Globalization of Markets and Consumption Home Bias: New Insights for the Environment *

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Abstract

We define a model of international oligopoly with two countries, two vertically differentiated goods, and heterogeneous consumers in terms of their willingness to pay for quality. We investigate various sources of pollution: 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 local abates transportation pollution. We investigate whether consumption home bias effectively curbs good-specific and global emissions. Finally, we uncover the role played by globalization that integrates markets.

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

JEL Classification: D43, F10, F15, Q56

*We thank Maria Eugenia Sanin, Cecilia Vergari and Jacques Thisse for valuable discussions. The paper benefitted from very insightful comments by the editor and two anonymous referees. The authors also thank their supportive partners whose help made the research possible during the COVID-19 pandemic. The usual disclaimer applies.

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1 Introduction

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

The process of globalisation has made the accessibility to spatially dispersed markets easier and transportation faster and cheaper. This ongoing process of interconnection among different spaces and people has generated two classes of consequences.

However, the long-term effects of globalisation and trade on carbon dioxide (CO2) emissions have been largely neglected. On the one hand, the quantity of traded goods has dramatically increased over the last decades, naturally with increased emissions from transportation. According to International Transport Forum (ITF) estimates, international trade-related freight transport accounts for around 30% of all transport-related CO2 emissions from fuel combustion and more than 7% of global emissions (OECD, ITF 2015). Thus, in the transport sector, the gradual decline in emissions that has been obtained elsewhere is not yet observed.

On the other hand, in several countries, various movements aiming to protect the local dimension of niche economies have surged. For instance, 'Buy local' campaigns are rising as a reaction to a globalised consumption pattern, endeavouring to support local businesses and protect domestic jobs. 'Wise leaders always put the good of their own people and their own country first. [...] The future does not belong to globalists. The future belongs to patriots.' Donald Trump declared this in his third-ever address to the United Nations General Assembly, touting his 'America First' policies.[1]Similar campaigns, such as 's/he who insists wins' (or $\varepsilon\pi\iota\mu\varepsilon\nu\omega\nu\ \varepsilon\lambda\lambda\eta - \nu\iota\kappa\alpha$), 'Compras made in Spain' or 'Buy Irish' have been developed in the so-called PIIGS countries (Portugal, Italy, Ireland, Greece, and Spain).

Labelling and other information schemes disseminate information about the negative environmental impacts of brown consumption choices among rational consumers, whereas

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

green persuasion links an intangible benefit (resp. an intangible penalty) to local (resp. foreign) consumption. Unsurprisingly, several green movements have embraced these campaigns, translating them, in large part, into 'buy local, be cleaner' and pushing forward the idea of local goods to curb emissions generated from transportation. These environmental movements are not confined to raising awareness among consumers that consumption is a polluting activity but work as drivers of green persuasion (Glaeser, 2014).[2]

Green-persuaded consumers obtain "a nonpecuniary feeling of being a good person" when buying domestically produced goods. This feeling translates into a benefit beyond the satisfaction of a material need and is added to their utility function, whatever the emissions generated to produce and consume the good. By symmetry, these consumers suffer "a nonpecuniary feeling of shame" otherwise (Glaeser, 2014, pg 209), i.e. when purchasing a foreign good, regardless of whether the foreign good has an ecological footprint in production and consumption, emissions are generated from transportation.[3]Due to this, it deserves social condemnation. This tendency of consumers towards local products is called consumption home bias.[4]

Although consumption home bias is a global and well-documented phenomenon in the existing empirical literature, its impact on emissions has been neglected. No doubt, inducing consumers to prefer domestic goods has a direct positive impact on the environment since it contributes to minimising emissions from transportation.[5]Nonetheless, goods are often differentiated along an environmental-quality dimension so that per-unit emissions

[2]Benefit and penalty can have both internal and external motivations. For this distinction, Gleaser 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".

[3]Although these internal and external motivations are not mutually exclusive, consumers buying green goods become socially worthy citizens when external motivation is the primary driver of green action. They can show "a kind of green pride" when preferring an environmentally friendly product over a common variant (Barringer, 2008), thereby obtaining a reputational payoff (Benabou and Tirole, 2006). Instead, internal motivation relates to a Kantian behaviour model: a consumer chooses a green good because this is moral and provides him/her with a positive self-image.

