The role of social value in the investment decision in cleaner technology

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Abstract

This paper studies the effect of social value on the investment decision in cleaner technology. Using a theoretical framework where we distinguish conformist and anti-conformist behaviours, we study the impact of consumer investment decision on environmental quality. This paper provides two major contributions. First, this model of social value is useful for understanding environmental decisions of investment. Indeed, we show that the weight of social value for consumer signaling his preferences for environment influences the decision to invest. Second, results stress the importance for an economy to understand the consumption profile of individuals. In a conformist society, information campaigns which stress the importance of environmental attributes would be successful. Moreover, neighborhood effects can be observed. In cities where solar panels are wide-spread, consumers are more willing to invest in cleaner technology in order to avoid disutility due to social distance.

JEL classification: D11, Q4, Q5

Keywords: cleaner technology, social value, social distance, environmental quality.

1 Introduction

Since Kyoto protocol in 1997, concerns about the global warming and the climate change caused by human-induced greenhouse gas emissions are dominant for governments. Climate change has important negative consequences such as health effect of air pollution. One solution to limit these negative outcomes can be increasing the share of green technology[1]. Renewable energies represent one-fifth of electricity generation worldwide and buildings represent 32% of total final energy consumption (IEA, 2010). Stern (1998) shows that residential sector offers considerable potential to reduce energy uses and GHG emissions, particularly with energy-saving investment. At the same time, there are an

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[1]Eurostat (2009) defines a green technology as the acquisition of technologies, goods, and services whose main purpose is to limit the degradation and depletion of natural resources.

increasing number of consumers claiming that they have an environmental consciousness, i.e. they are more concerned about environmental damage caused by their consumption (Eurostat, 2009). The recent theoretical literature in environmental economics considers environmental friendliness as a vertical attribute of a product and shows that environmentally conscious (green) consumers pay a price premium for an environment-friendly product (see Cremer and Thisse (1999), Arora and Gangopadhyay (2003), Bansal and Gangopadhyay (2003), Mahenc (2008)).

According to a recent European survey, "Slightly more than 8 in 10 EU citizens answered that a product's impact on the environment is an important element when deciding to purchase. A product's environmental impact is perceived as being more important in purchasing decisions by respondents who are generally more aware of the impact on the environment of products they buy or use. Environmental impact and energy efficiency as deciding factors when consumers decide buying products" (Eurobarometer 2009). Thus, a particular attention is paid by environmental consciousness consumer to green technology. Theoretical papers explain the decision to invest in a green technology but neglect social influences**.** Baker (1974) was the first to study social interactions in the economic analysis. He shows that social interactions have an impact on the decision and the behaviour of consumers. Akerlof (1997) explains why rational choice analysis of social decision must take into account the externalities involved in social decision-making. According to Lubell (2002, p. 437) « citizens with strong environmental values are more likely to receive psychological benefits from expressing their preferences through environmental activism or enjoy the social benefits of participating with like-minded citizens ». Olli et al. (2001) explore the effect of the social context on environmentalism in Norway and show that ecological attitudes explained about 25 per cent of active environmental behaviours. They show that consumers' willingness-to-pay is motivated by both private (energy cost savings) and public (environmental) benefits. The role of social interactions is essential to better understand economic behaviour.

In this paper, we focus on the consumer's decision to adopt an environmentally cleaner technology according to his environmental consciousness and according to a social value derives from other individuals respect. More precisely, we introduce a social value to signal environmental concerns due to the implementation of photovoltaic plants or solar panels, for instance. We show that the weight of social value for consumer signaling his preferences for environment influences the decision to invest.

