t \in [\breve{\mu}_t, 1]$, the environment-enhancing force due to the emissions intensity driver in transportation is so weak that the green good turns out to be environmentally detrimental. This finding holds *a fortiori* when $\mu_t > \breve{\mu}_t > 1$ because both the quantity driver and the emissions intensity driver in transportation reinforce each other, thereby magnifying the component of pollution from transportation. This effect on quantity is reminiscent of the composition effect, which considers how trade liberalization encourages some sectors at the expense of others. Here, the values of these coefficients may magnify the environmental impact of a variant, whereas it reduces that of the other (see Aller and Herrerias, 2015, *inter alia*).

If both coefficients μ_t and μ_p are set at one, it holds that $E_g^* = 2b - a - t/3\left(u_g - u_d\right) > E_d^*$. At equal emissions intensity in production and transportation between the green and the brown variants, the green good is still produced in larger quantities than the brown one. Due to the production-based emissions, the damage generated by the green firm is more relevant than the damage generated by the rival brown good.

As a final point, we want to draw attention to a simplifying assumption of our research: the absence of production costs. One can wonder whether this assumption has a strong impact on our main findings. Assume that the cleaner firm has higher costs due to, for instance, abatement costs. Then, the equilibrium price of the high quality variant would be higher than the one we have in the absence of costs, and this is true for both the equilibrium price set in the home market and for the one set abroad. We can guess that, if the price of the green good dramatically increases, the demand met at equilibrium by the cleaner firm may decrease. This will certainly mitigate the product mix effect highlighted in the paper. However, the demand faced by the more polluting firm increases as well, and this would have a negative impact on the environment. In fact, two drivers are the basis of the link between costs and emissions. On the one hand, costs will increase both prices (with different intensity). This will reshuffle the demands at equilibrium and a priori this could be in favor of the dirtier good, whose price could increase less than that of the dirtier variant. On the other hand, home bias will sustain the demand for the local good in each country, with unpredictable effects on the different components of damage. Overall, it seems that introducing productions costs will not necessarily change all our main conclusions.

3.3. The equilibrium configuration in the presence of consumption home bias

Consider now a setting where each good is evaluated *not only* based on its intrinsic environmental quality. In this setting, consumers are green persuaded to display consumption home bias. Green persuasion changes a green behavior into a socially desirable decision. A green persuaded consumer is not just environmentally aware but has "a nonpecuniary feeling of being a good person" when contributing to abating emissions, whereas the consumer suffers "a nonpecuniary feeling of shame" otherwise (Glaeser, 2014: 209). Local consumption abates the component of emissions from transportation. This abatement is obtained whatever the environmental quality of a good. Thus, when buying a local variant, consumers have a utility benefit because they contribute to curbing emissions. In contrast, they incur a utility loss when consuming the goods produced in a foreign country, whose transportation causes pollution. In this circumstance, whatever the quality of the foreign good, their choice is environmentally detrimental because of the emissions generated by the transportation of the product.

To formalize these ideas, we use the classical vertical differentiation model presented in Section 3.1, where standard preferences are now nested with a consumption home bias component. Formally, the utility function $U_h(\theta)$ of a consumer in country h is given by

$$U_h(\theta) = \begin{cases} \theta u_g - p_{hg} + (\gamma_h u_g - u_d) & \text{if she buys } g, \\ \theta u_d - p_{hd} - (\gamma_h u_g - u_d) & \text{if she buys } d. \end{cases} \tag{6}$$

Symmetrically, the utility function $U_l(\theta)$ of a consumer in l is written as

$$U_l(\theta) = \begin{cases} \theta u_g - p_{lg} - (\gamma_l u_d - u_g) & \text{if she buys } g, \\ \theta u_d - p_{ld} + (\gamma_l u_d - u_g) & \text{if she buys } d. \end{cases} \tag{7}$$

The term $\theta u_j - p_{ij}$, $i = h, l$ and $j = g, d$ follows from the traditional approach in vertical differentiation: *ceteris paribus*, the satisfaction of consuming a variant j increases with its quality u_j, $j = g, d$ and decreases with its price p_{ij}, $i = h, l$.

The component $(\gamma_i u_j - u_{-j})$, $i = h, l$ and $j = g, d$ is the by-product of the green persuasion of consumers. More specifically, this part of the utility function is the effect of environmental campaigns, actions, or policies that aim at raising green persuasion in consumers. Consumers know that a variant generates some per unit emissions whose level unambiguously defines its environmental quality. Nonetheless, if they prefer their local variant over the foreign one, they may curb some emissions generated during the transportation of that variant from the foreign country to their home country. Preferring local variants belongs to the set of green behaviors; for green persuaded consumers, it is a worthy consumption choice. The parameter γ_i $i = h, l$ measures the *intensity of consumption home bias* and, thus, of nonpecuniary feelings of being a good person when consuming domestic items. Symmetrically, it measures the intensity of nonpecuniary feelings of shame in consuming imported goods. For a consumer living in country i, consuming the domestic variant means higher abatement of emissions, *ceteris paribus*. This abatement translates into the higher *perceived* environmental quality of the local good, i.e., $\gamma_h u_g > u_d$ and $\gamma_l u_d > u_g$. Ultimately, in the spirit of the analysis, green persuasion gives an additional utility benefit to a consumer living in i, $i = h, l$, when buying local and, on the contrary, a penalty when buying foreign.[13] *Ceteris paribus*, the higher the environmental quality of a variant, the higher the satisfaction that a consumer obtains