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

[5]See on this Lambertini (2013).

from consumption are not uniform. Moreover, producers can adopt different techniques, generating different per-unit production emissions. Thus, even if the demand for domestic products comes at the expense of foreign products, the home bias can have an indirect and undesirable effect on total emissions. For example, suppose demand increases for goods with high per-unit emissions from consumption at the expense of a cleaner variant. In that case, total emissions will decrease if the corresponding per-unit emissions from production, jointly with per-unit emissions from transportation, decrease enough to counterbalance this increase. Otherwise, the expected gains from local consumption will be so low that home bias will negatively impact total pollution.

To tackle this issue, in this research, we propose an international duopoly model where international trade and consumption home bias coexist, products are differentiated in terms of environmental quality, and pollution is generated not only by consumption and production but also by the transportation of goods. In this setting, we explore whether home bias can sustain the consumption of a local good with a poor environmental footprint either in consumption or in production at the expense of a foreign variant with a better footprint in one of these two environmental dimensions. In addition, we consider the net impact of home bias on total emissions, thus jointly considering three sources of pollution: consumption, production, and transportation.

We define a model with two countries and two vertically differentiated goods, a high and a low environmental quality good that we call green and brown. Each country is populated by a firm producing a good. Firms export their product, thereby facing trade costs and generating pollution from transportation, in addition to pollution from production. Final consumers produce pollution from consumption. Firms are characterised by varying environmental efficiency in terms of production and transportation. As a benchmark, we consider environmentally aware consumers with a heterogeneous willingness to pay for environmental quality in each country. In this setting, we introduce home bias and characterise the market configuration at equilibrium when firms compete in terms of prices.

We find that consumption home bias has unforeseen effects on equilibrium prices and profits. It unambiguously increases the prices of domestic goods while reducing those of foreign variants. The effects on profits are ambiguous and depend on transportation costs. When markets are poorly integrated, home bias benefits firms as it sustains their market power in the domestic market, thanks to the trade barriers generated by the high transportation costs. As far as the environmental damage is concerned, consumption home bias can be environmentally detrimental. Interestingly, when total emissions increase in the presence of a strong home bias in the country where the cleaner good is produced, this is only due to the production-based emissions generated by the cleaner firm.

Our findings have two implications. First, they suggest that policies pushing for local consumption may have unexpected consequences and must be cautiously analysed. Some of the most widespread sources of home bias are the environmental campaigns that encourage the consumption of local goods. They argue that local consumption avoids the transportation of goods, which is one of the most polluting activities. In this paper, we question the theoretical foundations of this argument, showing that caution is needed because phenomena such as home bias may increase rather than decrease pollution. Second, our findings highlight the price effects of consumption home bias. More specifically, it can generate an unwarranted general price increase that contrasts with the expected effects of international trade.

In the following section, we place our paper in the context of the relevant literature. The roadmap of the paper is as follows. 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 analysing home-bias drivers of economic choices. We focus on consumption home bias for environmental reasons, expressed by consumers aware that close-substitute goods may have very different ecological footprints. The theoretical literature on pro-environmental behaviours and their effect on market equilibria has rapidly increased (Lombardini-Riipinen, 2005; Brécard, 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., 2020). 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), reputational payoff (Bènabou 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; Nyborg et al., 2006; Brekke et al., 2003). 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 he/she has "a nonpecuniary feeling of being a good person" when contributing to minimising emissions. In contrast, he/she suffers "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) rationalised these consumption preferences using the notion of ethnocentrism. In their seminal paper, Shimp and Sharma (1987) emphasise 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, and 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 behaviour 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, ...) 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) and Gabszewicz and Thisse (1979), 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.[6]

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), whereas the theo-

[6] See Jayadevappa and Chhatre (2000) for a survey of environment and trade.

retical pollution-haven argument and also 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 et al., 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, namely carbon monoxide emissions, known to have an immediate harmful effect on air quality. Our fundamental assumption is that consumers buy locally to minimise 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% 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/or 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.[7]

We characterise 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 analyse different sources of pollution, we consider heterogeneous goods. Consequently, pollution 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 a problem of misinformation and differentiated variants belonging to the same category of goods can be perceived as homogeneous.[8]

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 con-

[7] 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.