Other motivations can explain the decision to invest in energy efficient technology. Authors stress the importance of socio-demographic characteristics, building characteristics and they find that adoption of green technology is often associated with costs for investments and energy use. Studies show that age influences heating costs. Elderly people are less likely to adopt green technology than younger ones (Mahapatra and Gustavsson, 2008), because of their uncertainty about whether the investment will be paid off during their house occupancy and their relative lack of awareness of energy-efficiency measures (Linden et al., 2006). Education also influences households' decisions to renovate. Households who are more educated are more likely to invest in green technology (Nair et al., 2010). However, authors do not take into account consumers' environmental valuation as a driver of investment. If green technology adoption is usually associated with reduced GHG emissions, it also benefits others without compensating the energy savers. Consequently, the decision to adopt a cleaner technology is related to the environmental valuation and also affect other individuals.

Recently, authors link social interactions and environmental considerations. Axsen et al. (2013) study the role of social influences in formation of consumer preferences and perception for pro-environmental technologies in the transport sector. They show that

neglect social influence processes can lead to underestimation of the potential for shift in consumer preferences regarding green technology. Preferences, attitudes and values are key determinants to understand the consumer beheviour to environmental technologies (Axsen et al., 2012). Empirically, Mills and Schleich (2012) analyze the role of social value in consumer preference design in 10 EU countries and Norway. They underline a lack of theoretical papers taking into account consumer environment consciousness.

In our paper environmentally aware consumers can signal or not their preferences for environmentally products to others consumers. Signaling their preferences for the environment involved a social benefit from the interactions with other individuals. The model considers energy demand and consumer has the choice between two alternatives: to invest in green technology by installing photovoltaic plant or to purchase energy directly on the market. If consumer adopts the cleaner technology, on the one hand it receives a private benefit from the consumption of energy and a social benefit from the improvement of environment. By installing a photovoltaic plan, consumer signals his environmental consciousness, and this signal involves social interactions with other individuals which affect his social utility. If consumer buys energy directly on the market, it can buy conventional energy or green energy according his preferences for environment. The green energy consumption entails also a social benefit from the improvement of environment but there is no exogenous signal. Green consumers may gain utility from knowing that their ecological footprint is small. Within green communities there may be greater access to environmental friendly technologies (Kahn, 2007).

This decision-making process can be close to innovation adoption literature. Kim and Park (2011) show that social influence is important in the context of prompting behaviour. Diffusion is "the process by which an innovation is communicated through certain channels over time among the members of social systems" (Rogers, 1995). Researchers also suggest that a social system beyond the individual's and the innovation's idiosyncratic characteristics influences adoption decisions (e.g., Cooper & Zmud, 1990). A common explanation is that potential adopters feel uncertain about an innovation's expected consequences. Individuals are generally uncomfortable with uncertainty, and will, therefore, tend to interact with people in their social network to consult them on their adoption decisions (Katz & Tushman, 1979). In a such context, two consumers different beheviours can emerge. In the one hand, consumers can be "leader" on a market and decides to adopt a new innovative product to distinguish themselves. In the other part, consumers can be "followers" on a market when they are affected by uncertainty for exemple. Therefore, they wait for other individuals invest in a high tech product before buying it. In our model, these two types of behaviours can have some different consequences on social value and environment quality.

In the case where consumer signals his environmental consciousness by adopting a cleaner technology, two cases are studied. If a consumer is viewed as a "leader", he expects received a positive social value to be distinct from others. However, if a consumer is considered as a "follower", he benefits from being closed from others.

If a large part of the population behaves as leader, when the number of consumers investing in cleaner technology increases, this leads to a decrease in the social value. This case corresponds to the anti-conformist situation. In the same way, if a large part of the population behaves rather as follower, when the number of consumers investing in cleaner technology increases, this lead to an increase in the social value because consumers want to mimic others. This case corresponds to the conformist situation. In these different cases, the effect on social value can be positive or negative on the investment's decision, therefore this would have some negative consequences on environment in a long term.

The following section presents the basic model and the main assumptions. The decision

of investment in green technology is presented in section 3. The section 4 computed the equilibrium outcomes. The section 5 studies the indifferent consumer between the diverse options of consumption. The final section contains the conclusion.

