Some Simple Economics of Green Markets

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Abstract

Policymakers seek to reduce environmentally harmful production by leveraging consumers' demand for low-externality products. Should the exchange of such products be organized under the standard principle of "one market for one good", creating a separate market for green goods and integrating regional green markets? We show that this reduces harmful production if and only if green demand is sufficiently strong relative to green supply. Otherwise, a "demand displacement effect" arises: stronger demand for green goods induces substitution toward brown goods, thereby increasing externalities. This effect interacts with other policy instruments.

Keywords: Green markets; socially responsible consumers; externalities; market segmentation; demand displacement; environmental policy.

JEL Codes: D62; D64, Q58.

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1 Introduction

A basic principle emerging from classical economics is the optimality of *one market for one good*: separate goods should trade in separate markets, while the same good should trade in a single market. If some consumers prefer organic milk to identical-looking conventional milk, for instance, then a separate market for organic milk should be created through mandatory disclosure of the seller's milk type, and regional markets for organic milk should be integrated. The resulting market organization facilitates the satisfaction of consumer preferences and allocates production efficiently.[1]

In this paper, we reconsider the one-market-for-one-good principle in the context of green products — when functionally identical goods can be produced with different externalities, and some consumers prefer "green" (low-externality) to "brown" (high-externality) goods. That situation arises for a broad and economically large set of markets. For example, sustainable products comprise 25.4 percent of the US consumer packaged goods market, and electricity from renewable sources accounts for 47 percent of EU power production. Other green products include low-CO_2 steel and chemicals, animal-friendly food items, and "fair trade" coffee, textiles, and electronics. Many "conscious" consumers are willing to (and often do) pay a premium for these low externality goods because they do not want to contribute to harmful production.[2] Furthermore, policymakers constrained in using Pigouvian taxation and other regulations increasingly aim to leverage conscious demand to achieve environmental goals. Following the one-market principle, it may then seem natural to satisfy conscious consumers' preferences by creating a separate market for green goods through certification of green production, and integrating green markets across regions.[3] We ask whether and when these policies indeed reduce externalities.

Using a simple supply-demand framework with two physically identical goods produced with and without externalities respectively, we find that neither side of the principle can be applied in general, and we characterize when each can. Namely, the creation or integration of green markets reduces

[1]Standard general equilibrium theory (Debreu, 1959) shows that if there is a separate market for each good, a competitive equilibrium is Pareto efficient. In particular, asymmetric information about the type of product can result in an inefficient allocation (Akerlof, 1970). Samuelson (1939, 1952) shows that integrating regional markets for the same good improves social welfare.

[2]On the consumer packaged goods market, conscious consumers, and the green premium, see NYU Stern Center for Sustainable Business (2026). On the EU electricity market, see `https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20260319-2` (accessed April 21, 2026). For further evidence, see our discussion of related literature.

[3]For example, the EU is planning to introduce green markets for steel, cement, and basic chemicals as part of its Clean Industrial Deal.

externalities if and only if conscious demand is sufficiently high relative to green supply (in a sense we make precise); otherwise, these policies backfire and increase externalities. Intuitively, while both policies can raise green supply, they also raise green demand by improving the availability of green goods to conscious consumers. The resulting increase in the price of green goods can trigger a *demand displacement effect*: some standard (non-conscious) consumers who previously consumed green goods switch to brown consumption. If the demand displacement effect is strong, total externalities rise. This occurs if the demand of conscious consumers was initially smaller than green supply, leaving some green output to standard consumers.

These results extend to settings in which the origin of a good is impossible or prohibitively costly to verify. In a common grid, for example, it is impossible to determine whether a kWh of electricity was generated by a solar panel or by a coal-fired power plant. As a result, green electricity is traded through certificates guaranteeing that a given quantity has been produced using green technology. Under an empirically plausible condition, the same results hold for these "certificated" green goods as for true green goods. But this is not always the case: when one region can satisfy total demand through green production, certificate trade increases brown production, whereas physical trade reduces it.

Our results have important policy implications. As one case in point, our conditions suggest that the EU market for green electricity may actually increase CO_2 emissions. Furthermore, the conditions are especially relevant in light of other environmental policies. For example, subsidies or quotas that promote green production can make it more likely that green supply exceeds conscious demand. Hence, combining such supply-side policies with green-market design based on the one-market-for-one-good principle may (as with the EU electricity market) be counterproductive. Similarly, applying the principle may not make sense when the definition of a green product is too lax, again leading to more green production than there is conscious demand.

The demand displacement effect is distinct from other mechanisms often emphasized in environmental economics. The *rebound effect* arises when efficiency improvements lower prices and thereby induce additional demand.[4] Our mechanism also features an increase in demand, but this is driven by the interaction of conscious consumers and market structure rather than by falling

[4]This effect has first been described by William Jevons in 1865 (Jevons, 2018) for coal production. It has been applied to environmental economics by Khazzoom (1980) and others. See Font Vivanco et al. (2016) for a precise definition and historical discussion.

prices — indeed, prices may rise. The key mechanism is a shift in standard consumers' demand toward brown goods. The *leakage effect* arises if an environmental policy shifts production across regions.[5] In contrast, in our setup there is no leakage, but additional demand of conscious consumers. *Non-additionality* concerns whether green investments reduce emissions beyond what would have occurred anyway.[6] In our framework, green purchases correspond to green production, so non-additionality is not an issue. The problem is instead that brown production may increase due to demand reallocation.

Related literature Our paper contributes to a fast-growing literature on prosocial behavior in markets.[7] No previous paper, however, has considered the basic question we address here, the extent to which the one-market principle should be applied to green markets.

On the empirical side, one strand of research documents the existence of conscious consumers, and hence the relevance of green markets. In Bartling et al.'s (2015) experimental market, for instance, the green good trades at a premium, yet many consumers buy it anyway. Further incentivized studies include Meier et al. (2023), Andre et al. (2024), and Rodemeier (2026).

Another strand of the literature examines whether market interaction erodes moral behavior. Falk and Szech (2013) find such erosion, while work by Bartling et al. (2023) and Ziegler et al. (2024) clarifies the conditions under which it occurs.[8] In our setting, introducing a green market induces a prosocial response, yet brown production may still rise due to the demand displacement effect.