[8] Take the example of electric vehicles. No doubts 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 by far higher 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 GHG emissions.

sumers 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, Levin 1990, Wasik 1996, EC 2010, The Global Sustainability Study 2021).

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 h and l the countries 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 $u_g > u_d$. 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.[9]

For simplicity and without loss of generality, we assume $2u_d > u_g$.[10] 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, $1 \geq t \geq 0$. 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.[11]

[9] 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) analyse 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.*

[10] 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 to the authors.

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

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

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

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 $\theta_i(p_{ig}, p_{id})$, 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

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

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

$$x_g(p_{hg}, p_{hd}) = b - \theta_h(p_{hg}, p_{hd}) + b - \theta_l\,(p_{hg}, p_{hd})$$

$$x_d(p_{hd}, p_{ld}) = \theta_l\,(p_{hd}, p_{ld}) - a + \theta_h\,(p_{hd}, p_{ld}) - a,$$

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 write as:

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

Maximizing the above profits yields the equilibrium prices:

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

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:

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

and both expressions lie within the admissible interval $[a, b]$ if and only if $t < t' \equiv (u_g - u_d)\,(b - 2a)$, which we assume hereafter. If the value of trade costs is above the threshold t', these 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

$$x_g^* = \frac{2\,(2b-a)}{3} \quad \text{and} \quad x_d^* = \frac{2\,(b-2a)}{3}.$$

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

We define the total pollution damage in the economy E as the sum of pollution emitted by green firm E_g and brown firm E_d and by consumers in both countries when consuming variants g and d, i.e. $E_{g,c}$ and $E_{d,c}$.

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 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^* writes 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 more considerable 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 summarises the environmental characteristics of the transportation undertaken by the brown firm, i.e. it measures the per-unit emissions of the transported goods.[12] For the sake of simplicity and to better highlight the possible differences between the green and the brown good, we normalise $\phi_p = \phi_t = 1$.

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 the 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 a cleaner quality, the transportation of the high quality good can be more, less, or equally polluting than 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 better 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

[12] 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 the same intensity firms' environmental efficiency of transportation.

emissions from the brown. When the effects of trade are taken into account, it may happen that, for a setting of a closed economy, the emissions generated by the green good increase, while those flowing from the brown one decrease. Whenever the former rise overcompensates the latter reduction, total emissions increase. This is known as the *product mix effect.*[13]

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

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

Moving to the consumption-based damage from consumers buying variant j, $j = g, d$, it writes 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:

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

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 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 notice the following:

Proposition 1 *If pollution intensity from transportation is very low (i.e.* $\mu_t < \breve{\mu}_t$*), then*

[13] This effect is reminiscent of the *composition effect* and *the technique effect* introduced in the literature by Copeland and Taylor (1994).

the green firm generates a lower level of emissions compared to the brown one. Otherwise, it generates more emissions than the brown firm. Whenever the emissions coefficient of consumption β_g is not sufficiently low ($\beta_g > \breve{\beta}_g$), consumers exacerbate the detrimental environmental impact of the green variant.

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

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

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. ■

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 both in 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.[14]

If both coefficients μ_t and μ_p are set at one, it holds that $E_g^* = 2b - a - \frac{t}{3(u_g - u_d)} > E_d^*$. At equal emissions intensity in production and transportation between the green and the brown variant, the green good is still more largely produced 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.

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*.[15] Green persuasion changes a green behaviour 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 abate emissions, whereas the consumer suffers "a nonpecuniary feeling of shame" otherwise (Glaeser, pg. 209, 2014). 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 environment detrimental for 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

[14] See Aller et al. (2015), *inter alia*.