2 The model

The model focuses on energy demand to satisfy a fundamental need for lighting, heating or air conditioning needs, for example. The monopolist faces a demand composed of two types of consumers differentiated by their taste for the good and their preferences for environment. The parameter θ can be viewed as consumer-specific environmental consciousness index and is distributed uniformly on the interval $[0, 1]$. Note that a lower value of θ implies a more environmentally conscious consumer. A proportion λ_1 of consumers in the market place have a environmental consciousness and it called "green" consumers and a proportion λ_2 have no environmental consciousness therefore it is called "brown" consumers.

To satisfy its energy needs, a buyer has the choice between two alternatives : to invest in green technology by installing photovoltaic plant or to purchase energy directly on the market.

(i) If the consumer adopts the cleaner technology, on the one hand he receives a private benefit from the consumption of energy and a social benefit from the improvement of environment, and on the other hand he pays a price for each unit produced plus an investment cost. By installing a photovoltaic plant, consumer signals his environmental consciousness, and this signal involves social interactions with other individuals which affect his social utility.

(ii) If the consumer buys energy directly on the market, he can buy conventional energy or green energy according his type. The green energy consumption entails also a social benefit from the improvement of environment but there is no exogenous signal.

We introduce social interactions in the utility function of consumers. Here it will be assumed that the private and social benefit enter consumer's utility function in a separable way. Let $\upsilon_i(q, \theta)$ the private benefit from the consumption and $\varphi_i(x, e, \theta)$ the social benefit to improve the environmental quality from a consumer i relative to other consumers. Therefore the consumer utility is given by:

$$U(q_i, e, \theta_i) = \upsilon_i(q_i, \theta_i) + \varphi_i(x, e, \theta_i) - d(e)$$

where q is the level of energy achieved, e is the environmental quality and d is environmental damage (with $d > 0$ and $d_e < 0$). The environmental quality is an index, i.e, $0 < e < 1$. Environmental damage is an event that diminishing the welfare of the affected individuals and it can be specified as $d(e) = -e + \frac{1}{2}e^2$**.** Damage function $d(e)$ is the disutility caused by the aggregate level of pollution, which the consumer takes as given function. We assume that the damage function is decreasing with environmental quality and convex such that $d'(e) < 0$ and $d''(e) \geq 0$, implying damages are decreasing at a constant or decreasing rate in e. We can also specify the private utility function as: $\upsilon_i(q, \theta) = q_i(\theta_i - \frac{q_i}{2})$.

Following Akerlof (1997), we consider social interactions as a social distance. We will distinguish two cases. In a first time, we develop a setting where the consumer becomes as a "leader" insofar he has an innovative beheviour. In this case, he earns utility to distinguish itself from other people. There is a model of "anti-conformism" beheviour in

the sense that in France few people have installed a cleaner technology in their house, so when an individual decides to invest in a green technology he benefits to a social utility. In a second time, we develop a setting where the consumer is a "follower" insofar he has not an innovative (or a conformism) beheviour and benefit from being closed from other consumers. In this case, he losses utility when he moves away from other individuals. Thus, the social distance can be the esteem accorded to an individual and determined by public perceptions. The consumer wants to minimize the social distance between herself and others. The social value can be specified as :

$$\varphi_i(x, e, \theta_i) = e(\frac{e}{2} - \theta_i) + s\ e\ \ (x - \bar{x})^2 \tag{1}$$

where x is the location choice of consumer i whereas $\bar{x}$ is the location choice of everyone else. In the case where everyone is alike : $x = \bar{x} = 1$, therefore the social distance is equal to zero.

When consumer signals his environmental consciousness from other consumers $s = -1/1$ and when he doesn't signal $s = 0$. In the anti-conformist ("leader") behaviour, the consumer earns utility to signal his environmental consciousness and s is equal to 1. In the conformist ("follower") behaviour, the consumer is not innovative, he losses utility when he moves away from other individuals and $s = -1$.

Moreover, the environmental consciousness consumers receive psychological benefits $e(\frac{e}{2} - \theta_i)$ from expressing his preferences through environmental activism and by improving the environmental quality.