[13]While for a long time home bias has been largely studied in finance in the branch of optimal portfolio theory, the recent *"Buy Local" movements* pushing the idea that local consumption is more environmentally sustainable have opened the door to a different strand of analysis. Then, *home bias* has been inextricably linked to the *green supply of environmentalism* (Glaeser, 2014). We are in this strand and the reason why we need the term $(\gamma_i u_j - u_{-j})$ instead of having only γ_i is that we want to analyze how green persuasion affects the equilibrium configuration.

when purchasing that variant, due to the higher contribution they are making to the environment. Following the same rationale, their contribution to decarbonizing the world is by far more relevant, the lower the environmental quality of the alternative variant.[14]

We assume that $a > \max\left\{\gamma_h u_g/u_d - 1,\ 2\left(\gamma_l u_d - u_g\right)/\left(u_g - u_d\right)\right\}$ and $\gamma_h > 1$ and $\gamma_l > 1$, to guarantee that the utility level of a native h consumer buying good d is a priori positive and the utility of a native l consumer when buying g is also positive. The condition on the parameter a also guarantees that consuming the high quality good gives a higher level of utility than consuming the lower quality good (i.e., $\theta u_d + (\gamma_l u_d - u_g) < \theta u_g - (\gamma_l u_d - u_g)$, for $\theta \in [a, b]$). This condition avoids the fact that our model deviates from the standard vertical product differentiation setting (Gabszewicz and Thisse, 1979) and becomes horizontal differentiation: consumers in country l receive a higher utility from the dirty good. In this new scenario, the home bias would be so strong that it would dramatically alter the modes of competition and a high-quality variant would no longer exist. Thus, to be consistent with a standard vertically-differentiated approach, we restrict the analysis to the range of parameters such that $a > 2\left(\gamma_l u_d - u_g\right)/\left(u_g - u_d\right)$.[15]

The marginal consumer in each country $\theta_h\left(p_h, p_l\right)$ and $\theta_l\left(p_h, p_l\right)$, respectively, is written as

$$\theta_h(p_{hg}, p_{hd}) = \frac{p_{hg} - p_{hd} - 2\left(\gamma_h u_g - u_d\right)}{u_g - u_d} \text{ and } \theta_l(p_{lg}, p_{ld}) = \frac{p_{lg} - p_{ld} + 2\left(\gamma_l u_d - u_g\right)}{u_g - u_d}. \tag{8}$$

The smaller the *price gap* $\left(p_{hg} - p_{hd}\right)$ or the more prominent the *green persuasion* $\left(\gamma_h u_g - u_d\right)$, the larger the market share of the green good in country h. Similarly, the smaller the price gap $p_{lg} - p_{ld}$ or the more significant the green persuasion $\left(\gamma_l u_d - u_g\right)$, the larger the market share of the brown good in country l.

In this framework, demand functions faced by the green firm and the brown one are written, respectively, as

$$\begin{aligned} x_g(p_h, p_l) &= b - \theta_h(p_{hg}, p_{hd}) + b - \theta_l(p_{lg}, p_{ld}) \text{ and } x_d(p_h, p_l) \\ &= \theta_h(p_{hg}, p_{hd}) - a + \theta_l(p_{lg}, p_{ld}) - a. \end{aligned}$$

[14] In a way, it is as if consumers buying the local variant were considering what they really purchase, thereby being good citizens, and what they could consume when deviating from a green behavior. The contribution they make to the environment is evaluated *relative* to the one they could make when purchasing an alternative variant.

[15] As a consequence, it is possible that $\hat{p}^*_{lg} < \hat{p}^*_{ld}$. It is worth noting that the reverse ranking in prices would not be the only change in the model. Each firm would have a different demand function, i.e.,

$$x_g(p_h, p_l) = b - \theta_h(p_{hg}, p_{hd}) + \theta_l(p_{lg}, p_{ld}) - a \text{ and}$$
$$x_d(p_h, p_l) = \theta_h(p_{hg}, p_{hd}) - a + b - \theta_l(p_{lg}, p_{ld}).$$

Finally, one should check the positivity of $\theta_l(p_{lg}, p_{ld})$ at equilibrium, due to $\hat{p}^*_{lg} < \hat{p}^*_{ld}$. For example, at equilibrium $\theta_l(p_{lg}, p_{ld})$ could be negative in the presence of a high quality gap $u_g - u_d$, *ceteris paribus*. As a by-product of that, we could not exclude the possibility that the two firms could monopolize their own market. We thank one of the referees for a comment on this issue.