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

component. Formally, the utility function $U_h(\theta)$ of a consumer in country h is given by

$$U_h(\theta) = \begin{cases} \theta u_g - p_{hg} + (\gamma_h u_g - u_d) \text{ if she buys } g \\ \theta u_d - p_{hd} - (\gamma_h u_g - u_d) \text{ if she buys } d \end{cases} \tag{5}$$

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

$$U_l(\theta) = \begin{cases} \theta u_g - p_{lg} - (\gamma_l u_d - u_g) \text{ if she buys } g \\ \theta u_d - p_{ld} + (\gamma_l u_d - u_g) \text{ if she buys } d \end{cases} \tag{6}$$

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 a green persuasion to consumers. Consumers know that a variant generates some per unit emissions, whose level unambiguously defines its environmental quality. Nonetheless, if they privilege 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 behaviours; 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.

We assume that $a > \max\left\{\gamma_h \frac{u_g}{u_d}, \frac{2(\gamma_l u_d - u_g)}{(u_g - u_d)}\right\}$ 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. Finally, 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 $\theta \in [a, b]$).

The marginal consumer in each country $\theta_h(p_h, p_l)$ and $\theta_l(p_h, p_l)$, respectively, write as

$$\theta_h(p_{hg}, p_{hd}) = \frac{p_{hg} - p_{hd} - 2(\gamma_h u_g - u_d)}{u_g - u_d} \quad \text{and} \quad \theta_l(p_{lg}, p_{ld}) = \frac{p_{lg} - p_{ld} + 2(\gamma_l u_d - u_g)}{u_g - u_d}. \quad (7)$$

The smaller the *price gap* $(p_{hg} - p_{hd})$ or the more prominent the *green persuasion* $(\gamma_h u_g - u_d)$, 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 $(\gamma_l u_d - u_g)$, 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 write, respectively, as

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

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

$$\hat{p}^*_{hg} = p^*_{hg} + \frac{2(\gamma_h u_g - u_d)}{3} \quad \text{and} \quad \hat{p}^*_{lg} = p^*_{lg} - \frac{2(\gamma_l u_d - u_g)}{3} \quad (8)$$

$$\hat{p}^*_{ld} = p^*_{ld} + \frac{2(\gamma_l u_d - u_g)}{3} \quad \text{and} \quad \hat{p}^*_{hd} = p^*_{hd} - \frac{2(\gamma_h u_g - u_d)}{3} \quad (9)$$

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 $\partial \hat{p}^*_{ld}/\partial\gamma_l > 0$. Instead, the optimal price of the domestic good always decreases with the foreign 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_l 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, for international trade to take place, we need to impose $t'' < t < t'$ (see Appendix A). This condition 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

$$\hat{x}_g^{*} = x_g^{*} + \frac{2\left(\left(\gamma_h u_g - u_d\right) - \left(\gamma_l u_d - u_g\right)\right)}{3\left(u_g - u_d\right)} \tag{10}$$

$$\hat{x}_d^{*} = x_d^{*} - \frac{2\left(\left(\gamma_h u_g - u_d\right) - \left(\gamma_l u_d - u_g\right)\right)}{3\left(u_g - u_d\right)} \tag{11}$$

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 of 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: it increases the price and the quantity. Similarly, home bias in country l favours 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, and 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 variant.

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 at the detriment of the green rival.*

Proof. $\hat{x}_g^* - x_g^* = \frac{2((\gamma_h u_g - u_d) - (\gamma_l u_d - u_g))}{3(u_g - u_d)} \gtrless 0$ iff $\gamma_h \gtrless \bar{\gamma}_h$ and $\hat{x}_d^* - x_d^* = \frac{2((\gamma_l u_d - u_g) - (\gamma_h u_g - u_d))}{3(u_g - u_d)} \gtrless 0$ $if\ \gamma_h \lessgtr \bar{\gamma}_h$. ■

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^*. Accordingly, *a priori* home bias for the green good may have ambiguous environmental consequences as it may increase the production of the brown good and thus emissions, as we will show in the next section.

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 home bias's impact on the equilibrium profits. We bring in Appendix B 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 catch 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 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 for a twofold 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 under home bias

In this section, we uncover the environmental damage produced by goods. We consider each firm separately.