To take into account the tariff paid, the net utility can be rewritten as:

$$u(q, e, \theta) = U(q, e, \theta) - t\ q_i - I^2 + m \tag{2}$$

where t is the energy price, I is the investment and m is the numéraire good. Note that if consumer decides to not invest in the green technology $I = 0$, therefore it buys energy on the market at a tariff t.

The tariff t paid by the consumer can be rewritten as:

$$t = -\alpha\, I^2 + \gamma\, a \tag{3}$$

where $\alpha \in [0, 1]$ is a positive parameter to measure the energy efficiency of investment in green technology. A high value of α implies a technology more efficient, consumer could resale for example energy on the energy market. The parameter a represents the price of energy without any investment and $\gamma \in [0, 1]$ is an index which represents the cleanness of energy. Without investment in green technology, the price of energy can be low if the consumer buy conventional energy (when γ is weak) or high if the energy purchased is green (when γ is strong).

3 The investment decision

3.1 The green consumer decision

•Investment in green technology.

When a green consumer decides to invest in green technology, installing a photovoltaic plan for instance, he signals his type, he receives value of improving environment and

he pays the investment cost plus a price for each unit of energy consumed. He also faces to an environmental damage. In the model, we consider a proportion β of green consumers signaling their environmental consciousness with photovoltaic plant. Therefore, its maximization problem is given by:

$$\begin{aligned} &\max_{q,e} \beta\lambda_1(\upsilon_i(q,\theta) + \varphi_i(x,e,\theta) - d(e) - t\ q_i - I^2 + m) \\ &s/c \qquad u_i(q,e,\theta) > 0 \end{aligned} \tag{4}$$

•Not investment in green technology.

When consumer prefers to buy energy from the market, he has the choice between conventional electricity or green electricity, therefore we consider $I(e) = 0$. If consumer purchases green energy from the market, he doesn't signal his environmental consciousness ($s = 0$) but he receives social benefit to improve the environment quality. He pays a high price for each unit of energy consumed and faces to environmental damage. In the model, we consider a proportion $(1 - \beta)$ of green consumers who buy green energy directly from the market. In this case, the maximization problem is the following:

$$\begin{aligned} &\max_{q,e} (1-\beta)\lambda_1(\upsilon_i(q,\theta) + \varphi_i(x,e,\theta) - d(e) - t\ q_i + m) \\ &s/c \qquad u_i(q,e,\theta) > 0 \end{aligned} \tag{5}$$

3.2 The brown consumer decision

Finally, consumer can decide to purchase conventional energy on the market. This type of consumer is called as brown consumer and he doesn't benefit to a social value. He pays a low price for each unit of energy purchased but faces also to environmental damage. Therefore, its maximization problem is given by:

$$\begin{aligned} &\max_{q,e} \lambda_2(\upsilon_i(q,\theta) - d(e) - t\ q_i + m) \\ &s/c \qquad u_i(q,e,\theta) > 0 \end{aligned} \tag{6}$$

4 Equilibrium and environmental quality

To solve the model, we derivate the aggregate utility i.e the sum of utility for each type of consumers (greens who signal, greens who not signal and brown consumers). In the conformist and anti-conformist situations, the equilibrium quantity for each type of consumers is given by:

$$q^* = -t + \theta \tag{7}$$

The quantity of energy consumed depends on the level of consumers' environmental consciousness: higher environmental consciousness, lower quantity of energy consumed.

In the case where green consumers install solar panels, the tariff is equal to $t = -\alpha I^2 + \gamma a$. This result show that higher the level of investment, lower the energy cost and this leads to increase the energy consumption. Indeed, even if the energy is green, the consumer who invest consumes more energy to increase its level of welfare. Even if the investment is beneficial for environmental quality, there is a rebound effect. The rebound effect refers to the behevioural reactions due to the introduction of new technologies which increase the efficiency of heating system. These reactions tend to offset the benefits (in monetary and energy consumption terms) of the new technology. Economic theory also suggests that a decrease in demand and subsequent decrease in cost of using energy could cause a rebound in demand. This rebound effect can consist of direct, indirect and macroeconomic effects. In the first case, the household can choose to use more of the resource instead of realizing the energy cost savings. In the second case, the household can choose to spend the money saved by buying other goods which use the same resource (electricity for appliances for instance). In the third case, a decrease in demand for a resource leads to a lower resource price, making new uses economically viable (Khazzoom, 1980).