Maximizing the profit function of each firm, we get the optimal price $\hat{p}^*_{ij}$, $i = h, l$ and $j = g, d$:

$$\hat{p}^*_{hg} = p^*_{hg} + \frac{2\left(\gamma_h u_g - u_d\right)}{3} \text{ and } \hat{p}^*_{lg} = p^*_{lg} - \frac{2\left(\gamma_l u_d - u_g\right)}{3}, \tag{9}$$

$$\hat{p}^*_{ld} = p^*_{ld} + \frac{2\left(\gamma_l u_d - u_g\right)}{3} \text{ and } \hat{p}^*_{hd} = p^*_{hd} - \frac{2\left(\gamma_h u_g - u_d\right)}{3}. \tag{10}$$

Notice that the optimal price of the domestic good always increases with the intensity of the domestic consumption home bias: $\partial\hat{p}^*_{hg}/\partial\gamma_h > 0$ and $\partial\hat{p}^*_{ld}/\partial\gamma_l > 0$. In contrast, the optimal price of the foreign good always decreases with the domestic consumption home bias: $\partial\hat{p}^*_{lg}/\partial\gamma_l < 0$ and $\partial\hat{p}^*_{hd}/\partial\gamma_h < 0$. Clearly, the stronger the home bias in country h, the more significant the benefits consumers in country h obtain when buying the domestic variant and, thus, the higher the equilibrium price that the green firm sets to maximize profits. Symmetrically, an increase in γ_l magnifies the utility benefit of buying the domestic variant d for consumers living in country l, with an immediate raise of $\hat{p}^*_{ld}$. However, a rise in γ_l increases the penalty of buying the foreign good g in country l. This generates a downward pressure on $\hat{p}^*_{lg}$. *Mutatis mutandis,* a rise in γ_h reduces $\hat{p}^*_{hd}$.

Using the optimal prices, we obtain the optimal marginal consumer in each market $\hat{\theta}_h$ and $\hat{\theta}_l$,

$$\hat{\theta}^*_h = \theta^*_h - \frac{2\left(\gamma_h u_g - u_d\right)}{3\left(u_g - u_d\right)} \text{ and } \hat{\theta}^*_l = \theta^*_l + \frac{2\left(\gamma_l u_d - u_g\right)}{3\left(u_g - u_d\right)},$$

where both expressions lie within the admissible interval $[a, b]$ if, and only if, $t'' < t < t'$ (see online appendix A) , which we assume hereafter. If $t'' < t < t'$ there is bilateral trade; if $t < t'' < t'$ only the green good is traded; and if $t'' < t' < t$ there is no trade. This condition on t also guarantees that all optimal prices are non-negative.

It follows that

$$\hat{\theta}^*_h - \theta^*_h < 0 \text{ and } \hat{\theta}^*_l - \theta^*_l > 0.$$

Home bias increases the domestic quantities in both countries h and l, whereas it reduces the demand for the exported goods. This happens although the utility benefit from consuming local products is coupled with the high price for these goods. Ultimately, domestic goods are consumed more, whereas imported goods are consumed less.

The corresponding quantities $\hat{x}^*_g$ and $\hat{x}^*_d$ at equilibrium are

$$\hat{x}^*_g = x^*_g + \frac{2\left(\left(\gamma_h u_g - u_d\right) - \left(\gamma_l u_d - u_g\right)\right)}{3\left(u_g - u_d\right)},$$

$$\hat{x}^*_d = x^*_d - \frac{2\left(\left(\gamma_h u_g - u_d\right) - \left(\gamma_l u_d - u_g\right)\right)}{3\left(u_g - u_d\right)}.$$

Comparative statics show that

$$\frac{\partial\hat{x}^*_g}{\partial\gamma_h} > 0 \text{ and } \frac{\partial\hat{x}^*_g}{\partial\gamma_l} < 0; \frac{\partial\hat{x}^*_d}{\partial\gamma_h} < 0 \text{ and } \frac{\partial\hat{x}^*_d}{\partial\gamma_l} > 0.$$

In line with the rationale evoked above for optimal prices, the equilibrium demand for the domestic green good $\hat{x}^*_g$ increases unambiguously with γ_h, implying that a consumption home bias in country h has a positive effect on the firm producing the green good:

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it increases the price and the quantity. Similarly, home bias in country l favors the dirty rival: the price of its variant and the corresponding price is increasing in γ_l. We now compare the market solution in the presence and absence of home bias. Direct comparison of optimal prices yields:

Lemma 1. *Home bias undoubtedly increases domestic prices, whereas it decreases the prices of exported goods.*

This *price effect* is the direct consequence of the green persuasion of consumers that exercises a downward pressure on the willingness to pay for the exported good, and it boosts the willingness to pay for the domestic good. As expected, this finding also implies that home bias increases the price gap between the domestic and exported goods for the green and brown variants.

Turning to the total quantities exchanged at the market equilibrium, denote by $\bar{\gamma}_h \equiv \frac{u_d+\gamma_l u_d-u_g}{u_g}$ the threshold value such that $\hat{x}^*_g = x^*_g$ and $\hat{x}^*_d = x^*_d$.

Lemma 2. *Strong home bias in the country producing the green good, i.e., $\gamma_h > \bar{\gamma}_h$, decreases the quantity produced by the brown firm to the advantage of the green rival, while weak home bias in that country, i.e., $\gamma_h \leq \bar{\gamma}_h$, increases the quantity produced by the brown firm to the detriment of the green rival.*

Proof : $\hat{x}^*_g - x^*_g = 2\left(\left(\gamma_h u_g - u_d\right) - \left(\gamma_l u_d - u_g\right)\right)/3\left(u_g - u_d\right) \gtrless 0$ iff $\gamma_h \gtrless \bar{\gamma}_h$ and $\hat{x}^*_d - x^*_d = 2(\left(\gamma_l u_d - u_g\right) - (\gamma_h u_g - u_d))/3\left(u_g - u_d\right) \gtrless 0$ *if* $\gamma_h \lesseqgtr \bar{\gamma}_h$. □

Although home bias is present in both countries, the total produced quantity of either good may decrease at the equilibrium. When home bias about the green good is strong, the demand increases despite the high price since the utility consumers obtain from that product in country h is exceptionally high. In that case, the domestic consumption component is large enough to raise $\hat{x}^*_g$. This is no longer true when home bias γ_h is weak. In this circumstance, although the domestic component of consumption of the green good increases, the demand for that good observed in the other country l decreases, and this reduction is so relevant that the demand $\hat{x}^*_g$ turns out to be lower than the one occurring in the absence of home bias, i.e., x^*_g. The above findings open the door to new results about the effect of policies pushing for home bias in consumption.