On the theory side, research in industrial organization studies the strategic behavior of firms when green markets exist and some consumers are environmentally conscious. A general message is that stronger environmental preferences need not reduce externalities due to firms' pricing and product-design responses (García-Gallego and Georgantzís, 2009, Deltas et al., 2013, Marini et al., 2022). In contrast, we focus on the more fundamental question of market organization, i.e., whether to separate green and brown markets and integrate green markets, abstracting from imperfect competition.

Other research in the general-equilibrium tradition (e.g., Herweg and Schmidt, 2022, Kaufmann

[5]See Felder and Rutherford (1993) for an early discussion.

[6]See Gillenwater (2012) for a discussion of how to define and measure additionality.

[7]See Rodemeier and Semken (2026) for a recent survey.

[8]Other papers on "morals and markets" include Bartling and Özdemir (2023), Bartling et al. (2024), Dewatripont and Tirole (2024), Engelmann et al. (2024), Falk et al. (2020), Huber et al. (2023), and Sutter et al. (2020).

et al., 2024, 2025) shows that responsible consumption may be dampened by general-equilibrium effects: lower demand by conscious consumers reduces prices and induces offsetting responses by others. If conscious consumers understand this, they engage less in prosocial behavior. This effect does not play a role in our model, and the questions considered are very different.

The remainder of the paper is organized as follows. Section 2 introduces the model, in particular the modeling of conscious consumer preferences. Section 3 compares an undifferentiated market with separate markets for green and brown goods. Section 4 examines the integration of regional green markets. Section 5 compares certified and true green goods. Section 6 discusses policy implications and concludes. All proofs are in the Appendix.

2 Conscious and Standard Consumers

We consider a market for a good that can be produced in a "brown" fashion causing a negative externality, or in a "green" fashion without externalities. The green and brown versions are physically identical. There are two groups of consumers, conscious consumers who care whether the good is green or brown, and standard consumers who do not care. Conscious consumers experience a disutility of $k > 0$ for each unit of the brown product they consume. We assume for simplicity that the same is the case for undifferentiated (indistinguishable) goods; our results continue to hold if in this case the disutility experienced by conscious consumers is k' with $0 < k' < k$. Thus, if the market price of the brown or undifferentiated good is p, then the "effective price" perceived by a conscious consumer is $p^e = p + k$, while the effective price of a green good equals its market price. For standard consumers, the effective price always equals the market price.

Both standard and conscious consumers buy the product(s) with the lowest effective price p^e, and their demand functions are given by $D^S(p^e)$ and $D^C(p^e)$, respectively. If the two goods have the same effective price for a consumer of type $i \in \{C, S\}$, then the type-i population is indifferent and willing to satisfy its demand $D^i(p^e)$ with any combination of the goods.[9] We impose the standard regularity conditions that $D^i(\cdot)$ is continuous and strictly decreasing, $\lim_{p\to 0} D^i(p) = \infty$, and $\lim_{p\to\infty} D^i(p) = 0$ for $i \in \{C, S\}$. Throughout the paper, our main interest is in how market organization affects *total brown production*, i.e., the total externality produced. A secondary question is the effect on green production.

[9] For a more detailed derivation of consumer demand see the Online Appendix.

Discussion Our formalization of conscious consumers' preferences is standard in the literature.[10] It naturally arises, for instance, if conscious consumers are deontologists with a preference "to do the right thing" or they experience warm glow from consuming a green good (Andreoni, 1990). If consumers are instead rational consequentialists (Kaufmann et al., 2024), they care about the net (general-equilibrium) effects of their actions. Under our assumptions, consequentialists and deontologists exhibit similar, and in most cases identical, market behavior.[11] A rational consequentialist, however, would oppose the introduction or integration of green markets whenever doing so increases externalities.

For analytical and presentational simplicity, we assume that all conscious consumers have the same disutility k from brown consumption. With heterogeneity in k, the conditions for the introduction or integration of green markets to be beneficial would be similar, but they would need to be formulated over the "marginal" consumers who might switch their choice of product due to separation or integration.

Because green and brown goods are physically identical, a separate market for the green good requires certification of green production. We assume that there is an accepted definition of green production and that certification of it is costless. Thus, we abstract from issues of the cost of certification, forum shopping for green labels of different stringency, greenwashing, and outright fraud that all play an important role in reality but are orthogonal to the issues discussed here.

In most of the paper, we assume that if a unit of a good is certified as green, then it is actually this unit that has been produced in a green fashion. For some goods, however, such item-level certification is impossible or prohibitively costly. For example, it is (with current distribution networks) physically impossible to determine the origin of the electricity a consumer purchases. Still, a provider can offer "certificated" electricity, guaranteeing that the purchased amount has been produced somewhere with renewable sources. We consider this possibility in Section 5.

We focus on whether applying the one-market principle reduces externalities. This is the declared rationale for introducing or integrating green markets, so its policy relevance is immediate. Moreover, if the externality is sufficiently large, then applying the principle when it increases ex-

[10]See, e.g., Aghion et al. (2023) or Dewatripont and Tirole (2024).

[11]In a differentiated market, they behave identically whenever both conscious and standard consumers have strict preferences between products. In that case, there is no general-equilibrium margin through which purchasing a green product affects brown production. In an undifferentiated market, consequentialists behave like deontologists with a potentially lower k: a purchase may affect both brown and green production. As discussed above, this leads to the same substantive insights.

ternalities will reduce social welfare. We do not state exact conditions under which social welfare falls, because the answer depends on how we count conscious consumers' disutility from consuming brown goods, which raises difficult and controversial issues (see, e.g., Kaufmann et al. (2024)).

Relatedly, as a first pass, we assume that green production generates no externalities relative to production of the numeraire good. If green production also generates externalities, then following the one-market principle is often even less beneficial (or more harmful). This is because separating green and brown markets always increases green production, and integrating green markets often does as well.

3 Differentiating Markets for Green and Brown Goods

In this section, we consider the first, simpler part of the one-market principle, investigating whether it is optimal to have separate markets for green and brown goods.

We assume that there are continuous and increasing supply functions $S^B(p)$ and $S^G(p)$ for the brown and green products. In an undifferentiated market, consumers cannot distinguish the products, so these trade at the same price p^U. With differentiated markets, the two goods are distinguishable and trade at possibly different prices p^B and p^G.