Emissions from the green firm To explore the effect of the home bias, we consider the environmental damage $\hat{E}_g^*$

$$\hat{E}_g^* = \mu_p \left((b - \hat{\theta}_h^*) + (b - \hat{\theta}_l^*) \right) + \mu_t \left(b - \hat{\theta}_l^* \right) \tag{12}$$

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

The *overall* impact of home bias on environmental damage coming from the green firm yields the following proposition:

Proposition 2 *Home bias increases emissions generated by the green firm whenever the production emissions coefficient is relatively high, i.e.* $\mu_p/\mu_t > \bar{\mu}$*. Otherwise (i.e.* $\mu_p/\mu_t < \bar{\mu}$*), home bias decreases the level of emissions from the green firm.*

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

$$\hat{E}_g - E_g^* = \frac{2 \left[\mu_p \left((u_g \gamma_h - u_d) - (u_d \gamma_l - u_g) + t \right) - \mu_t \left((u_d \gamma_l - u_g) - t \right) \right]}{3 \left(u_g - u_d \right)} \gtreqqless 0 \tag{13}$$

if and only if

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

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 not significant (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 large μ_p/μ_t ratio, the negative environmental effect of production dominates the pollution reduction generated by the lower amount of traded goods.

Considering the interplay between market integration and consumption home bias is interesting. Threshold μ depends on both coefficients of home bias γ_h and γ_l, and the trade intensity captured by the transport costs t. 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,

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

In words, buying local is increasingly bad news for the environment 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. Finally, when the transport costs decrease, $\bar{\mu}$ raises, thereby reducing the set of parameters such that home bias is environmentally detrimental. Indeed when transport costs decrease, markets become more integrated. In that case, the production of the green good targeted to the foreign country decreases and the emissions from transportation too.

In words:

Remark 1 *Home bias may be detrimental to the environment. If the green good is not that different from the dirty good in terms of emissions intensity in production or the environmental efficiency in transportation is not very pronounced, then, home bias in the country h increases the environmental damage due to the domestic firm.*

This is an unexpected and largely neglected effect of buying local campaigns.

Emissions from the brown good 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 $\hat{E}_d^*$ writes 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, we can state:

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

Proof. $\hat{E}_d^* - E_d^* = 2\frac{(u_d\gamma_l - u_g) - 2(u_g\gamma_h - u_d)}{3(u_g - u_d)} \gtreqless 0 \Leftrightarrow \gamma \lesseqgtr \ddot{\gamma}_h \equiv \frac{2u_d - u_g + u_d\gamma_l}{2u_g}$. ■

We observe that when 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, due to the emissions coefficients of consumption β_g and β_d, the environmental impact of a change in the demand x_d is not neutralized by the change of 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 favour of that 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 significant ($\gamma > \bar{\gamma}_h$), it reduces consumption-based emissions. Moreover, it unambiguously curbs emissions generated by the brown producer since $\bar{\gamma}_h > \ddot{\gamma}_h$. Nonetheless, it increases emissions generated from the production of the green good.*

We can now evaluate the overall emissions generated from the brown and the green good, combining the role of firms and consumers.

Proposition 4 *Home bias can be environmentally detrimental. When total emissions increase in the presence of a strong home bias in country h, this is only due to the production-based emissions generated by the green firm.*

Proof. Whenever $\gamma_h > \bar{\gamma}_h > \ddot{\gamma}_h$, home bias reduces the emissions from consumption, since the demand of green variant increases at the expense of the dirties variant, due to home bias in country h. Moreover, in that circumstance, emissions from the brown producer unambiguously decrease with home bias in country h. Thus, if emissions raise, this is only due to the higher level of pollution generated by the green firm. ■

Our finding suggests that marketing a good of high environmental quality in terms of consumption-based emissions and whose transportation is environmentally friendly has not *a priori* a positive impact on the environment. It is good news for the environment as long as the home bias is not excessive. The presence of a product in the market generates three sources of pollution: emissions flow from consuming, producing and transporting a good. Accordingly, if the green product is highly pollutant during the production process and/or consumption, it can be that its increased production and consumption hurt the environment when considering the total emissions associated with it.