Before moving to the emission analysis, we treat the impact of home bias on equilibrium profits. Online appendix B provides the technical details of the proof that the presence of home bias in countries h and l may increase or reduce profits. In particular, we find that equilibrium profits are higher in the presence of home bias than in the absence of home bias for high transportation costs. In order to capture the economic reason for this surprising result, one has to keep in mind the impact that home bias has on the equilibrium prices and quantity. We know that home bias raises the price of the domestic good. For example, γ_h raises $\hat{p}^*_{hg}$. Nonetheless, it decreases $\hat{p}^*_{hd}$, the price of the imported good. The same argument holds for the impact that home bias in country l exerts on prices. Of course, these effects are weakened or magnified by transportation costs. The higher the level of these costs, the more distant the markets and, thus, the higher the equilibrium prices that firms can set in the domestic and foreign markets—a similar economic rationale applies to the analysis of equilibrium quantities. Indeed, the demands in each country depend on t. In particular, as transportation costs rise, the

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equilibrium domestic demand gets larger and larger. Since, due to home bias, the price set by firms in their domestic market is extremely high, the transportation costs benefit firms through a two-fold mechanism: they enable firms to set very high prices in their domestic market, and jointly they sustain the demand for firms in these markets. As a result, equilibrium profits are higher in the presence of home bias than in the absence of home bias for sufficiently high transportation costs. Finally, it is worth noting that a rise in home bias in country h (resp. l) always benefits firm g (resp d):

$$\frac{\partial \hat{\Pi}_g^*}{\partial \gamma_h} = \frac{4u_g\left(t + (2b-a)\left(u_g - u_d\right) + 2(u_g\gamma_h - u_d)\right)}{9\left(u_g - u_d\right)} > 0,$$

$$\frac{\partial \hat{\Pi}_d^*}{\partial \gamma_l} = \frac{4\left(t + (b-2a)\left(u_g - u_d\right) + 2(u_d\gamma_l - u_g)\right)u_d}{9\left(u_g - u_d\right)} > 0,$$

while the *cross-effect* of home bias,

$$\frac{\partial \hat{\Pi}_g^*}{\partial \gamma_l} = \frac{4\left(t - (2b-a)\left(u_g - u_d\right) + 2(u_d\gamma_l - u_g)\right)}{9\left(u_g - u_d\right)}u_d \gtrless 0,$$

$$\frac{\partial \hat{\Pi}_d^*}{\partial \gamma_h} = \frac{4\left(t - (b-2a)\left(u_g - u_d\right) + 2(u_g\gamma_h - u_d)\right)}{9\left(u_g - u_d\right)}u_g \gtrless 0,$$

changes with the transportation costs.

Once more we observe that home bias in country $i = h, f$ pushes the price of the domestic good upward, with a direct and positive effect on the corresponding equilibrium profits. Nonetheless, it affects the rival country too. In particular, when focusing on the equilibrium prices, home bias in country i reduces the price of the imported goods in that country, negatively affecting profits. The intensity of these conflicting effects depends on transportation costs. Since the transportation costs magnify the positive effect of the domestic price on the equilibrium profits, the higher these costs, the larger the set of parameters such that the cross-effect is positive.

As a natural step, having elucidated the effects of home bias on the market configuration, we now turn to the focal question: how does home bias impact the environment?

3.4. Environmental damage of home bias

The impact of home bias on the environment is the disparity between total environmental damage under the two market scenarios: one with home bias and one without. Given preferences, we define the total environmental damage in the economy as the sum of pollution emitted by green firm E_g, brown firm E_d and by consumers in both countries when consuming variants g and d, i.e., $E_{g,c}$ and $E_{d,c}$. Then, to assess the effects of home bias, we conduct an analysis that compares total emissions with home bias, $\hat{E}$, and those without home bias, E^*. Formally, the impact of the home bias, $\hat{E} - E^*$, is written as follows:

$$\hat{E} - E^* = (\hat{E}_g - E_g^*) + (\hat{E}_d - E_d^*) + (\hat{E}_{g,c}^* - E_{g,c}^*) + (\hat{E}_{d,c}^* - E_{d,c}^*).$$

In this equation, the first two terms represent the environmental damage caused by the production and transportation of green and brown goods by firms. The last two terms relate to emissions resulting from the consumption of these goods.

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In this section, our analysis begins by assessing the environmental damage caused by each individual firm. We then explore the damage arising from consumption patterns. Finally, we examine the total environmental damage caused by home bias.

Emissions from the green firm

The environmental damage caused by the green firm $\hat{E}_g^*$ is

$$\hat{E}_g^* = \mu_p \left((b - \hat{\theta}_h^*) + (b - \hat{\theta}_l^*) \right) + \mu_t \left(b - \hat{\theta}_l^* \right).$$

By symmetry, with environmental damage in the absence of home bias E_g^* in (5), the former component $\mu_p((b - \hat{\theta}_h^*) + (b - \hat{\theta}_l^*))$ captures the emissions generated by production to serve both the domestic and the foreign market, whereas the second component $\mu_t(b - \hat{\theta}_l^*)$ represents emissions during transportation.