Proposition 1. *There are unique equilibria both when the market is undifferentiated and when it is differentiated.*

Brown production is weakly lower with differentiated markets than with an undifferentiated market if and only if

$$D^C(p^U + k) \geq S^G(p^U). \tag{1}$$

Green production is always weakly larger with differentiated markets.

The proposition says that moving to a differentiated market reduces the externality if and only if on the undifferentiated market conscious demand is larger than green supply (Condition (1)). On the differentiated market, conscious consumers favor green consumption and — because consumption is less aversive — purchase more, raising both green supply and green demand. If the increase in demand is greater, then a *demand displacement effect* occurs: conscious consumers crowd out green consumption by standard consumers, raising the latter's brown consumption and thus the externalities. This occurs if and only if standard consumers were consuming green goods on the undifferentiated market, i.e., green supply was greater than conscious demand.

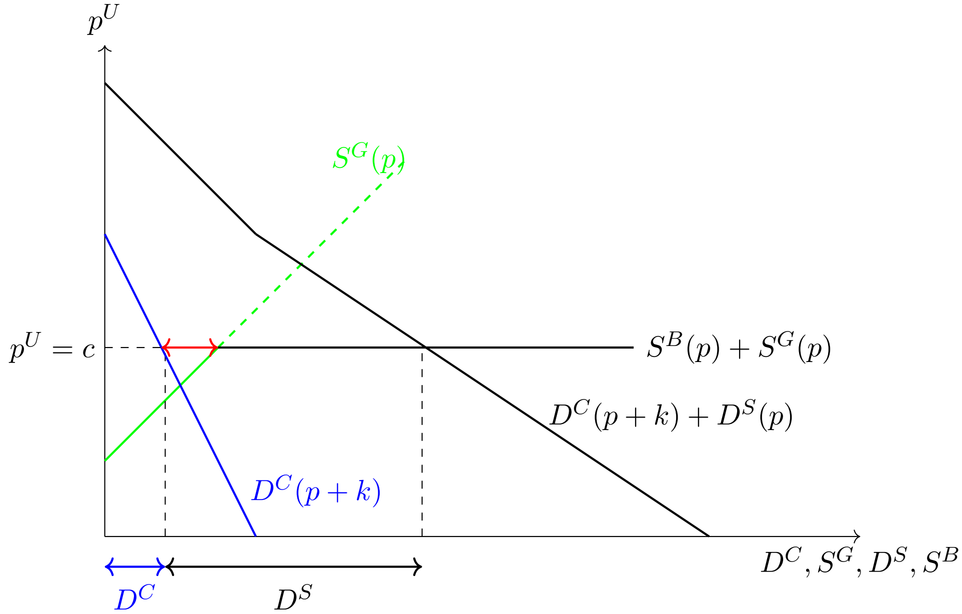

Figure 1: Undifferentiated market for the case where market separation increases externalities.

Figure 1 illustrates Proposition 1 for the case where the undifferentiated market results in less brown production than two differentiated markets. Green supply is given by the upward-sloping green curve. For simplicity, we assume that the brown good is produced at constant marginal cost c. On the undifferentiated market, total supply therefore increases along the green line curve $p = c$, after which it follows the horizontal black line. Demand by conscious consumers on the undifferentiated market is given by the blue line, while total demand is given by the downward-sloping black line. At the equilibrium price of $p^U = c$, demand of conscious consumers falls short of green supply, so some green production (indicated by the red double arrow) is consumed by standard consumers. If markets are differentiated, conscious consumers will consume more, and all of their consumption is green. The price of the brown good remains at c, so the demand of standard consumers is unchanged. Because standard consumers now consume none (or less) of the green good, brown production must increase with market differentiation.

As a potential example where differentiation harms the environment, consider the European Union's electricity market, where 47 percent of production stems from renewable sources. Prima facie, it is plausible that conscious demand is relatively weaker. Indeed, the price premium for green electricity has declined over time and is now close to zero.[12] The proof of Proposition 1 implies that this is a sufficient condition for Condition (1) to be violated, i.e., for differentiation to raise brown production.

While our focus is on lowering brown production, a social planner may also care about raising green production, especially if it features economies of scale and/or learning-by-doing effects.[13] Proposition 1 shows that market differentiation is always beneficial in this respect. On the differentiated market, conscious consumers can express their preference for green goods, which always pushes up the green price and thus benefits green producers.

4 Integrating Green Markets

We now address the second part of the one-market principle, asking when the integration of two regional green markets lowers brown production.

We assume that the brown good is produced with constant marginal cost c in each region $i \in \{1, 2\}$, fixing the brown price at c in any equilibrium.[14] The supply function of the green good in region i, $S_i^G(\cdot)$, is strictly increasing on $[0, c+k]$, and the standard and conscious demand functions in region i, $D_i^S(\cdot)$ and $D_i^C(\cdot)$ respectively, satisfy the same regularity conditions as in Section 3. We denote by p_i^G the regional prices for the green good under unintegrated markets, and by p^G the price under integration.

We assume perfectly elastic brown supply to isolate our mechanism from standard trade effects operating through brown prices. It is well-known that if brown production efficiencies differ across regions, then trade can increase externalities simply by changing brown prices and thus shifting brown production toward the more efficient region. With a constant marginal cost of brown production, this conventional channel is absent.

Because it will play a central role in our characterization, we introduce terms for the comparison of green supply and conscious demand. We call $S_i^G(c) - D_i^C(c)$ the residual green supply in region i; if

[12]The market price of certificates for green electricity, called "guarantees of origin", plummeted in 2024 (`https://futureenergygo.com/guarantees-of-origin-price/`, accessed April 25, 2026).

[13]For example, the levelized cost of solar energy decreased by more than 90 percent over the last 15 years making it competitive with fossil energy in many regions of the world (`https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024`). This was only possible because the demand for solar power increased massively, in part due to the subsidies provided by Germany, China, and other countries.

[14]Another interpretation of this assumption is that the brown good (e.g., oil) is traded on a world market at price c, and that the two regions under consideration are too small to affect the world market price.

this is positive, then even at the lowest possible green price, green supply exceeds conscious demand, so there is residual supply for standard consumers. Analogously, we call $D_i^C(c+k) - S_i^G(c+k)$ residual green demand; if this is positive, then even at the highest possible green price, conscious demand exceeds green supply, so conscious consumers purchase brown goods as well. We say that the green market clears (i.e., there is no residual supply or demand) if there is a $p_i^G \in [c, c+k]$ such that $D_i^C(p_i^G) = S_i^G(p_i^G)$.