In the case where the green consciousness consumers who not signal their type, the tariff is $t = \gamma a$. This result is similar for brown consumers. However, note that $\gamma \in [0, 1]$ is an index which represents the cleanness of energy. Without investment in green technology, the price of energy can be low if the consumer buys conventional energy (when γ is weak) or high if the energy purchased is green (when γ is strong). In all configurations, the quantity consumed also depends on parameter θ that can be viewed as consumer-specific environmental consciousness index. A lower value of θ implies a more environmentally consciousness consumer and a lower quantity of energy consumed. We can infer that to inform consumers about their energy use and to give advice on how, can fall the global energy consumption and make consumers awareness of the environmental cause. European Commission (2013) compares different campaign strategies. They conclude that energy audits and consultation, when individuals are informed about their own energy use and given advice on how to lower their consumption, were the most effective. Under this strategy, consumers reduced their energy use by 13.5% on average. Moreover, results show that the best second approach was providing individuals with comparisons with their peers' energy use; this reduced consumption by 11.5% (Delmas, M. A., Fischlein, M. and Asensio, O. I., 2013).

Concerning the level of environmental quality we distinguish two cases : the anti-conformist and the conformist situations.

- **The anti-conformist case**

$$e^* = \frac{(1 + \beta |x - \bar{x}|^2 - \theta)\lambda_1 + \lambda_2}{\lambda_2} \tag{8}$$

The environmental quality of the economy depends negatively on the consumer-specific environmental consciousness index. Higher the index (i.e brown consumer), lower the environmental quality. This result is quite intuitive. Higher the share of environmental consumers, better the quality of environment because green consumers earn utility from improving environmental quality.

Finally, another interesting result is about the signal. An increase in the social distance enhances the level of environmental quality. In this situation, anti-conformist people earn

utility in amount $(x - \bar{x})^2$, distinguishing itself from other people. This social distance can be viewed as the esteem accorded to an individual and determined by public perceptions. If the social value due to the investment in a green technology increases, this leads to an improvement of environment. This result is interesting in terms of public policies. Emphasize the social value, self-esteem and uniqueness of investment by information campaign is a way to improve environment. In terms of public policies, information campaigns seem relevant to diminish energy consumed and to improve environmental quality.

- **The conformist case**

Therefore, the net utility is the same than the equation 2 and the consumers decisions are similar than previously (equations 6, 5 and 4). However, results differ concerning the level of environmental quality and it is given by:

$$e^* = \frac{(1 - \beta \left|x - \bar{x}\right|^2 - \theta)\lambda_1 + \lambda_2}{\lambda_2} \tag{9}$$

The environmental quality of the economy still depends on the consumer-specific environmental consciousness index (θ), the social distance ($x - \bar{x}^2$) and the share of respectively green and brown consumers, as well as, the share of green consumers who signal their preferences by investing in solar panel. Results are unambiguous for social distance, consumer-specific environmental consciousness index and share of green consumers who signal (β). As in the previous case, higher the index (i.e brown consumer), lower the environmental quality. However, in this case, higher the share of environmental consumers who signals and higher the social distance, lower the level of environmental quality. Conformist people who losses utility in amount $(x - \bar{x})^2$ distinguishing itself from others do not invest in solar panel and prevent the improvement of environment quality.

Concerning the effect of the share of respectively green and brown consumers (respectively λ_1 and λ_2) on environmental quality, results depends on the sign of $1-\beta \left|x - \bar{x}\right|^2-\theta$, or, the magnitude of each parameters accordingly to others. Results are summarized in Tables 1 and 2.