Directly comparing $\hat{E}_g^*$ and E_g^*, the impact of home bias on environmental damage coming from the green firm yields the following proposition:

Proposition 2. *The presence of home bias leads to an increase in emissions from the green firm when the ratio of the production and transportation emissions coefficient is relatively high (i.e., $\mu_p/\mu_t > \bar{\mu}$). Conversely, when this ratio is low (i.e., $\mu_p/\mu_t < \bar{\mu}$), home bias results in a decrease in emissions from the green firm.*

Proof : Comparing $\hat{E}_g^*$ and E_g^*:

$$\hat{E}_g^* - E_g^* = \frac{2}{3} \frac{\left(u_g - \gamma_l u_d + \gamma_h u_g - u_d\right) \mu_p + \left(u_g - \gamma_l u_d\right) \mu_t}{\left(u_g - u_d\right)} \gtreqless 0 \tag{11}$$

if, and only if,

$$\frac{\mu_p}{\mu_t} \gtreqless \bar{\mu} \equiv \frac{\gamma_l u_d - u_g}{\gamma_h u_g - u_d - \gamma_l u_d + u_g},$$

which concludes the proof. □

It follows that in the presence of a large ratio between the emissions intensity of production and that of transportation ($\mu_p/\mu_t > \bar{\mu}$), home bias certainly increases the pollution generated by the green firm. This effect is generated by a more significant consumption of the more environmentally friendly good in the domestic country, which expands pollution from production while reducing pollution from transport. Suppose the ratio is low (i.e., $\mu_p/\mu_t < \bar{\mu}$), then home bias reduces emissions because of the efficiency in production and the lower pollution from transportation. Instead, if the green producer is not very efficient in production (i.e., $\mu_p/\mu_t > \bar{\mu}$), then the greater demand in the domestic market due to home bias generates higher emissions. In this circumstance, with a high μ_p/μ_t ratio, the negative environmental effect of production dominates the pollution reduction generated by the lower amount of traded goods.

In addition, it is interesting to consider the interplay between market integration and consumption home bias. Threshold $\bar{\mu}$ depends on both coefficients of home bias, γ_h

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and γ_l. In fact, there is a spillover effect of γ_l on the emissions produced by the green good because of the export-import relations between the two economies. In particular,

$$\frac{\partial \bar{\mu}}{\partial \gamma_h} < 0 \text{ and } \frac{\partial \bar{\mu}}{\partial \gamma_l} > 0.$$

Stated in words, buying local is increasingly bad news for the emissions produced by the green firm as the green home bias increases. Furthermore, rising home bias in the country producing the brown variant has positive spillover effects. A rise in γ_l unambiguously increases the threshold value $\bar{\mu}$, thereby shrinking the range of parameters where home bias increases total emissions generated by the green product ($\frac{\mu_p}{\mu_t} > \bar{\mu}$). The rationale is that γ_l decreases emissions from the production of variant g. If this reduction is relevant, it can overcompensate for the higher emissions from transportation of the green variant generated by a higher γ_l. These are unexpected and largely neglected effects of buying local campaigns.

Emissions from the brown firm

Consider now the damage generated by the brown firm in production and transportation of the brown good, $\hat{E}_d^*$. The level of pollution caused by the brown firm $\hat{E}_d^*$ is written as:

$$\hat{E}_d^* = \frac{2\left(u_d - u_g + 2au_d - bu_d - 2au_g + bu_g - u_g\gamma_h + u_d\gamma_l\right)}{3\left(u_g - u_d\right)} + \frac{(b-2a)\left(u_g - u_d\right) - 2(u_g\gamma_h - u_d) - t}{3\left(u_g - u_d\right)}.$$

Thus, using the expression for E_d^* in (5), and taking the difference of the two levels of emissions, we can state:

Proposition 3. *Strong (resp. weak) home bias in country h unequivocally reduces (resp. increases) emissions generated by the brown firm.*

Proof: Comparing $\hat{E}_d^*$ and E_d^*, we find $\hat{E}_d^* - E_d^* = 2\frac{(u_d\gamma_l - u_g) - 2(u_g\gamma_h - u_d)}{3(u_g - u_d)} \gtrless 0 \Leftrightarrow \gamma \lessgtr \ddot{\gamma}_h \equiv \frac{2u_d - u_g + u_d\gamma_l}{2u_g}$. □

We observe that home bias in country h may reduce emissions generated by the brown producer. The reason is that a higher γ_h increases the demand for the green good in country h at the expense of the dirty variant. Although the demand for the dirty variant increases in country l, for a high value of γ_h, this rise does not suffice to sustain the demand for the dirty good worldwide. As a result, the contribution to pollution from the brown producer decreases in terms of production and transportation. Of course, the reverse occurs when γ_h is low.