Throughout the section, we maintain the following empirically plausible assumption:

Assumption 1. $D_i^S(c) + D_i^C(c+k) > S_i^G(c+k)$ for all $i \in \{1, 2\}$.

The assumption says that in each region, the smallest possible total demand exceeds the highest possible green supply. This implies that green supply is not sufficient to satisfy all demand, so there is scope for brown production in both regional markets. In the next section, we briefly consider a setting where Assumption 1 does not hold.

The proof of Proposition 1 implies:

Corollary 1. *There are unique competitive equilibria in both the separated markets of the two regions and the integrated market.*

First, we characterize the cases where market integration does not affect total brown production.

Proposition 2. *Moving from separate regional markets to integrated markets does not affect total brown production if one of the following conditions holds:*

(a) There is residual green demand in both regions.

(b) There is residual green supply in both regions.

(c) The green market clears in both regions.

In all three cases, green supply and conscious demand are related similarly in the two regions: there is residual demand, residual supply, or market clearing. Then, green trade does not affect brown consumption and production. The conditions are also almost exhaustive: except for the knife-edge case in which the two sides of Inequality (2) below are equal, no other situation leaves brown production unchanged.

In cases (a) and (b), there is residual green supply or demand in both regional markets, so the same occurs in the integrated green market. Hence, prices remain unchanged following market integration, and total brown production and total green production are also unaffected. In case (c), the regional green markets clear, implying that the integrated green market also clears. In both cases, therefore, conscious consumers purchase only the green good, while standard consumers purchase only the brown good. Since the brown price remains constant at c, total standard demand is unchanged, implying unchanged brown production. In addition, due to a single green price, green production and consumption are allocated more efficiently across regions.

The following proposition shows under what conditions and how integration affects brown production.

Proposition 3. *Green-market integration strictly decreases total brown production if and only if one region has residual green demand while the other does not, and the latter's residual green supply is smaller than the former's residual green demand, i.e.,*

$$D_i^C(c+k) - S_i^G(c+k) > S_j^G(c) - D_j^C(c). \tag{2}$$

Conversely, integration strictly increases brown production if and only if one region has residual green supply while the other does not, and the latter's residual green demand is smaller than the former's residual green supply, i.e., Inequality (2) *is reversed.*

Figure 2 illustrates the logic for the case when integration is harmful for the externality. In region 1, there is residual green supply equal to the black double arrow, which is consumed by standard consumers. In region 2, the green market clears at p_2^G satisfying $c < p_2^G < c + k$. In the integrated market, there is a common price p^G with $p_1^G < p^G < p_2^G$ at which excess supply in region 1 equals excess demand in region 2 (red double arrows). Conscious consumers in region 2 consume more of the green good at the lower price and satisfy their excess demand with imports from region 1. Standard consumers in region 1, however, no longer consume the green good. Because total demand by standard consumers is unchanged, brown production must increase by the amount of standard consumers' former green consumption, indicated by the black double arrow.

The mechanism at work is again the demand displacement effect. When conscious consumers in region 2 obtain access to cheaper green products from region 1, their demand increases the

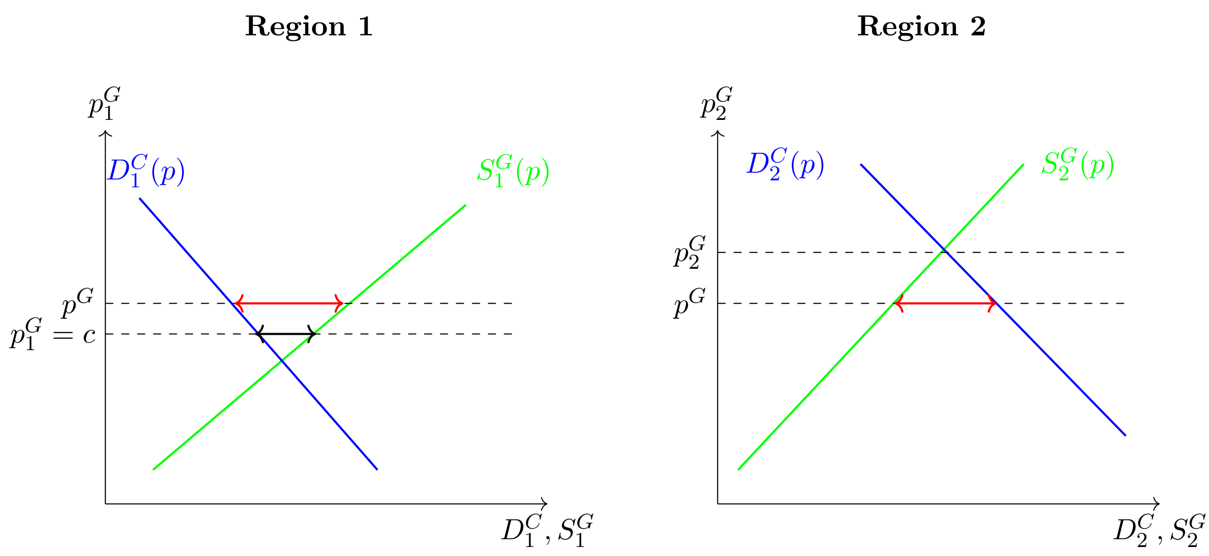

Figure 2: Green markets in regions 1 and 2 for the case where integration increases externalities.

green price in region 1. This displaces the green consumption of standard consumers in region 1, increasing the need for brown production. More generally, integration raises brown production if and only if residual green supply in one region exceeds residual green demand in the other region. This condition says that the green consumption of standard consumers in the first region is larger than the brown consumption of conscious consumers in the other region. Equivalently, the potential for demand displacement is larger than the potential for shifting conscious demand toward green goods.

Rearranging Inequality (2) gives that integration (weakly) lowers brown production if

$$D_i^C(c+k) + D_j^C(c) > S_i^G(c+k) + S_j^G(c), \tag{3}$$

while it (weakly) raises brown production if the inequality goes the other way. Again, therefore, the one-market principle applies if conscious demand is strong relative to green supply, where this condition must now be interpreted for the overall economy. Furthermore, the decrease or increase in brown production is strict if in addition the conditions of Proposition 2 are not satisfied.