Table 1: Effect of λ_1 on environmental quality index e^*

$\left\|x - \bar{x}\right\|^2$	β	θ	Value of $1 - \beta \left\|x - \bar{x}\right\|^2 - \theta$	Effect λ_1 on $e*$
Small value	$\forall$	Small value	Positive	+
Small value	$\forall$	High value	Positive	+
High value	$\forall$	Small value	Positive	+
High value	High value	High value	Negative	-
High value	Small value	High value	Positive	+

Table 2: Effect of λ_2 on environmental quality index e^*

$\left\|x - \bar{x}\right\|^2$	β	θ	Value of $1 - \beta \left\|x - \bar{x}\right\|^2 - \theta$	Effect λ_2 on $e*$
Small value	$\forall$	Small value	Positive	-
Small value	$\forall$	High value	Positive	-
High value	$\forall$	Small value	Positive	-
High value	High value	High value	Negative	+
High value	Small value	High value	Positive	-

Concerning the effects of the share of green consumers (λ_1), in an economy where a consumer is conformist and quite close to the other consumers, higher the share of green consumers, higher the benefits of environmental quality level. In another case, when a conformist consumer is distant from other, in an economy with green consumer's preference, higher the value of λ_1, higher the level of environmental quality. Finally, when a conformist consumer is distant from other in an economy (he suffers from disutility due to social distance), the effect of the signal is very important. In this economy, if there is either brown consciousness consumers, the share of persons who signals will have a crucial impact on environment. In the case where the share of green consumers who signals is high, higher the value of λ_1, lower the level of environmental index quality. There is an opposite effect in the case where the share of not signaling consumers is high.

Now, lets us to turn to the effects of the share of brown consumers (λ_2) on the environmental quality. In an economy where a consumer is conformist and quite distant to the other consumers, if the share of brown consumers rises, the level of environmental quality diminishes. Moreover, when a conformist consumer is distant from others and has more preferences for the green energy, higher the value of λ_2, lower the quantity of environmental quality. Finally, when a conformist consumer is distant from others in an economy, the effect of the signal remains very important than previously. If, in this economy, there is a more brown consciousness consumers' type, the share of persons who signals will have a crucial impact on environment. In the case where the share of green consumers who signals is high, higher the value of λ_2, higher the level of environmental quality. There is an opposite effect in the case where the share of not signaling consumers is high.

In conclusion, the signal effect is important in economies where conformist people are distant from others. Most particularly, depending on the consumer-specific environmental consciousness index θ, the increase in a specific share of consumer (i.e λ_1 or λ_2) can have an ambiguous effect on environment. Conformist people, distant from others, with a brown consciousness index, in an economy where the share of green consumers rises but also with a high share of signaling people, has a negative impact on the environmental quality. On the contrary, conformist people, distant from others, with a brown consciousness index, in an economy where the share of brown consumers rises but also with a high share of signaling people has a positive impact on the environmental quality.

5 The indifferent consumer

Using equations 7 and 8, we compute values at equilibrium for indifferent consumers according to the different options of consumption. Results are available in appendix 9.

To present the different results, we calibrate the data and conduct some sensitivity analysis. To not influence the results, we divide population into two equal parts between green and brown consumers. For the green consumers, we have assumed that the half signals his preferences for environment by investing in solar panel, and the other half of green consumers buys directly green energy on the market (they not signal their preferences for environment). We have compared the saving of energy before, and after, installing a solar panel to ensure that the values of investment and energy efficiency of the investment are correct. So we have: $\lambda_1 = \lambda_2 = 0.5$; $\beta = 0.5$; $x = 0.01$; $\bar{x} = 1$; $Y = 1.5$; $\alpha = 0.01$; $a = 0.01$; $\gamma = 0.9$.