Emissions from consumption

When moving to the consumption-based damage, due to the assumption of market coverage, it holds that the change in the demand faced by the green variant is counterbalanced by an opposite change in the demand faced by the brown good. Nonetheless,

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due to the emissions coefficients of consumption β_g and β_d, the environmental impact of a change in demand x_d is not neutralized by the change in x_g. In particular, knowing $\hat{x}_g^*$ and $\hat{x}_d^*$, we can state that whenever home bias in country h is weak, i.e., $\gamma < \bar{\gamma}_h$, then emissions from consumption rise, since the consumption of the green variant decreases in favor of consumption of the brown good. Finally, it is helpful to notice that $\bar{\gamma}_h > \ddot{\gamma}_h$. Thus, whenever home bias in country h is very strong ($\gamma > \bar{\gamma}_h$), it reduces consumption-based emissions.

Total environmental damage

We can now evaluate the impact of home bias on total emissions, combining the role of firms and consumers. Formally, we can rewrite the total damage as follows:

$$\hat{E} - E^* = \frac{2}{3}\frac{\left(\mu_p - \Delta\beta - 2\right)\hat{\gamma}_h + \left(1 + \Delta\beta - \left(\mu_t + \mu_p\right)\right)\hat{\gamma}_l}{\left(u_g - u_d\right)},$$

where for readability $\hat{\gamma}_h = (\gamma_h u_g - u_d)$; $\hat{\gamma}_l = (\gamma_l u_d - u_g)$, and $\Delta\beta = \beta_d - \beta_g$. Recall that $\hat{\gamma}_h$ and $\hat{\gamma}_l$ capture green persuasion. The first component of the numerator encompasses the gains and losses due to home bias in country h. Pollution will increase due to the larger production of the green good (μ_p), but it will decrease due to larger consumption of the green ($\Delta\beta$) and due to the lower production and transportation of the dirty good, ($\phi_p + \phi_t = 2$). The second terms represents the gains and losses due to home bias in country l. Pollution increases due to the higher production of the brown ($\phi_p = 1$) and due to higher consumption of the dirty good, $\Delta\beta$. But it will decrease thanks to lower production and transportation of the green towards country l, $\left(\mu_t + \mu_p\right)$.

Solving the equality $\hat{E} - E^* = 0$ gives the threshold level of utility benefit in country h, denoted by $\vec{\gamma} \equiv \left(\mu_t + \mu_p\right) - 1 - \Delta\beta/\mu_p - \Delta\beta - 2\hat{\gamma}_l$ (see online appendix C for details). We can then express the following result:

Proposition 4. *When the green firm has high environmental efficiency in production ($\mu_p < 1 + \Delta\beta - \mu_t$), strong green persuasion in h (i.e., $\hat{\gamma}_h > \vec{\gamma}$) is globally beneficial. By contrast, when the green firm has low environmental efficiency ($\mu_p > 2 + \Delta\beta$), strong green persuasion h is globally detrimental. Finally, when the green firm has moderate environmental efficiency ($\mu_p \in [1 + \Delta\beta - \mu_t, 2 + \Delta\beta]$), any level of green persuasion is always detrimental.*

Proof : See appendix C for details. □

Our findings suggest that promoting a product with high environmental quality in terms of consumption-based emissions and eco-friendly transportation does not necessarily guarantee a positive impact on the environment. This finding brings some good news for the environment, as long as the marketing of such green products does not become excessively persuasive or, if it does, then the green good must be very green in production. When a product enters the market, it becomes a source of three types of pollution: emissions arising from its consumption, production and transportation. Therefore, even if a product is labeled as "green," it is crucial to consider the overall emissions associated with it. In some cases, a green product may actually have a detrimental effect on the environment if it is highly polluting during the production process and/or consumption.

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The increased production and consumption of such a green product can result in a significant negative impact on the environment when we take into account the total emissions it generates. Therefore, it is essential to assess the entire life cycle of a product, including its production, consumption and transportation, in order to fully understand its environmental implications.

4. The asymmetric model

Empirical literature shows that environmental preferences are country-specific (Litina *et al.*, 2016). It is, therefore, interesting to analyze the case when home bias due to green persuasion appears only in the country where the green good is produced. In this section, we treat this asymmetric scenario. Assume that home bias is only present in country h while absent in country l. Accordingly, the utility function of a consumer living in countries h and l is written, respectively, as:

$$U_h(\theta) = \begin{cases} \theta u_g - p_{ig} + (\gamma_h u_g - u_d) & \text{if she buys g,} \\ \theta u_d - p_{id} - (\gamma_h u_g - u_d) & \text{if she buys d,} \end{cases} \tag{12}$$

$$U_l(\theta) = \begin{cases} \theta u_g - p_{ig} & \text{if she buys g,} \\ \theta u_d - p_{id} & \text{if she buys d.} \end{cases} \tag{13}$$

From the standard profits maximization, we get the equilibrium price $\check{p}^*_{hg}$ and $\check{p}^*_{ld}$,

$$\check{p}^*_{hg} = p^*_{hg} + \frac{2\left(\gamma_h u_g - u_d\right)}{3} \text{ and } \check{p}^*_{lg} = p^*_{lg}, \tag{14}$$

$$\check{p}^*_{ld} = p^*_{ld} \text{ and } \check{p}^*_{hd} = p^*_{hd} - \frac{2\left(\gamma_h u_g - u_d\right)}{3}. \tag{15}$$

Given these equilibrium prices, the corresponding equilibrium quantities $\check{x}^*_g(\check{p}^*_{hg}, \check{p}^*_{lg})$ and $\check{x}^*_d(\check{p}^*_{hd}, \check{p}^*_{ld})$ for firm g and firm d are:

$$\check{x}^*_g(\check{p}^*_{hg}, \check{p}^*_{lg}) = x^*_g + \frac{2}{3}\frac{(u_g\gamma_h - u_d)}{\left(u_g - u_d\right)}) \text{ and } \check{x}^*_d(\check{p}^*_{hd}, \check{p}^*_{ld}) = x^*_d - \frac{(u_g\gamma_h - u_d)}{\left(u_g - u_d\right)}.$$

We are now positioned to disentangle the effects of home bias on the equilibrium configuration when it affects consumers' preferences in only one of the two countries.