As a potential, albeit somewhat speculative, example, consider green steel in the United States and Sweden. There is demand for green steel in both countries. Since President Trump took office, however, the nascent green-steel industry in the United States has been in retreat. In Sweden, by contrast, the steel industry is further ahead in establishing green plants, which are projected to produce more green steel than the total domestic demand for steel — green and brown combined. Proposition 3 implies that if Sweden's residual green supply is smaller than residual green demand in the United States — a plausible condition given the difference in country size — then integration lowers brown-steel production.

5 Certificated Green Products

So far, we analyzed markets for "true" green goods, in which units that have been produced in a green fashion are traded. As we have mentioned, however, such markets are infeasible for some goods (e.g., electricity) because tracking the origin of each unit is infeasible. For other goods (e.g., steel), keeping parts produced with green technology separate from those produced with brown technology is possible but costly. In these cases, one can create a market for "certificated" green goods by issuing one certificate for each unit of green production, trading certificates separately, and designating a good (of any origin) plus a certificate as a green good. Then, there are market prices for the base good and certificates, all producers sell their goods at the base-good price, green producers additionally sell their certificates, and consumers decide whether to purchase units with or without certificates. This is exactly how all real-world markets for green electricity work. Here, we answer the obvious question of whether our insights hold for certificated green goods.

Before we begin, we note that consumers may have a lower willingness to pay for a certificated green product than for a true green product. As an extreme example, consider a butcher who sells beef from animals that have been raised under appalling conditions, but also offers certificates guaranteeing that other cattle have been raised under animal-friendly conditions. A consumer may feel that this is not the same as buying beef from cattle that were actually raised under humane conditions. If so, that corresponds to a lower k in our model, but otherwise the same preferences can be used.

It is immediate that our result on the separation of green and brown markets (Proposition 1) applies unchanged to certificated green goods, and the same is the case for our results on the integration of green markets (Proposition 2 and 3) if certificated green goods can be shipped between regions. These conclusions hold because — given k — both supply and demand are the same as when green goods are true ones. The following proposition considers integration of markets for certificated green goods when only certificates can be shipped between regions.

Proposition 4 (Integration of Certificate Markets)**.** *Propositions 2 and 3 continue to hold with certificate trade.*

The logic behind Proposition 4 is that any equilibrium with product trade can be replicated by an equilibrium with certificate trade where certificates instead of goods are shipped. If the certificate price equals the green premium $p^G - p^B$, demand by both types and the supply of the green good in both regions are the same with product trade and certificate trade, so conditions for equilibrium are the same. However, the production locations of the brown goods differ between product trade and certificate trade. With certificate trade, green goods are stripped of their certificates in the region with excess green supply and sold as brown goods in this region. In the region with excess green demand, brown goods are equipped with certificates and sold as green goods. Total brown production is unchanged, but in the region with excess green supply, brown production is lower, and vice versa in the other region.

Proposition 4 requires that in the region with excess green supply, brown production with product trade exceeds the amount of exported certificates; otherwise, brown production cannot adjust in the above way. This is guaranteed by Assumption 1. To conclude our analysis, we consider one economically interesting case in which Assumption 1 does not hold.

Suppose that region i has a plentiful and efficient source of green supply that is sufficient to satisfy total demand on both markets with the green good at price $p^G \leq c$. In region j, green supply is limited or less efficient and smaller than the demand of conscious consumers at $p^G = c$. As a somewhat futuristic example, the product could be electricity, with region i being North Africa and region j being Europe. Although not implemented today, solar electricity can in principle be produced cheaply and at a large scale in North Africa, but not in Europe.

Proposition 5 (Trade with an Efficient Green Region)**.** *Suppose that at price c, region i can cover total demand with green production, i.e.,*

$$S_i^G(c) \geq D_1^S(c) + D_1^C(c) + D_2^S(c) + D_2^C(c), \tag{4}$$

while in region j, conscious demand exceeds green supply, i.e., $D_j^C(c) > S_j^G(c)$*. Then, certificate trade weakly raises brown production, while product trade strictly reduces it.*

While our previous insights hold unchanged for certificated green goods, Proposition 5 cautions that the two types of green goods can have economically different properties. Intuitively, if electricity could be transported at no cost from North Africa to Europe, North African electricity would take over the entire market, reducing externalities to zero. Hence, product trade is beneficial. With certificate trade, however, competition from North Africa lowers the certificate price in Europe, depressing local green supply and raising green demand. This shortfall must be covered by brown production, thus increasing environmental harm.

6 Policy Implications and Conclusion

Our results have an immediate and important policy implication: applying classical market principles to green goods — separating green and brown products and integrating green markets — can be an effective environmental policy tool, but only under specific conditions. Qualitatively, the overarching condition for green markets to benefit the environment is that conscious demand is strong relative to green supply. In addition, green-market integration is beneficial when a region with substantial residual green demand integrates with one that has no residual green demand or even a small residual green supply. In principle, these conditions can be verified using conventional demand and supply estimates, with the important caveat that conscious demand must be measured separately from standard demand. Fortunately, existing work shows that it is possible to identify conscious consumers and their preferences through survey or experimental methods (e.g., Rodemeier, 2026).

The conditions we have derived imply that the optimal market organization for green goods interacts with other green policies. For example, many countries already employ supply-side policies such as subsidies for green production, taxes on brown production, or regulations of the share of green output. These policies can result in green production exceeding conscious demand, so complementing them with green consumer markets can be harmful for the environment. Furthermore, if a separate market for the green good is created, the definition of "green" must not be too lenient. If qualifying as green is too easy, green supply may be high and conscious demand low, so that the green market is actually harmful.

Several directions for future research suggest themselves. First, we treat the share of conscious consumers as exogenous. In practice, the introduction of a green market may itself shift consumer awareness and preferences — for instance through increased salience of environmental issues or social signaling effects. Endogenizing the formation of conscious demand would be an interesting and policy-relevant extension. Second, the Kyoto Protocol imposes national targets for CO_2 emissions. Even if the introduction of green markets reduces global emissions, it shifts production across regions and may thereby increase national emissions. How does the optimal policy change if the policy maker wants to achieve national targets? Finally, our model abstracts from market power, assuming perfect competition throughout. In many green markets, e.g., renewable energy, green steel, and sustainable aviation fuel, a small number of large producers play a dominant role. Analyzing the demand displacement effect under imperfect competition is an important open question.