4 The equilibrium configuration in the presence of asymmetric consumption home bias

Empirical literature shows that environmental preferences are country-specific (Litina et al., 2016). It is, therefore, interesting to analyse 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 case. 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 write, respectively, as:

$$U_i(\theta) = \begin{cases} \theta u_g - p_{ig} + (\gamma_h u_g - u_d) \text{ if she buys g} \\ \theta u_d - p_{id} - (\gamma_h u_g - u_d) \text{ if she buys d} \end{cases} \tag{14}$$

$$U_i(\theta) = \begin{cases} \theta u_g - p_{ig} \text{ if she buys g} \\ \theta u_d - p_{id} \text{ if she buys d} \end{cases} \tag{15}$$

with $i = h, l$. Thus, it is immediate to see that the consumers indifferent between buying the green or the brown good, in country h, i.e. $\breve{\theta}_h$ and in country l, i.e. $\breve{\theta}_l$, respectively, are:

$$\breve{\theta}_h = \frac{p_{hg} - p_{hd} - 2(\gamma_h u_g - u_d)}{u_g - u_d} \text{ and } \breve{\theta}_l = \frac{p_{lg} - p_{ld}}{u_g - u_d}.$$

The profit functions $\Pi_g(p_{hg}, p_{lg})$ and $\Pi_d(p_{ld}, p_{hd})$ for firm g and firm d write, respectively, as:

$$\Pi_g(p_{hg}, p_{lg}) = \left(b - \frac{p_{hg} - p_{hd} - 2(\gamma_h u_g - u_d)}{u_g - u_d}\right) p_{hg} + (b - \frac{p_{lg} - p_{ld}}{u_g - u_d})(p_{lg} - t)$$
$$\Pi_d(p_{ld}, p_{hd}) = \left(\frac{p_{lg} - p_{ld}}{u_g - u_d} - a\right) p_{ld} + (\frac{p_{hg} - p_{hd} - 2(\gamma_h u_g - u_d)}{u_g - u_d} - a)(p_{hd} - t).$$

From the standard profits maximization with respect to p_{ij}, $i = h, l$ and $j = g, d$, we get the equilibrium price $\check{p}^*_{ij}$,

$$\check{p}^*_{hg} = p^*_{hg} + \frac{2(\gamma_h u_g - u_d)}{3} \quad \text{and} \quad \check{p}^*_{lg} = p^*_{lg} \tag{16}$$
$$\check{p}^*_{ld} = p^*_{ld} \quad \text{and} \quad \check{p}^*_{hd} = p^*_{hd} - \frac{2(\gamma_h u_g - u_d)}{3} \tag{17}$$

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:

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

We are now positioned to disentangle the effects of home bias on the equilibrium configuration when it affects consumers' preferences only in 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 notice that

$\hat{p}^*_{lj} = p^*_{lj}, j = g, d.$ ■

The presence of home bias in country h suffices to alter the expected results in the absence of home bias. At first sight, the main findings seem to align with the ones observed when home bias is present in both countries. However, the mechanisms through which home bias in one country alters the standard setting of a vertically differentiated market are not equivalent to those observed when it is present in both countries. In particular, it changes only the prices of goods in country h where it is present, leaving unaffected prices in the other country l and knowing that consumers in country l display standard preferences, firms g and d quote in that country, at the equilibrium, the same prices observed in the absence of home bias. Moreover, the higher demand for firm g is only driven by the higher demand in the domestic country h since the demand faced in country l is unaffected by the home bias. 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 environmental detrimental effect. We can conclude that:

Proposition 5 *Compared with a scenario of the absence of home bias in either country, home bias for the green good does not alter the equilibrium configuration of the market in country l, whereas it expands the equilibrium demand for the green good at the expense of that for the brown good in country h. As a result, efficiency in transportation turns out to be less significant for the environment.*

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 favour 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 favour local goods. Nationalist movements can also fuel home bias.

Consuming local goods has also become a campaign for environmentalist movements that 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. In this paper, 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 profit of the green firm and the level of emissions. We believe some of our findings can be brought to the data in future research. Several survey data exist that can be used to proxy for green persuasion. Using these databases, one could test whether the intensity of consumption home bias has differentiated effects on green and brown firms that may increase or reduce pollution (Propositions 4). Secondly, with proxies on how easy international trade is, we could empirically investigate the role of trade as a multiplier of the effects of consumption home bias (Remark 1).