Lemma 3. *Compared with a scenario in the absence of home bias in either country, home bias in country h:*

(i) *Raises the price of the domestic good while decreasing that of the foreign good in country h;*
(ii) *Raises the demand for the green good while decreasing that for the dirtier good*;
(iii) *Does not affect the equilibrium prices in country l.*

Proof : For the first statement (i) to be evident, it suffices to see that $\hat{p}^*_{hg} > p^*_{hg}$ whereas $\hat{p}^*_{hd} < p^*_{hd}$. For the second statement (ii) it is straightforward. For (iii) just compare optimal prices. □

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In this setting, home bias changes only the prices and quantities of goods where it is present, leaving unaffected prices and quantities in the other country *l*. This has an interesting consequence on environmental damage. Compared with the scenario where home bias is absent, firm *g* now produces more than before to meet the greater demand in the domestic country. However, it does not export more now than in the traditional scenario without home bias, since the market in country *l* is unaffected by the home bias in country *h*. As a result, environmental damage decreases whenever the green firm is particularly efficient in production (μ_p sufficiently low), whereas transportation efficiency plays a minor role: no firm expands its market share in a foreign country. In a way, it is as if an asymmetric home bias reduced the connection between markets, thereby reducing transportation's possible detrimental environmental effect.

5. Conclusion

Consumption home bias is a global and well-documented phenomenon in the existing empirical literature, and several causes can explain its existence. First, home bias may arise due to the willingness to protect local employment that otherwise would be reduced in favor of foreign workers. Another reason is that information about the quality of domestic products is better than that available for foreign ones. Furthermore, geographical frictions generating substantial trade costs hinder trade and favor local goods. Nationalist movements can also fuel home bias.

Consuming local goods has also become a campaign for environmentalist movements which argue that transporting goods is one of the most polluting activities. Buying local is intended as a form of ethical consumption by environmentalists. They propose that reducing transport for delivering products is one of the most effective tools to lower emissions. We focus on the environmental impact of consumption home bias and investigate its effects in the presence of the globalization of markets. Consumers display consumption home bias. In this setting, we study the effects of home bias on the environment and highlight its impact on pollution from consumption, production and transportation. We build a model with two countries and two vertically-differentiated goods, a high-quality and a low-quality variant, and heterogenous consumers in terms of their willingness to pay for quality. Our main results show that home bias can have surprising effects on the profits of the green firm and the level of emissions. We believe some of our findings can be brought to the data in future research. Data from several surveys exist that can be used to proxy for green persuasion. One could test whether the intensity of consumption home bias has differentiated effects on green and brown firms that may increase or reduce pollution (proposition 4). Relying on the rich databases namely in the presence of a standard set of observables such as the average income of countries; trade costs measures; population size; indicators of environmental quality as an environmental performance index; and CO_2 emissions across sectors and many surveys that collect information on ecological preferences, we can advance on the empirical investigation of our findings.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S1355770X23000086

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Competing interest. The authors declare none.

References

Aller C, Ductor l and Herrerias MJ (2015) The world trade network and the environment. *Energy Economics* **52**, 55–68.
Andreoni J (1990) Impure altruism and donations to public goods: a theory of warm-glow giving. *The Economic Journal* **100**, 464–477.
Antweiler W, Copeland BR and Taylor MS (2001) Is free trade good for the environment?. *American Economic Review* **91**, 877–908.
Ardalan K (2019) Equity home bias: a review essay. *Journal of Economic Surveys* **33**, 949–967.
Bacchiega E and Minniti A (2009) The quality-income effect and the selection of location. *Journal of Urban Economics* **65**, 209–215.
Bacchiega E, Minniti A and Palestini A (2016) Quality, distance and trade: a strategic approach. *Papers in Regional Science* **95**, 165–192.
Barringer F (2008) The new trophy home, small and ecological. *New York Times*, 22 June 2008.
Bénabou R and Tirole J (2006) Incentives and prosocial behavior. *American Economic Review* **96**, 1652–1678.
Ben Elhadj N and Tarola O (2015) Relative quality-related (dis)utility in a vertically differentiated oligopoly with an environmental externality. *Environment and Development Economics* **20**, 354–379.
Brecard D (2013) Environmental quality competition and taxation in the presence of green network effect among consumers. *Environmental & Resource Economics* **54**, 1–19.
Brekke KA, Kverndokk S and Nyborg K (2003) An economic model of moral motivation. *Journal of Public Economics* **87**, 1967–1983.
Ceccantoni G, Tarola O and Zanaj S (2018) Green consumption and relative preferences in a vertically differentiated international oligopoly. *Ecological Economics* **149**, 129–139.
Choi CJ and Shin HS (1992) A comment on a model of vertical product differentiation. *Journal of Industrial Economics* **40**, 229–231.
Copeland BR and Taylor MS (2004) Trade, growth, and the environment. *Journal of Economic Literature* **42**, 7–71.
Cristea A, David H, Puzzello L and Avetisyan M (2013) Trade and the greenhouse gas emissions from international freight transport. *Journal of Environmental Economics and Management* **65**, 153–173.
Ederington J, Levinson AM and Minier J (2005) Footloose and pollution-free. *Review of Economics and Statistics* **87**, 92–99.
Esty DC (2001) Bridging the trade–environment divide. *Journal of Economic Perspectives* **15**, 113–130.
European Commission (2009) Greenhouse gas emissions from transport in Europe. Available at www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-greenhouse-gases/transport-emissions-of-greenhouse-gases-10.
Farhar BC and Houston AH (1996) Willingness to pay for electricity from renewable energy. National Renewable Energy Lab, No. NREL/TP-460-21216, Golden, CO.
French K and Poterba J (1991) Investor diversification and international equity markets. *American Economic Review* **81**, 222–226.
Gabszewicz JJ and Thisse JF (1979) Price competition, quality and income disparities. *Journal of Economic Theory* **20**, 340–359.
Gabszewicz JJ and Thisse JF (1980) Entry (and exit) in a differentiated industry. *Journal of Economic Theory* **22**, 327–338.
Glaeser E (2014) The supply of environmentalism. Discussion Paper n 14-56, Harvard Environmental Economics Program, Cambridge, MA.
ITF Transport Outlook (2015) OECD. Available at https://www.oecd.org/environment/itf-transport-outlook-2015-9789282107782-en.htm.
Kandel E and Lazear EP (1992) Peer pressure and partnerships. *Journal of Political Economy* **100**, 801–817.
Krugman P (1980) Scale economies, product differentiation, and the pattern of trade. *American Economic Review* **70**, 950–959.
Lambertini L (2013) *Oligopoly, the Environment and Natural Resources*. London: Routledge.