Appendix: Proofs

Proof of Proposition 1. The proof of existence and uniqueness of the equilibrium follows standard arguments; a detailed version is provided in the Online Appendix.

Before comparing brown production across regimes, we first establish the following observations and definitions.

Undifferentiated market: The equilibrium price p^U solves

$$D^S(p) + D^C(p+k) = S^B(p) + S^G(p). \tag{5}$$

Differentiated market: Let $\bar{p}^B$ ($\bar{p}^G$) denote the unique price that clears the brown (green) market against the demand of standard (conscious) consumers, i.e., $D^S(\bar{p}^B) = S^B(\bar{p}^B)$ and $D^C(\bar{p}^G) = S^G(\bar{p}^G)$.

Any equilibrium must satisfy $p^B \le p^G \le p^B + k$, so exactly one of the three mutually exclusive relations holds: (i) $p^B < p^G < p^B + k$, (ii) $p^G = p^B + k$, or (iii) $p^G = p^B$.

We now compare brown production across the undifferentiated and differentiated markets.

Case 1: $D^C(p^U + k) \ge S^G(p^U)$. By (23), this implies $D^S(p^U) \le S^B(p^U)$. This implies $\bar{p}^G > p^U \ge \bar{p}^B$, so regime (iii) cannot occur, and thus the differentiated-market equilibrium is in regime (i) or (ii). In regime (i), only standard consumers buy brown, so $p^B = \bar{p}^B \le p^U$, and we are done. In regime (ii), we must have $p^B < p^U$; otherwise the demand of both types would be lower than on the undifferentiated market, with brown supply weakly higher and green supply strictly higher.

Case 2: $D^C(p^U + k) < S^G(p^U)$. Then $D^S(p^U) > S^B(p^U)$, so that $\bar{p}^G < p^U + k$ and $\bar{p}^B > p^U$, ruling out regime (ii). In regime (i), only standard consumers buy brown, so $p^B = \bar{p}^B > p^U$, and we are done. In regime (iii), we must also have $p^B > p^U$; otherwise production is weakly lower, while standard consumption is weakly higher and conscious consumption is strictly higher than on the undifferentiated market. This completes the proof. □

Proof of Proposition 2.

The proof follows from the arguments in the main text; a detailed version is given in the Online Appendix. □

Proof of Proposition 3.

The proof distinguishes between two main cases.

Case (a): Weak excess demand for the green good in market i while green market j clears at a strictly interior price or has weak excess supply:

$$D_i^C(c+k) \geq S_i^G(c+k) \text{ and } D_j^C(c+k) < S_j^G(c+k), \tag{6}$$

Case (b): Weak excess supply in green market j while green market i clears at a strictly interior price or has weak excess demand:

$$D_i^C(c) > S_i^G(c) \text{ and } D_j^C(c) \leq S_j^G(c). \tag{7}$$

We proceed by considering each case in turn.

Case (a): In this case the equilibrium prices satisfy $p_i^G = c + k > p_j^G \geq c$. Under separate markets, total brown production is given by the sum of demand from standard consumers and excess demand from conscious consumers in market i, net of any excess supply of the green good in market j. Formally,

$$B^S = \sum_{l=1,2} D_l^S(c) + D_i^C(c+k) - S_i^G(c+k) - \max\{S_j^G(c) - D_j^C(c), 0\}. \tag{8}$$

To specify total brown production under market integration, we consider three subcases.

(i) (Weak) excess demand on integrated green market, $\sum_{i=1,2} D_i^C(c+k) - S_i^G(c+k) \geq 0$, implying that $p^G = c + k$. Under market integration, total brown production is given by the sum over both markets, jointly constituting the integrated market, of demand from standard consumers and excess demand from conscious consumers. Formally,

$$B^I = \sum_{i=1,2} \left\{ D_i^S(c) + [D_i^C(c+k) - S_i^G(c+k)] \right\}. \tag{9}$$

Thus,

$$\begin{aligned}\Delta B &= B^I - B^S \\ &= D_j^C(c+k) - S_j(c+k) + \max\{S_j^G(c) - D_j^C(c), 0\} < 0 \qquad (10)\end{aligned}$$

Note that in this subcase the condition (2) is always satisfied.

(ii) The integrated green market clears, i.e., there is a $p^G \in [c, c+k]$ such that $\sum_{i=1,2} D_i^C(p^G) - S_i^G(p^G) = 0$. Under market integration, total brown production equals aggregate demand from standard consumers. Formally,

$$B^I = \sum_{i=1,2} D_i^S(c). \qquad (11)$$

Thus,

$$\Delta B = \max\{S_j^G(c) - D_j^C(c), 0\} - [D_i^C(c+k) - S_i^G(c+k)]. \qquad (12)$$

Since $D_i^C(c+k) - S_i^G(c+k) \geq 0$ we have $\Delta B < 0$ if and only if condition (2) holds.

(iii) (Weak) excess supply on integrated green market, $\sum_{i=1,2} D_i^C(c) - S_i^G(c) \leq 0$, implying that $p^G = c$. Under market integration, total brown production equals aggregate standard consumer demand net of aggregate excess supply of the green good. Formally,

$$B^I = \sum_{i=1,2} \left\{D_i^S(c) - [S_i^G(c) - D_i^C(c)]\right\}. \qquad (13)$$

Note that in this case we have $S_j^G(c) - D_j^C(c) > 0$. Thus,

$$\Delta B = D_i^C(c) - S_i^G(c) - [D_i^C(c+k) - S_i^G(c+k)] > 0. \qquad (14)$$

Note that in this subcase the condition (2) is always violated.

Case (b): In this case we have $c + k \geq p_i^G > p_j^G = c$. Under separate markets, total brown production is given by the sum of demand from standard consumers and potential excess demand from conscious consumers in market i, net of excess green supply in market j. Formally,

$$B^S = \sum_{l=1,2} D_l^S(c) + \max\{D_i^C(c+k) - S_i^G(c+k), 0\} - [S_j^G(c) - D_j^C(c)]. \tag{15}$$

To specify total brown production under market integration, we need to consider the same three subcases as in (a).