- **The anti-conformist case:**

Parameters	Green consumers who signal and green consumers who not signal	Green consumers who signals and brown consumers	Green consumers who not signals and brown consumers
β	+	+	+
λ_1	+	+	+
λ_2	-	-	-
x	-	-	-
Y	-	-	
α	+	+	
γ	-	-	
a	-		

The environmental consciousness index parameter θ is an increasing function of β, λ_1 and α. Higher the share of green consumers (and green consumers who signal), higher the consciousness index i.e. that consumers are less concerned by environmental quality then they are anti-conformist or innovative. An opposite results is obtained with all other parameters. If the share of brown consumers rise, anti-conformist people are more concerned about the environment. Moreover, higher the tariff to investment sensitivity, lower the environmental consciousness. Thus, if investment becomes more profitable, a large share of people will invest. In terms of public policy, in an economy where anti-conformist people are dominant, it is important to stress the importance of self-esteem by investing in energy saving investments. This behaviour is a means to distinguish to others. Focus must be done on environmental damages and bad behaviour of individuals about environment.

- **The conformist case**

Parameters	Green consumers who signal and green consumers who not signal	Green consumers who signals and brown consumers	Green consumers who not signals and brown consumers
β	-	-	-
λ_1	-	-	-
λ_2	+	+	+
x	+	+	+
Y	+	+	
α	-	-	
γ	+	+	
a	+		

Results are the opposite of the anti-conformist case. The environmental consciousness index parameter θ is a decreasing function of β, λ_1 and α. Higher the share of green consumers (and green consumers who signal), lower the consciousness index i.e. that consumers are more concerned by environmental quality then they are conformist or not-innovative. An opposite result is obtained with all other parameters. If the share of brown consumers rises, conformist people are care less about the environment. Moreover, higher the tariff to investment sensitivity, higher the environmental consciousness. Thus, if investments become more profitable, a large share of people will invest and in the conformist situation more people will follow them. In terms of public policy, results stress the importance for an economy to understand the consumption profile of individuals. In a conformist society, information campaigns who show the importance of environmental attributes would be successful. Moreover, neighborhood effects can be observed. In cities with a lot of solar panels, consumers are more willing to invest also in solar panels in order to avoid disutility due to social distance. This is an element which can explain why today some neighborhoods are more endowed with energy saving systems such as solar panels.

6 Conclusion

This paper allows to better understand the decision to invest in a green technology regarding social influences. More precisely, we focus on the consumer's decision to adopt an environmentally cleaner technology according to his environmental consciousness and according to a social value derives from other individuals respect. We introduce a social value to signal environmental concerns due to the implementation of photovoltaic plants or solar panels, for instance.

At the equilibrium, the quantity of energy consumed depends on the level of consumers' environmental consciousness: higher environmental consciousness, lower quantity of energy consumed. We show that even if the energy is green, the consumer who invest consumes more energy to increase its level of welfare. Even if the investment is beneficial for environmental quality, there is a rebound effect. The rebound effect refers to the behevioural reactions due to the introduction of new technologies which increase the efficiency of heating system. These reactions tend to offset the benefits (in monetary and energy consumption terms) of the new technology.

We distinguish two different situations according to the consumers' behaviour. On the one hand, consumers can be "leader" on a market and decides to adopt a new innovative product to distinguish themselves: it is the anti-conformist case. On the other hand, consumers can be "followers" on a market when they are affected by uncertainty for example: it is the conformist case.

In the anti-conformist case, the environmental quality of the economy depends negatively on the consumer-specific environmental consciousness index. Higher the index (i.e brown consumer), lower the environmental quality. This result is quite intuitive. Higher the share of environmental consumers, better the quality of environment because green consumers earn utility from improving environmental quality. The paper highlights an interesting result is about the signal. An increase in the social distance enhances the level of environmental quality. In this situation, anti-conformist people earn utility distinguishing itself from other people. This social distance can be viewed as the esteem accorded to an individual and determined by public perceptions. If the social value due to the investment in a green technology increases, this leads to an improvement of environment. This result is interesting in terms of public policies. Emphasize the social value,

self-esteem and uniqueness of investment by information campaign is a way to improve environment. In terms of public policies, information campaigns seem relevant to diminish energy consumed and to improve environmental quality.