Litina A, Moriconi S and Zanaj S (2016) The cultural transmission of environmental preferences: a comparative approach. *World Development* **84**, 131–148.

Lombardini-Riipinen C (2005) Optimal tax policy under environmental quality competition. *Environmental & Resource Economics* **32**, 317–336.

Mantovani A, Tarola O and Vergari C (2016) Hedonic and environmental quality: a hybrid model of product differentiation. *Resource and Energy Economics* **45**, 99–123.

Marini MA, Tarola O and Thisse JF (2022) When is environmentalism good for the environment?. *Environmental & Resource Economics* **82**, 1–28.

McAusland AL and Millimet DL (2013) Do national borders matter? Intranational trade, international trade, and the environment. *Journal of Environmental Economics and Management* **65**, 411–437.

Munksgaard J and Pedersen KA (2001) CO2 accounts for open economies: producer or consumer responsibility?. *Energy Policy* **29**, 327–334.

Mussa M and Rosen S (1978) Monopoly and product quality. *Journal of Economic Theory* **18**, 301–317.

Nyborg K (2000) Homo economicus and homo politicus: interpretation and aggregation of environmental values. *Journal of Economic Behavior & Organization* **42**, 305–322.

Nyborg K, Howarth RB and Brekke KA (2006) Green consumers and public policy: on socially contingent moral motivation. *Resource and Energy Economics* **28**, 351–366.

Ostrom E (2000) Collective action and the evolution of social norms. *The Journal of Economic Perspectives* **14**, 137–158.

Pantelaiou I, Hatzipanayotou P, Kostantinou P and Xepapadeas A (2020) Can cleaner environment promote international trade? Environmental policies as export promoting measures. *Environmental & Resource Economics* **75**, 809–833.

Picard PM and Tampieri A (2021) A vertical differentiation and trade among sym-metric countries. *Economic Theory* **71**, 1319–1355.

Sartzetakis ES, Xepapadeas A and Petrakis E (2012) The role of information provision as a policy instrument to supplement environmental taxes. *Environmental & Resource Economics* **52**, 347–368.

Schooler RD (1965) Product bias in the Central American common market?. *Journal of Marketing Research* **2**, 394–397.

Shaked A and Sutton J (1983) Natural oligopolies. *Econometrica* **51**, 1469–1483.

Shimp TA and Sharma A (1987) Consumer Ethnocentrism: Construction and Validation of the CETSCALE. *Journal of Marketing Research* **24**, 280–289.

Stark O (1991) *The Migration of Labor*. Blackwell: Cambridge & Oxford.

Sundt S and Rehdanz K (2015) Consumers' willingness to pay for green electricity: A meta-analysis of the literature. *Energy Economics* **51**, 1–8.

Taylor MS (2005) Unbundling the pollution haven hypothesis. *Advances in Economic Analysis & Policy* **3**, 1–28.

Veen-Groot van DB and Nijkamp P (1999) Globalisation, transport and the environment: new perspectives for ecological economics. *Ecological Economics* **31**, 331–346.

Wang H and Yang BZ (2001) Mixed-strategy equilibria in a quality differentiation model. *International Journal of Industrial Organization* **19**, 213–226.

Wauthy X (1996) Quality choice in model of vertical differentiation. *Journal of Industrial Economics* **54**, 345–353.

Wiedmann T, Lenzen M, Turner K and Barrett J (2007) Examining theglobal environmental impact of regional consumption activities–Part 2: Review of input–output models for the assessment of environmental impacts embodied in trade. *Ecological Economics* **61**, 15–26.

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