(i) (Weak) excess demand on integrated green market: Thus

$$\Delta B = D_i^C(c+k) - S_i^G(c+k) - \max\{D_i^C(c+k) - S_i^G(c+k), 0\} \\ + D_j^C(c+k) - S_j^G(c+k) - D_j^C(c) + S_j^G(c) < 0. \tag{16}$$

Note that in this subcase the condition (2) is always satisfied.

(ii) The integrated green market clears: Thus

$$\Delta B = -\max\{D_i^C(c+k) - S_i^G(c+k), 0\} + S_j^G(c) - D_j^C(c). \tag{17}$$

Note that $\Delta B < 0$ requires that $D_i^C(c+k) - S_i^G(c+k) > 0$. Thus, $\Delta B < 0$ if and only if condition (2) holds.

(iii) (Weak) excess supply on integrated green market: Thus,

$$\Delta B = D_i^C(c) - S_i^G(c) - \max\{D_i^C(c+k) - S_i^G(c+k), 0\} > 0. \tag{18}$$

In this subcase, condition (2) is always violated.

□

Proof of Proposition 4. We prove the result by showing that, under Assumption 1, certificate trade is outcome-equivalent to product trade for the variables relevant to Propositions 2 and 3: regional green demand, regional green supply, the common green premium, and total brown production. Hence, once this equivalence is established, the comparative statics characterized in Propositions 2 and 3 carry over to certificate trade.

Consider first the unique equilibrium under product trade. Let the common green-good price be $p^G = c + z^G$, where $z^G \in [0, k]$ is the green premium over the brown price c. Let D_i^B and D_i^G denote brown and green demand in region $i \in \{1, 2\}$, respectively. Since the integrated green market clears under product trade,

$$S_1^G(p^G) + S_2^G(p^G) = D_1^G + D_2^G. \tag{19}$$

Equivalently, any excess green supply in one region equals excess green demand in the other:

$$S_1^G(p^G) - D_1^G = D_2^G - S_2^G(p^G). \tag{20}$$

We now construct a certificate-trade equilibrium with certificate price $z = z^G$. Consumers face the same effective green price $c + z = p^G$ as under product trade, so their demands for green and brown consumption are unchanged. Green producers receive the same total price $c + z = p^G$, so green supply in each region is unchanged as well. Certificates are shipped from the region with excess green supply to the region with excess green demand in exactly the amount

$$\left|S_i^G(p^G) - D_i^G\right|. \tag{21}$$

Brown production in each region adjusts so that local physical consumption equals local physical production. In particular, brown production in region i is given by

$$B_i = D_i^B + D_i^G - S_i^G(p^G). \tag{22}$$

By Assumption 1, $B_i \geq 0$, so this construction is feasible. Thus, the certificate-trade allocation reproduces the same green demand, green supply, green premium, and aggregate brown production as the product-trade equilibrium.

Conversely, take any certificate-trade equilibrium with a certificate price $z \in [0, k]$. A product-trade equilibrium can be constructed by setting the green-good price equal to $p^G = c + z$ and shipping physical green goods instead of certificates from regions with excess green supply to regions with excess green demand. Since consumers and green producers face the same prices as under certificate trade, demands and supplies coincide, and market clearing is preserved.

Therefore, certificate trade and product trade are equivalent with respect to the variables determining total brown production. Since Propositions 2 and 3 characterize the effect of product-trade integration on total brown production, the same characterization applies to certificate-trade integration. □

Proof of Proposition 5: The statement regarding product trade is obvious.

Concerning certificate trade, under autarky, the certificate price in region 1 is zero ($z_1 = 0$) and all consumption is satisfied with the green good. In region 2 the certificate price is positive ($z_2 > 0$) and all standard consumers consume the brown good. If there is product trade, green supply serves total demand in both markets at a green price $p^G \leq c$, so brown production is reduced. With certificate trade, the common certificate price z must also be equal to 0 (otherwise, there would be an excess supply of certificates from region 1). As a result, conscious demand in region 2 is higher than under autarky, while green supply is lower. Excess conscious demand can only be satisfied by brown production in region 2. Since standard demand is the same, brown production must increase as compared to autarky. □

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Online Appendix

Some Simple Economics of Green Markets

A Additional Proofs

Proof of Existence and Uniqueness (part of Proposition 1).

Undifferentiated market. On an undifferentiated market, the equilibrium price p^U solves

$$D^S(p) + D^C(p+k) = S^B(p) + S^G(p). \tag{23}$$

The left-hand side of (23) is strictly decreasing in p and the right-hand side is increasing, so a unique p^U exists.

Differentiated market. Let $\bar{p}^B$ denote the unique price that clears the brown market against the demand of standard consumers, $D^S(\bar{p}^B) = S^B(\bar{p}^B)$, and similarly, let $\bar{p}^G$ denote the unique price that clears the green market against conscious demand, $D^C(\bar{p}^G) = S^G(\bar{p}^G)$. Both $\bar{p}^B$ and $\bar{p}^G$ exist and are unique by the assumptions on demand and supply.

Now consider any equilibrium (p^B, p^G). First, $p^G < p^B$ is impossible because then all consumers strictly prefer green, so brown demand is zero while $S^B(p^B) > 0$. Likewise, $p^G > p^B + k$ is impossible because then all consumers strictly prefer brown, so green demand is zero while $S^G(p^G) > 0$. Hence any equilibrium must satisfy $p^B \leq p^G \leq p^B + k$, so exactly one of the three mutually exclusive relations holds: (i) $p^B < p^G < p^B + k$, (ii) $p^G = p^B + k$, or (iii) $p^G = p^B$. We consider each in turn.

Regime (i): $p^B < p^G < p^B + k$. Then standard consumers buy only brown and conscious consumers buy only green, so market clearing implies $p^B = \bar{p}^B$ and $p^G = \bar{p}^G$. Hence a regime-(i) equilibrium exists if and only if $\bar{p}^B < \bar{p}^G < \bar{p}^B + k$, and if it exists it is unique by the same argument as before.