To conclude, we remain optimistic that relying on the rich databases available nowadays, 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 (EPI) and CO2 emissions across sectors and many surveys that collect information on ecological preferences, we can advance on the empirical investigation of our findings.

Competing interests:

The authors declare none.

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Appendices

Appendix A. International trade condition

International trade takes place when

$$a < \theta_h^* = \frac{a+b}{3} - \frac{t}{3\left(u_g - u_d\right)} - \frac{2\left(\gamma_h u_g - u_d\right)}{3\left(u_g - u_d\right)} < b$$
$$a < \theta_l^* = \frac{a+b}{3} + \frac{t}{3\left(u_g - u_d\right)} + \frac{2\left(\gamma_l u_d - u_g\right)}{3\left(u_g - u_d\right)} < b$$

Denote $t'' \equiv (b-2a)\left(u_g - u_d\right) - \left(2u_g\gamma_h - 2u_d\right)$ and $t' \equiv \left(u_g - u_d\right)(2b-a) - 2\left(\gamma_l u_d - u_g\right)$. Solving the above inequalities for t, we obtain

$$t'' < t < t'.$$

5.1 Appendix B. Profits in presence of home bias

Profit of both firms in absence of home bias are:

$$\Pi_g^* = \frac{2}{9}\frac{t^2}{u_g - u_d} + \frac{2}{9}\left((2b-a)^2\left(u_g - u_d\right)\right) \text{ and}$$

$$\Pi_d^* = \frac{2}{9}\frac{t^2}{u_g - u_d} + \frac{2}{9}\left((b-2a)^2\left(u_g - u_d\right)\right,$$

while in presence of home bias, each firms obtain $\hat{\Pi}_g^*$ and $\hat{\Pi}_d^*$:

$$\hat{\Pi}_g^* = \frac{2}{9}(2b-a)^2(u_g-u_d) + \frac{4}{9}(2b-a)(u_g-u_d+u_g\gamma_h-u_d\gamma_l) + \Gamma$$
$$\hat{\Pi}_d^* = \frac{2}{9}(b-2a)^2(u_g-u_d) + \frac{4}{9}(b-2a)(u_d-u_g-u_g\gamma_h+u_d\gamma_l) + \Gamma$$

where $\Gamma = \frac{2\left(2t((u_g\gamma_h-u_g)+(u_d\gamma_l-u_d))+t^2+2(u_d\gamma_l-u_g)^2+2(u_g\gamma_h-u_d)^2\right)}{9(u_g-u_d)}$. The difference of equilibrium in presence and in absence of home bias is:

$$\hat{\Pi}_g^* - \Pi_g^* = \frac{4}{9}(2b-a)(u_d-u_g-u_g\gamma_h+u_d\gamma_l) + \tau \gtrless 0 \Leftrightarrow t \gtrless \hat{t}$$
$$\hat{\Pi}_d^* - \Pi_d^* = \frac{4}{9}(b-2a)(u_d-u_g-u_g\gamma_h+u_d\gamma_l) + \tau \gtrless 0 \Leftrightarrow t \gtrless \tilde{t}$$

where $\tau = \frac{4\left((u_g\gamma_h-u_d)^2+(u_d\gamma_l-u_g)^2+t(u_g\gamma_h-u_g-u_d+u_d\gamma_l)\right)}{9(u_g-u_d)}$ and

$$\hat{t} = \frac{(u_g-u_d)(2b-a)(u_d\gamma_l-u_g\gamma_h+u_d+u_g)-(u_g\gamma_h-u_d)^2-(u_d\gamma_l-u_g)^2}{(u_g\gamma_h-u_g-u_d+u_d\gamma_l)}$$
$$\tilde{t} = \frac{(b-2a)(u_g-u_d)(u_g\gamma_h-u_d+u_g-u_d\gamma_l)-(u_g\gamma_h-u_d)^2-(u_d\gamma_l-u_g)^2}{(u_g\gamma_h-u_g-u_d+u_d\gamma_l)},$$

with $\hat{t} > \tilde{t}$.