In the conformist case, results are unambiguous for social distance, consumer-specific environmental consciousness index and share of green consumers who signal. Higher the index (i.e brown consumer), lower the environmental quality. However, in this case, higher the share of environmental consumers who signals and higher the social distance, lower the level of environmental quality. Conformist people who losses utility distinguishing itself from others do not invest in solar panel and prevent the improvement of environment quality. The signal effect is important in economies where conformist people are distant from others. Most particularly, depending on the consumer-specific environmental consciousness index θ, the increase in a specific share of consumer can have an ambiguous effect on environment. Conformist people, distant from others, with a brown consciousness index, in an economy where the share of green consumers rises but also with a high share of signaling people, has a negative impact on the environmental quality. On the contrary, conformist people, distant from others, with a brown consciousness index, in an economy where the share of brown consumers rises but also with a high share of signaling people has a positive impact on the environmental quality.

Finally, concerning the indifferent consumer we distinguish also the two different situation. In the anti-conformist situation, if investment becomes more profitable, a large share of people will invest. In terms of public policy, in an economy where anti-conformist people are dominant, it is important to stress the importance of self-esteem by investing in energy saving investments. This behaviour is a means to distinguish to others. Focus must be done on environmental damages and bad behaviour of individuals about environment.

Results are the opposite of the anti-conformist case. Thus, if investments become more profitable, a large share of people will invest and in the conformist situation more people will follow them. In terms of public policy, results stress the importance for an economy to understand the consumption profile of individuals. In a conformist society, information campaigns who show the importance of environmental attributes would be successful. Moreover, neighborhood effects can be observed. In cities with a lot of solar panels, consumers are more willing to invest also in solar panels in order to avoid disutility due to social distance. This is an element which can explain why today some neighborhoods are more endowed with energy saving systems such as solar panels.

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8 Appendix

9 The indifferent consumer in the innovative case

Using equation 7 and 8 , we compute values at equilibriums for indifferent consumers making the difference. between the net value functions according to the each type of consumers.

•Indifferent consumer between green energy and brown energy on the market:

$$\theta = \frac{(1+\beta\left|x-\bar{x}\right|^2)\lambda_1+\lambda_2}{\lambda_2} \qquad \text{or} \qquad \theta = \frac{(1+\beta\left|x-\bar{x}\right|^2)\lambda_1+\lambda_2}{\lambda_1+2\lambda_2}$$

Consumer-specific environmental consciousness index depends on the signal according to the social distance, the share of brown and green consumers in the economy. Thus, the environmental consciousness index is positively directly linked to the social distance. Higher the social distance, higher the index of green consumers in the markets. This result show again the importance of information and uniqueness of investment. Consumers, with a higher social value or higher self-esteem, are more likely to be environmental friendly.

•Indifferent consumer between green consciousness who signals and green consumer who not signals:

$$\theta = \frac{\phi + \left(2\left(\beta\left|x-\bar{x}\right|^2-1\right)\lambda_1\left(1+\left|x-\bar{x}\right|^2\beta\right)\right.}{2\left|x-\bar{x}\right|^2\lambda_1 - 2Y^2\alpha\lambda_2}$$

$$\phi = (1+\beta\left|x-\bar{x}\right|^2)\lambda_1 + 2(\left|x-\bar{x}\right|^2 + Y^2(\alpha^2Y^2-2-2a\alpha Y))\lambda_2$$

•Indifferent consumer between green consumer who signals and brown consumer:

$$\theta = \psi + \sqrt{\psi^2 - (\lambda_1(\lambda_1+2\lambda_2)((1+\beta\left|x-\bar{x}\right|^2)^2{\lambda_1}^2 + (1+2\left|x-\bar{x}\right|^2)1 + (1+\beta\left|x-\bar{x}\right|^2)\lambda_1\lambda_2 + \lambda_2(\phi+\lambda_2}$$

$$\psi = (1+\left|x-\bar{x}\right|^2\beta{\lambda_1}^2 + (2+\left|x-\bar{x}\right|^2(1+\beta))\lambda_1\lambda_2 + (1-Y^2\alpha)\lambda^2{}_2$$