Regime (ii): $p^G = p^B + k$. Then standard consumers buy only brown and conscious consumers are indifferent. Thus $S^G(p^B + k) \leq D^C(p^B + k)$ and $S^B(p^B) \geq D^S(p^B)$, i.e., $\bar{p}^G \geq \bar{p}^B + k$. If that is the case, then market clearing for brown pins down p^B uniquely via $D^S(p^B) + D^C(p^B + k) = S^B(p^B) + S^G(p^B + k)$ (which has a unique solution on $[\bar{p}^B, \bar{p}^G - k]$ by monotonicity), and $p^G = p^B + k$. Thus a regime-(ii) equilibrium is unique whenever it exists.

Regime (iii): $p^G = p^B$. Then conscious consumers strictly prefer green, while standard consumers are indifferent, so that $S^G(p^B) \geq D^C(p^B)$ and $S^B(p^G) \leq D^S(p^G)$, i.e., $\bar{p}^G \leq \bar{p}^B$. If this is the case, p_B is pinned down uniquely by the market-clearing condition $D^S(p^B) + D^C(p^B) = S^B(p^B) + S^G(p^B)$ (which has a unique solution on $[\bar{p}^G, \bar{p}^B]$ by monotonicity). Hence a regime-(iii) equilibrium is unique whenever it exists.

Now notice that exactly one of the conditions identified for the three regimes ($\bar{p}^B < \bar{p}^G < \bar{p}^B + k$, $\bar{p}^G \geq \bar{p}^B + k$, and $\bar{p}^G \leq \bar{p}^B$, respectively) holds. This completes the proof of existence and uniqueness.

□

Proof of Proposition 2.

Case (a): There is a (weak) excess demand for green goods in both regions, i.e., $D_i^C(c+k) \geq S_i^G(c+k)\ \forall i \in \{1,2\}$. In equilibrium we have $p_1^G = p_2^G = p^G = c+k$. Thus, total brown production under separate markets as well as under market integration is

$$\sum_{i=1,2} D_i^S(c) + [D_i^C(c+k) - S_i^G(c+k)]. \tag{24}$$

Case (b): There is a (weak) excess supply of green goods in both regions, i.e., $D_i^C(c) \leq S_i^G(c)\ \forall i \in \{1,2\}$. In equilibrium we have $p_1^G = p_2^G = p^G = c$. Thus, total brown production under separate markets as well as under market integration is

$$\sum_{i=1,2} D_i^S(c) - [S_i^G(c) - D_i^C(c)]. \tag{25}$$

Case (c): The market for green goods clears in both regions, i.e., there exists a $p_i^G \in [c, c+k]$ such that $D_i^C(p_i^G) = S_i^G(p_i^G)\ \forall i \in \{1,2\}$. Thus, total brown production under separate markets is given by $\sum_{i=1,2} D_i^S(c)$. Under market integration the green market clears at a price $p^G \in (\min\{p_1^G, p_2^G\}, \max\{p_1^G, p_2^G\})$ and thus total brown production remains at $\sum_{i=1,2} D_i^S(c)$. □

B Foundations of Demand

Utility Functions and Corresponding Demand Functions The assumed demand functions can be micro-founded, for instance, by the following assumptions regarding consumers' utility. Suppose there is a continuum of consumers, each of whom purchases at most one unit of the product. Gross valuations are denoted by $v \in [0, \bar{v}]$. Consumers belong to one of two groups: standard (S) and conscious (C), with measures m^i for $i \in \{S, C\}$. The utility from not purchasing is normalized to zero. Let p^j, with $j \in \{B, G\}$, denote the price of the brown and green product, respectively.

A standard consumer with valuation v derives utility

$$u^S = \begin{cases} v - p^G & \text{if purchasing the green product,} \\ v - p^B & \text{if purchasing the brown product,} \\ 0 & \text{if not purchasing.} \end{cases} \tag{26}$$

Hence, standard consumers purchase the cheaper product whenever $v \geq \min\{p^B, p^G\}$; if prices coincide, they are indifferent between the two goods.

Conscious consumers (partially) internalize the environmental externality generated by consumption. Their utility is

$$u^C = \begin{cases} v - p^G & \text{if purchasing the green product,} \\ v - k - p^B & \text{if purchasing the brown product,} \\ 0 & \text{if not purchasing,} \end{cases} \tag{27}$$

where $0 < k$ measures the degree of environmental awareness. Conscious consumers are therefore willing to pay a premium of k for the green product; when $p^G = p^B + k$, they are indifferent between the two goods.

For each group $i \in \{S, C\}$, gross valuations are distributed according to the cumulative distribution function $F^i(v)$, with density $f^i(v) > 0$ on $[0, \bar{v}]$.

In an undifferentiated market with uniform price p^U, demand by standard and conscious consumers (who expect to purchase a brown product at the margin) is given by

$$D^S(p^U) = m^S\big[1 - F^S(p^U)\big], \tag{28}$$

$$D^C(p^U + k) = m^C\big[1 - F^C(p^U + k)\big], \tag{29}$$

respectively.

Now consider a differentiated market with prices p^G and p^B. First, suppose that $p^B < p^G < p^B + k$. Standard consumers purchase the brown product, while conscious consumers purchase the green product. Demands are then given by

$$D^B(p^B) = D^S(p^B) = m^S\big[1 - F^S(p^B)\big], \tag{30}$$

$$D^G(p^G) = D^C(p^G) = m^C\big[1 - F^C(p^G)\big]. \tag{31}$$

Second, if $p^G < p^B$, both consumer groups purchase the green product, brown demand is zero and green demand is

$$D^G(p^G) = m^S\big[1 - F^S(p^G)\big] + m^C\big[1 - F^C(p^G)\big]. \tag{32}$$

Third, if $p^G > p^B + k$, both groups purchase the brown product, the demand for which is

$$D^B(p^B) = m^S\big[1 - F^S(p^B)\big] + m^C\big[1 - F^C(p^B + k)\big], \tag{33}$$

while there is no demand for the green product.

When one consumer group is indifferent between the two products, its demand is split across them. For instance, if $p^G = p^B + k$, demand satisfies

$$D^G \in \big[0,\, m^C\big(1 - F^C(p^G)\big)\big], \tag{34}$$

$$D^B = m^S\big[1 - F^S(p^B)\big] + m^C\big(1 - F^C(p^G)\big) - D^G. \tag{35}$$

In this case realized demand for the green good is determined by $S^G(p^G)$ in equilibrium.