

INNOVATION DECISIONS FOR GREEN PRODUCTS: THE ROLE OF REGULATORY INCENTIVES AND ACQUISITIONS IN A CONSUMER-FIRM GAME

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Overview

Consumers are increasingly aware of the impact that their consumption choices have on the quality of public goods, such as the environment, and are paying more attention to sustainability. As a result, supplying green products is emerging as a strategy for reaching these environmentally conscious consumers, while capturing a price premium and/or increasing market share.

Since product attributes, such as “greenness” and inherent quality, can be considered vertical attributes, i.e., no consumer finds them undesirable, technological innovation arises as an essential element of green growth. However, the costs and risk of developing new low-carbon products or technologies is relatively high for firms. Without low-carbon policies firms may lack incentives to overcome their self-interest and invest in innovation. Furthermore, relying only on the market is not enough to allow social investment to reach optimal levels, given the multiple positive externalities of green technological innovation. Thus, policy and government intervention play a crucial role in the development of a low-carbon economy. Regulations will affect firms’ technological innovation and improve production performance, ultimately benefiting society as whole (Pan et al., 2021; Safarzadeh and Rasti-Barzoki, 2020; Wang et al., 2020; Huang et al., 2019).

This paper builds a model of green technology investment and adoption in a firm that may receive incentives from the government to innovate and develop a green product, together with a consumer that considers “greenness” a vertical attribute and is choosing between green and non-green products, also with the possibility of receiving incentives from the government. Game theory is used to assess the interactions between the two players. To the best of our knowledge, this paper is the first that models technology transfer and acquisitions as a path to acquire low-carbon technologies alongside with government regulation.

Methods

We establish five models to achieve our research objectives. First, a model with no government intervention. Second, two models with government intervention: one in which the consumer that chooses green receives a subsidy, other in which the government applies discriminatory policy. Then, a model in which the firm may acquire a startup to obtain the desirable green innovation, instead of investing in R&D and develop the innovation in-house. Finally, the last scenario admits that one side of the market observes the characteristics of the other side before making its own decision. Equilibria in both pure and mixed strategies are provided for all the models with simultaneous decision making, as well as the subgame perfect Nash equilibria for the models with sequential decision making.

The game players are the consumer and the firm, both rational players aiming at maximizing their payoffs. They are representative of consumers and producers in the society. The consumer has two strategies available: *Consume Green* (CG) and *Consume Non-Green* (CNG). Since we assume that product “greenness” is a vertical attribute, the highest utility will be associated with the consumer that decided to purchase green and has indeed a green product available. Moreover, choosing to consume green implies a willingness to pay for a green premium. The firm also has two strategies available: *Produce Green* (PG) and *Produce Non-Green* (PNG). We assume that the firm is not green or does not have a green product available and so in order to produce green it will have to invest in technological innovation (for instance R&D). Table 1 presents the payoff matrix of the model with firm discriminatory policy, where a is the base utility, x 's (z 's) represent utility (revenue) losses due to mismatches between supply and demand or due to acquiring a good with inferior quality, b is the base payoff from selling the product, y is the opportunity cost of investing in technological innovation, and s_p and e are components of the discriminatory policy applied to the firm.

Table 1. Representation of the strategic form game with payoffs of the model considering firm discriminatory policy.

		Firm	
		PG	PNG
Consumer	CG	$a, b + s_p$	$a - x_3, b + y - z_2 - e$
	CNG	$a - x_1, b - z_1 + s_p$	$a - x_2, b + y - e$

Results

Without government intervention, society cannot transition to a green path if the opportunity cost for the firm of investing in low-carbon innovation is higher than the revenue lost when selling a non-green product to a green consumer: under these circumstances, there is only one Nash equilibrium which is *Consume Non-Green* and *Produce Non-Green*. Only when the opportunity cost is lower than the revenue lost when selling a non-green product to a green consumer the society might be able to move towards a green path (and even there it is not guaranteed, given that the non-green outcome is still a Nash equilibrium). It is worth notice that under no regulation the total welfare associated with *Consume Non-Green* and *Produce Non-Green* is higher than total welfare associated with *Consume Green* and *Produce Non-Green*. This means that even though low-carbon technological innovation provides multiple positive externalities, as long as firms have a non-green behavior it is preferable from a private point of view that consumers also have a non-green attitude. This puts in evidence the inconsistency between private and social objectives in the presence of externalities. This difference between costs and benefits originates market failures and highlights the need for government incentives and/or environmental and market regulations.

When introducing firm discriminatory policy in the model, for sufficiently large subsidy values that cover the opportunity cost of innovating, the revenue lost, and any punishment associated with not producing green, if the players play pure strategies the result of the game will be with certainty for the firm to produce green and for the consumer to have a green attitude. Moreover, the presence of discriminatory policy makes the required probability associated with consumers' green attitude lower when comparing with the no regulation situation. As for directed government regulation aimed at the consumer, we show that applying a subsidy to the consumption of green goods does not affect the interactions and decisions in the game. Accordingly, policy intervention should depart from this type of regulation and concentrate on firm discriminatory policy.

Regarding the possibility of acquiring a green startup as means to obtain the attractive green innovation, a green outcome via acquisition is only obtainable if the acquisition cost is lower than the revenue lost due to the mismatch between demand and supply.

Noticeable, when the decisions are taken simultaneously between consumers and firms, consumers never have a dominant strategy. Their decisions always depend on what they expect firms will do. However, once they are given the opportunity to decide first, if they choose to *Consume Green* they can drive the society to a green subgame perfect Nash equilibrium. But if firms decide first the subgame perfect Nash equilibrium is a non-green pathway.

Conclusions

We conclude that without government intervention there may be a tendency for non-green outcomes to prevail in society. An outcome in which both firms and consumers prefer to have a green attitude is obtainable but, either there is intervention that guarantees that the costs associated with the low-carbon innovation are very low and that the utility lost by the consumers when purchasing non-green goods is very high, or consumers must adopt a clear green attitude, taking a leadership position and dictating the rules of the market. Thus, the main implication of this paper is the role that the consumers can have on the decarbonization of economies and the impact that customer pressures can have on the markets. Consumers should not be on the backstage of this transition when they are needed in the main stage to drive firms towards green innovation. Accordingly, policy measures should not neglect the need to empower, educate and engage the consumers towards a low-carbon and environmental-friendly lifestyle. From the side of the firms, green marketing arises as an effective tool to convert consumers' awareness into actual purchasing behavior, since consumers green attitude is directly related with their knowledge of green products.

References

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